CORONAVIRUS DISEASE (COVID-19): PSYCHOLOGICAL AND BEHAVIORAL CONSEQUENCES OF CONFINEMENT ON PHYSICAL ACTIVITY, SEDENTARISM, AND REHABILITATION

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CORONAVIRUS DISEASE (COVID-19): PSYCHOLOGICAL AND BEHAVIORAL CONSEQUENCES OF CONFINEMENT ON PHYSICAL ACTIVITY, SEDENTARISM, AND REHABILITATION

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Editorial: Coronavirus Disease (COVID-19): Psychological and Behavioral Consequences of Confinement on Physical Activity, Sedentarism, and Rehabilitation

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Keywords: Coronavirus, pandemic (COVID-19), lockdown, psychological distress, physical activity

Editorial on the Research Topic

Coronavirus Disease (COVID-19): Psychological and Behavioral Consequences of Confinement on Physical Activity, Sedentarism, and Rehabilitation

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INTRODUCTION

COVID-19 is an unprecedented global crisis and has changed the world. Lockdown, confinement, and other sanitary actions were developed to mitigate this coronavirus spread. Under such unusual conditions, barriers to keep an active lifestyle were hard to overcome. Fifty-nine articles written by authors from Africa, America, Asia, Europe, and Oceania provide a rich discussion about the topic "Coronavirus Disease (COVID-19): Psychological and Behavioral Consequences of Confinement on Physical Activity, Sedentarism, and Rehabilitation." This collection is dedicated to understanding the adaptive psychological and behavioral responses to COVID-19, with the focus on the consequences of exercise and physical activity programs for different populations, across the lifespan. The COVID-19 context is explored to discuss lockdown and confinement, physical and social distances, fear of diseases, and opportunities to use innovative technologies in health.

CONTRIBUTIONS

Physically active persons [athletes (Abenza-Cano et al.; Anyan et al.; Bazett-Jones et al.; Freire et al.; Fuentes-García et al.; González-Hernández et al.; Li et al.; Lautenbach et al.; Mehrsafar et al.; Rubio et al.; Szczypińska et al.) and active adults (Guicciardi and Pazzona)] were surveyed to ascertain how the pandemic has affected their behavioral, psychological, and training patterns. Training activities were changed, the coach-athlete relation was evaluated, and coping-pandemic issues to deal with stress were discussed. These studies present how athletes in different sports have adapted their activities during confinement due to COVID-19.

Parents had to deal with emotional and behavioral problems of their children induced by the confinement. Monteiro et al. evaluated how parents and children younger than 7 years old behaved under the stress of lockdown, while Ren et al. discussed parenting stress to deal with children with special needs during the pandemic.

Most of the original research studies analyzed the relations of physical activity and different dimensions of human behavior in adults. Therefore, physical activity behavior was compared with eating behavior (Constant et al.; Diniz et al.; Ingram et al.; Machado-Lima et al.), health risk habits (Diniz et al.), mental health (Diniz et al.), motivation to exercise (Leyton-Román et al.), psychological states (Ingram et al.; Hargreaves et al.; León-Zarceño et al.; Machado-Lima et al.; Meira et al.; Sang et al.; Terry et al.), sleep (Ingram et al.), self-efficiency to exercise (Teran-Escobar et al.), and wellbeing (Brand et al.; Jenkins et al.).

Different strategies to manage the issues during the pandemic were also presented. To promote active behaviors, Marchant et al. asked adults about the use of eHealth for exercise and physical activity, Carfora and Catellani assessed persuasive messages to promote physical activity at home, while Alsalhe et al. evaluated the association between physical activity and fear of COVID-19. Abu-Akel et al. compared the effect of who gives information about social distancing on individual behavior. Borrega-Mouquinho et al. compared the effects of high and moderate-intensity training on psychological factors in a randomized controlled trial. Reigal et al. applied a data mining approach to find behavioral patterns. Alsukah et al. investigated the awareness of COVID-19.

Across the lifespan, other original research articles studied the connections between physical activity and behavior. Physical activity levels were also affected in teenagers and young adults. Bösselmann et al. evaluated the relation among physical activity, boredom, and fear of COVID-19. Liébana-Presa et al. studied stress, emotional intelligence, and the intention to use cannabis during the confinement. Young adults were emotionally affected by the pandemic. Wang et al. showed anxiety in Chinese college students. Lippke et al. investigated physical activity, loneliness, and friendship in European university students. Slimani et al. studied the relation between physical activity and quality of life in young adults in Tunisia. In older adults, Carvalho et al. evaluated the effects of confinement in physical fitness and physical activity behavior, and Lage et al. analyzed the association between depressive symptoms and physical activity intensity during the lockdown. While Torriani-Passn et al. evaluated the barriers and facilitators for stroke survivors to engage in a remote physical exercise program, da Silva, da Silva, et al. studied the use of game platforms for home-based telerehabilitation in patients with cerebral palsy.

For the perspective and opinion articles, different proposals were discussed to face the health issues and sedentary behavior during the pandemic. Rüth and Kaspar have highlighted the benefits of exergaming at home, regarding its physical, and non-physical effects. Sá Filho et al. emphasized the importance of the recommendations of exercising and training at home during the pandemic. Aguirre-Loaiza et al. discussed the embodied cognition approach to explain the importance of physical activity during the pandemic. Filipas et al. discussed the differences for athletes from low- and high-income countries to be continuously engaged with their training routines during the pandemic.

The narrative reviews have gathered the impacts of physical activity in health during the pandemic. Ghram et al. discussed the importance of exercising to reduce the deleterious effects of the COVID-19 pandemic. Clemente-Suárez et al. reviewed the impact of physical inactivity and modifications in nutritional habits, at psychological and physiological levels during the pandemic. Scartoni et al. discussed the protective effect of physical exercise against COVID-19 infection in the elderly.

Methods studies have provided interesting new tools to understand the consequences of the COVID-19 pandemic on health and physical activity. da Silva, de Oliveira, et al. proposed a protocol to compare conventional intervention and non-immersive virtual reality rehabilitation in an COVID-19 inpatient hospital unit. Lete-Lasa et al. propose a tool to identify potential COVID-19 contagion situations in sports and physical education situations. Berasategi et al. proposed and validated a scale to measure wellbeing of children in lockdown.

SUMMARY

This collection shows that physical activity behavior and COVID-19 are related. Active life during the pandemic provided fewer negative psychological states in different populations. Lockdown and social distancing have created conditions to increase stress, which exercising was a positive action for its reduction or prevention.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.816368/full#supplementary-material

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ORIGINAL RESEARCH
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The Relationship Between Physical Activity and Quality of Life During the Confinement Induced by COVID-19 Outbreak: A Pilot Study in Tunisia

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The present study aimed to determine the relationship between physical activity (PA) and quality of life (QoL) during the confinement caused by the COVID-19 outbreak. A total of 216 participants (men: $n = 112$, women: $n = 114$) were included in the present study. They were divided into three groups [i.e., inactive group (IG): less than 600 metabolic equivalent of tasks (METs), $n = 131$; minimally active group (MAG): from 600 to 2,999 METs, $n = 49$; and health-enhancing PA group (HEPAG): 3,000 + METs, $n = 36$] based on their habitual PA level in the period of confinement. WHO Quality of Life Instrument-Short Form (WHOQOL-BREF) and International Physical Activity Questionnaire-BREF (IPAQ-BREF) questionnaires were used to assess QoL and PA intensities. The main findings of the present study showed that MAG and HEPAG have better total PA, physical, psychological, social, and environmental QoL domains scores than IG (all, $p < 0.01$). Small to large correlations (r ranging from 0.14 to 0.72) were also observed between total PA, total walking activity, total moderate-intensity PA, total vigorous-intensity PA, and QoL domains (all, $p < 0.01$). PA with light-, moderate-, and vigorous-intensities can be well recommended to decrease the negative psychosocial effect of confinement. However, longitudinal studies are needed to draw causal inferences and underpin more robust and evidence-based and informed recommendations.

Keywords: coronavirus, COVID-19, prevention, psychosocial, confinement

INTRODUCTION

"Severe Acute Respiratory Syndrome coronavirus type 2 (SARS-CoV-2)," responsible for an infection termed the coronavirus disease (COVID-19), is a newly discovered pathogen in humans. It was first discovered on November 17, 2019 in the city of Wuhan, mainland China, and then spread throughout the world. On March 11, 2020, COVID-19 was declared a pandemic by the World Health Organization (WHO). As of 24 March 2020, the number of confirmed cases was 372,755 cases and 16,231 deaths, which increased to 2,160,207 cases and 146,088 deaths as of 18 April 2020 (WHO Situation reports; Zhu et al., 2020). In this context, the WHO recommended the adoption of various protective, behavioral, and non-pharmacological measures (such as avoiding physical contact, handshakes, hugs and kisses; banning social gatherings and major events; closing universities and schools; and implementing self-isolation, social/physical distancing, confinement, and quarantine) to curb the spread of the virus as well as preventive approaches [including practicing physical activity (PA), sleeping well, etc.] to keep oneself healthy during the ongoing outbreak.

Governments of all countries ordered their people to self-isolate (stay at home). However, long-term isolation or home-confinement may have negative effects on psychosocial and mental health, especially causing stress, negative emotions, and impaired cognition (Hawkley and Capitanio, 2015). If prolonged, they may suppress immune system and physiological functions (Kiecolt-Glaser et al., 2002), which may increase the risk of exposure to SARS-CoV-2 and the likelihood of contracting the infection. For instance, the WHO suggested that people stay physically active at home in order to optimize their health status, decrease the negative psychosocial consequences of confinement, and maintain their immune system function.

Many studies have reported positive effects of PA on psychosocial status, such as quality of life (QoL), outside of confinement (Anokye et al., 2012; Vagetti et al., 2014; Krzepota et al., 2018; Ho et al., 2019). However, no study has so far investigated the relationship between PA and QoL during a period of confinement, such as the quarantine caused by COVID-19. Therefore, we aimed to explore the relationship between PA and QoL in the general population of Tunisia during the first 4 weeks of the confinement implemented by the government to curtail the COVID-19 pandemic. This may help the community members to improve their QoL in the face of a future pandemic, such as the COVID-19 outbreak or potential secondary waves/relapses, should the virus not be completely eradicated and suppressed by means of pharmacological interventions (drugs and vaccines).

MATERIALS AND METHODS

Participants

A non-probabilistic sampling approach was utilized. Subjects were considered eligible to take part into the study if meeting the following inclusion criteria: (i) age in the range 18–30 years; (ii) not using alcohol, drugs, or other substances; and (iii) no co-morbidities and/or orthopedic limitations that could interfere with the perceived QoL or level of PA.

A link to the online questionnaires was sent *via* mail to 242 potential participants, of which 216 returned valid questionnaires (participation rate of 89.3%). Thus, 216 participants were included in the analysis. The link contained a brief explanation of the questionnaires and instructions on how to complete them. It was sent 4 weeks after the implementation of the quarantine by the Tunisian government. All measures were collected on the same day, to avoid any bias in the study, considering the constantly evolving situation of the pandemic.

Most participants in the current survey were men (n = 112, 51.9%), and the mean age at the time of the study was 27.9 years (SD = 8.1). Participants were divided into three groups [i.e., inactive group (IG): less than 600 metabolic equivalent of tasks (METs), n = 131; minimally active group (MAG): from 600 to 2,999 METs, n = 49; and health-enhancing PA group (HEPAG): 3,000 + METs, n = 36] based on their habitual PA level in the period of quarantine, as recommended by previous research (Lee et al., 2011).

We excluded participants who were not compliant to government guidelines at home during the COVID-19 epidemic. Participants completed the online PA and QoL questionnaires. They were thoroughly advised of the aims of the study. All participants signed a free and informed consent form. Local institutional ethical approval was provided for this study, which was conducted in accordance with the 1964 Declaration of Helsinki and its subsequent amendments.

Measures

Physical Activity

PA was assessed using the International Physical Activity Questionnaire-BREF (IPAQ-BREF; Lee et al., 2011). This questionnaire comprised of seven questions which assessed the frequency and duration of vigorous intensity, moderate intensity, and walking PA for at least 10 min during the past week. Participants were asked to respond to one of the frequency options: from 1 to 7 days. Duration options included the number of minutes exercised, never do, or do not know. Participants who had not undertaken any PA in the previous 7 days responded only to the question "During the last 7 days, how much time did you spend sitting on a week day?"

The IPAQ assessed total PA and total sedentary time, whereas the intensity of activity was converted to MET units ($MET^{\cdot h}\cdot week^{-1}$), as recommended by previous study (Ainsworth et al., 2000).

Quality of Life

QoL was measured using the self-administered WHO Quality of Life Instrument-Short Form (WHOQOL-BREF; Skevington et al., 2004). It comprised 26 items including domains and facets (or sub-domains). The first two items assessed the "overall rating of QoL (OQOL)" and subjective satisfaction with health. The other 24 items measured four domains, namely, physical health (seven items), psychological health (six items), social relations (three items), and environment (eight items). The participants marked a response using a 5-point Likert scale [ranging from 1 (very dissatisfied/very poor) to 5 (very satisfied/very good)]. The domain scores of the WHOQOL-Bref were computed according to the guideline of the WHO (WHO, 1998).

Statistical Analysis

Statistical analyses were performed by means of the commercial software "Statistical Package for the Social Sciences" (SPSS for Windows, version 20.0, SPSS Inc., Chicago, Illinois, USA). Descriptive statistics were calculated for all experimental data. Kolmogorov-Smirnov test was used to assess if data were normally distributed. Differences in PA level and QoL domains were determined by using Mann-Whitney U tests. To assess a difference between different categories of participants based on their PA level, Kruskal-Wallis tests were used. In the case of significant differences, *post hoc* comparisons with Bonferroni corrections were applied using the Mann-Whitney U test. Furthermore, bivariate correlations were computed by using Spearman's Rho to examine the relationship between PA level and QoL domains.

RESULTS

An overview of the participants' METs and QoL domain scores is shown in **Table 1**. Most of the time was spent with participants being sedentary, followed by light-, moderate-, and high-intensity activities, regardless of the group. In general, all dependent variables differed among the groups (Kruskal-Wallis test, $p < 0.001$; **Table 1**), except being sedentary. *Post hoc* analyses revealed that the differences between groups were significant in all comparisons and by the pattern, where the IG accumulated less light-, moderate-, and high-intensity activities when compared to HEPAG (**Table 1**). When compared to the MAG, the IG did not differ in total time spent at light activities only.

Regarding QoL, the IG reported lower scores compared to the MAG and HEPAG for all four domains, while the MAG and HEPAG did not differ ($p = 0.950$). The same pattern was observed for QoL total score, where the IG reported lower scores compared to the MAG and HEPAG, while the MAG and HEPAG did not differ ($p = 0.659$; **Table 1**).

Correlation analysis showed that total PA (MET) had a small to moderate relationship with QoL domains (**Table 2**). More in-detail, small to moderate correlations (r ranging from 0.14 to 0.42) between all PA intensities and QoL domains were observed (**Table 2**).

DISCUSSION

The present study aimed to determine the relationship between PA and QoL during the confinement caused by the COVID-19 outbreak. The main findings of the present study showed that MAG and HEPAG groups have better total PA, physical, psychological, social, and environmental domains scores than the IG. Small to large correlations were also observed between total PA, total walking activity, total moderate-intensity PA, total vigorous-intensity PA, and the QoL domains.

The relationship between active living and QoL is well studied in patients with different diseases and also in healthy participants (Ellingson and Conn, 2000; Brown et al., 2003; Anokye et al., 2012; Ha et al., 2014; Krzepota et al., 2018; Ho et al., 2019). However, the current study showed that total PA (MET) was correlated with all QoL domains during a period of government directed confinement and a limiting of personal freedom. Specifically, large correlations were observed between total PA and psychological and social QoL domains. Accordingly, some studies have also reported a positive correlation between PA and QoL domains (Mourady et al., 2017). For instance, some authors have reported positive correlations between total PA and physical and mental domains (Stewart et al., 2003; Wendel-Vos et al., 2004; Fox et al., 2007; Shibata et al., 2007), while others have shown positive correlations between PA and some QoL domains, namely general QoL; functional capacity; mental health; autonomy, past, present, and future activities; death and dying; intimacy; vitality; and psychological domain (Vagetti et al., 2014). Mourady et al. (2017) reported that total PA was significantly correlated with physical and psychological health, general QoL, social relationships, and the environmental domains in healthy participants. On the contrary, in one study, sedentary PA was significantly associated with the social relationship domains (Mourady et al., 2017). The last finding is not in agreement with our study result regarding the correlation between sedentary and QoL domains (e.g., in our study total sedentary mostly had non-significant relationships with QoL domains). This contradiction may be explained by the differences in the study contexts. Participants in the present study practiced social distancing to avoid the spread of COVID-19. In addition, by staying at home, without practicing PA, they may feel insecure.

Regarding the dose-response relationship between PA and QoL domains, the current study reported small to moderate correlations between all PA intensities and QoL domains.

TABLE 1 | Differences in the levels of physical actvity (PA) as assessed by means of the International Physical Activity Questionnaire (IPAQ) and perceived quality of life (QoL) between the different groups recruited in the present study.

Variables	IG *n* = 131	MA group *n* = 49	HEPA *n* = 36	Kruskal-Wallis test	IG vs. MA Z (*p* value)	IG vs. HEPA Z (*p* value)	MA vs. HEPA Z (*p* value)
Age	28.2 ± 8.4	24.8 ± 4.9	27.9 ± 9.7	0.097	-	-	-
Total PA (MET)	39.2 ± 122.9	1630.3 ± 680.7	6074.4 ± 2993.4	<0.001	−12.053 (<0.001)	−11.255 (<0.001)	−7.845 (<0.001)
WHOQoL physical domain score	40.6 ± 10.9	47.5 ± 16.1	49.3 ± 11.9	<0.001	−3.448 (0.001)	−4.484 (<0.001)	−0.063 (0.950)
WHOQoL psychological domain score	41.6 ± 12.3	57.4 ± 11.3	60.6 ± 10.1	<0.001	−6.578 (<0.001)	−6.858 (<0.001)	−1.102 (0.270)
WHOQoL social domain score	43.5 ± 11.3	62.4 ± 21.6	64.6 ± 13.1	<0.001	−5.882 (<0.001)	−7.270 (<0.001)	−0.816 (0.415)
WHOQoL environmental domain score	41.0 ± 13.5	53.4 ± 16.2	55.6 ± 15.6	<0.001	−4.894 (<0.001)	−4.816 (<0.001)	−0.504 (0.614)
WHOQoL total score	166.7 ± 38.2	221.6 ± 49.9	230.1 ± 34.9	<0.001	−6.057 (<0.001)	−6.966 (<0.001)	−0.441 (0.659)

Data are presented as mean ± SD. HEPA, health enhancing physical activity; IG, inactive group; MA, minimally active; MET, metabolic equivalent of task; PA, physical activity; WHOQOL, World Health Organization Quality of Life.

TABLE 2 | Coefficients showing the strength of the association between PA and the WHOQOL domain scores for the sample recruited (n = 216).

Variables	Total walking activity (MET)	Total moderate-intensity activity (MET)	Total vigorous-intensity activity (MET)	Total sedentary time	Total PA (MET)
WHOQoL physical domain score	0.196**	0.170*	0.187**	0.006	0.232**
WHOQoL psychological domain score	0.401**	0.354**	0.264**	0.201**	0.418**
WHOQoL social domain score	0.422**	0.312**	0.242**	0.025	0.407**
WHOQoL environmental domain score	0.265**	0.249**	0.141*	0.042	0.263**

*MET, metabolic equivalent of task; PA, physical activity; WHOQOL, World Health Organization Quality of Life. *$p < 0.05$, **$p < 0.001$.*

More in-detail, moderate correlations were observed between low- and moderate-intensities and psychological and social domains. Previous studies have reported positive relationships between moderate to vigorous PA and several SF-36 domains in participants attending a behavior change service within primary care, with these domains including: (a) general health and vitality, (b) physical functioning, and (c) the role of physical activity (Blom et al., 2019). Light PA was also associated with the aforementioned domains and the emotional sphere (Blom et al., 2019). This is not surprising, since a lot of studies showed the beneficial effect of light, moderate, and vigorous physical activities on all QoL domains (Gillison et al., 2009; Gill et al., 2013).

Regarding the correlation between PA and QoL domains, in our study, total PA, total walking activity, total moderate-intensity PA, and total vigorous-intensity PA were positively correlated with all QoL domains in both males and females. These findings are in agreement in part with Nakamura et al. (2014), who reported that leisure-time PA, moderate-intensity PA, and vigorous-intensity PA were associated with physical health domains. Moderate intensity and total activity leisure-time PA were also correlated with mental health in men (Nakamura et al., 2014). Van den Berg et al. (2008) reported that only vigorous-intensity PA was associated with the physical and mental health domains in workers. However, our study showed large correlations between psychological and social domains and all intensities of PA. In addition, a previous study reported that light-intensity of PA was positively correlated with psychological health and social relationship domains in healthy participants (Mourady et al., 2017). These studies and the current investigation support the latest guidelines issued by the WHO suggesting that people attain 150 min of moderate-intensity, 75 min of vigorous-intensity PA per week, or a combination of both to improve health, well-being, and QoL during the confinement.

Despite its novelty and methodological rigor, the present study is not without any limitations that should be properly acknowledged. The major limitation is given by the sampling approach, which calls up for caution when interpreting and generalizing the results. A further drawback is represented by the study design that being cross-sectional does not allow causal inferences to be drawn from the data. Given the preliminary nature of the present report, further research is needed to confirm our conclusions among different populations, using representative samples. In particular, longitudinal studies are needed to better understand the relationship between PA levels and perceived QoL during the confinement measures and after their lifting.

From the present findings, we can conclude that there is an association between PA levels and perceived QoL during the confinement period and the COVID-19 outbreak. If longitudinal studies replicate our data, PA with light-, moderate-, and vigorous intensities can be well recommended as an important method to improve QoL and to decrease/counteract the negative psychosocial effects of confinement. However, based on the above-mentioned limitations, along with the impact that disease-caused confinement has on people physically and psychologically, further research in the field is urgently warranted.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are readily available from the corresponding author (maamer2011@hotmail.fr).

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by local institutional ethical approval provided for this study, which was conducted in accordance with the 1964 Declaration of Helsinki. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

All authors: conceptualization and methodology. MS and AP: software. All authors: validation and formal analysis. MS: investigation and resources. MS and AP: data curation. All authors: writing, original draft preparation, review and editing, and visualization. DT: supervision. NB: funding acquisition. All authors contributed to the article and approved the submitted version.

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OPINION
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Born to Run Out of COVID-19: What Gives Us Wings

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WHEN COVID-19 EXACERBATES ANOTHER PANDEMIC: PHYSICAL INACTIVITY

A pandemic called COVID-19 has spread worldwide in the first months of 2020. Several measures have been taken by mostly affected countries to contain the virus outbreak, from social distancing to closing social and commercial activities. Also, sports dynamics has been dramatically impacted by this pandemic, with training and competitions canceled and no clear hypotheses on the expected restart dates. The International Olympic Committee even postponed Tokyo 2020 Olympics to 2021, with lots of consequences on athlete's preparation and mental focusing. Long-distance runners have seen canceled or postponed all the spring races, included the Major Marathons, and associated economic sequalae are real.

This pandemic could potentially have a huge impact not only on elite athletes' preparation for the Olympics, but also for global health. In fact, the impossibility to engage in regular activities (e.g., school, work, fitness facilities) and utilize community resources (e.g., parks, playgrounds, walking trails) have caused a sharp reduction in the levels of physical activity, and has upended western societies lifestyles. In turn, this may result in a substantially increased risk of developing cardiovascular and metabolic diseases. Indeed, physical activity is associated with reduced risk of mortality and incident cardiovascular and metabolic diseases in all regions of the world, with no indication of a ceiling effect for higher doses. Therefore, the scientific community rated physical activity as a low-cost approach to reducing deaths and cardiovascular disease that is applicable globally with potential large impact (Lear et al., 2017).

POOR MENTAL HEALTH AND PHYSICAL INACTIVITY: TWO HITS FROM COVID-19

Other factors, such as fear of social contacts and the inability to carry out group activities, could contribute to physical inactivity even once community resources will be reopened. Hence, the prevalence of physical inactivity may rise tragically in the upcoming months, as the social distances measures are expected to be extended at least until summer or autumn. To the best of our knowledge, no studies assessed the long-lasting effect of such a pandemic on physical activity behaviors. However, previous research has assessed the persisting effect of natural disasters on it. As an example, following the 2011 earthquake and tsunami in East Japan, Okazaki and colleagues (Okazaki et al., 2015) reported a significant decrease in physical activity up to 3 years following the disaster.

The evidence base for the relationship between physical activity and mental well-being is well-established (Mason and Kearns, 2013). A large body of literature has consistently shown that physical activity is positively associated with increased mental well-being (Bize et al., 2007; Cerin et al., 2009). In a recent review on psychological impact of quarantine periods, Brooks and colleagues compared post-traumatic states such as stress, depression, and confusion, with experiencing epidemic outbreaks (Brooks et al., 2020). Therefore, a COVID-19-associated reduction in physical activity could impair physiology as well as generate worrying effects at psychological and psychosocial level (Harris, 2018).

AN ALTERNATIVE RESPONSE TO THE OUTBREAK

Sustained physical inactivity and sedentary behaviors are typically accompanied by poor physical and mental health and increased disease-specific and all-cause mortality risk (Booth et al., 2017). Even brief periods of exposure to these behaviors can be deleterious; for example, a 2-week reduction in daily steps from ∼10,000 to ∼1,500 steps led to impaired insulin sensitivity and lipid metabolism, increased visceral fat and decreased fat-free mass and cardiovascular fitness in healthy adults (Krogh-Madsen et al., 2014).

Despite acknowledging the tremendous impact of COVID-19 emergency, the authors would like to highlight potential long-term effects of a sedentary lifestyle that could even cause worse consequences than the infection itself. In this regard, the spread out of the COVID-19 has been greater in the high-income countries, that have at the same time the highest prevalence of physical inactivity (WHO, 2016). A further increase in physical inactivity could have potential drastic effects not only in the onset of cardiovascular and metabolic diseases, but also, in the long-term trends, in sport- performances and results.

SOCIOCULTURAL AND LIFESTYLE HABITS COULD PRESERVE METABOLISM AND LEAD TO OLYMPIC MEDALS

Long-distance athletics could be a mirror of this situation and the dominance of east-African runners at the Olympics and World Championships during the last years provides hints in a global health prospective. In the top-50 all-time performances of the track distance events (from 800 m upward), east Africans men and women passed from 11.4% in 1989 to 61% in 2019, mostly Kenyans, Ethiopians and, even recently, Ugandans. The dominance in the top 50 middle- and long-distance races reflected a spurt in the number of medals at the Olympics and World Championships (Tucker et al., 2015). On the other side, the increase in middle- and long-distance athletics medals at the Olympics and World Championships by Africans athletes was paralleled by the decrease of Europeans' ones, from 1983 (i.e., the first edition of the World Championships) onwards (**Figure 1**).

The association between physical performance in long-distance athletics competitions and global health prospective finds supports in the 2016 report of the World Health Organization (WHO, 2016). This report showed that the prevalence of insufficient physical activity rises worldwide according to the level of income: high income countries had more than doubled this prevalence compared to low income countries for both men and women (i.e., 32 and 42% of insufficient physical activity in high income compared to 13 and 19% in low income countries, respectively, for men and women). Specifically, if we look at the physical inactivity levels in the east Africa and in particular in Kenya, official reports show a strong difference between children from urban and rural areas, where successful Kenyan runners were born and raised (Onywera et al., 2016). The average levels of children's physical activity in some regions of Kenya are well-above the recommended threshold of 60 min of daily moderate-vigorous physical activity, with more than 150 min spent in free-living physical activity (Ojiambo et al., 2013). Conversely, in western countries more than 80% of adolescents do not reach the claimed minimum level. Moreover, while 13.1% of children of urban areas spend more than 11 h per week playing screen games, instead 62.5% of the children of rural areas spend no time in these activities (Onywera et al., 2012). Increased urbanization in high income countries has resulted in several negative environmental factors such as violence, high-density traffic, low air quality, pollution, lack of parks, sidewalks, and sports/recreation facilities (Manferdelli et al., 2019). This may discourage participation in physical activity along with making adults resistant to leave children play freely outside. Interestingly, while the levels of physical activity are decreasing among children and adults in high income countries and in urban areas, the bound between cardiorespiratory fitness and high levels of physical activity is seemingly reinforced in those emergent countries where fortunate endurance performances are registered (Santos-Lozano et al., 2017).

As this gap is growing further when comparing low- and high-income countries, the next Olympics might confirm east Africans as the favorites for medals in long-distance athletics races. Moreover, the Olympic races show only a part of the phenomenon as, in these events, the number of athletes for each nation is limited to three, thus allowing athletes from other nations to place themselves in prominent positions although their overall rank is lower. As an example, in the 2019 men's marathon lists, the first athlete not born in east Africa is ranked 34th whereas the first athlete born outside of Africa is ranked 45th.

Only by changing some modern detrimental habits and putting again physical activity as pivotal in our lifestyles, we might be able to revert this negative trend, for which high income countries increase exponentially metabolic and cardiovascular diseases while they reduce competitiveness in endurance events.

CONCLUDING REMARKS

Results and performances are not only "sports outcomes," but also offer an ideal context for understanding deep socio-cultural processes rooted in the development of a country. The lack of a date for the next Olympics is certainly a sports problem, but could have a translation in what is around the world of sport: the example of athletics long-distance events are a clear indicator of how a healthy lifestyle can allow a country to remain at the top of the sport for decades, generating benefits for the health system. As early-life high levels of maximum aerobic capacity are linked to protection from coronary heart diseases (Batty and Lee, 2004), they likewise introduce a sociocultural

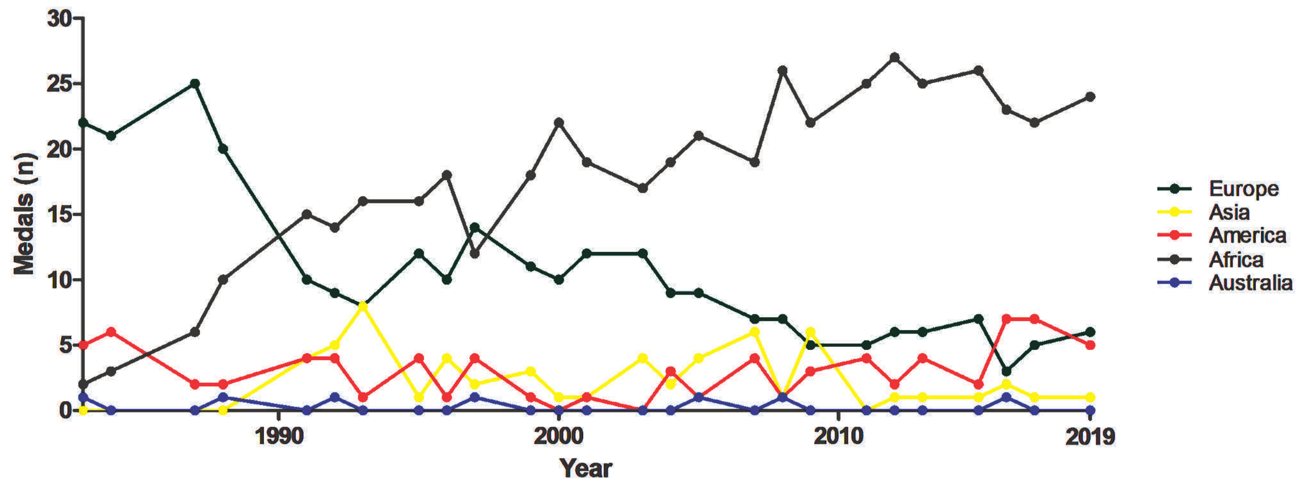

FIGURE 1 | Medals in middle- and long-distance events of athletics at the Olympics and World Championships from 1983 to 2019. Country are grouped in macro-areas (i.e., Africa, America, Asia, Australia, and Europa).

factor that is determinant, amongst the others, for the success in running competitions. Beyond the extraordinary athletic aptitudes, the strong psychological motivation to succeed is the discriminating factor for any-country runners (Wilber and Pitsiladis, 2012). On the other hand, watching athletes from your country winning medals in international competitions can be a strong incentive to physical activity. In this sense, the Olympics are the fundamental engine of a champion emulation process which lays the foundations for a growth of a national sports movement and, consequently, an increase in the level of physical activity of the nation (Thomas et al., 2019). Elite sport has the potential role to be the psychosocial driving force in pushing the population through a regular practice of physical exercise. We urge public health authorities and community at large not to leave sport at the short end of the stick in this emergency, considering the long-term deleterious effects that a lack of physical activity could cause at metabolic, cardiovascular, psychological, and social levels.

AUTHOR CONTRIBUTIONS

LF, AL, LL, and RC participated in conception and design and critically revised the manuscript. LF completed the acquisition of data. LF and RC carried out the analysis, interpretation of data, and participated in drafting of the manuscript. All authors have read and approved the final version of the manuscript and agree with the order of presentation of the authors.

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BRIEF RESEARCH REPORT
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Changes in Diet, Sleep, and Physical Activity Are Associated With Differences in Negative Mood During COVID-19 Lockdown

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The United Kingdom and Scottish governments instigated a societal lockdown in response to the COVID-19 pandemic. Subsequently, many experienced substantial lifestyle changes alongside the stresses of potentially catching the virus or experiencing bereavement. Stressful situations and poorer health behaviors (e.g., higher alcohol consumption, unhealthy diet, poorer sleep quality, physical inactivity) are frequently linked to poor mental health. Our objective was to examine changes in health behaviors and their relationship with negative mood during COVID-19 lockdown. We also considered associations between health behaviors and socio-demographic differences and COVID-19-induced changes. 399 participants completed a questionnaire asking about their personal situation and health behaviors during lockdown as well as a negative mood scale. The significance threshold for all analyses was $\alpha = 0.05$. Poorer diet was linked to more-negative mood, and to changes to working status. Poorer sleep quality was linked with more-negative mood, and with 'shielding' from the virus. Being less physically active was related to more-negative mood and student status, whereas being more physically active was linked to having or suspecting COVID-19 infection within the household. Increased alcohol consumption was linked to living with children, but not to negative mood. Changes to diet, sleep quality, and physical activity related to differences in negative mood during COVID-19 lockdown. This study adds to reports on poor mental health during lockdown and identifies lifestyle restrictions and changes to health behaviors which may, to some extent, be responsible for higher negative mood. Our data suggests that it is advisable to maintain or improve health behaviors during pandemic-associated restrictions.

Keywords: COVID-19, lockdown, diet, sleep, physical activity, alcohol, mood, mental health

INTRODUCTION

Lockdown conditions, arising from the developing COVID-19 situation, were introduced across the United Kingdom on 23rd March 2020. Residents of Scotland spent a total of 66 days under the most restrictive lockdown conditions, with these being eased to some extent on 28th May 2020[1]. The threat of contracting COVID-19 is an on-going stressor, though personal circumstances regarding work and home life may significant influence how individuals cope.

[1] With the exception of outdoor exercise which became unrestricted on 11th May 2020.

Restrictions and lifestyle changes during lockdown have been associated with poorer psychological wellbeing. Reduced social contact, feelings of isolation, and fear of contracting or spreading dangerous viruses have been historically linked to poor wellbeing (Bai et al., 2004; Hawryluck et al., 2004; Cacioppo and Hawkley, 2009; Chen and Feeley, 2014). Time spent in quarantine during previous disease outbreaks has been shown to have negative psychological effects (Brooks et al., 2020). Psychological symptoms (stress, anxiety, depression) have been shown to rise in tandem with time spent in lockdown (Ozamiz-Etxebarria et al., 2020). López-Bueno et al. (2020) proposed that poorer psychological wellbeing and mental health during COVID-19 lockdown is associated with health behaviors such as alcohol consumption, diet, sleep, and physical activity. We therefore examined the relationships between socio-demographic circumstances (e.g., living arrangements), COVID-induced changes in circumstances (e.g., changes to working arrangements, shielding), and changes in health behaviors. We also considered how changes to health behaviors related to negative mood, and we monitored changes in negative mood as lockdown restrictions eased.

Alcohol Change United Kingdom reported that individuals were drinking differently during the COVID-19 pandemic (Alcohol Change UK, 2020). In Scotland specifically, whilst 29% of drinkers surveyed reported that they had been drinking more-often since the beginning of lockdown, the same percentage reported they were drinking less-often (Alcohol Focus Scotland, 2020). Whilst there is evidence to suggest that alcohol-dependant individuals drink to alleviate negative emotional states (Koob, 2011), the relationship between emotional experience and alcohol in social drinkers is less-clearly defined (Sayette, 2017). Poor mental health has consistently been reported in abusive (Pottenger et al., 1978; Grant and Harford, 1995; Schuckit, 2006) and social drinkers (Birnbaum et al., 1983; Parker et al., 1987; Jones et al., 2007), and drinking alcohol has been associated with negative mood (Howland et al., 2010; Alford et al., 2020). In our study we focused specifically on *changes* to drinking behavior and examined links between these changes, socio-demographic and COVID-induced change circumstances, and negative mood.

Heightened life stress has been linked to unhealthy eating (Greeno and Wing, 1994; Ball and Lee, 2000), and stressed people are more likely to crave food high in energy, fats, and sugars (Steptoe et al., 1998; Wardle et al., 2000). Thus, it was expected that stressful changes and restrictions to daily life would lead to less-healthy eating habits. Research has already demonstrated poorer diet in children during COVID-19 lockdown (Pietrobelli et al., 2020), although other sources suggest that eating habits in adults have not changed or may even have improved for some (NL Times, 2020). Potential links between diets high in processed and sugary food and poor mental health have been reported (Jacka et al., 2010).

Stress has also been implicated in poor sleep quality and disrupted sleep (see Sanford et al., 2014 for a review). The COVID-19 pandemic has been linked to poor sleep quality in China (Xiao et al., 2020) and Italy (Casagrande et al., 2020), with over half of Italian respondents experiencing poor sleep quality. However, in Spain, the quality of respondents' sleep seemed to improve as the lockdown progressed (López-Bueno et al., 2020). Critically, poor sleep quality has been linked to negative emotions and mood (see Baglioni et al., 2010 for a review).

Initial United Kingdom restrictions allowed leaving the house for exercise once per day, and facilities usually available for physical activities were closed. Lower rates of physical activity have been associated with feelings of social isolation (Robbins et al., 2018; Werneck et al., 2019), which may already be exacerbated by other restrictions of lockdown. It has been well-documented (see Landers and Arent, 2007 for a review) that physical activity is beneficial for mental health and wellbeing, and it would be assumed that any restrictions to physical activity would lead to poorer wellbeing. However, studies in Italy (Di Renzo et al., 2020) and Spain (López-Bueno et al., 2020) suggest that most individuals were increasing their physical activity levels during lockdown, which may be one of the ways of maintaining healthy behaviors and mitigating the negative impact of lockdown on mood and wellbeing.

Within the current study, we examined the associations between socio-demographic factors and COVID-induced changes, and health behaviors (changes in alcohol consumption, diet, sleep, and physical activity). We hypothesized that those who have experienced more restrictions or greater lifestyle changes would have increased incidence of change toward poor health behaviors (increased alcohol consumption, unhealthier diet, poorer sleep quality, and decreased physical activity). We considered how changes and differences in these behaviors related to mood. We predicted that those with changes toward poorer health behaviors would show higher negative mood. We also tracked changes in negative mood over three time points. At timepoint one, Scotland was under strict lockdown conditions where leaving the house was allowed for necessary work, to shop for essentials, and for unrestricted exercise. At timepoint two – two weeks later – restrictions had eased to allow meeting outside with one other household. At timepoint three – a further two weeks later – additional easing had taken place; meeting with two households was allowed outdoors and some people (e.g., those living alone) could form extended households. Restrictions to those in the shielding group (individuals who were completely isolating due to high risk) were also lifted around timepoint three. We hypothesized that this easing of lockdown restrictions would be associated with gradual improvements in mood.

MATERIALS AND METHODS

Participants and Recruitment

Based on the work of Schönbrodt and Perugini (2018), anticipated small-to-medium effect sizes for F-tests, and an estimated Scottish adult population of approximately 4.3 million (National Records of Scotland, 2020), a target sample size between 250–430 was identified. 399 participants (56.4% female, 41.9% male, 1% non-binary, and 0.8% transgender) of various ages (range: 18–72 years, M_{age} = 32.4, SD_{age} = 11.4) completed the study. All were recruited through convenience sampling via

Prolific Academic[2]; the sample consisted of the first 399 Prolific Academic users who identified as Scottish nationals/long-term residents (0.5–72 years; $M_{residence}$ = 29.0, $SD_{residence}$ = 12.2). 98.2% of the participants identified themselves as Caucasian, 1.5% as Asian, and 0.3% as Armenian. 315 of the 399 participants completed additional mood ratings in Week 3. 275 out of the 399 participants completed the ratings in Week 5.

Table 1 presents a summary of key demographics. Additionally, 27.3% and 8.5% of the sample had a child/children living in the same or a different household, respectively. 9.5% of the participants worked in the health/social care sector.

Exposure to COVID-19

12.8% of participants suspected they had had COVID-19, 1% confirmed they had tested positive. 8.0% of participants reported they had lived with someone who suspected or had COVID-19 (half of whom suspected/had it themselves). 4.8% of participants had experienced bereavement due to COVID-19. 15.3% of participants reported that they were included in the shielding group, or a list of patients who were at high-risk of developing complications from COVID-19 due to pre-existing conditions (e.g., cancer, immunodeficiency).

Materials and Procedure

The study received ethical approval from the School of Education and Social Sciences, University of the West of Scotland Ethics Committee, following World Medical Association (2013) and British Psychological Society (2014) protocols. Participants provided electronic informed consent prior to the study.

The study consisted of a questionnaire followed by a negative mood scale, both designed in Gorilla[3]. The first section of the questionnaire gathered the data presented in **Table 1**. The next section included yes-no questions on whether participants tested positive or suspected they had had COVID-19, lived with someone who tested positive or suspected they had had COVID-19, suffered bereavement as a result of COVID-19, and whether they were included in the shielding/vulnerable group. The third section included questions on how often participants would go out in public (and for what reasons), communicate with individuals from a different household (and how), and exercise in an average week during lockdown. We also included an 18-item multiple-choice checklist for participants to indicate how they spent time outside of working hours (e.g., exercise, reading books, gaming, online shopping), with an option to list additional activities.

Changes in Health Behaviors

In this section, participants rated changes to their alcohol consumption, diet, sleep quality, and physical activity during COVID-19 lockdown. A 5-point scale was used for all four (alcohol: 1 = "drinking a lot more", 3 = "about the same", 5 = "a lot less"; diet: 1 = "a lot more unhealthy", 3 = "about the same", 5 = "a lot more healthy"; sleep: 1 = "a lot worse", 3 = "about the same",

TABLE 1 | Participant sample demographics.

Sample	***N***	***Mean Age***					
	399	**32.4 years (SD = 11.4)**					
Gender-Sex	*Female*	*Male*	*Non-Binary*	*Trans*			
	56.4%	41.9%	1%	0.8%			
Location	*Town*	*City*	*Suburbs*	*Village*	*Countryside*		
	32.3%	27.8%	21.1%	12.5%	6.0%		
Sexuality	*Heterosexual*	*Bisexual*	*Homosexual*	*Pansexual*	*Demisexual*	*Asexual*	*Queer*
	85.5%	7.5%	3.8%	0.8%	0.3%	0.3%	0.3%
Relationship Status	*Single*	*Married*	*Living with partner*	*In a relationship*	*Divorced*	*Separated*	
	29.3%	26.3%	23.3%	17.8%	1.8%	1.5%	
Household	*Living with partner only*	*Living with parents*	*Living with partner + children*	*Living alone*	*Other adult*	*Alone + child(ren)*	
	29.3%	26.8%	22.1%	12.0%	5.8%	4.0%	
Student Status	*Full-time*	*Part-time*	*Non-student*				
	21.8%	4.3%	73.9%				
Employment	*Working from home*	*Unemployed*	*Furloughed*	*Keyworker*	*Carer/Parent*	*Working Away*	
	35.3%	21.6%	19.0%	15.0%	5.0%	2.5%	
Employment Change	*Furloughed*	*Working from home*	*Unemployed*	*Keyworker*	*Carer/Parent*		
	46.9%	21.9%	17.2%	8.6%	2.3%		

[2] https://prolific.co

[3] https://gorilla.sc/

5 = "a lot better"; physical activity: 1 = "a lot less", 3 = "about the same", 5 = "a lot more"). The number and percentage of participants providing each rating can be seen in **Table 2**.

Negative Mood Score

We selected 10 negative items from Grove and Prapavessis' (1992) abbreviated Profile of Mood State (POMS) scale, with two items taken from each of the five sub-dimensions of Confusion (*forgetful, unable to concentrate*), Tension (*anxious, uneasy*), Depression (*helpless, sad*), Fatigue (*exhausted, worn out*), and Anger (*angry, annoyed*). The abbreviated POMS scale has a mean subscale inter-correlation of 0.58 (0.53–0.67), mean subscale internal consistency (Cronbach's α) of 0.80 (0.66–0.80), and clear validity (winner-loser differences $p < 0.001$). Total mood disturbance in the POMS is calculated by summing the scores on the negative subscales and subtracting the positive subscale; however, in the present study we used only the negative subscales. At each time point, participants in our study rated their mood on each of the 10 adjectives *at that point in time* using a 100-point slider scale, with higher scores indicating greater negative mood. For the current data set, a Cronbach's $\alpha = 0.91$ was observed for Negative Mood Score (NMS; $n_{items} = 10$), and the five subscales ranged from $\alpha = 0.69$–0.89 ($M_{\alpha} = 0.85$).

Data Analysis

Prior to inferential analysis, online survey responses were checked for completeness. Participants who identified as non-drinkers were excluded from analyses involving changes in alcohol consumption. A series of Pearson's chi-square (χ^2) analyses were conducted to explore the associations between socio-demographic factors and COVID-19 induced change on changes in health behaviors. A series of Spearman's correlations were conducted to analyze relationships between changes in health behaviors – positive correlations represented 'positive' changes in the health behaviors (reduced alcohol consumption, healthier diet, better sleep, more physical activity). A series of univariate Analyses of Variance (ANOVAs) were conducted to explore the relationship between changes in health behaviors and isolation history on negative mood. All assumptions were met (e.g., expected frequencies, normality and equality of variance). Our significance threshold was $\alpha = 0.05$, and corrections associated with follow-up comparisons are identified within the Results section.

RESULTS

Socio-Demographic Circumstances, COVID-19 Induced Change, and Health Behaviors

Analyses are summarized in **Table 3** below, and significant associations are explored in detailed below.

Alcohol

Analyses revealed that there was a significant association between whether or not the participants had children in their household during lockdown and their alcohol consumption [$\chi^2(4) = 10.474$, $p = 0.033$]. For those with children at home, there were more participants than expected drinking "a lot more" (10 vs. 5.8), and fewer than expected drinking "a lot less" (9 vs. 15.1); for child-less participants, there were fewer participants than expected drinking "a lot more" (12 vs. 16.2) and more participants than expected drinking "a little less" and "a lot less" (30 vs. 26.4 and 48 vs. 41.9, respectively).

Diet

Analyses revealed that there was a significant association between a change in work-status and a change in diet [$\chi^2(4) = 9.768$, $p = 0.045$]. For those whose work-status had changed, more participants than expected reported that their diet was "a little more unhealthy" (42 vs. 33.7), and fewer participants than expected maintained the same diet (28 vs. 40.9); for those participants reporting no change in work-status, fewer participants than expected reported that their diet was "a little more unhealthy" (61 vs. 69.3), and more participants than expected had maintained their pre-lockdown diet (97 vs. 84.1).

Sleep

Analyses revealed that there was a significant association between shielding status and lockdown changes in perceived sleep quality [$\chi^2(4) = 13.200$, $p = 0.010$]. With respect to shielding group participants, a greater number of participants than expected were sleeping "a lot worse" (22 vs. 12.4), and fewer shielding participants than expected maintained their pre-lockdown sleeping pattern (13 vs. 18.9); in contrast, fewer non-shielding

TABLE 2 | Frequency and percentage of participants providing each health behavior rating.

Alcohol			Diet			Sleep			Physical activity		
Change	***N***	**%**	**Change**	***N***	**%**	**Change**	***N***	**%**	**Change**	***N***	**%**
A lot more	23	*5.8%*	A lot more unhealthy	51	*12.8%*	A lot worse	85	*21.3%*	A lot less	99	*24.8%*
A little more	118	*29.6%*	A little more unhealthy	112	*28.1%*	A little worse	124	*31.1%*	A little less	90	*22.6%*
Same	76	*19.0%*	Same	136	*34.1%*	Same	124	*31.1%*	Same	67	*16.8%*
A little less	41	*10.3%*	A little more healthy	75	*18.8%*	A little better	47	*11.8%*	A little more	94	*23.6%*
A lot less	60	*15.0%*	A lot more healthy	12	*6.3%*	A lot better	19	*4.8%*	A lot more	49	*12.3%*
Non-drinkers	81	*20.3%*	–	–	–	–	–	–	–	–	–

TABLE 3 | Associations between socio-demographic circumstances, COVID-19 induced change, and health behaviors.

Changes in	Alcohol Consumption			Diet			Sleep Quality			Physical Activity		
	χ^2	*df*	*p*	χ^2	*df*	*p*	χ^2	*df*	*p*	χ^2	*df*	*p*
Child(ren) at home	**10.474**	**4**	**0.033**	5.913	4	0.206	2.894	4	0.576	3.916	4	0.418
Student status	13.279	8	0.103	12.480	8	0.131	10.987	8	0.202	**19.481**	**8**	**0.012**
Work status change	3.552	4	0.470	**9.768**	**4**	**0.045**	7.609	4	0.107	1.849	4	0.763
COVID-19 (Self)	0.981	4	0.913	1.166	4	0.884	1.697	4	0.791	0.926	4	0.921
COVID-19 (Household)	1.221	4	0.875	1.572	4	0.814	5.011	4	0.286	**12.055**	**4**	**0.017**
Shielding status	6.439	4	0.169	2.420	4	0.659	**13.200**	**4**	**0.010**	5.696	4	0.223
Vulnerability status	6.859	4	0.144	4.666	4	0.323	8.440	4	0.077	7.953	4	0.093
Self-isolation status	1.652	4	0.799	3.906	4	0.419	3.877	4	0.423	6.200	4	0.185

Significant p-values (one-tailed) highlighted in bold.

participants than expected were sleeping "a lot worse" (54 vs. 63.6), and more non-shielding participants than expected had maintained their pre-lockdown sleeping pattern (103 vs. 97.1).

Physical Activity

Analyses revealed that there was a significant association between student-status and changes in activity levels [$\chi^2(8) = 19.481$, $p = 0.012$]. The pattern of observed vs. expected effects reveals that this is an association marked by general decline in activity. For full-time students, a greater number than expected reported being "a lot less" physically active (15 vs. 10.7), but fewer than expected reported being "a little less" active (17 vs. 21.6); for non-students, fewer participants than expected reported being "a lot less" physically active (29 vs. 32.5), but more than expected reported being "a little less" active than pre-lockdown (72 vs. 65.6).

Analyses also revealed an association between household COVID-19 infection status and activity level changes [$\chi^2(4) = 12.055$, $p = 0.017$]. For participants who had/suspected a case of COVID-19 infection within their households, more participants than expected reported being "a lot more" physically active than pre-lockdown (14 vs. 7.2), and less than expected reported being "a little more" active (3 vs. 6.3); for participants who had/suspected no cases in their household, more participants than expected had maintained their activity or were "a little more" active (58 vs. 54.3 and 77 vs. 73.7, respectively), but fewer than expected were "a lot more" active (77 vs. 83.8).

Relationships Between Changes in Health Behaviors

Analyses revealed a moderate positive correlation between changes in alcohol consumption and diet ($r_S = 0.299$, $p < 0.001$), and a smaller positive relationship between alcohol consumption and physical activity level ($r_S = 0.132$, $p = 0.006$). There was no linear relationship between changes in alcohol consumption and changes in perceived sleep quality. There was a small positive correlation between changes to diet and perceived sleep quality ($r_S = 0.187$, $p < 0.001$), and a moderate positive correlation between changes in diet and changes in physical activity ($r_S = 0.354$, $p < 0.001$). Finally, there was a small positive correlation between changes in sleep quality and changes in physical activity ($r_S = 0.191$, $p < 0.001$).

Health Behaviors and Negative Mood Score

ANOVAs across mood subscales are summarized in **Supplementary Material 1** and **Supplementary Table A1**. Only total Negative Mood Score (NMS) will be discussed in detail. Post-hoc comparisons were conducted using Hochberg's GT2 adjustment to account for differences in group sizes. Post-hoc comparisons are summarized in **Supplementary Material 2** and **Supplementary Table A2**, and illustrated in **Figure 1**.

Alcohol

There was a no significant differences in NMS relating to changes in alcohol consumption [$F(4,313) = 2.207$, $p = 0.068$, $\eta_p^2 = 0.027$].

Diet

There were differences in NMS relating to changes in diet during lockdown [$F(4,395) = 6.745$, $p < 0.001$, $\eta_p^2 = 0.064$]. *Post-hoc* tests revealed that those with a much unhealthier diet during lockdown had greater NMS than those whose diets were the same ($p = 0.001$) or had improved a lot ($p = 0.002$). Those participants whose diet had only changed a little for the worse still reported greater NMS than those who had maintained the same diet ($p = 0.014$) and those who had a much-improved diet ($p = 0.022$) as before lockdown.

Sleep

There were clear differences In NMS relating to changes in perceived sleep quality during lockdown [$F(4,395) = 13.831$, $p < 0.001$, $\eta_p^2 = 0.123$]. *Post-hoc* tests revealed that those reporting that their sleep was much worse had greater NMS than all other groups (all p's < 0.05), and those whose sleep was only a little worse during lockdown still had greater NMS than those whose sleep had been unaffected by lockdown ($p < 0.001$).

Physical Activity

There were difference in NMS relating to changes in physical activity during lockdown [$F(4,395) = 5.321$, $p < 0.001$, $\eta_p^2 = 0.051$]. *Post-hoc* tests revealed that those who were doing much less activity had greater NMS than those whose activity

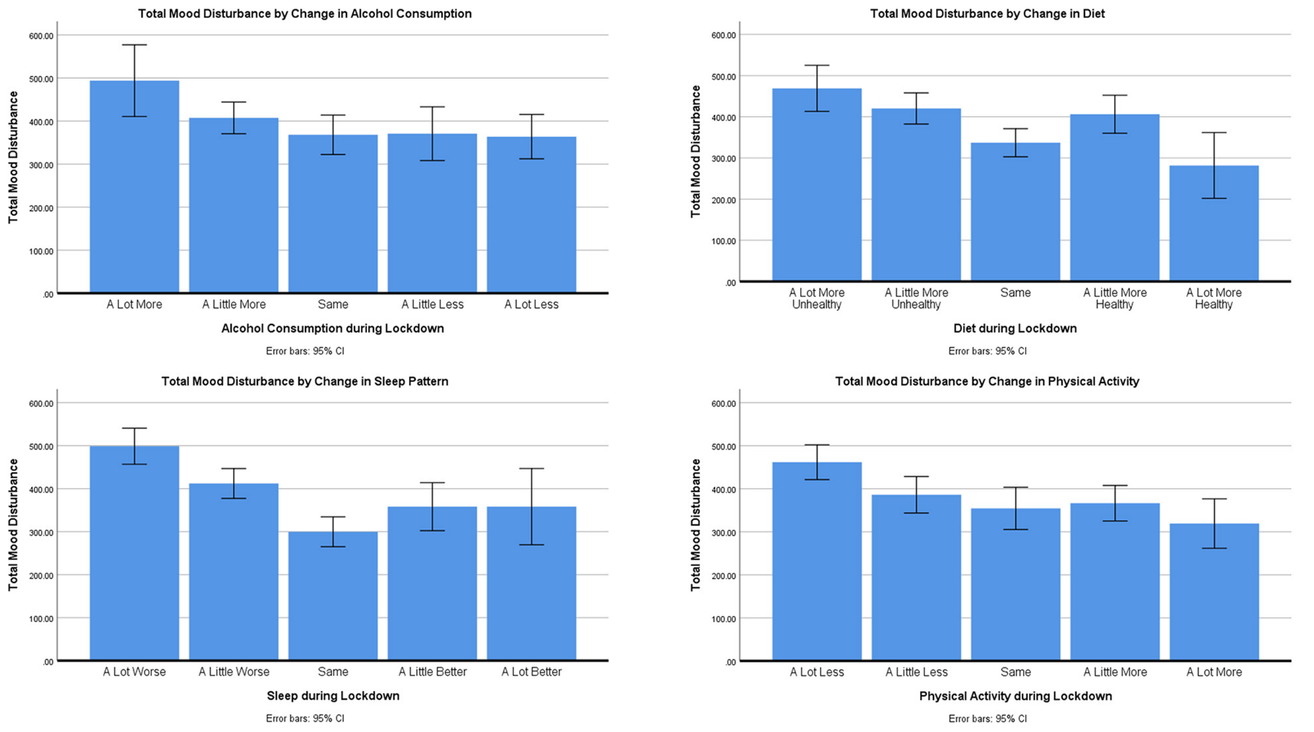

FIGURE 1 | Mean negative mood score by health behavior.

levels has stayed the same (p = 0.010) or improved a little (p = 0.013) or a lot (p = 0.001).

Isolation

There was a clear difference between whether or not participants had isolated or not during lockdown and NMS [$F(1,397) = 8.818$, $p = 0.003$, $\eta_p{}^2 = 0.022$]. Participants who had self-isolated reported higher NMS ($M_{NMS} = 421.25$, $SD_{NMS} = 205.05$) than those who had not isolated ($M_{NMS} = 359.15$, $SD_{NMS} = 208.50$).

We considered that there might have been an interaction between someone's isolation status, health behaviors and NMS. We conducted a series of two-way between-subjects ANOVAs, and found no evidence for interactions between isolation status (yes, no) and changes in health behaviors on NMS (all $Fs < 1.763$, all p's > 0.136). These two-way ANOVAs returned consistent main effects of health behaviors and isolation group on NMS as the univariate ANOVAs summarized in **Supplementary Material 1** and **Supplementary Table A1**.

Changes in Mood Over Time

We examined whether the gradual easing of lockdown restrictions across the three time points (Weeks 1, 3, and 5) had any impact on participants' mood states. Total NMS from 275 participants who completed all the time points were analyzed using an ANOVA with Time as a within-participants factor. The results showed that Time had a significant impact on NMS [$F(2,548) = 31.99$, $p < 0.001$, $\eta_p{}^2 = 0.110$]. We followed this up with pairwise comparisons (Bonferroni corrections) which revealed higher scores (i.e., more-negative mood) in Week 1 ($M = 374.51$, $SD = 205.72$) than Week 3 ($M = 300.61$, $SD = 201.08$; $p < 0.001$) but comparable scores in Weeks 3 and 5 ($M = 306.29$, $SD = 215.96$; $p = 1$). This suggests that participants' mood states improved as a result of easing lockdown restrictions, albeit only in the early stages of the process.

DISCUSSION

This study has identified associations between socio-demographic factors, COVID induced change and health behaviors, and differences in negative mood dependent on changes to health behaviors. With the exception of alcohol and sleep, health behaviors were inter-related. Changes in diet, sleep, and physical activity had the clearest link to negative mood states.

Given previous links between mental health, mood, and alcohol (Birnbaum et al., 1983; Parker et al., 1987; Howland et al., 2010; Alford et al., 2020), it was predicted that those who were drinking more during lockdown would have higher negative mood scores. This prediction was not borne out in the analysis. Whilst changes in alcohol consumption were correlated with changes in other health behaviors (with the exception of sleep), it is not possible to associate better mood with a reduction in alcohol consumption during COVID-19 lockdown. There is some evidence to suggest that for social drinkers, under certain specific situations, alcohol can have a positive effect on emotion (Sayette, 2017), hence it is possible that under the short-term strict conditions alcohol consumption can improve the emotional state of some individuals. Overall, more participants in this study reported increases in drinking behavior in comparison to previously published data (Alcohol Focus Scotland, 2020).

Changes in work status were associated with changes in diet, those who had changed their work status due to the COVID-19 pandemic reported that their diet had been unhealthier. It was clear that those with an unhealthier diet had higher NMS. Poorer mental health has previously been linked to unhealthy diets (Sánchez-Villegas et al., 2009; Jacka et al., 2010; Parletta et al., 2017), and unhealthy diets have been linked to higher levels of life stress (Greeno and Wing, 1994; Ball and Lee, 2000). This suggests that COVID-19 related stress may have led to a change to less-healthy eating habits which could have led to development of more negative mood over lockdown. However, the current data set is limited as no conclusions can be drawn with respect to the causal relationship between negative mood and the health behaviors.

Shielding was the only COVID-19-related factor which was associated with changes in sleep quality. Those who were shielding during the COVID-19 lockdown were experiencing poorer sleep quality. As predicted, those who were sleeping more poorly during the lockdown were also found to have higher NMS. Links between stress and poor sleep (Sanford et al., 2014) are consistently reported, and NMS for those experiencing poorer sleep during this time would suggest complex interplay between stress, sleep disturbance, and mental health during COVID-19 lockdown.

Student status was associated with changes in physical activity, with those studying full-time seeing a greater reduction in their physical activity. Households where COVID-19 had been experienced or suspected were associated with a lot more physical activity, whilst households with no experience or suspicion of COVID-19 maintained physical activity or were a little more active. Those who were doing a lot less physical activity had significantly higher NMS than all other groups, with the exception of those doing a little less physical activity. It is clear that a reduction in the level of physical activity is associated with higher NMS. It is possible that this reduction is having an influence on participants' mental health as being physically active has been shown to improve mood (Hartescu et al., 2015; Fritz and O'Connor, 2016), and is positively associated with mental wellbeing (Cerin et al., 2009). However, it is also possible that those experiencing high negative mood has reduced participants level of physical activity, which could support previously seen reduced levels of physical activity when feeling socially isolated (Robbins et al., 2018; Werneck et al., 2019). 35.9% of the participants reported having increased levels of physical activity during lockdown in comparison to 47.4% of the participants who had decreased their level of physical activity during lockdown. These results are in contrast to studies from Italy (Di Renzo et al., 2020) and Spain (López-Bueno et al., 2020) where participants generally reported an increase in activity during lockdown. This may reflect a trend for physical inactivity within Scotland (Murray, 2013). During and after lockdown periods, we recommend that physical activity – even within the home (da Cunha de Sá-Caputo et al., 2020; Mattioli et al., 2020) – and healthy diet should be promoted to combat sedentary behavior.

Lockdown conditions were associated with higher negative mood overall. This is compatible with previous research indicating that reduced, or the perception of reduced, social contact and health-based fears are related to poor wellbeing (Bai et al., 2004; Hawryluck et al., 2004; Cacioppo and Hawkley, 2009; Chen and Feeley, 2014) as well as previous research on psychological effects of quarantine or lockdown conditions (Brooks et al., 2020; Ozamiz-Etxebarria et al., 2020). Our results show that improvement in negative mood states were found quite quickly after the easing of lockdown conditions. Differences were found two weeks after lockdown conditions were relaxed. No further differences were found two weeks later, but this may reflect the relatively small differences in lockdown restrictions made during this time. Data on health behaviors was not collected at later timepoints for comparison.

Spending time in lockdown conditions has had a negative impact on mood, and this is in line with previously published work on the effects of COVID-19 lockdown on mental health (Ozamiz-Etxebarria et al., 2020). These results add to the growing body of literature on health and wellbeing during and after the COVID-19 pandemic and demonstrates that changes to health behaviors during this time may be to come extent responsible for poorer mood, anxiety and depression. However, the impact of these changes may be transient and persist primarily during the strictest lockdown conditions. The current study is somewhat limited in that potential co-variant health factors (i.e., pre-lockdown body-mass index, smoking / changes in smoking behavior) were not examined. Our sample – although large and representative – is somewhat limited in that only active internet users were recruited; COVID-19 lockdown was ongoing during recruitment; thus it was impossible to recruit outwith the online domain.

Future research should focus on establishing more specific details of the likely bidirectional causal relationship between poor mental health and changes in health behaviors during lockdown. Overall results suggest that those who had made small positive changes were demonstrating less negative mood. It is then suggested that were lockdown conditions to be reintroduced due to COVID-19 or another pandemic, wellbeing may be linked to making small improvements in diet, sleep and physical activity.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by School of Education and Social Sciences, University of the West of Scotland Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JI performed initial research question, literature review, design, interpretation, and write-up. GM performed design, online survey/experiment building, data analysis, interpretation, and write-up. CH performed initial research question, design, data analysis, interpretation, write-up, and submission. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.588604/full#supplementary-material

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Corrigendum: Changes in Diet, Sleep, and Physical Activity Are Associated With Differences in Negative Mood During COVID-19 Lockdown

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In the original article, there was an error. An inaccurate statement was made in the Funding statement.

A correction has been made to Funding. The corrected statement reads as follows:

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Does Distance Produce Beauty? The Influence of COVID-19 Lockdown on the Coach-Athlete Relationship in a Chinese Football School

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This paper examined the relationship between coaches and youth athletes in China by comparing data collected before and after the lockdown. A total of 221 youth athletes aged 13–19 years in one professional football school completed coach-athlete relationship questionnaires. The rank-sum test was used to verify the differences in the data. The results of the Mann-Whitney U test showed that mean value of the three dimensions of the coach-athlete relationship (closeness, commitment, and complementarity) increased after the COVID-19 lockdown. The results also showed that athletes of different age categories showed different changes in the coach-athlete relationship after the lockdown, and the changes were not significantly related to the severity of the COVID-19 epidemic. The theoretical and practical implications are discussed.

Keywords: COVID-19, lockdown, coach-athlete relationship, Chinese football school, improvement

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INTRODUCTION

COVID-19 is spreading rapidly around the world. To control the spread of the epidemic, countries with severe outbreaks, such as China, Italy, and the United Kingdom, have adopted different levels of lockdown measures. Among these, the lockdown measures adopted in China are probably the most stringent. The lockdown measures have exerted a severe impact on the economy and people's lives. Taking China as an example, in the first quarter of 2020, GDP fell by 6.8% in comparison to the same period of the previous year (National Bureau of Statistics, 2020). In addition to affecting the economy, the lockdown policy also affects the people. Here, we are concerned with the impact of the lockdown on youth athletes in a Chinese professional football school. We are curious to determine whether the coach-athlete relationship has been influenced by the lockdown.

In recent years, researchers have addressed the relationship between coaches and athletes as a psychological phenomenon (Jowett and Arthur, 2019). This relationship is an essential concept in sports psychology and has received extensive attention (Horne and Carron, 1985; Philippe and Seiler, 2006; Yang and Jowett, 2016; Currie, 2019; Jowett and Arthur, 2019; Wachsmuth et al., 2020). The conceptual model of Wylleman (2000) asserted that the relationship between coaches and athletes could be defined based on the behavior of coaches and athletes on the playing field (Wylleman, 2000). LaVoi (2004) described the coach-athlete relationship in a sports environment as a sense of belonging and noted the possible personal benefits of closeness with others (LaVoi, 2004). Poczwardowski and colleagues (Poczwardowski, 1998; Poczwardowski et al., 2002) proposed the use of a qualitative research binary framework to study the coach-athlete relationship, conceptualizing it as a repeating pattern of mutual care between athletes and coaches (Poczwardowski et al., 2002). Jowett and her colleagues defined the coach-athlete relationship as "a social situation created from the interplay of their interpersonal feelings, thoughts, and behaviors" (Jowett, 2007; Jowett and Arthur, 2019, 430). In Jowett's conceptual model, this relationship was characterized as comprising (a) closeness, which refers to the emotional bond established between coaches and athletes, reflected in their mutual trust and respect, emotional care and support, and interpersonal communication and appreciation; (b) commitment, which refers to the cognitive ties between coaches and athletes, which show that they are willing to maintain a close, long-term relationship; and (c) complementarity, which refers to the behavioral connection between coaches and athletes, expressed as a degree of collaboration and cooperation (Jowett and Arthur, 2019, 430).

The focus of each conceptual model above is different, but scholars seem to agree that the coach-athlete relationship is a mutual relationship between coaches and athletes (Wylleman, 2000; Poczwardowski et al., 2002; LaVoi, 2004; Jowett, 2007). Based on their research, we can propose an integrated coach-athlete relationship influence model: personal characteristics, social-cultural sports environment and relationship characteristics affect feelings (closeness), thoughts (commitment) and behavior (complementarity) through mutual communication, which once again influences intrapersonal outcomes, interpersonal outcomes and team outcomes (Jowett and Poczwardowski, 2007, 10). Communication is a bridge and bond between members of the coach-athlete relationship (Montgomery and Baxter, 1998; Jowett and Poczwardowski, 2007, 11). In other words, communication is the process of alienation, closeness, or even merging between coaches and athletes (Montgomery and Baxter, 1998; Jowett and Poczwardowski, 2007, 11). Communication is the basis for establishing a harmonious and stable coach-athlete relationship; in turn, the relationship will also affect communication (Montgomery and Baxter, 1998; Jowett and Poczwardowski, 2007, 11). Therefore, communication plays a very important role in the coach-athlete relationship. During the COVID-19 lockdown, the way people (including coaches and athletes) communicate has changed dramatically (Dalton et al., 2020; Yu et al., 2020). Will this extensive change in communication affect the coach-athlete relationship? This question deserves further study. Most existing empirical studies have focused on the antecedent variables (leadership, stress), outcome variables (burnout, satisfaction), and mediation effects (achievement goals) of coach-athlete relationships (Isoard-Gautheur et al., 2016; Thelwell et al., 2017; Davis et al., 2019). Some scholars have conducted comparative research based on coach-athlete relationships (Lenzen et al., 2004; Yang and Jowett, 2012). Existing comparative studies of coach-athlete relationships have focused on cross-cultural research (Yang and Jowett, 2012) and cross-sport types (Lenzen et al., 2004). To the best of our knowledge, no scholars have conducted comparative research on the coach-athlete relationship itself as related to the COVID-19 lockdown. To explore the impact of changes in communication on coach-athlete relationships, a comparative study of coach-athlete relationships data before and after the COVID-19 lockdown may be meaningful and innovative.

Sports psychologists have pointed out that new hypotheses related to theories are based on researchers' observations related to social behavior (Jowett and Poczwardowski, 2007, 7). Such exploratory research will lead to an increase in our understanding of the theory (Jowett and Poczwardowski, 2007, 7). To better understand coach-athlete relationships, it is meaningful to continue to deepen the research on such relationships under the significant changes in communication caused by the COVID-19 lockdown.

MATERIALS AND METHODS

Participants

With the consent of the football school and the participants' legal guardian/next of kin, two hundred twenty-one male football players from the school agreed to complete the same questionnaire survey before the lockdown from January 4–17, 2020 and again after the lockdown on April 17, 2020. The mean age of the athletes was 15.11 years (M_{age} = 15.11 years, age range, 13–19 years, SD ± 1.82) before lockdown and 15.47 years (M_{age} = 15.47 years, age range, 13–19 years, SD ± 1.96) after lockdown. The sample distribution according to age is shown in **Table 4**. The regional distribution of participants was as follows: Anhui 6, Beijing 9, Fujian 2, Gansu 1, Guangdong 6, Guangxi 2, Hebei 4, Henan 8, Heilongjiang 1, Hunan 7, Jiangsu 5, Jiangxi 1, Liaoning 8, Ningxia 1, Shandong 113, Shnxi 1, Sichuan 5, Tianjin 3, Xinjiang 9, and Yunnan 5.

Measures

We used the Chinese version (Yang and Jowett, 2010) of the Coach-Athlete Relationship Questionnaire (CART-Q), developed by Jowett and Ntoumanis (2004), in this study. The 11-item CART-Q was employed to assess athletes' perceptions of the quality of the relationship with their coach. This questionnaire contained four items on closeness (e.g., I respect my coach), three items on commitment (e.g., I feel committed to my coach), and four items on complementarity (e.g., When I am coached by my coach, I feel at ease). A five-point Likert scale was used for the measures. The Cronbach alpha values of the questionnaire in this study were as follows: closeness 0.769, commitment 0.723, complementarity 0.668, and the whole scale 0.877 (before lockdown); closeness 0.763, commitment 0.754, complementarity 0.722, and the whole scale 0.902 (after lockdown). We conducted a confirmatory factor analysis of the scale, and the results showed that the scales had appropriate validity indicators (Eisinga et al., 2013). The results were as follows: KMO = 0.885, χ^2/df = 1.842, GFI = 0.942, RMSEA = 0.067, RMR = 0.039, CFI = 0.968, NFI = 0.934, NNFI = 0.950 (before lockdown); KMO = 0.908, χ^2/df = 1.767, GFI = 0.957, RMSEA = 0.062,

RMR = 0.012, CFI = 0.983, NFI = 0.963, NNFI = 0.966 (after lockdown).

Procedure

This study was carried out in accordance with the recommendations and ethical guidelines of the Ethical Review Board of Beijing Jiaotong University JG201905017. The protocol was approved by the Ethical Review Board of Beijing Jiaotong University. All subjects gave written informed consent in accordance with the Declaration of Helsinki. This study was conducted at a Chinese professional football school that was closed for 3 months under the COVID-19 lockdown. During these participants' time at the school before the COVID-19 lockdown, coaches were responsible for the cultivation of football skills among the youth players. To improve training efficiency and effectiveness, coaches usually lived in campus dorms. The sudden outbreak of COVID-19 forced the players to return home and stay at home for a long time due to the lockdown. The participants ended their winter training and returned to their homes around January 20. At that time, online teaching of general knowledge by teachers and online professional training by coaches were adopted, using WeChat, WeChat groups, and telephone instant messaging to manage the learning and training of athletes.

The data were collected twice, and the two questionnaires had the same content. The first data collection procedure used a paper questionnaire, and the participating athletes completed the questionnaire in the classroom. During the completion process, the coach and teacher were not present. The researchers distributed the questionnaire to the athletes and explained to them that the purpose of the questionnaire survey was scientific research and that it needed to be completed anonymously and independently according to their own understanding. The athletes were given 5 min to fill out the questionnaires, and then the researchers collected them all. The entire survey, including the instructions, took a total of 10 min. Due to the limitations of the research conditions, it was not possible for all athletes to complete the questionnaires at the same time, so the first group of questionnaires were completed and collected within a 2-week period. After the questionnaires were collected, they were manually encoded and entered into the computer, thereby constituting the first data set of this study.

Casler et al. (2013) has noted that electronic questionnaires can obtain data characteristics similar to paper questionnaires. The athletes were distributed in their homes in 20 provinces after they left Shandong Luneng Taishan Football School. They had not yet returned to the school, and it was thus impossible to collect the paper questionnaire again. Therefore, the second survey took the form of an electronic questionnaire. During the completion process, neither the coach nor the teacher was present. The researchers sent the electronic questionnaire to the athletes through the WeChat group and explained to them that the purpose of the questionnaire survey was scientific research and that the survey needed to be filled out anonymously and independently according to their own understanding. The athletes completed the response and submission of the questionnaire on April 17. We obtained the secondary data of this study from the questionnaire system on April 18.

We cleaned the survey data by deleting scales with open items, all answers the same, contradictory answers or more than one answer. The electronic questionnaire was tested before it was issued. The test showed that the questionnaire response time was 40–50 s. Given the youths' cognitive level, we deleted any scales with a response time within 60 s (answering too quickly may reflect a coping attitude and may pollute the data). Therefore, we obtained 190 (86%) valid questionnaires for the first survey and 197 (89%) for the second survey. The respondents were not compensated for their participation in the study. The researchers informed the participants about the purpose of the study (for research only) and that the questionnaires were anonymous. In addition, respondents were told to complete the scales alone.

Statistical Analysis

We used SPSS software version 25.0, The The SPSSAU project (2020), and Microsoft Excel software to analyze the sample data obtained through measuring the three dimensions of the coach-athlete relationship before and after the COVID-19 lockdown. Distribution normality was assessed using the Kolmogorov–Smirnov test. Normally distributed data were analyzed with the T-test, while non-normally distributed data were analyzed with the rank-sum test. We tested the significance level (**Table 1**) and Pearson correlation coefficient of each test variable and conducted comparative studies based on age groupings and regional differences.

RESULTS

Normality Test

In this study, the Kolmogorov–Smirnov test was used to evaluate distribution normality. As shown in **Table 2**, the test results showed that the samples collected before and after the COVID-19 lockdown did not conform to a normal distribution, and thus the rank-sum test should be used to verify the differences in the data.

Average Value Difference Examination

Difference Examination

Because the samples did not conform to a normal distribution, the rank-sum test was used to verify the differences in the data. The Mann-Whitney U significance test method was thus adopted to verify the differences in the samples collected before and after lockdown. As **Table 3** shows, the results showed that athletes' closeness to coaches before COVID-19 lockdown was significantly different from that after the COVID-19 lockdown ($Z = -5.390$, $p < 0.001$), as was their commitment to coaches ($Z = -7.586$, $p < 0.001$) and their complementarity with coaches ($Z = -6.068$, $p < 0.001$).

Next, we compared the differences between the two groups. As **Table 3** shows, the mean value of closeness after the COVID-19 lockdown was higher than that before ($4.799 > 4.514$), the mean value of commitment after the COVID-19 lockdown was higher than that before ($4.592 > 4.072$), and the mean value of

TABLE 1 | Significance of the variables.

	Dimensions	α	α	KMO	χ^2/df	GFI	RMSEA	RMR	CFI	NFI	NNFI
1	Closeness	0.769	0.877	0.885	1.842	0.942	0.067	0.039	0.968	0.934	0.950
	Commitment	0.723									
	Complementarity	0.668									
2	Closeness	0.763	0.902	0.908	1.767	0.957	0.062	0.012	0.983	0.963	0.966
	Commitment	0.754									
	Complementarity	0.722									

1 = sample before COVID-19 lockdown; 2 = sample after COVID-19 lockdown; α = Cronbach α; KMO = KMO and Bartlett test.

TABLE 2 | Normality test of data before and after lockdown.

	Variables	*N*	Normality	Extreme difference			Kolmogorov–Smirnov Z	*Sig.*
			Mean ± SD	Absolute	Plus	Minus		
1	Closeness	190	4.514 ± 0.610	0.229	0.213	−0.229	0.229	0.000
	Commitment	190	4.072 ± 0.787	0.154	0.119	−0.154	0.154	0.000
	Complementarity	190	4.270 ± 0.637	0.148	0.126	−0.148	0.148	0.000
2	Closeness	197	4.799 ± 0.393	0.381	0.305	−0.381	0.381	0.000
	Commitment	197	4.592 ± 0.575	0.284	0.239	−0.284	0.284	0.000
	Complementarity	197	4.638 ± 0.496	0.244	0.233	−0.244	0.244	0.000

N, number of samples; 1 = sample before COVID-19 lockdown; 2 = sample after COVID-19 lockdown.

TABLE 3 | Testing of significant differences and comparison of samples.

Variables	Group	*N*	Mean ± SD	Mean rank	Sum of ranks	Mann-Whitney U	Wilcoxon W	*Z*	*Sig.*
Closeness	1	190	4.514 ± 0.610	165.82	31506.50	13361.500	31506.500	−5.390	0.000
	2	197	4.799 ± 0.393	221.18	43571.50				
Commitment	1	190	4.072 ± 0.787	151.28	28742.50	10597.500	28742.500	−7.586	0.000
	2	197	4.592 ± 0.575	235.21	46335.50				
Complementarity	1	190	4.270 ± 0.637	159.92	30385.00	12240.000	30385.000	−6.068	0.000
	2	197	4.638 ± 0.496	226.87	44693.00				

N, number of samples; 1 = sample before COVID-19 lockdown; 2 = sample after COVID-19 lockdown.

complementarity after the COVID-19 lockdown was also higher than that before (4.638 > 4.270).

Analysis by Age

We next compared and analyzed the data of the three dimensions of coach-athlete relationship before and after the COVID-19 lockdown according to age (see **Table 4**). As shown in the table, in the 13-, 14-, 15-, 16-, 17-, and 19-year-old age groups, the values of closeness, commitment, and complementarity significantly increased after lockdown. We separately measured the percentage change in the mean according to age by group in the following order: 13-, 14-, 15-, 16-, 17-, and 19-year-olds. The increases in closeness by age group were 1.97%, 3.49%, 10.90%, 7.40%, 9.13%, and 15.12%, respectively. Among these groups, the increase is largest for the 19-year-old group and is the smallest for the 13-year-old group. Similarly, the increases in age in terms of commitment were, respectively, 12.79%, 7.13%, 19.3%, 13.96%, 10.30%, and 26.23%. Among these groups, the data show the greatest increase for the 19-year-olds; however, unlike the closeness index, the data for commitment is the smallest for the 14-year-olds. Finally, in terms of complementarity, each age group also improved as follows: 3.32%, 5.25%, 20.64%, 7.24%, 11.05%, and 12.30%, respectively. Unlike the other two variables, the data for complementarity show the greatest improvement for the 15-year-olds and the smallest improvement for the 13-year-olds.

Analysis by Region

We used correlation analysis to study the correlations among regional confirmed COVID-19 cases and closeness, commitment, and complementarity, using the Pearson correlation coefficient to indicate the strength of the correlation (Arndt et al., 1999; Hauke and Kossowski, 2011). Specific analysis showed the following (see **Table 5**): confirmed cases and closeness, commitment, and complementarity did not show significant correlations among the three items; the correlation coefficient values were 0.155, 0.056, 0.074, respectively; all were close to 0; and the *p* values were all greater than 0.05, indicating that there were no significant correlations among confirmed cases and closeness, commitment, and complementarity. **Figure 1** represents the actual relationships among these variables. The trend line of the number of confirmed cases in various regions has no common or

TABLE 4 | Analysis results based on age.

	Age	N	Closeness		Commitment		Complementarity	
			Mean ± SD	Increase	Mean ± SD	Increase	Mean ± SD	Increase
1	13	39	4.76 ± 0.60	1.89%	4.20 ± 1.11	12.79%	4.51 ± 0.88	3.32%
2		45	4.85 ± 0.41		4.73 ± 0.52		4.66 ± 0.68	
1	14	49	4.76 ± 0.55	3.49%	4.42 ± 0.74	7.13%	4.53 ± 0.82	5.25%
2		19	4.92 ± 0.27		4.74 ± 0.51		4.76 ± 0.56	
1	15	35	4.30 ± 1.03	10.90%	3.80 ± 1.09	19.30%	3.83 ± 1.28	20.64%
2		40	4.77 ± 0.49		4.53 ± 0.76		4.62 ± 0.66	
1	16	24	4.48 ± 0.76	7.40%	4.04 ± 0.95	13.96%	4.30 ± 0.89	7.24%
2		33	4.81 ± 0.57		4.61 ± 0.75		4.61 ± 0.78	
1	17	24	4.21 ± 0.87	9.13%	3.81 ± 0.84	10.30%	3.97 ± 0.98	11.05%
2		27	4.59 ± 0.75		4.20 ± 0.97		4.41 ± 0.89	
1	18							
2		13	4.79 ± 0.45		4.49 ± 0.75		4.67 ± 0.61	
1	19	19	4.22 ± 0.91	15.12%	3.79 ± 1.21	26.23%	4.26 ± 0.77	12.30%
2		20	4.86 ± 0.47		4.78 ± 0.52		4.79 ± 0.54	

N, number of samples; 1 = sample before COVID-19 lockdown; 2 = sample after COVID-19 lockdown.

TABLE 5 | Correlation analysis results of CAR and regional confirmed cases.

	Mean ± SD	Case	Closeness	Commitment	Complementarity
Case	567.85 ± 438.982	1			
Closeness	4.763 ± 0.311	0.155	1		
Commitment	4.506 ± 0.447	0.056	0.653**	1	
Complementarity	4.583 ± 0.347	0.074	0.820**	0.805**	1

$^{**}p < 0.01$; Case: COVID-19 Regional Confirmed Cases.

opposite trend with the coach-athlete relationship level before or after lockdown, as shown in **Figure 1**.

DISCUSSION

The main purpose of this study was to examine the changes in the coach-athlete relationship from before to after lockdown. The research provided important information for the academic community on the cultivation of youth athletes. The establishment and application of multiple communication methods, combined with tension-relief and relaxation training methods, might help to better develop coach-athlete relationships.

The first conclusion we draw is that the mean values of the three dimensions of coach-athlete relationship after lockdown are higher than those before lockdown, which is contrary to our expected result based on common sense (Przybylski and Weinstein, 2013). We expected the coach-athlete relationship to be negatively affected due to lockdown. The second conclusion is that lockdown has different effects on closeness, commitment, and complementarity at different ages. This point is a more in-depth analysis of the first conclusion. The comparison results for the various age groups are different, which is consistent with the trend of the first conclusion. The third conclusion is that the relationship between the impact of lockdown on the coach-athlete relationship and the severity of the epidemic of each province is not significant. Through this study, we evaluated each of the dimensions of the CART-Q, which would be very useful for future researchers to better understand what this instrument evaluates. The following factors may be involved in these findings. First, lockdown changes the way coaches and athletes communicate (Dalton et al., 2020; Yu et al., 2020). Indirect online communication reduces the sense of leadership (coach) status and shortens the psychological distance between leaders (coach) and their subordinates (athletes). This kind of communication avoids the reduced communication effect caused by the unequal status (Remland, 1984) and psychological distance (Brunelle, 2013) experienced in face-to-face communication between the superior and the subordinate. These changes in communication methods and the long-term lockdown may make athletes miss their training life with their coaches and teammates and, consequently, make them more eager to return to the training ground, thereby improving the relationship between coaches and athletes from the perspective of athletes. These postulations may require deeper empirical research to prove. In addition to these possible causes, we would assert that there are other reasons for this change.

The face-to-face communication relationship is more inclined toward hierarchical and one-way communication (Sannomiya and Kawaguchi, 1999; Kirkman et al., 2004); after the lockdown,

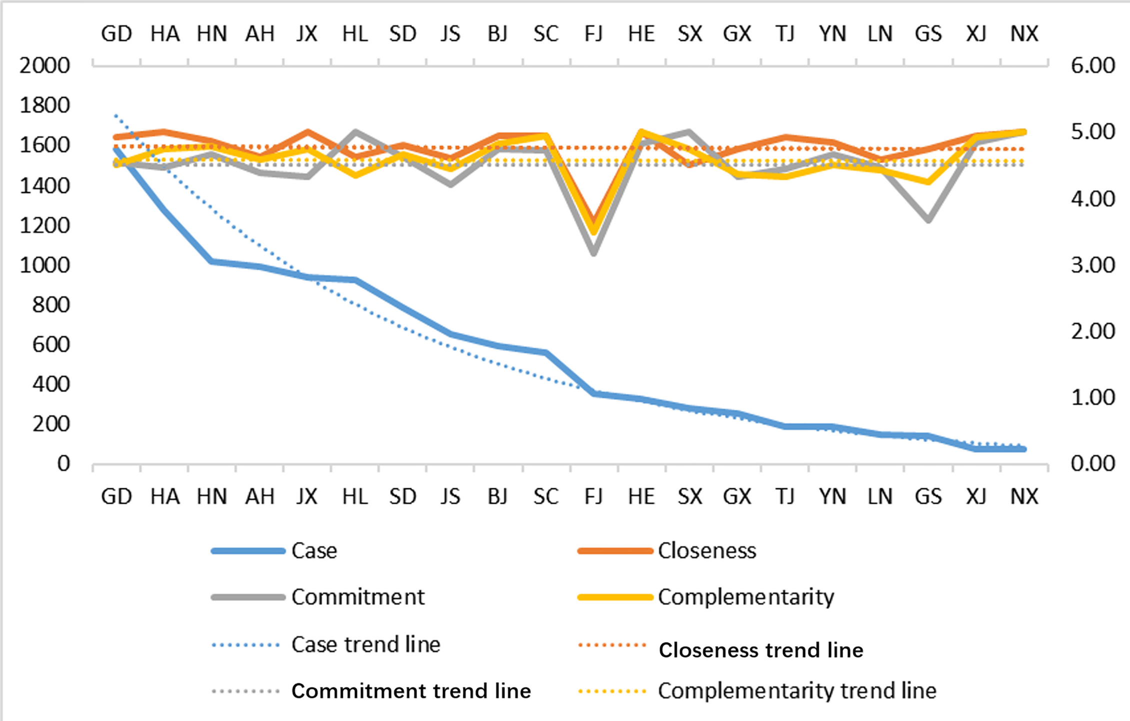

FIGURE 1 | Comparison of regional confirmed cases and CAR mean level. Case: number of COVID-19 confirmed cases by region; Data source: China National Health Commission, provincial and municipal health committees, provincial and municipal governments, Hong Kong, Macao and Taiwan official channels. Data as of April 25, 2020 1:51. English abbreviations of Chinese provinces: Ningxia NX, Xinjiang XJ, Gansu GS, Liaoning LN, Yunnan YN, Tianjin TJ, Guangxi GX, Shanxi SX, Hebei HE, Fujian FJ, Sichuan SC, Beijing BJ, Jiangsu JS, Shandong SD, Heilongjiang HL, Jiangxi JX, Anhui AN, Hunan HN, Henan HA, Guangdong GD.

a greater use of social media created more equal and diversified communication (Clarke and Eslami, 2019). However, if no previous foundation has been built through face-to-face communication, it is impossible to engage in truly effective social media communication (Dunbar, 2016). Lockdown gives more opportunities to think, supplement and correct existing interpersonal relationships (Pan et al., 2020). These two communication methods are complementary (Casler et al., 2013; Dunbar, 2016). Therefore, we should give full play to the role of multiple communication media to encourage athletes to actively participate in decision-making and learn from one another (Wu et al., 2016). In addition, lockdown also allows for more empathy, mutual care and concern between the two sides of the exchange (Pan et al., 2020), which lays the foundation for establishing a good relationship after returning to work and school (Westerman et al., 2016).

Second, the lockdown has changed the communication environment between coaches and athletes. Athletes accept militarized boarding management in football schools, and families play a limited direct role in communication. Although coaches and athletes communicate face to face, players lack family support and security. When athletes are at home and participate in online communication, the family gives the athletes support and a sense of security (Fitriana and Xin, 2019). The athletes may then dare to communicate with the coach with a more equal and peaceful attitude and accept the coach's guidance. From this hypothesis, we also infer that the family's role for athletes during lockdown is not only communicating but also providing a warm and harmonious environment (Fitriana and Xin, 2019). Athletes returning home on vacation experience a kind of psychological relaxation and adjustment (Kühnel and Sonnentag, 2011). Proper vacations are conducive to the growth of athletes and help reduce the effects of burnout (Lemyre et al., 2007). This situation also proves that family support can be conducive to athletes' progress, better coach-athlete relationships and superior performance (Fitriana and Xin, 2019).

These results lead us to think deeply. Should young athletes differentiate their mental training content by age in Chinese football school? The difference between the mean before and after lockdown according to age provides us with certain empirical evidence. Moreover, will the diligent and controlled method advocated by football schools lead to psychological disorders in young athletes? In the past, we have advocated not wasting time, orienting training toward efficiency, and ignoring the role of relaxation in life and training, which is, in fact, not conducive to the recovery of youth athletes' mental health (Li, 2019). The goal of coaches to improve performance-oriented training ignores athletes' other psychological needs, resulting in the failure of the coach-athlete relationship to attain a high level (Li, 2019). Shandong Luneng Taishan Football School delivered more than 230 players to the Chinese national football team at all levels (Chinese Football Association, 2019). The data survey based on this case reflects some issues in talent training and provides a reference for future training models.

As discussed above, the lockdown has changed the method and content of communication between coaches and athletes. From the results of geographic analysis, it can be seen that the average value of coach-athlete relationship has no significant correlation with the number of confirmed cases in the region. The above content has analyzed the reasons for the change of the mean, which further shows that online education is not easily restricted by social emergencies, and also shows the advantages of online education (Xinhuanet, 2020). Further, we have found from observation and investigation that during face-to-face training between athletes and coaches, the coaches offered assistance through on-site teaching tools for on-site professional training, personal demonstrations, and demonstration by high-performing team members. In online teaching, to express the training content more vividly, the coaches use more words to describe the training content, which muscles should be trained to obtain specific types of strength, and which muscle groups are being exercised in each training drill (evidence found through observation; Xu, 2017). In front of the camera, the coach used more body language to demonstrate the teaching content (Yue and Zou, 2019). For more effective expression, the coach used more vibrant language in descriptions (Xu, 2017; Yue and Zou, 2019). In addition, the coach was able to observe the movement of each athlete through the camera and make timely corrections (Xu, 2017; Yue and Zou, 2019). These changes are positive and may be effective in improving coach-athlete relationship.

This research offers many inspiring ideas for practical application: (a) We will usher in the explosion of online education and diversification of online teaching methods (Weisband and Atwater, 1999; Radha et al., 2020; Su, 2020). Online teaching has been carried out for years, but there has been resistance to placing great pressure on a single group and taking a full 3-month period to conduct online teaching to verify the effect of this approach. Lockdown has provided us with an opportunity to verify the effectiveness of online teaching (Shenoy et al., 2020; Su, 2020). Therefore, it is expected that the lockdown will usher in the explosive development of online teaching for years into the future (Yue and Zou, 2019; Radha et al., 2020; Shenoy et al., 2020; Su, 2020). This situation is an opportunity for online educators and a challenge to traditional tutoring and training institutions (Shenoy et al., 2020; Su, 2020). It may be that some offline education and training institutions will face challenges to their survival (Su, 2020).

(b) We can improve employment and change people's perception of new occupations. At present, people's perception of online anchors has a specific entertainment value (He, 2019). During the lockdown period, Chinese teachers have become online anchors, and they have also produced many internet humorous videos for various reasons (Zhang, 2020). These internet jokes include the following: *the most tired anchor of the live-broadcast classroom: the physical education teacher; the online classroom in the epidemic situation: the embarrassing "teacher anchor"; and the teacher is also crazy: I broadcast the online class at home, and I crashed faster than the live-broadcast software* (Tencent, 2020). Coaches at football schools have also had to lead players to train at home through live webcasts. The findings of this study confirm that live-broadcast courses that can effectively control the classroom are practical (Yue and Zou, 2019; Zhang, 2020). This finding may develop another career: online sports coaching, which is not restricted by space, geography, or time (coaches give physical education lessons through online media). There is potentially a variety of teaching methods and a variety of class sizes. Live broadcasts to homes will allow students to be recruited from all over the world and will enable the full sharing of global resources (Yue and Zou, 2019).

(c) We will save social resources. Most sports projects have venue requirements (Yue and Zou, 2019). If football training can be combined with offline training in the future, in places where the venue resources are insufficient, it will improve the efficiency of venue utilization, reduce the cost of sports training, and reduce the space required for sports grounds (Yue and Zou, 2019). This study also has limitations. First, when we first collected data, we did not predict that the lockdown would occur, so the first dataset did not include geographic information. This omission made it impossible for us to conduct a comparative analysis by region before and after lockdown, and we cannot obtain a more in-depth analytical result. Furthermore, this study is limited by the source and number of samples. The regional sample size distribution is uneven, and the interpretation of the results may produce biased conclusions. Finally, this study selected one school as the research object, and the sample size is limited. Due to the different requirements of the education authorities in different regions, the specific implementation measures of the school are unique to that region. Due to the limitations of the school's supporting teaching methods, the situation of each school may vary.

CONCLUSION

The multimedia teaching method of communication adopted during lockdown gave us an opportunity to reexamine the coach-athlete relationship. The results of the study showed that during the lockdown period, remote communication methods such as multimedia based on face-to-face communication, assisted by a loose communication environment and rich communication content, promoted the improved quality of the coach-athlete relationship as experienced by athletes.

The coach-athlete relationship is an essential variable in sports teams (Côté and Gilbert, 2009; Yang and Jowett, 2012). Its improvement will bring a chain reaction, fostering satisfaction (Lorimer and Jowett, 2009), reduced burnout (Isoard-Gautheur et al., 2016), organizational citizenship behavior (Cummins and Spencer, 2015), performance (Jowett, 2017), team cohesion (Jowett and Chaundy, 2004) and other changes. To assess the degree of impact on the other variables due to the lockdown, further research is needed for observation and investigation.

Several Chinese leaders have mentioned that football should start with children (Hanwang-Wuhan Evening News, 2014), and the professional ability training of young athletes relies on a good relationship between coaches and athletes (Jiang, 2018). This goal requires us to fully understand the coach-athlete relationship.

In the field of Chinese youth football training, such understanding requires more in-depth scientific research.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Beijing Jiaotong University. The participants, and where necessary, the participants' legal guardian/next of kin provided written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JL designed the research and completed the manuscript. HG designed the research with JL and proposed the discussion. CZ completed the data collection. PL completed most of the data analysis and writing of the results. All authors contributed to the article and approved the submitted version.

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The Effect of COVID-19 Confinement in Behavioral, Psychological, and Training Patterns of Chess Players

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The outbreak of COVID-19 has triggered a pandemic, jeopardizing global health. The sports world is also suffering enormous consequences, such as the suspension of the Olympic Games in Tokyo or, in chess, the cancelation of the World Candidates Tournament 2020. Chess is a sport characterized by high psychophysiological demands derived from long training durations, tournaments, and games, leading to mental, emotional, and physical stress. These characteristics could provide chess players a certain advantage in facing quarantine situations. This study aimed to analyze the effect of COVID-19 confinement on behavioral, psychological, and training patterns of chess players based on their gender, level of education, and level of chess played. We analyzed chess players (*N*: 450; age = 38.12 ± 14.01 years) in countries where confinement was mandatory: Professional players (*N*: 55; age = 43.35 ± 13), high-performance players (*N*: 53; age = 38.57 ± 13.46), competitive players (*N*: 284; age = 36.82 ± 13.91), and amateur players (*N*: 58; age = 39.10 ± 14.99). Results showed that chess players significantly decreased physical activity per day while increased chess practise during the confinement period. However, anxiety levels remained moderate despite the anti-stress effects of physical activity. Amateur players showed a significantly higher level of social alarm than professional and high-performance players. Moreover, professional players showed higher values of extraversion than high-performance players and amateur players. In neuroticism, professional players showed higher values than high-performance players. In addition, the professional players showed higher scores in psychological inflexibility than competitive players. Finally, chess players with the highest academic level showed higher levels of personal concern and anxiety due to COVID-19 as well as lower psychological inflexibility compared to those with a lower academic level. In conclusion, chess players, especially those with a higher academic level, might have adapted their psychological profile to fit confinement situations and the worrying levels of physical inactivity.

Keywords: chess, physical activity, psychological inflexibility, personality, anxiety, stress

INTRODUCTION

In December 2019, a novel coronavirus emerged in China, which posed an international public health emergency. This virus was named as the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) (Rodriguez-Morales et al., 2020). On April 6, 2020, there were 1,210,956 confirmed cases and 67,598 deaths worldwide [World Health Organization (WHO), 2020a]. Therefore, on March 11, 2020 the new coronavirus disease 2019 (COVID-19) was described as a pandemic by the World Health Organization (WHO) (2020a). With no vaccine available and no herd immunity, most of the world governments decreed a quarantine to stop the pandemic (Clemente-Suárez et al., 2020).

COVID-19 confinement produces negative psychological effects, including post-traumatic stress, confusion, or anger (Brooks et al., 2020). In this context, the confinement is the highest rated preventive measure of the Spanish population (de la Vega et al., 2020). During the confinement, most individuals are exposed to an unprecedented situation of unknown duration, being exposed to anxiety, fear, depression, or sleep disruption (Altena et al., 2020). Considering the behavioral immune system theory (Terrizzi et al., 2013), in the pandemic, people would develop these somatizations due to a negative appraisal of the situation and self-protection (Li et al., 2020). Previous studies in long confinement (105 days) produced direct modifications in stress hormone levels and immune functions (Strewe et al., 2015). Moreover, studies carried out on involuntary confinement (prisoners), showed a different incidence of psychiatric morbidity (Andersen et al., 2000).

The COVID-19 pandemic is globally affecting physical activity behaviors, forcing many people around the world to self-isolate for a prolonged time (Hammami et al., 2020). This makes it challenging to comply with the global World Health Organization (WHO) (2020b) physical activity recommendations (2020), and leads to an increase in sedentary behaviors, such as spending excessive time sat down, or using screens (playing games, watching television, using mobile devices) (Chen P. J. et al., 2020). Nevertheless, practical recommendations for staying active at home, with aerobic exercise on ergometers, bodyweight training, dance, or active video games, can help to counteract the detrimental physical and mental side effects of the COVID-19 confinement (Hammami et al., 2020).

Ahtlethes have also suffered the enormous consequences of this pandemic. For instance, the Tokyo 2020 Olympic Games was postponed until 2021 (International Olympic Committee, 2020) and the International Chess Federation (2020) (FIDE) canceled the World Candidates Tournament 2020 (FIDE, 2020). Chess is considered a sport with high psychophysiological demands where players are exposed to higher levels of stress and cognitive load (Fuentes-Garcia et al., 2018, Fuentes-Garcia et al., 2019a,b,c, 2020; Villafaina et al., 2019). Previous neuropsychological studies have shown the benefits of chess practice in executive functions, facilitating the adaptation to complex or not routine situations (Grau-Perez and Moreira, 2017; Ramos et al., 2018). Therefore, chess players showed an excellent ability for planning, self-controlling, coping, or problem-solving (Cuéllar and Díaz, 2009; Aciego et al., 2012).

Since personality modulates stress and cognition relationships (Radtke et al., 2020), a chess player's personality could influence how they face COVID-19 confinement. In this regard, chess players are characterized for unconventional thinking and orderliness (Radtke et al., 2020), being highly competitive players, and more suspicious (Avni et al., 1987), and introverted (Vollstadt-Klein et al., 2010) than non-players. Interestingly, personality differences are evident even in young children who play chess. Children, who scored high in intellect/openness and energy/extraversion, are more likely to play chess, while children who score higher on agreeableness are less likely to play chess (Bilalic et al., 2007). Then, this study aimed to analyze the effect of COVID-19 confinement in behavioral, psychological, and training patterns of chess players based on their gender, level of education, and level of chess game.

MATERIALS AND METHODS

Participants

A total of 450 chess players (38.12 ± 14.01), residents in 29 different countries of Asia, America, Africa, and Europe were analyzed. All the participants competed in the World Chess Federation (FIDE) and were classified according to the ranking system developed by Elo (1978). They were divided into four groups: (1) Professional players: players holding the highest level qualification or the second-highest level awarded by the FIDE, Grand Master and International Master (*N*: 55; age = 43.35 ± 13; ELO = 2414.15 ± 157); (2) High-performance players: players holding the third or fourth highest level of FIDE, FIDE Master and Master Candidate (*N*: 53; age = 38.57 ± 13.46; ELO = 2096.55 ± 156.49); (3) Competitive players: players with FIDE ranking (*N*: 284; age = 36.82 ± 13.91; ELO = 1743.34 ± 276.52) and (4) Amateur players: people who practice chess regularly but do not compete in FIDE tournaments (*N*: 58; age = 39.10 ± 14.99).

The inclusion criteria were: (a) be a chess player of 18 years or older, (b) live, at the time of data collection, in a country where COVID-19 confinement was decreed, (c) have read and signed the written informed consent.

Before participation, experimental procedures were explained to all the participants who gave their voluntary written informed consent, following the Declaration of Helsinki. All the procedures were approved by the Commission of Bioethics and Biosecurity of the University of Extremadura (Spain) (approval number: 57/2020).

Procedure

Chess players completed an online-based questionnaire between March 3, 2020 and April 14, 2020. Firstly, they had to sign the informed consent and then disclose the following information:

Personal Information

- Age, gender, and current country of residence.

Academic and Sport-Related Information

- Academic training (university training, professional training, and high school).
- Indicate the current ELO FIDE, if appropriate.
- Highest FIDE qualification (Grand Master, International Master, FIDE Master, or Master Candidate).
- Before the COVID-19 confinement: how long did you practice chess (playing, giving or receiving classes) approximately daily, on average, considering the 7 days of the week (Nothing, Less than 30 min, Between 30 min and 1 h, between 2 and 3 h, between 4 and 5 h, between 6 and 7 h, 8 or more h)?
- In the present moment (during the confinement): how long did you practice chess (playing, giving or receiving classes) approximately daily, on average, considering the 7 days of the week (Nothing, Less than 30 min, Between 30 min and 1 h, between 2 and 3 h, between 4 and 5 h, between 6 and 7 h, 8 or more h)?
- Before the COVID-19 confinement: how long did you do physical activity (sports, gymnastics) approximately daily, on average, considering the 7 days of the week (Nothing, Less than 30 min, Between 30 min and 1 h, between 2 and 3 h, 4 or more h)?
- In the present moment (during the confinement): how long did you do physical activity (sports, gymnastics) approximately daily, on average, considering the 7 days of the week (Nothing, Less than 30 min, Between 30 min and 1 h, between 2 and 3 h, 4 or more h)?

Individual Perceptions About COVID-19 Crisis in a Liker 1–5 Scale (Adapted From de la Vega et al., 2020)

- Because of the current confinement rules, I consider my options to get my best performance in the most important chess competitions when they are already allowed.
- In this context of COVID-19, I am satisfied with the level of support that public institutions have had with chess players to try to maintain the highest level of preparation.
- Level of personal concern about COVID-19.
- Perception of social alarm by COVID-19.
- Control perception level to avoid getting infected by COVID-19.
- Level of personal care to avoid contagion by COVID-19.
- I consider that the current situation generated by COVID-19 has dramatically affected my chess training routines.

Psychological Profile

- Personality was assessed by the brief version of the Big Five Personality Inventory, where extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience factors were analyzed (Rammstedt and John, 2007).
- Loneliness was evaluated by the short version of the UCLA Loneliness Scale (Hughes et al., 2004).
- Psychological inflexibility was measured by the Acceptance and Action Questionnaire-II. It is a 7-item questionnaire where participants must respond in a 1–7 scale (Ruiz et al., 2013).
- Anxiety was assessed by the State-Trait Anxiety Inventory (STAI) short form (Marteau and Bekker, 1992).

Statistical Analysis

Based on the results of Kolmogorov-Smirnov and Shapiro-Wilk tests, non-parametric tests were used.

The Chi-Square tests were performed (χ^2) to analyze the ordinal categorical variables related to the number of chess and physical activity practises. Mann-Whitney *U* tests were conducted to investigate gender-based differences in ELO and psychological variables. Moreover, Kruskal-Wallis tests were performed to investigate between-group differences (according to the chess performance and level of study) in the psychological variables. The Mann-Whitney *U*-test with the Bonferroni correction for multiple comparisons was conducted to explore pairwise differences.

Kendall's Tau b (τb) was used to explore the correlation between the practice of physical activity and the practice of chess as well as the psychological profile of chess players.

Effect sizes (r), for each test, were calculated. It is classified as follows: 0.5 is a large effect, 0.3 is a medium effect and 0.1 is a small effect (Fritz et al., 2012).

RESULTS

Table 1 showed the descriptive data such as the number of subjects (*N*), Mean (*M*) and Standard deviation (*SD*) of the age, ELO FIDE, and the different variables associated with the Individual perceptions about COVID-19 and the psychological profile. The recruited data (N = 450), were grouped by age (M = 38.12; SD = 14.01), gender [N_{male} = 400 (88.9%), N_{Female} = 50 (11.1%)], level of education [$N_{\text{Universitary}}$ = 284 (63.1%), $N_{\text{Professional}}$ = 72 (16%), $N_{\text{highschool}}$ = 94 (20.9%)], and game level according to FIDE [$N_{\text{Professional players}}$ = 55 (12.2%), $N_{\text{High-performance players}}$ = 53 (11.8%), $N_{\text{Competitive players}}$ = 284 (63.1%), $N_{\text{Amateur players}}$ = 58 (12.9%)].

The Chi-Square tests showed significant higher scores in physical activity practice before confinement (χ^2 = 186.71 p < 0.001 τb = 0.32). Significant effects were observed in the four groups (professional players, high-performance players, competitive players, and amateur chess players) (see **Table 2**).

Regarding chess practice (before and during confinement) results showed significantly higher scores in practice time during the COVID-19 confinement (χ^2 = 367.68 p < 0.001 τb = 0.12). Only amateur chess players did not significantly change the chess practice during confinement (**Table 3**).

Mann Whitney U showed a significantly higher ELO level [Z = -3.156, p < 0.002, effect size (r) = 0.15] in men when compared to women. Moreover, the ELO FIDE score [Z = -2.084, p < 0.037, effect size (r) = 0.10] was higher in men. Regarding the differences in the perception they have about COVID-19, only differences in the level of personal care to avoid infection appeared, with higher scores in the female group [Z = -2.474, p < 0.013, effect size (r) = 0.12]. Finally, in the rest of the variables studied, anxiety and personality, only significant differences in

TABLE 1 | Descriptive statistics of the study variables.

	N	*M*	*SD*
Age	450	38.31	13.70
ELO FIDE	392	1885.21	349.33
Personal concern	450	3.68	1.15
Perception of social alarm	450	4.06	0.98
Perception of control to avoid contagion	450	4.15	0.85
Personal care to avoid contagion	450	4.01	0.95
Altered options for maximum chess performance	450	2.82	1.28
Satisfaction with institutional support	450	3.00	1.26
Alteration of chess training routines by COVID	450	4.59	0.80
Extraversion	450	5.17	1.79
Agreeableness	450	5.58	1.35
Conscientiousness	450	6.78	2.09
Neuroticism	450	4.87	1.87
Openness to experience	450	7.67	1.78
Loneliness (UCLA)	450	4.86	1.77
Psychological inflexibility	450	15.00	6.35
Anxiety	450	12.26	3.54

neuroticism were found with higher scores in the female group [$Z = -1.982$ $p < 0.047$, effect size $(r) = 0.93$].

Kruskal-Wallis tests showed significant differences in the perception of social alarm, extraversion, neuroticism, and cognitive inflexibility ($p < 0.05$). Pairwise comparisons showed that differences were observed between professional players and amateur players, with higher values in the professional players [$Z_{(4,1)} = 61.875$ $p < 0.007$, effect size $(r) = 0.29$]. Differences were also observed between the high-performance players and the amateur players, with higher scores in the high performance group [$Z_{(4,2)} = 66.154$ $p < 0.005$, effect size $(r) = 0.31$]. Regarding personality variables, differences in extraversion were found between the amateur players and the high-performance players, with higher scores in the high performance group [$Z_{(4,2)} = 76.791$ $p < 0.002$, effect size $(r) = 0.36$]. In neuroticism, statistically significant differences were obtained between the professional players and the high-performance players, with higher scores in the high performance group [$Z_{(1,2)} = 78.052$ $p < 0.002$, effect size $(r) = 0.37$]. Lastly, competitive players showed greater psychological inflexibility than professional players [$Z_{(1,3)} = 50.504$ $p < 0.008$, effect size $(r) = 0.23$].

The Kruskal-Wallis analyses also showed differences when comparing chess players according to the level of study. Thus, chess players with a high school education showed higher personal concern than those with university studies [$Z_{(1,3)} = 56.639$ $p < 0.001$, effect size $(r) = 0.26$], as well as those with professional training showed higher scores than those with a high school level education [$Z_{(2,3)} = 67.747$ $p < 0.003$, effect size $(r) = 0.31$]. Regarding cognitive inflexibility, chess

TABLE 2 | Physical activity practise before and during the confinement.

Physical activity practice	Professional players *N* (%)		High-performance players *N* (%)		Competitive players *N* (%)		Amateur players *N* (%)	
	Before	During	Before	During	Before	During	Before	During
Did not practise PA	7 (12.7%)	16 (29.1%)	5 (9.4%)	16 (30.2%)	47 (16.5%)	80 (28.2%)	12 (20.7%)	23 (39.7%)
Less than 30 min/day	9 (16.4%)	17 (30.9%)	16 (30.2%)	12 (22.6%)	61 (21.5%)	89 (31.3%)	8 (13.8%)	10 (17.2%)
Between 30 and 60 min/day	29 (52.7%)	18 (32.7%)	17 (32.1%)	20 (37.7%)	116 (40.8%)	91 (32%)	23 (39.7%)	15 (25.9%)
Between 2 and 3 h/day	7 (12.7%)	2 (3.6%)	11 (20.8%)	2 (3.8%)	44 (15.5%)	19 (6.7%)	8 (13.8%)	5 (8.6%)
More than 4 h/day	3 (5.5%)	2 (3.6%)	4 (7.5%)	3 (5.7%)	16 (5.6%)	5 (1.8%)	7 (12.1%)	5 (8.6%)
	Chi-squared	***p*-value**	**Chi-squared**	***p*-value**	**Chi-squared**	***p*-value**	**Chi-squared**	***p*-value**
	37.758	0.002	28.955	0.024	106.056	< 0.001	34.368	0.005

PA, Physical activity; min, minutes; h, hours.

TABLE 3 | Chess practise before and during the confinement.

Chess practise	Professional players *N* (%)		High-performance players *N* (%)		Competitive players *N* (%)		Amateur players *N* (%)	
	Before	During	Before	During	Before	During	Before	During
Did not play chess	1 (1.8%)	2 (3.6%)	3 (5.7%)	3 (5.7%)	7 (2.5%)	5 (1.8%)	1 (1.7%)	2 (3.4%)
Less than 30 minutes/day	4 (4.7%)	5 (9.1%)	4 (7.5%)	7 (13.2%)	47 (16.5%)	22 (7.7%)	10 (17.2%)	4 (6.9%)
Between 30 and 60 min/day	9 (16.4%)	6 (10.9%)	18 (34%)	9 (17%)	105 (37%)	63 (22.2%)	22 (37.9%)	19 (32.8%)
Between 2 and 3 h/day	9 (16.4%)	10 (18.2%)	17 (32.1%)	16 (30.2%)	67 (23.6%)	99 (34.9%)	13 (22.4%)	16 (27.6%)
Between 4 and 5 h/day	12 (21.8%)	14 (25.5%)	5 (9.4%)	9 (17%)	28 (9.9%)	47 (16.5%)	7 (12.1%)	11 (19%)
Between 6 and 7 h/day	13 (23.6%)	8 (14.5%)	2 (3.8%)	1 (1.9%)	16 (5.6%)	22 (7.7%)	3 (5.2%)	3 (5.2%)
More than 8 h/day	7 (12.7%)	10 (18.2%)	4 (7.5%)	8 (15.1%)	14 (4.9%)	26 (9.2%)	2 (3.4%)	3 (5.2%)
	Chi-squared	***p*-value**	**Chi-squared**	***p*-value**	**Chi-squared**	***p*-value**	**Chi-squared**	***p*-value**
	71.573	< 0.001	55.368	0.021	307.057	< 0.001	39.425	0.319

PA, Physical activity; min, minutes; h, hours.

players with professional training showed higher values than those with university training [$Z_{(1,2)} = 44.976$ $p < 0.026$, effect size (r) = 0.21]. Regarding anxiety level, chess players with a high school level education showed significantly higher values than those with university [$Z_{(1,3)} = 51.045$ $p < 0.003$, effect size (r) = 0.24] and professional training [$Z_{(2,3)} = 61.166$ $p < 0.008$, effect size (r) = 0.28].

Significant positive correlations between chess practice and physical activity both before ($p < 0.005$ τb = 0.102) and during confinement ($p < 0.005$ τb = 0.089) were found. In addition, significant correlations were found between different variables in the psychological profiles of chess players (see **Table 4** for further details).

DISCUSSION

This research aimed to analyze the effect of COVID-19 confinement in behavioral, psychological, and training patterns of chess players, based on their gender, level of education, and level of chess game. The study showed that chess players significantly decreased physical activity per day while increased chess practise during the confinement period. However, anxiety levels remained moderate despite the anti-stress effects of physical activity.

In the present confinement context, increased somatization of anxiety, resulting from the perception of lack of control in adapting to contextual demands (Halabchi et al., 2020) and the imposition of a restriction of liberty or perception of non-voluntary self-isolation was described (Halabchi et al., 2020). Its health impact may be related to the duration of the confinement (extended periods are associated with poorer mental health, avoidance behaviors, and anger), the fear of infection, frustration, and boredom, inadequate supplies (e.g., water, clothes, accommodation), or inadequate information (Brooks et al., 2020). However, the anxiety values evaluated could be considered as medium, despite the low values of physical activity during the pandemic, since it has an anxiolytic effect (Petzold et al., 2020). These results could be related to the higher cognitive resources and wide experience of these high-performance athletes when coping with anxiety contexts such as competitions (Belinchon-deMiguel et al., 2019).

Interestingly, 15.8% of chess players did not practise physical activity (sports, maintenance gymnastics) before the confinement (20.9% less than 30 min on average a day) and this percentage went to almost double, 30% (28.4% less than 30 min on average a day) during the confinement. The 12.7% (29.1% during confinement) of professional chess players did not carry out any type of physical training before COVID-19, and 16.4% (30.9% during confinement) did less than 30 min per day. This is a controversial fact since a good physical condition is recommended to obtain the maximum chess performance (Alifirov et al., 2017). The physical activity analyzed did not accomplish the health requirements of World Health Organization (WHO) (2020c), which is in line with the increased sedentarism of the general population around the world (Middelbeek and Breda, 2013).

Focusing on gender-based differences, the results of the present study showed a significantly higher ELO FIDE in men than in women. This finding is in line with a previous study (Chess-rankings, 2020), and could be explained by different factors such as participation rates, degree of involvement, starting age, and perseverance. Our results also showed that women reported a higher level of care to avoid infection than men. This is consistent with a previous study (de la Vega et al., 2020) in the Spanish population where men and women significantly differed

TABLE 4 | Correlational analysis of study variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Concern	1														
2. Alarm	0.22**	1													
3. Control	0.22**	0.10**	1												
4. Personal care	0.35**	0.13**	0.44**	1											
5. Influence Performance	−0.07*	−0.07	0.07	0.00	1										
6. Institutions support	−0.07*	−0.01	0.08	0.01	0.19**	1									
7. Training routines	0.09*	0.07	0.01	0.06	0.01	−0.07	1								
8. Extraversion	−0.01	0.12**	−0.02	−0.03	−0.01	0.00	−0.03	1							
9. Agreeableness	0.02	−0.03	−0.03	−0.06	−0.07	0.03	0.03	−0.09*	1						
10. Conscientiousness	0.10**	0.04	0.13**	0.18**	0.08*	−0.01	0.06	−0.02	−0.02	1					
11. Neuroticism	0.10**	0.01	−0.08*	−0.04	−0.06	0.00	0.05	−0.05	0.00	−0.09**	1				
12. Openness	0.06	−0.04	0.03	0.12**	0.05	−0.03	0.04	−0.48**	−0.06	0.13**	0.00	1			
13. Loneliness	0.03	−0.01	−0.02	−0.06	−0.07*	−0.06	0.07	−0.05	0.08*	−0.13**	0.24**	−0.07*	1		
14. Psychological inflexibility	0.07*	−0.02	−0.03	−0.11**	−0.08**	0.00	0.05	−0.07	0.06	−0.19**	0.29**	−0.06	0.38**	1	
15. Anxiety	0.28**	0.05	−0.05	0.00	−0.12**	−0.09**	0.17**	0.00	0.06	−0.06	0.31**	−0.03	0.17**	0.28**	1
M	3.68	4.06	4.01	4.26	5.84	2.40	3.09	5.17	5.58	6.78	4.87	7.67	4.86	15.00	12.26
SD	1.16	0.99	0.96	0.80	2.55	1.67	1.38	1.79	1.35	2.09	1.88	1.78	1.77	6.36	3.54
N	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450

*$P \leq 0.05$; **$P \leq 0.01$.

in compliance with safety measures, exercising proper care to wash hands, and in keeping at least 1.5 m distance from others in public spaces. However, this greater compliance with safety measures does not translate into a higher number of infections (Wenham et al., 2020). Nevertheless, there seems to be higher mortality and vulnerability to the disease in men (Epidemiology Working Group for Ncip Epidemic Response and Chinese Center for Disease Control and Prevention, 2020) which could be due to differences in the immunological response (Chen N. S. et al., 2020) or the prevalence of smoking (Liu et al., 2017).

Regarding chess performance groups, professional and high-performance groups reported higher values of social alarm than amateur ones. This may be due to a high control perception to avoid infection and personal care to avoid infection, which is also shown in our results. In addition, positive correlations were found between the level of personal concern, the perception of social alarm, the control perception level to avoid getting infected, and the level of personal care to avoid infection by COVID-19. Similar results were obtained in a previous study (de la Vega et al., 2020) regarding attitudes toward COVID-19 in Spain. Moreover, Vollstadt-Klein et al. (2010) showed that elite chess players showed a direct correlation between skill and extraversion, which is in line with an effect of extraversion on the psychological and physical strain. These results are in line with ours since our participants showed that the highest level of performance had the highest values of extraversion and neuroticism. In contrast, in the study of Vollstadt-Klein et al. (2010), the authors did not find significant differences between the level of neuroticism between competitive players and non-players.

Differences in cognitive inflexibility were not found between the different performance groups. Although previous studies as Grau-Perez and Moreira (2017) or Ramos et al. (2018), showed that children who practice chess have higher scores on tasks that value cognitive flexibility than those who do not. This is probably because chess practice facilitates adaptation to complex or novel situations, which are not routine and demand control mechanisms to resolve effectively. However, when participants were divided by education levels, the professional education level group showed higher values than the university level group. These results are in line with a previous study showing a negative correlation between educational level and psychological inflexibility (Wicksell et al., 2010). On the other hand, the psychological inflexibility was related to an inadequate adaptive response in the confinement situation, since it correlated with a negative perception in their sports performance and more neuroticism trait, loneliness feeling, and anxiety. In this sense, psychological inflexibility has been shown to be detrimental to mental health (Makriyianis et al., 2019).

The present study has some limitation that should be addressed. Firstly, the use of non-validated questionnaires for assessing some of the outcomes. Second, due to COVID-19 confinement, only self-reported answers were possible to obtain. Therefore, physical activity data should be taken with caution. Thus, future studies should validate these questionnaires and use direct methods to assess physical activity, such as objective monitoring devices (accelerometers and pedometers).

CONCLUSION

Chess players perceived that COVID-19 confinement negatively affected their physical activity profile, increasing chess practice, despite anxiety levels remained moderate. The perception of alarm is higher in the lower level of play, while the extraversion, neuroticism, and psychological inflexibility is higher in the higher level of play. A higher academic level seems to be related to higher levels of personal concern and anxiety due to COVID-19 and lower psychological inflexibility levels. Chess players, especially those with a higher chess level, might have an adapted psychological profile to confinement situations, as well as worrying levels of physical inactivity.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Commission of Bioethics and Biosecurity of the University of Extremadura (Approval No. 57/2020). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JF-G and MM conceived the study and collected the data. JF-G and VC-S designed the questionnaire and analyzed the data. JF-G and SV designed the tables. JF-G wrote the manuscript. JF-G, MM, SV, and VC-S provided critical revisions on the successive drafts. All authors approved the manuscript in its final form.

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Design and Validation of a Scale for Measuring Well-Being of Children in Lockdown (WCL)

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The objective of this study was to create and validate an instrument to measure the well-being of children in lockdown. As a response to the COVID-19 pandemic, and in the interest of maintaining social distancing, millions of people have been confined to their homes, including children, who have been withdrawn from school and barely able to leave their homes. Thus, it would be useful to evaluate, from a holistic perspective, the well-being of children under these challenging circumstances. The participants were 1,046 children, 48.7% of which were boys and 50.7% girls, recruited in the Basque Country (Northern Spain). The scale was answered by their parents. The survey, entitled "Well-being of Children in Lockdown" (WCL), is composed of six subscales: Emotions, Playful and creative activities, Education, Addictions, Routine, and Physical Activity. Exploratory factor analyses indicate that all the reliability indices were acceptable. The survey demonstrated adequate reliability (alpha = 0.804). We were thus able to confirm the validity of this simple instrument for evaluating the well-being of children aged between 4 and 12 years in lockdown situations. The WCL can be regarded as a useful tool to evaluate the well-being of children in lockdown situations.

Keywords: children, well-being, scale, validation, lockdown, COVID-19

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INTRODUCTION

The new coronavirus (COVID-19) epidemic has created an unprecedented threat to global health. The outbreak first emerged in late December 2019 when clusters of pneumonia cases of unknown etiology were found in China. Since then, the number of cases has continued to escalate exponentially, firstly within China and then worldwide. On the 30th of January 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a public health emergency of international concern, and on the 11th of March 2020, it was declared a pandemic (World Health Organization [WHO], 2020).

Children represent a small percentage of COVID-19 cases (Hamzelou, 2020; Pavone et al., 2020) with most infected infants being asymptomatic (Cai et al., 2020) or presenting only mild clinical manifestations (Jiao et al., 2020). However, children are not impervious to the dramatic impact of the COVID-19 epidemic. In fact, it has been pointed out that, due to the mild symptomatology shown by children, they could play a prominent role in spreading COVID-19. As a consequence, in most countries of the world schools have been ordered to close (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2020) and children, like the rest of the population, have been confined to their homes. Nonetheless, each country has its own set of rules and guidelines in relation to the lockdown. Thus, while, in some countries, children can go out for sports or walks, in other countries such activities have been prohibited (García, 2020). Spain is one of the countries in which children have faced the most stringent lockdown regulations, since from March 14th to 26th April (a period of 6 weeks) children had been completely banned from leaving their homes. Since then, a slight easing of the lockdown measures has meant that from 26th April onward, children have been allowed outside, but only for 1 h each day and they must remain within close proximity of their homes (Lucas, 2020).

Furthermore, this reality does not affect only Spain; countries around the world have been affected among other Latin countries like Italy in Europe (Pisano et al., 2020). Besides, it has been stated that for example in Latin America children are the hidden victims of COVID-19 crisis (Catalán, 2020; SOS Children's Villages International, 2020; TRT Español, 2020; United Nations International Children's Emergency Fund [UNICEF], 2020).

Pediatricians, psychologists, and educators have all warned of the threats that this lockdown could have for the well-being of children, from both physical and emotional perspectives (Grechyna, 2020; Jiloha, 2020). Moreover, international researchers are already studying these consequences from multiple perspectives. At a physical level, research conducted in China has found that during lockdown, 3- to 18-year-old children are physically less active, have much longer screen time, show irregular sleep patterns, and eat less favorable diets, all of which is resulting in weight gain and a loss of cardiorespiratory fitness (Jiao et al., 2020; Jiloha, 2020; Wang et al., 2020). In fact, this dramatic reduction in physical activity and insufficient exposure to sunlight as a result of being forced to remain at home have been highlighted as some of the most visible consequences of this lockdown situation (Lippi et al., 2020).

From an emotional perspective, research carried out in China has found that lockdown is generating feelings of fear, worry, sadness, loneliness, or stress among children from 3 to 18 years (Jiao et al., 2020; Jiloha, 2020; Leung et al., 2020; Qiu et al., 2020). Added to this are observations of clinginess, distraction, irritability, and an apparent fear of asking questions about the pandemic (Wang et al., 2020). In a similar vein, a research study in Italy with children aged between 4 and 10 years has found that, during this lockdown, children are showing fears that they had never expressed before, along with increased irritability, nervousness, intolerance to rules, whims and excessive demands, mood changes, and sleep problems (Pisano et al., 2020).

At academic and social levels, social isolation and lockdown means that children from preschool, primary school, and secondary school may not be at school for a prolonged period of time (Jiao et al., 2020) and their social interactions will be limited, thereby reducing dramatically the possibilities of socializing and playing with peers (Wang et al., 2020), which could only serve to exacerbate the sense of loneliness felt during lockdown (Jiao et al., 2020; Okruszek et al., 2020; Singh and Singh, 2020). Several researchers have noted that these disruptions could also have long-term consequences for the affected groups and that, for the most vulnerable members of the population, existing inequalities are likely to become even more evident (Armitage and Nellums, 2020; Burgess and Sievertsen, 2020) [see **Figure 1**].

Thus, children are not unaffected by the dramatic impact of the COVID-19 epidemic, and their well-being in this situation is likely to be influenced in various ways.

The concept of well-being is highly variable and has been studied across a wide range of disciplines, age groups, cultures, communities, and countries, resulting in a wide range of definitions (Pollard and Lee, 2003). In fact, this debate has resulted in well-being becoming a field of research in its own right (Amerijckx and Humblet, 2013). From a holistic view, well-being has been defined as "a multidimensional construct incorporating mental/psychological, physical and social dimensions" (Columbo, 1986, p. 288). In the same vein, in reference to health, and according to the World Health Organization [WHO] (1946) "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (p. 100). Some authors agree that children's well-being cannot be represented by a single domain or indicator, as their lives are lived in terms of multiple domains and each domain has an impact on their well-being (Ben-Arieh et al., 2001; Bradshaw and Mayhew, 2005; Hanafin and Brooks, 2005a,b; Land et al., 2007; Domínguez-Serrano et al., 2019; Fattore et al., 2019; Migliorini et al., 2019). For example, Brandshaw and Richardson (2009) have argued that children's well-being should be represented in terms of seven domains: (1) health; (2) subjective well-being; (3) personal relationships; (4) material resources; (5) education; (6) behaviors and risks; and (7) housing and environment. Indeed, the most recent reference may be the "Index of Child and Youth Well-Being" by Land et al. (2007). This index was created to measure changes in child well-being in the United States and can serve as an example for a system of analysis based on outcome indicators. Specifically, that system is based on the results of subjective well-being studies that identify content areas that occur over and over again—for guidance in the selection of domains of well-being and statistical indicators within those domains. Concretely, those domains are family economic well-being, health, safety/behavioral concerns, educational attainment (productive activity), community connectedness (participation in schooling or work institutions), social relationships (with family and peers), and emotional/spiritual well-being.

Although challenging, there are both theoretical and practical reasons for approaching well-being as a multidimensional construct across life domains (Huppert and So, 2013) and while the integration of various dimensions has been defined as fundamental to achieving positive well-being throughout the lifespan (Zaff et al., 2003), relatively little research has been dedicated to the cognitive, emotional, physical, and social aspects of children's well-being (Ajdukovic and Ajdukovic, 1993; Househnecht and Sastry, 1996; McCormick et al., 1996; Evans et al., 1998; Qin et al., 2020). Therefore, there is a relatively small body of national data for the indicators used to track child health and well-being, which all countries have agreed to collect (Clark, 2020).

Likewise, there are few standardized methods for assessing well-being in childhood. The majority of researchers who

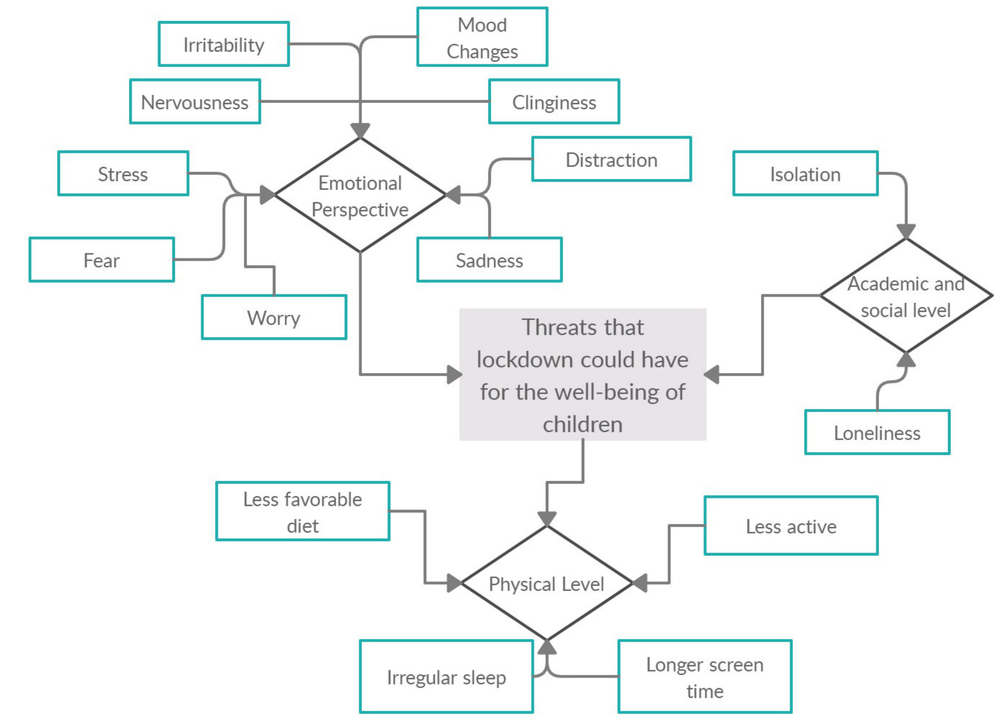

FIGURE 1 | Summary of threats that lockdown could have for the well-being of children.

have analyzed child well-being used multiple separate measures of pre-assumed indicators in an effort to capture a more complete assessment of the state of the child's well-being (Pollard and Lee, 2003). Pollard and Lee (2003) conducted a systematic review of the literature on child well-being by searching five databases to assess the current state of child well-being research to address the following questions: (1) How do we define the well-being of children? (2) What are the domains of children's well-being? (3) What are the indicators of children's well-being? and (4) How do we measure the well-being of children? In relation to the scales measuring children's well-being, these authors conclude that there is an inconsistent use of definitions, indicators, and measures of well-being, which has created a confusing and contradictory research base.

Among those scales that analyze the well-being of children from a holistic perspective, taking into account the physical, social, and psychological dimensions (among others), the Perceived Competence Scale for Children (Harter, 1982) is noteworthy. Designed to measure 8–13-year-old children's perceptions of their competence and self-adequacy, this scale considers their cognitive competence, peer relationships, scholastic performance, physical skills/competence, and global self-worth. In a similar vein, The Battelle Developmental Inventory Screening Test (Newborg et al., 1988), which was designed as a tool for the screening, diagnosis, and evaluation of early development, takes into account the self-concept, affect, coping, adult interaction, peer interaction, social role, personal responsibility, eating, dressing, attention, toileting, receptive and expressive communication, academic skills, memory, reasoning, cognitive development, perceptual motor, locomotion, muscle control, and body coordination from birth to 8 years. Finally, Castilla-Peón (2014) used a method of direct questioning to evaluate the well-being of children aged between 11 and 15 years, in relation to family, school, play, growth, development, friends, and peers.

Another international study—which did not take into account emotional and physical domains— was carried out by The Children's Worlds, The International Survey of Children's Well-Being (ISCWeB), which is a worldwide research survey of children's subjective well-being. The questionnaire consists of eight life domains: the home and the people they live with, money and things they have, relationships with friends and other people, the area where they live, school, health, time management, and leisure time and self. Indeed, there are also recent studies that evaluate the well-being of children with chronic diseases and/or with cognitive, motor, and social disorders as autism (Salomone et al., 2018); refugee children (Baker et al., 2019); physical limitations, as child's spinal cord injury (January et al., 2019); or adverse behavioral of school-age children relating to sleep duration (James and Hale, 2017). This reinforces that it is more and more relevant to investigate the general well-being of the child, taking into account that previous illnesses may further influence his general condition.

In addition, there is no single scale to measure the well-being of children in lockdown that could help to identify the physical, psychological, social, and academic consequences of this situation. Such information is critical if we are to establish the actions that can be taken to mitigate the negative effects of confinement and improve the well-being of children. Moreover, at all life stages, but even more so in childhood, the biological, psychological, and social processes are merged into a network of intimate interactions that make it impossible to conduct studies or analyses from a unidirectional approach (Villaroel, 2012). Thus, given that in lockdown situations there are threats to children's health and well-being that originate from multiple levels or dimensions, a deliberately multidimensional approach is required to safeguard the well-being of children. Therefore, the main objective of this study was to create and validate an easy-to-use survey that is capable of measuring—from a holistic perspective—the well-being of children in a situation of lockdown. Based on the theoretical framework described above, it is hypothesized that the scale that measures the well-being of children will have several factors or domains that converge in adequate psychometric properties of the overall well-being of children in lockdown situation.

MATERIALS AND METHODS

Participants

A total of 1046 children participated in this study. Of these, 48.7% were boys (n = 505) and 50.7%% girls (n = 530), aged between 2 and 14 years (M = 6.43; SD = 2.95). 74.5% of those children said they have another brother or sisters (n = 779), and 25.5% said no (n = 267). 2.5% had special educational needs (n = 26), and 97.5% did not have educational special needs (n = 1020). Regarding exterior spaces that they have in their home, 36.6% said that they did not have an exterior space (n = 383) and 63.4% said no (n = 663). Lastly, regarding the socioeconomic status of their parents the majority, 72.86% were from a high class (n = 639), 24.74% were of low status (n = 217), and 2.4% were of high socioeconomic status. All the information about the children was gathered through their parents, as they were the ones who answered the scale.

All participants were recruited from the Autonomous Community of the Basque Country in the North of Spain.

Instrument

The survey entitled "Well-being of Children in Lockdown" (WCL) was used. The preliminary version of the survey was drawn up by a group of university professors experienced in Childhood and Infectious Diseases. In order to create each of the items, preliminary qualitative information was collected with regard to the situation of children in lockdown (Idoiaga et al., 2020; Idoiaga Mondragon et al., 2020). Furthermore, we took as a reference all of the surveys and works that include the various dimensions and indicators used for children's well-being (cited in the section "Introduction").

The preliminary version included a total of 26 items, 3 items in the "Academic" dimension, 4 items in the "Routine" dimension, 2 items in the "Physical activity" dimension, 5 items in the "Emotions" dimension, 4 items in the "Addiction" dimension, and 4 items in the "Playful and creative activities" dimension. A 4-point Likert scale response format was chosen, ranging from 1 = strongly disagree to 4 = strongly agree. In order to ensure both the validity of the content and applicability of the instrument, this initial version was subject to a two-step refinement process:

(1) *Expert consideration*. In order to ensure the validity of its content, the first version of the survey was submitted to a panel of 4 experts in research and childhood education. Using a purpose-designed table, the experts had to evaluate the dimension corresponding to each item according to its content, as well as the degree of precision and clarity. They were also invited to make suggestions for improving the draft. The only items kept were those considered by 3 out of the 4 experts to be well written and those for which all experts agreed on their inclusion within a given dimension.

(2) *Pilot study*. A total of 65 parents of children aged between 2 and 14 years participated with a view to modifying and/or eliminating the most problematic items in terms of understanding or those that contained errors in their formulation. Three items were eliminated from each dimension, meaning that the final version (**Table 1**) was reduced to 22 items.

The final scale consisted of the following 6 dimensions: Emotions (5 items), Playful and creative activities (4 items), Academic (3 items), Addictions (4 items), Routine (4 items), and Physical activity (2 items). The items included in the first dimension are related to emotions, those in the second dimension are related to playful or creative activities, the third dimension consists of items related to academic issues, the items of the fourth dimension are related to habits of overuse (technology or eating habits), the fifth dimension is concerned with daily routines (the maintenance of a daily schedule, e.g., eating and sleeping habits), and finally, the sixth dimension contains items related to physical activity. The participants were required to respond on a 4-point Likert-type scale ranging from strongly agree (4) to strongly disagree (1). Items 8, 9, 10, 11, 14, 15, 16, and 17 were recorded, since they had been formulated in a negative way. The various subscales were shown to have adequate values of internal consistency (Cronbach's alpha > 0.60).

Procedure

The project was approved by the Ethics Committee of the Basque Country University of [M10/2020/055]. The data were collected during the period of confinement from March 14th to April 22nd. This study was conducted ethically according to the principles in line of the Declaration of Helsinki.

In order to recruit the participants, all the centers registered in the database of the Department of Education of the Basque Government were considered, and the schools were asked to forward these questionnaires to the families of the pupils. Both the data of the sample and the consent for participation in the study were collected with the help of Google online forms. Family members were informed of the research study by e-mail. In the same questionnaire, it was explained that participation in the

TABLE 1 | Survey on the well-being of children in lockdown.

(1)	Your child has been sent materials, assignments, and homework by your school (¿Has recibido recursos, propuestas o deberes enviados desde la escuela?)	1	2	3	4
(2)	Your child spends enough time on your schoolwork during the day (¿Dedica un tiempo adecuado al trabajo escolar durante el día?)	1	2	3	4
(3)	Your child has an agreed routine and you try to stick to it (¿Tiene una rutina establecida e intentamos mantenerla?)	1	2	3	4
(4)	Your child usually has breakfast, lunch, and dinner at the same time each day (¿Desayuna, come y cena normalmente a la misma hora?)	1	2	3	4
(5)	Your child gets enough physical exercise during the day (¿Hace suficiente ejercicio físico durante el día?)	1	2	3	4
(6)	Your child moves his/her body enough (¿Mueve su cuerpo suficiente?)	1	2	3	4
(7)	Your child has healthy sleeping habits (¿Tiene unos hábitos saludables de sueño?)	1	2	3	4
(8)	Your child cries more than usual (¿Llora más de lo normal?)	1	2	3	4
(9)	Your child feels more nervous than usual (¿Está más nervioso/a que lo habitual?)	1	2	3	4
(10)	You get angry more than usual (¿Se enfada más de lo habitual?)	1	2	3	4
(11)	Your child feels sadder than usual (¿Está más triste de lo habitual?)	1	2	3	4
(12)	Your child is happy (¿Está contento?)	1	2	3	4
(13)	Your child is eating a well-balanced diet (¿Lleva una dieta equilibrada?)	1	2	3	4
(14)	Your child is eating more than usual during lockdown (¿Come más de lo normal en esta situación de confinamiento?)	1	2	3	4
(15)	Your child is eating more treats (e.g., cookies, chocolate, and chips) during lockdown (¿Come más chucherías (Galletas, chocolate, patatas, etc.) o comida rápida en esta situación de confinamiento?)	1	2	3	4
(16)	Your child is overusing new technology (¿Está abusando de las nuevas tecnologías?)	1	2	3	4
(17)	Your child is watching too many TV programs, cartoons, or movies (¿Está abusando de ver la tele, dibujos o películas)	1	2	3	4
(18)	Your child is taking part in creative activities (e.g., theater, music, and art) (¿Realiza actividades para trabajar la creatividad (Teatro, música, arte. . .)?	1	2	3	4
(19)	Your child plays different games throughout the day (¿Juega a diferentes cosas a lo largo del día?)	1	2	3	4
(20)	Your child works on school projects with your family throughout the day (¿Realizamos a lo largo del día actividades escolares en familia?)	1	2	3	4
(21)	Your child does leisure activities with your family throughout the day (¿Realizamos a lo largo del día actividades lúdicas en familia?)	1	2	3	4
(22)	Your child plays with your family throughout the day (¿Jugamos en familia a lo largo del día?)	1	2	3	4

Emotions: 8, 9, 10, 11, 12; activities: 18, 19, 21, 22; academic: 1, 2, 20; addiction: 14, 15, 16, 17; routine: 3, 4, 7, 13; physical activity: 5, 6.

TABLE 2 | Mean, standard deviation, rotated factor matrix, and reliability analysis of variables and factors.

	M	***SD***	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**
Item 1.	2.92	0,85	0.029	−0.044	0.805	−0.018	−0.022	−0.024
Item 2.	2.55	0,84	−0.024	−0.125	0.825	−0.012	0.070	0.020
Item 3.	2.95	0,69	−0.056	0.133	0.184	0.122	0.641	0.119
Item 4.	3.35	0,65	0.062	0.054	−0.041	−0.022	0.815	0.020
Item 5.	2.44	0,7	0.064	0.130	0.004	0.147	0.092	0.886
Item 6.	2.61	0,72	0.160	0.173	−0.050	0.064	0.096	0.875
Item 7.	3.28	0,66	0.180	0.081	−0.014	0.050	0.709	0.019
Item 8.	3.18	0,89	0.799	−0.134	0.158	0.057	0.070	−0.015
Item 9.	2.9	0,94	0.871	0.027	−0.006	0.169	0.011	0.041
Item 10.	2.75	0,97	0.874	0.044	0.041	0.157	0.034	0.050
Item 11.	3.23	0,84	0.800	0.094	−0.084	0.148	0.057	0.112
Item 12.	3.07	0,67	0.591	0.353	−0.151	0.132	0.161	0.149
Item 13.	3.38	0,57	0.038	0.202	−0.018	0.348	0.486	0.072
Item 14.	3.06	0,86	0.214	−0.033	0.097	0.669	0.083	−0.067
Item 15.	3.12	0,74	0.185	−0.027	0.056	0.745	0.120	−0.010
Item 16.	2.48	0,84	0.035	0.332	−0.161	0.586	0.046	0.223
Item 17.	2.5	0,79	0.112	0.175	−0.041	0.579	0.033	0.203
Item 18	2.64	0,84	−0.052	0.628	0.145	0.024	0.023	0.201
Item 19.	3.08	0,71	0.079	0.717	−0.003	0.110	0.107	0.196
Item 20.	2.54	0,87	0.016	0.244	0.701	0.044	0.042	−0.043
Item 21.	2.92	0,67	0.069	0.834	0.003	0.086	0.150	−0.014
Item 22.	2.93	0,71	0.064	0.832	−0.074	0.083	0.136	−0.018

TABLE 3 | Bivariate correlations between all elements of the study and effect size.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
(1)	–																					
(2)	0.517** (0.267)	–																				
(3)	0.062* (0.001)	0.167** (0.003)	–																			
(4)	−0.027 (−0.001)	−0.005 (−0.001)	0.382** (0.15)	–																		
(5)	−0.0036 (−0.001)	−0.016 (−0.001)	0.169** (0.03)	0.100** (0.001)	–																	
(6)	−0.056 (−0.001)	−0.067* (−0.001)	0.141** (0.02)	0.118** (0.02)	0.735** (0.54)	–																
(7)	−0.006 (−0.001)	0.031 (0.001)	0.262** (0.07)	0.430** (0.20)	0.107** (0.02)	0.133** (0.02)	–															
(8)	0.117** (0.02)	0.122** (0.002)	0.039	0.072* (0.001)	0.037 (0.001)	0.099** (0.001)	0.174** (0.03)	–														
(9)	0 (0)	−0.023 (−0.001)	0.004 (−0.001)	0.06 (0.001)	0.134** (0.02)	0.184** (0.03)	0.156** (0.02)	0.641** (0.41)	–													
(10)	0.023 (0.001)	0.024 (0.001)	0.069* (0.001)	0.089** (0.001)	0.143** (0.02)	0.182** (0.03)	0.163** (0.03)	0.678** (0.46)	0.781** (0.61)	–												
(11)	−0.042 (−0.001)	−0.093** (−0.002)	0.057 (0.001)	0.107** (0.01)	0.170** (0.03)	0.241** (0.06)	0.175** (0.03)	0.523** (0.27)	0.648** (0.42)	0.633** (0.40)	–											
(12)	−0.085** (−0.001)	−0.160** (−0.03)	0.090** (0.001)	0.185** (0.03)	0.222** (0.05)	0.304** (0.09)	0.220** (0.05)	0.273** (0.07)	0.475** (0.22)	0.477** (0.23)	0.586** (0.34)	–										
(13)	0.014 (0.001)	−0.002 (−0.001)	0.265** (0.07)	0.262** (0.07)	0.190** (0.03)	0.183** (0.04)	0.272** (0.07)	0.06 (0.001)	0.151** (0.02)	0.099** (0.001)	0.125** (0.01)	0.271** (0.07)	–									
(14)	0.091** (0.001)	0.011 (−0.001)	0.108** (0.002)	0.094** (0.001)	0.099** (0.001)	0.094** (0.001)	0.126** (0.02)	0.186** (0.03)	0.277** (0.07)	0.269** (0.07)	0.240** (0.02)	0.201** (0.04)	0.192** (0.04)	–								
(15)	0.02 (0.001)	0.02 (−0.001)	0.124** (0.02)	0.108** (0.02)	0.163** (0.03)	0.112** (0.02)	0.116** (0.01)	0.206** (0.04)	0.268** (0.07)	0.249** (0.05)	0.265** (0.06)	0.231** (0.05)	0.287** (0.08)	0.447**	–							
(16)	−0.129** (−0.02)	−0.132** (−0.02)	0.162** (0.03)	0.093** (0.001)	0.261** (0.07)	0.250** (0.06)	0.164** (0.02)	0.016 (0.001)	0.158** (0.03)	0.179** (0.03)	0.197** (0.04)	0.274** (0.06)	0.218** (0.05)	0.188**	0.256**	–						
(17)	−0.083** (−0.001)	0.004 (−0.001)	0.146** (0.02)	0.071* (0.001)	0.231** (0.05)	0.202** (0.04)	0.166** (0.03)	0.160** (0.03)	0.198** (0.04)	0.234** (0.05)	0.212** (0.04)	0.181** (0.03)	0.163** (0.02)	0.174** (0.03)	0.241** (0.06)	0.487** (0.24)	–					
(18)	0.047 (0.001)	0.036 (0.001)	0.154** (0.02)	0.080** (0.001)	0.193** (0.03)	0.221** (0.05)	0.068* (0.001)	−0.078* (−0.001)	0 (0)	0.009 (0.001)	0.064* (0.001)	0.191** (0.04)	0.175** (0.03)	0.023 (0.001)	0.027 (0.001)	0.224** (0.05)	0.128** (0.02)	–				
(19)	−0.025 (−0.001)	−0.083** (−0.001)	0.161** (0.03)	0.152** (0.02)	0.266** (0.07)	0.296** (0.09)	0.179** (0.03)	0.005 (0.001)	0.113** (0.01)	0.121** (0.2)	0.150** (0.02)	0.343** (0.12)	0.227** (0.05)	0.100** (0.01)	0.118** (0.01)	0.321** (0.10)	0.199** (0.03)	0.477** (0.23)	–			
(20)	0.381** (0.145)	0.406** (0.165)	0.130** (0.02)	0.061* (0.001)	0.027 (0.001)	−0.006 (−0.001)	0.080** (0.001)	0.044 (0.001)	0.014 (0.001)	0.037 (0.001)	0.011 (0.001)	0.055 (0.001)	0.015 (0.001)	0.067* (0.001)	0.067* (0.001)	0.031 (0.001)	0.047 (0.001)	0.148** (0.02)	0.122** (0.02)	–		
(21)	−0.03 (−0.001)	−0.073* (−0.001)	0.224** (0.05)	0.149** (0.02)	0.194** (0.03)	0.205** (0.04)	0.161** (0.03)	−0.009 (−0.001)	0.107** (0.02)	0.124** (0.02)	0.123** (0.01)	0.296** (0.07)	0.263** (0.06)	0.078* (0.001)	0.107** (0.01)	0.266** (0.06)	0.193** (0.03)	0.366** (0.13)	0.481** (0.23)	0.166** (0.03)	–	
(22)	−0.096** (−0.002)	−0.126** (−0.02)	0.193** (0.04)	0.151** (0.02)	0.184** (0.03)	0.212** (0.04)	0.156** (0.02)	−0.019 (−0.001)	0.097** (0.001)	0.115** (0.01)	0.129** (0.01)	0.282** (0.07)	0.242** (0.05)	0.072* (0.001)	0.097** (0.001)	0.274** (0.07)	0.199** (0.03)	0.337** (0.11)	0.495** (0.25)	0.128** (0.02)	0.775** (0.60)	–

****p <0.0000, **p <0.001, *p <0.01.*

study was voluntary and anonymous. Moreover, the parents or legal guardians of the children gave written consent for two phases of this research. The questionnaire was filled by the parents, and it takes around 5 min to fill out. Consent was given to, first, analyze the data and, second, to make the data public in scientific articles while respecting anonymity. A total of 30 questionnaires were excluded for not giving consent for this second phase.

Statistical Analysis

All of the data were analyzed using the statistics program SPSS version 24.0 (IBM, Chicago, IL, United States). For the purpose of comparing the proposed measurement scale, exploratory factor analysis was carried out to identify the number and composition of the common factors (latent variables) necessary to explain the common variance of all items analyzed and to thus validate the scale.

The calculation that determines the desired sample for this type of research is calculated through a statistical platform.

Univariate statistics (mean and standard deviation) were calculated for each item, and factor analysis was carried out to analyze the dimensionality of the scale.

In each dimension, an independent calculation of the partial item test was made to estimate the item discrimination rate. Cronbach's alpha coefficient was used to calculate reliability. Confirmatory factor analysis was conducted in an attempt to confirm the factor structure obtained.

The significance value indicating that the association is statistically significant has been arbitrarily selected and by consensus is considered to be 0.05. A 95% confidence carries an implicit $p < 0.05$ (Fisher, 1971). For the calculation of the magnitude of the results, the size of the effect was calculated by Lenhard and Lenhard (2016) and interpreted by Cohen (1988).

RESULTS

Exploratory Factor Analyses

Once the exploratory factor analysis had been carried out, 6 factors were rotated with 26 items and 4 were eliminated to obtain a load of less than 0.30. Both the Bartlett statistic [8325.42(df = 231; $P < 0.000$)] and the Kaiser–Meyer–Olkin test (KMO) = 0.799 show adequate fit of the data for subsequent factor analysis. The six factors extracted explain 62.7% of the total variance. The first factor explains 22.2% of the variance, the second factor 12.29% of the variance, the third factor 9.23% of the variance, the fourth factor 6.81% of the variance, the fifth factor 6.40% of the variance, and the sixth factor 5.82% of the variance. These data show an excellent fit of a six-dimensional structure for these items (García et al., 1998) [see **Table 1**].

The first factor, termed "Emotions," contains a series of items (8, 9, 10, 11, and 12) that explore emotional aspects. The second factor "Playful and creative activities" contains items (18, 19, 21, and 22) related to playful and creative activities. The third factor, "Academic," consists of items (1, 2, and 20) referring to educational aspects. The fourth factor, "Addiction," consists of a series of items (14, 15, 16, and 17) looking at the overuse of new technology, or overeating.

Items of the fifth factor (3, 4, 7, and 13) are concerned with the daily routine, referring to aspects such as timetable, diet, and sleeping habits. Finally, the sixth factor asks about physical activity (items 5 and 6). The estimated reliability coefficients were 0.872 for the first factor, 0.783 for the second, 0.696 for the third, 0.627 for the fourth, 0.646 for the fifth, and 0.847 for the sixth factor. The reliability of the entire scale was 0.804.

For the same scale, **Table 2** indicates the main statistics for the items that make up the scale (mean and standard deviation). It is clear that the items in intermediate positions near the mid-point of the cutoff are Item 5, related to the amount of physical activity during the day ($M = 2.44$); the items of Factor 3 (Education); Item 2, which is related to how much time they spend on school tasks ($M = 2.44$); and Item 10, related to how much time they spend on school activities with their families ($M = 2.54$). A similar score was obtained for Item 17, related to new technology ($M = 2.5$).

In contrast, higher scores are obtained for the items corresponding to Factor 5 (Routine), particularly on Item 13, which is related to whether they eat a well-balanced diet ($M = 3.38$), Item 4, which asks if they have breakfast, lunch and dinner at the same time each day ($M = 3.35$), and Item 7, which asks about healthy sleeping habits ($M = 3.28$).

Bivariate Correlations and Effect Size

Table 3 shows the correlations between all the elements of the study. It is evident that the highest correlations can be observed between the elements measuring the same dimension, showing a larger size of the effect. Effect sizes vary (from no effect to a large effect).

DISCUSSION AND CONCLUSION

In order to address our proposed objective, the definitive "Well-being of Children in Lockdown Situations" (WCLS) scale was submitted to the following statistical tests: exploratory factor analysis, reliability analysis using Cronbach's alpha, and bivariate correlations. The exploratory factor analyses revealed that the reliability indices were acceptable in all cases, while Cronbach's alpha values were found to be above the minimum recommended value of 0.80 (Nunnally, 1978), with the total alpha for the scale standing at 0.80, meaning that the reliability of the measurements can be considered adequate. Further, it has been established that the factor structure of the scale is compatible with the predicted factors and reconfirms their weight and level of confidence. Taken together, the results of all of the analyses indicate that the WCL has adequate psychometric properties.

This methodological process was analyzed with the objective of obtaining a reliable and valid research instrument for gathering information on the well-being of children in a lockdown situation. In the light of the comments made in the results section, we can confirm an adequate fit of the data to the dimensional structure of the items making up the scale. We therefore consider that this could be a highly useful instrument for evaluating the well-being of children amid these challenging circumstances. In particular, this scale could help to identify how children are feeling, along with their well-being needs, since this knowledge will be of vital importance if we are to manage this health crisis in the best possible way. The size of the scale (22 items) makes this an easy to use instrument, while its extension—enabling its use at different stages of education—makes it highly useful.

In order to safeguard the immediate future of all children, a holistic strategy is needed in response to the uncertainty that surrounds them as a result of COVID-19. Therefore, it should be in the interests of all stakeholders—from governments and researchers to parents—to protect the physical, psychological, social, and academic well-being of children in this current public health crisis. In light of all the issues that have already been mentioned, we consider that the WCL scale represents an advance in the study of well-being. In particular, this scale will be useful for both the present health crisis and those that might arise in the future, particularly since there is currently no instrument that measures the well-being of children during a lockdown situation.

Overall, this study shows that WCL-S has satisfactory psychometric properties. The availability of a reliable and shortened tool for measuring the well-being of children from a holistic way in a lockdown situation is important for two main reasons. First, it could help to explain who has the situation where children attend to different aspects of their well-being (emotional, social, academic, and physical), and second, it could be beneficial from a research perspective, for example given detailed information of children's well-being to know who to prevent and redirect the situation taking into account the lacks that could be in the different dimensions analyzed from a holistic view.

In terms of expanding the findings and overcoming some of the limitations of this study, three general directions for future research could be recommended. First, to obtain further evidence of the social, cultural, or religious aspects that can influence the results, other specific questions or scales could be added in order to analyze the data taking into account those aspects. Also, aspects in relation with parents' situation (emotional, social, or economic) will be interesting to collect in order to analyze what can influence the well-being of children. Second, to study the role that religion plays in lockdown situations, it would be interesting to analyze how religious families can influence the well-being of children. Third, attempting to generalize the findings of this study to related interventions, it could be useful to examine the results of the well-being of children in other samples.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Committee of Ethics for Research related to Human Beings of the University of the Basque Country (CEISH). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Moderation Effect of Physical Activity on the Relationship Between Fear of COVID-19 and General Distress: A Pilot Case Study in Arabic Countries

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Aims: This study aimed to investigate the effects of the fear of COVID-19, level of physical activity, and gender on negative stress (distress) in an Arab population by means of structural equations based on partial least squares.

Materials and Methods: The sample population comprised of 459 participants from four Arab countries (age M = 33.02, SD = 8.46; n = 237 women and n = 222 men). The level of education was basic (<9 years of study; n = 144), secondary/vocational (between 9 and 12; n = 178), and university (n = 137). The "Fear of COVID-19" Scale, the short form of the "International Physical Activity Questionnaire," and the "Perceived Stress Scale" questionnaires were disseminated by emails and social networks *via* Google Forms. SMARTPLS software version 3.2.9 was used to model the relationships between the variables under study.

Results: Results confirmed the links between level of physical activity, fear of COVID-19, and gender, showing a significant mediating effect of the fear of COVID-19 on the relationship between gender and general distress. The level of physical activity was also found to influence the fear of COVID-19, varying depending on gender. In addition, the model highlighted the presence of a moderation effect of the level of physical activity.

Conclusion: Based on the model presented in the present study, we can conclude that the COVID-19 pandemic has a profound impact on psychological distress in the target populations. The impact of the level of physical activity on psychological distress is shown to be very important during the pandemic phase.

Keywords: COVID-19, fear, gender, general distress, physical activity, partial least square modeling

INTRODUCTION

"Severe Acute Respiratory Syndrome Coronavirus type 2" (SARS-CoV-2) is the infectious agent responsible for the "Coronavirus disease 2019" (COVID-19), which represents an emerging communicable disorder characterized by an extremely high infection rate and a relatively high mortality. This viral outbreak that originated in the city of Wuhan, province of Hubei, mainland

China, has been officially designated as a global pandemic by the World Health Organization (WHO), affecting the majority of countries around the world (Cucinotta and Vanelli, 2020; Rothan and Byrareddy, 2020). Great fear and perceived threat of the disease have been directly associated with its rate and route of transmission (spreading quickly and invisibly) as well as with its morbidity and mortality worldwide.

The consequences of the spread of the pandemic, its associated fear, and the impact of the repeated consumption of negative messages related to COVID-19 (Holmes et al., 2020), in addition to fake and "post-truth" news divulged on social networks, have affected not only vulnerable groups but also entire populations. Lessons learnt from previous natural disasters and hazards have demonstrated psychological effects to last longer than the episode itself, with a dramatically high economic impact. For this reason, all scientists are seriously concerned by both the physical and the mental health of individuals (Zhou et al., 2020).

In such a context, indeed many people in several countries are expected to experience emotional, cognitive, physical, and behavioral reactions. According to several studies, stress, anxiety, depression (Tan B. Y. et al., 2020; Tan W. et al., 2020), post-traumatic stress disorder symptoms (Chew et al., 2020), insomnia (Tan B. Y. et al., 2020; Tan W. et al., 2020), and suicidal ideation (Hao et al., 2020) have been reported in response to the pandemic spread. For example, during the *Ebola* outbreak, fear-related behaviors increased the population's rates of suffering and psychiatric symptoms, which contributed to the increase in indirect mortality (Shultz et al., 2016).

Even for virus-free households, COVID-19 can act as a major stressor, resulting in chronic anxiety and exposing individuals to economic–financial hardship. All these can be even amplified by the public health interventions (self-isolation, social/physical distancing, quarantine, and lockdown) that have been implemented and enforced to curb the pandemic spread. Such highly stringent and restrictive policies can exacerbate the feelings of social isolation and can impair and disrupt social relationships. Besides the stress generated by the disease itself, the strictures of the confinement are unprecedented and, being completely new to citizens, can raise concerns about how people could react at the individual and collective levels. In such a context, individuals are expected to experience high levels of stress: this indeed occurs when subjects feel that their resources are not enough to cope with a given event or situation in a particularly demanding environment.

Stress levels may increase (Pfefferbaum and North, 2020; Polizzi et al., 2020; Qiu et al., 2020; Sun et al., 2020; Thakur and Jain, 2020; Wang et al., 2020a,b) both because of direct causes, such as fear of contracting the infection and anxiety or depression after being exposed to the virus (Rajkumar, 2020), and because of the consequences of the societal and economic–financial impact of the pandemic (Pfefferbaum and North, 2020; Wind et al., 2020). In addition, several families may be affected by school closing and lack of free school meals and may experience problems with employment and changes in daily habits. Wang et al. (2020a,b) assessed the emotional and the psychosocial effects of COVID-19 in 194 Chinese cities. The results of the study showed that approximately 16.5, 28.8, and 8.1% of the interviewees exhibited moderate-to-severe depression, anxiety, and stress, respectively. Gender (being female) and poor health status were statistically significant determinants of the psychological impact of the outbreak. In another Chinese survey conducted during the pandemic, the results highlighted a relevant prevalence rate of depression, anxiety, and stress-related symptoms (Liu N. et al., 2020; Liu S. et al., 2020).

Concerning the measures that can be taken to counteract such a burden, there is an increasing body of scholarly evidence documenting the advantages of exercising or practicing physical activity in terms of health and psychological gains (Stults-Kolehmainen et al., 2014). Indeed regular physical activity can result in positive behavioral changes and in the adoption of a healthy lifestyle, as such enhancing mental health and fostering abilities and skills to successfully face stressful events (Long, 1983; Salmon, 2001).

Several studies have shown that physical activity is an effective way to reduce stress in adults. Stults-Kolehmainen et al. (2014) reviewed 55 studies in depth. The majority of studies have indicated that psychological stress examined through objective (i.e., life events) and subjective (i.e., distress) measures is linked to a decrease in the level of physical activity and an increase in the adoption of sedentary lifestyles (Burg et al., 2017).

Despite the well-known advantages conferred by physical activity (Weyerer and Kupfer, 1994), this is not regularly practiced in Arab countries. Few people achieve the minimum level of physical activity necessary to maintain a good health status. During the pandemic, despite the quarantine and the restriction of movement, many people, especially males, began to practice physical activity in order to strengthen their immune system, improve mental health, and reduce the negative psychological impact of the measures implemented (Jiménez-Pavón et al., 2020). Recent scientometric analysis found that the most common research topics include emergency and surgical care, viral pathogenesis, and global responses to the COVID-19 pandemic, but there is a lack of research on the benefits of physical activity during the outbreak (Tran et al., 2020a,b).

Therefore, the aim of this investigation was to explore the impact of fear of COVID-19, level of physical activity, and gender on negative stress (distress) experienced in an Arab population by a second-generation statistical method. Indeed second-generation statistical techniques, called structural equation modeling (SEM), are currently applied by social scientists to model the causal links between unobservable variables.

Basically, there exist two major approaches to SEM: one being covariance-based (CB-SEM) and one based on partial least squares (PLS-SEM; also known as PLS path modeling). The former is mainly utilized to confirm (or reject) theories, whereas the latter is mainly employed to devise new theoretical models and frameworks. In this paper, given the novelty of the topic explored, the second approach (PLS-SEM) will be used.

MATERIALS AND METHODS

Ethics Statement

The protocol of this investigation was fully approved by the UNESCO Chair "Health Anthropology Biosphere and Healing Systems," University of Genoa, Genoa (Italy), the College of

Sport Sciences and Physical Activity, King Saud University, Riyadh (Saudi Arabia), the Higher Institute of Sport and Physical Education of Sfax, Sfax (Tunisia), and the Faculty of Letters and Human Sciences of Sfax, Sfax (Tunisia). The Ethical Committee of the University of Sfax, Sfax, Tunisia, approved the project.

The present study was conducted in accordance with the ethical principles of the 1964 Helsinki Declaration and its subsequent amendments.

Psychometric Instruments

The "Fear of COVID-19 Scale"

The adapted Arabic version of the "Fear of COVID-19 Scale," developed by Alyami et al. (2020), was employed to quantitatively assess the fear of COVID-19. Reliability and validity were inspected in a sample of 693 Saudi participants and confirmed the uni-dimensional construct of the tool. The internal consistency was deemed satisfactory ($\alpha = 0.88$), with a sound concomitant validity as demonstrated by statistically significant positive correlations ($r = 0.66$) with the "Hospital Anxiety and Depression Scale."

The initial scale was examined in a sample of 717 Iranian participants. After evaluation, using both the classical test theory and the Rasch model, the properties of the scale were judged satisfactory: internal consistency ($\alpha = 0.82$) and test–retest reliability (intra-correlation coefficient = 0.72) were indeed acceptable (Ahorsu et al., 2020).

Good psychometric properties similar to the original instrument have been proven for a Turkish version (Haktanir et al., 2020), an Italian adaptation (Soraci et al., 2020), and a model built in the Bangla population (Sakib et al., 2020).

The Turkish version (Haktanir et al., 2020) revealed its measurement robustness and the one-dimensional nature of the tool in an investigation conducted by recruiting a sample of 1,304 participants, aged 18–64 years, in 75 cities. A variety of analyses included confirmatory factor analysis, Item Response Theory, assessment of convergent validity, and internal consistency (namely, Cronbach's α, McDonald's ω, Guttmann's λ6, and composite reliability). Cronbach's alpha of the Italian version (Soraci et al., 2020) was also satisfactory (0.871), and the instrument displayed high reliability. Finally, results of the confirmatory factor analysis of the Bangla version (Sakib et al., 2020) confirmed the uni-dimensional factor structure of the scale and a very good internal reliability.

The Short Form of the "International Physical Activity Questionnaire"

The physical activity level was assessed by means of the validated Arabic version of the short form of the "International Physical Activity Questionnaire" (IPAQ) (Al-Hazzaa, 2007).

This tool has established good psychometric properties in several populations (Macfarlane et al., 2007; Lee et al., 2011; Vasheghani-Farahani et al., 2011).

The nine-item IPAQ enables to record self-reported physical activity level in the last 7 days. Scholars can convert the responses into metabolic equivalent task minutes per week according to a well-validated scoring protocol: total minutes spent on vigorous activity, moderate-intensity activity, and walking can be multiplied by 8.0, 4.0, and 3.3, respectively, to obtain metabolic equivalent of task (MET) scores for the different physical activity levels. The MET scores can be summed up to obtain the overall physical activity level. Based on the scores, three categories are possible: small, moderate, and high. In this research, we utilized the classification consisting of three categories to judge the level of physical activity practiced.

The Arabic Version of the "Perceived Stress Scale"

The "Perceived Stress Scale" (PSS) developed by Cohen et al. (1983) was employed to quantitatively measure the level of perceived stress. In particular, the 10-item PSS enables to assess the global perceived stress experienced in the past 30 days using a five-point scale (0 = never, 1 = almost never, 2 = once in a while, 3 = often, 4 = very often).

The Arabic version of the PSS was previously assessed in terms of reliability and validity, with acceptable results. Cronbach's alpha coefficient was computed at 0.80 for the overall instrument. The test–retest reliability yielded an intra-correlation coefficient of 0.90 (Almadi et al., 2012).

Data Collection and Procedures

In the context of the current study, a non-probabilistic, convenient sampling approach was utilized, and potential participants were contacted by email by the researchers contributing to the study from four Arab countries (Saudi Arabia: $n = 157$, Algeria: $n = 102$, Tunisia: $n = 117$, and Libya: $n = 83$).

The total sample comprised of 459 participants (age $M = 33.02$, SD age = 8.46), 237 women and 222 men. The level of education was basic (<9 years of study; $n = 144$), secondary/vocational (between 9 and 12; $n = 178$), and university ($n = 137$). The main characteristics are reported in **Tables 1**, **2**.

The multiple-choice questionnaire was filled by the participants via Google Forms from May 4 to May 15, 2020. The survey was sent to the participants and shared as well on social media and network platforms (including Twitter and Facebook).

After being advised of the study objectives, the respondents gave their free and informed consent before starting the survey.

No financial incentives were provided to the participants, and anonymity was maintained to ensure the confidentiality and the reliability of data.

Statistical Software and Statistical Analysis

Descriptive data analysis was conducted by means of the commercial software "Statistical Package for the Social Sciences" (IBM SPSS software for Windows, version 26.0, IBM Corp., Armonk, NY, United States; released 2012), while PLS path

TABLE 1 | Age and gender characteristics of the recruited participants.

	Frequency	%	Age (Mean)	Age (SD)
Gender				
Male	222	48.4	33.13	8.990
Female	237	51.6	32.92	7.955

TABLE 2 | Main characteristics of the recruited participants broken down according to education level, intensity of physical activity, and country.

	Frequency	%
Country		
Saudi Arabia	102	22.2
Algeria	157	34.2
Tunisia	83	18.1
Libya	117	25.5
Age		
18–20 years	11	2.4
21–30 years	171	37.3
31–40 years	214	46.6
41–50 years	40	8.7
More than 50 years	23	5.0
Education level		
Primary school	144	31.4
Middle school	178	38.8
High school	137	29.8
Physical activity intensity		
Low intensity	179	39.0
Middle intensity	141	30.7
High intensity	139	30.3

modeling was carried out using SmartPls Software 3.2.9 (Ringle et al., 2015).

Two steps were carried out sequentially. First, the measurement model was evaluated and then the structural model was assessed.

For all the statistical analyses performed, figures with *p*-value equal to or less than 0.05 were considered as statistically significant.

RESULTS

Figure 1 pictorially shows the findings of the PLS analysis, showing the path coefficients (β), the path statistical significance (*p*-value), and the variance explained by the structural model (in terms of R^2 values).

Assessment of the Measurement Model

The assessment of the measurement model is a fundamental step, providing useful details in terms of the reliability and the validity of the scales employed to assess latent constructs and their observed indicators (Loehlin, 1998).

There are different criteria that can be utilized to assess the reliability or the internal consistency of a psychometric instrument: (i) Cronbach's alpha, which is based on the inter-correlations of the observed indicators (if greater than 0.70, reliability is acceptable; if greater than 0.80, it is considered excellent), (ii) composite reliability (Hair et al., 2016), and (iii) reliability coefficient of Dijkstra–Henseler's rho (ρA) (Dijkstra and Henseler, 2015). The latter indices have a recommended cutoff value of 0.70 (Hair et al., 2016).

Table 3 shows the values of the three indices for the two measurement scales of COVID-19 and general distress which, being greater than 0.70, present adequate reliability.

Convergent Validity

It shows the extent to which observable indicators can converge to form a latent construct representative of the data.

Convergent validity is measured using the mean extracted variance (AVE) which must be greater than 0.5. The results of our study show that the AVEs have acceptable values of 0.745 for COVID-19 fear and 0.758 for the general distress scale (see **Table 3**).

Discriminant Validity

Two criteria are widely used for assessing discriminant validity: Fornell–Larcker criterion [developed by Fornell and Larcker (1981)] and heterotrait–monotrait (HTMT) [proposed by Henseler et al. (2015)]. The Fornell–Larcker criterion specifies that the square root of the AVE of each construct should be greater than the construct's highest correlation with any other construct in the model, while the HTMT is an estimate of the factor correlation (**Table 4**).

To distinguish between two factors, the HTMT should be significantly less than 1. Henseler et al. (2015) suggested that values should be below 0.9 or, better, below 0.85.

Table 5 provides inference statistics for the HTMT values. These values should be smaller than 0.85 and demonstrate good reliability.

Indicator Reliability

Another way to assess an individual indicator's reliability is to look at outer loadings for indicator constructs, which show how much variance is explained by the observed variable in terms of latent constructs (Hair et al., 2016). **Table 6** reports the outer loadings of all indicators of constructs, which are greater than the minimum acceptable value (0.7).

Assessment of the Structural Model

A structural model can be employed to assess the linear regression effects of the endogenous construct upon one another (Hair et al., 2016) by specifying the pattern of the relationships among the various constructs (Loehlin, 1998).

Collinearity Assessment

To investigate the presence of collinearity within the structural model, tolerance or variance inflation factor (VIF) criteria can be applied (Hair et al., 2011). All the indicators of the constructs under study have a VIF value less than 5 (**Table 7**), indicating the absence of collinearity between the indicators.

Coefficient of Determination

According to previous work, the coefficient of determination (or R^2 value) denotes the amount of variation in the dependent variable(s) that can be explained by one or more predictors, ranging between 0 and +1 and indicating the predictive accuracy of the structural model. According to Chin (1998), cutoff values of 0.19, 0.33, and 0.67 indicate a weak, moderate, and strong coefficient of determination, respectively.

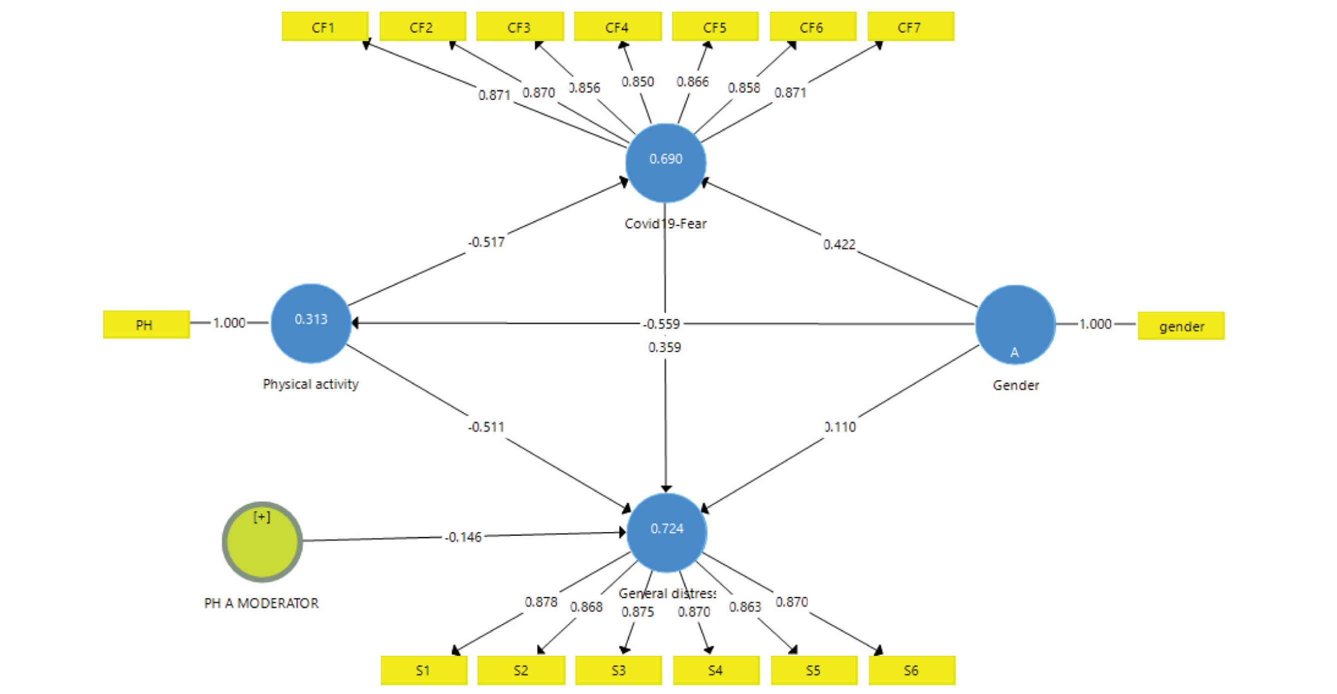

FIGURE 1 | The main findings of the partial least squares algorithm reporting path coefficients and R^2 values.

Table 8 shows that fear of COVID-19, level of physical activity, and gender can together explain 72.4% of the variation of general distress in the population. In addition, gender and physical activity can explain 69.0% of the variance of fear of COVID-19, while 31.3% of the variance in physical activity can be explained by a gender effect.

TABLE 3 | Internal consistency/reliability and average variance extracted.

Constructs	Internal consistency/reliability			Average variance extracted
	Cronbach's alpha	Rho_A	Composite reliability	
COVID-19 fear	0.943	0.943	0.953	0.745
General distress	0.936	0.936	0.949	0.758

TABLE 4 | The Fornell–Larcker criterion.

	COVID-19 fear	Gender	General distress	Physical activity
COVID-19 fear	0.863			
Gender	0.711	1.000		
General distress	0.775	0.629	0.871	
Physical activity	−0.753	−0.559	−0.792	1.000

TABLE 5 | The heterotrait–monotrait ratio of correlations.

	Fear of COVID-19	Gender	General distress
Gender	0.732		
General distress	0.824	0.650	
Physical activity	0.775	0.559	0.818

f^2 Effect Size

According to Cohen (1988, p. 413), 0.02 f^2 values for the significant independent variables indicate a weak effect, whereas 0.15 and 0.35 indicate moderate and substantial effects, respectively.

Table 9 shows that the effect sizes of COVID-19 fear, gender, and physical activity on general distress are 0.111, 0.030, and 0.333, respectively. This shows that physical practice has a

TABLE 6 | Indicator reliability.

	COVID-19 fear	General distress
CF1	0.871	
CF2	0.870	
CF3	0.856	
CF4	0.850	
CF5	0.866	
CF6	0.858	
CF7	0.871	
S1		0.878
S2		0.868
S3		0.875
S4		0.870
S5		0.863
S6		0.870

TABLE 7 | Collinearity assessment.

Indicators	VIF	Indicators	VIF
CF1	3.126	S1	3.214
CF2	3.144	S2	2.976
CF3	2.927	S3	3.198
CF4	2.859	S4	3.214
CF5	3.085	S5	3.135
CF6	2.859	S6	3.288
CF7	3.183		

TABLE 8 | R^2 of endogenous constructs.

Scale	R^2
COVID-19 fear	0.690
General distress	0.724
Physical activity	0.313

TABLE 9 | Effect size (f^2).

	COVID-19 fear	General distress	Physical activity
COVID-19 fear		0.111	
Gender	0.395	0.030	0.455
Physical activity	0.593	0.333	

medium effect size, while COVID-19 fear and gender have low effect sizes. In addition, great effects of gender and physical activity on fear of COVID-19 have been highlighted. Finally, a large size effect of physical activity on gender was recorded.

Predictive Relevance Q^2

Stone–Geisser's Q^2 value (Geisser, 1974; Stone, 1974) measure is an indicator of predictive power or predictive relevance. Running the blindfolding procedure, we got Q-values greater than zero (**Table 10**), indicating that our path model's predictive relevance is high.

Standardized root mean square residual

According to Henseler and Sarstedt (2013), the standardized root mean square residual (SRMR), computed as the difference between the observed correlation and the predicted correlation, can be considered as an absolute goodness-of-fit measure particularly adequate for PLS-SEM-based models. Values less than 0.10 up to 0.08 (in a conservative sense) are judged as a good fit (Hair et al., 2016). Our model has a good SRMR (0.034).

Effects Testing

To validate the direct and the indirect link hypotheses, a bootstrapping procedure (Davison and Hinkley, 1997) is generally used to test the statistical significance of the coefficients.

Tables 11, **12** report both significant direct and indirect effects in the path model and show means, standard deviation, and t- and p-values.

Both the cause-and-effect relationships imply that exogenous constructs directly affect endogenous ones without any

TABLE 10 | Predictive relevance Q^2.

	Sum of squares of prediction errors (SSO)	Sum of squares of observations (SSE)	Q^2 (=1 − SSE/SSO)
COVID-19 fear	3,213.000	1,574.892	0.510
General distress	2,754.000	1,279.696	0.535
Physical activity	459.000	316.647	0.310

TABLE 11 | Results of bootstrapping for structural model direct effects evaluation.

	M	SD	*T*	*P*-values
COVID-19 fear → general distress	0.361	0.051	7.001	0.000
Gender → COVID-19 fear	0.421	0.037	11.304	0.000
Gender → general distress	0.108	0.047	2.365	0.018
Gender → physical activity	−0.559	0.035	16.091	0.000
Physical activity (moderator) → general distress	−0.147	0.036	4.086	0.000
Physical activity → COVID-19 fear	−0.519	0.038	13.656	0.000
Physical activity → General distress	−0.511	0.047	10.778	0.000

TABLE 12 | Results of bootstrapping for structural model indirect effects evaluation.

Paths	*M*	SD	*T*	*P*-values
Gender → physical activity → COVID-19 fear	0.290	0.028	10.233	0.000
Gender → COVID-19 fear → general distress	0.152	0.026	5.794	0.000
Physical activity → COVID-19 fear → general distress	−0.187	0.030	6.225	0.000
Gender → physical activity → COVID-19 Fear → general distress	0.105	0.018	5.762	0.000
Gender → physical activity → general distress	0.286	0.033	8.774	0.000
Physical activity (moderator) → general distress	−0.15	0.03	4.54	0.000

systematic influence from other variables. However, the inclusion of a third variable in the analysis may impact on the model's relationships. The two major effects are mediation and moderation.

Mediation occurs when a third variable (called the mediating variable) is present in the model (example, COVID-19 fear). A change in the exogenous construction (for example, gender) may lead to a change in the mediating variable, which, in its turn, modifies the endogenous construction (for example, general distress).

In the present research, we have a mediating effect of COVID-19 fear which intervenes in the relationship between gender and general distress. At this level, a gender effect (the highest score attributed to the female gender) increases the fear of COVID-19 and therefore the general distress. In addition, another mediating effect is given by the level of physical activity: in the presence of this variable, the fear of COVID-19 varies by gender.

The other effect present in the model is moderation: when it is present, the direction and the strength of a given relationship between two constructions depend on a third variable. As such, the nature of the relationship between COVID-19 fear and general distress can differ depending on the values of the third variable (in our case, the level of physical activity). In other words, people who engage in physical activity and are afraid of COVID-19 do not have a great deal of stress compared to those who do not.

Figure 2 pictorially illustrates the moderation effect of the level of physical activity on the relationship between general distress and COVID-19 fear.

DISCUSSION

The aim of the present investigation was to develop and assess a model that examines the impact of COVID-19 fear, level of physical activity, and gender on general distress.

Results confirmed the links between level of physical activity, fear of COVID-19, and gender. They showed a significant mediating effect of COVID-19 fear in the relationship between gender and general distress. At this level, the female gender is more afraid of COVID-19, and the mediation effect is manifested by an effect on general distress. In addition, physical activity has an effect on COVID-19, varying by gender.

Furthermore, the results highlighted the presence of a moderation effect: physical activity practitioners, even if they are afraid of COVID-19, have a lower general distress score than those who do not practice physical activity.

In line with our results, Qiu et al. (2020) attempted to measure psychological distress in the general population of China during the COVID-19 pandemic. The authors found that, with respect to men, women were more vulnerable to stress and more likely to develop post-traumatic stress disorder. Similarly, a study conducted in Iran has shown that women experience more distress. The age of the participants and their level of education did not predict distress in the two countries. In contrast, exercise hours predicted distress both in Iran and China.

Fear is an adaptive defense mechanism fundamental and instrumental to survival (Ornell et al., 2020), involving biological processes necessary to react to potentially life-threatening events. On the other hand, if chronic or disproportionate, it can become harmful and can result in various psychological/psychiatric diseases.

When individuals feel that their resources can help them cope with the demands of a given stressor, stress is perceived as a challenge, but when the demands are particularly taxing, overwhelming and straining their resources, stress becomes a threat (Blascovich, 2008). After a threat assessment, stress generally results in a series of psychological and/or physiological responses (Chrousos, 2009). The harmful effects of stress on health are well-known and include both psychological (i.e., generalized anxiety disorder, depression, post-traumatic stress disorder) and physiological (i.e., cardiovascular disease, obesity, type 2 diabetes) consequences (Thoits, 2010).

In another study, Aldana et al. (1996) examined the relationship between physical activity during leisure time and perceived stress in 32,229 adults. The results indicated that employees with high physical activity were less likely to have high perceived stress. In addition, working adults who are engaged in moderate amounts of physical activity have about half the perceived stress rate of inactive people.

Wunsch et al. (2017) have shown that physical activity and exercise during a school exam period may reduce the negative impact of stress on health outcomes. As such, sustained levels of physical activity should be maintained during periods of high stress to avoid negative effects on sleep and well-being. On the other hand, it should be noted that the relationship is reciprocal. Sloan et al. (2013) showed that a sedentary lifestyle was positively associated with an increase in psychological distress, while regular physical activity was inversely associated with it. Similar results have been reported by Hamer et al. (2010) on a large sample in Scotland and by Atkin et al. (2012) who highlighted this relationship for workers in the United Kingdom (N = 2,707).

However, in another study, Kim et al. (2008) examined the relationship between psychological distress and physical activity using a dose–response approach (total, professional, and leisure). A long duration (1 h/day) of physical activity was associated with a score of lower distress, but the relationship appeared

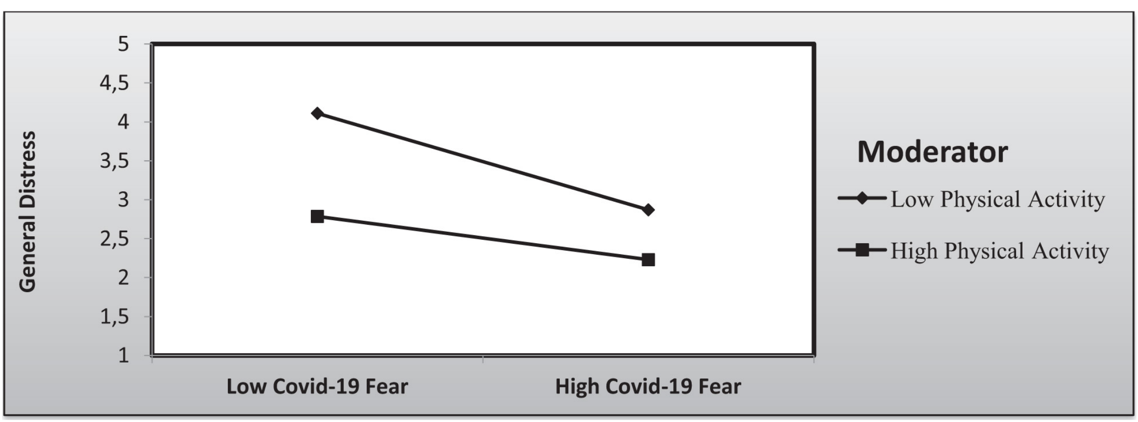

FIGURE 2 | Moderation effect of physical activity on the relationship between general distress and COVID-19 fear.

to vary depending on the activity performed, with the type of activity being a determinant of the psychological benefits conferred by physical activity. Therefore, physical activity should be incorporated as part of the cognitive behavior therapy (Ho et al., 2020) and psychoeducation (Tran et al., 2020a,b) during the COVID-19 pandemic.

To summarize, physical activity appears to be an effective means of maintaining a good health status and even improving/enhancing mental and physical health during the COVID-19 outbreak. In this perspective, Jiménez-Pavón et al. (2020) have proposed physical exercise as therapy to counteract or at least mitigate the mental and physical consequences of COVID-19-induced restrictive measures especially among vulnerable groups, such as the elderly. However, the precise nature, type, and duration of this activity should be carefully evaluated and warrant further research.

Limitations

Like all studies, the present investigation also has a number of limitations that should be acknowledged. For instance, the socio-economic status of the participants has not been explored. However, links have been highlighted between socio-economic status and COVID-19-related behaviors. Indeed Tran et al. (2020a,b) concluded that economically vulnerable populations are at the highest risk of suffering if they are affected by COVID-19. In addition, self-medication was the most widely used method to remedy health problems. Finally, the dates on which the questionnaires were filled do not coincide with the peaks of the pandemic and present some variations among countries. As such, further research is needed: a high-quality longitudinal survey could capture behavioral and psychological changes during the different phases of the outbreak.

CONCLUSION AND RECOMMENDATIONS

From the model presented in this study, the COVID-19 pandemic has an impact on psychological distress in the target populations. The effect of physical activity on psychological distress is shown to be very important during the pandemic phase. It can be recommended for stress management and adaptation during the pandemic period. In addition, many people have shown that they have not reduced their physical activities as a response to this emergency despite the stringent safety measures taken.

The results of this study suggest the following recommendations for future interventions: (1) greater attention should be paid to psychological distress which may have harmful consequences on physical and mental health, (2) physical activity can be exploited to counteract the burden of stress experienced during the containment measures implemented and enforced, (3) more attention should be paid to women to increase their level of practice of physical activity, and, (4) education and training on psychological issues should be provided to health workers and professionals in the countries under study.

DATA AVAILABILITY STATEMENT

All datasets generated for this study are included in the article/supplementary material.

ETHICS STATEMENT

The study protocol of the present investigation received ethical clearance from the UNESCO Chair "Health Anthropology Biosphere and Healing Systems," University of Genoa, Genoa (Italy), the College of sport sciences and physical activity, King Saud University, the Higher Institute of Sport and Physical Education of Sfax, Sfax (Tunisia), and the Faculty of Letters and Human Sciences of Sfax, Sfax (Tunisia). The Ethical Committee of the University of Sfax, Sfax, Tunisia, approved the project. The present investigation was carried out in accordance with the ethical principles of the 1964 Helsinki declaration and its subsequent amendments. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

TA, SA, DA, and NB conceived and performed the experiment. NC, NG, and FA collected and analyzed data. All authors wrote the draft and approved the final version of the manuscript.

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When Pandemic Hits: Exercise Frequency and Subjective Well-Being During COVID-19 Pandemic

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The governmental lockdowns related to the COVID-19 pandemic have forced people to change their behavior in many ways including changes in exercise. We used the brief window of global lockdown in the months of March/April/May 2020 as an opportunity to investigate the effects of externally imposed restrictions on exercise-related routines and related changes in subjective well-being. Statistical analyses are based on data from 13,696 respondents in 18 countries using a cross-sectional online survey. A mixed effects modeling approach was used to analyze data. We tested whether exercise frequency before and during the pandemic would influence mood during the pandemic. Additionally, we used the COVID-19 pandemic data to build a prediction model, while controlling for national differences, to estimate changes in exercise frequency during similar future lockdown conditions depending on prelockdown exercise frequency. According to the prediction model, those who rarely exercise before a lockdown tend to increase their exercise frequency during it, and those who are frequent exercisers before a lockdown tend to maintain it. With regards to subjective well-being, the data show that those who exercised almost every day during this pandemic had the best mood, regardless of whether or not they exercised prepandemic. Those who were inactive prepandemic and slightly increased their exercise frequency during the pandemic, reported no change in mood compared to those who remained inactive during the pandemic. Those who reduced their exercise frequency during the pandemic reported worse mood compared to those who maintained or increased their prepandemic exercise frequency. This study suggests that under similar lockdown conditions, about two thirds of those who never or rarely exercise before a lockdown might adopt an exercise behavior or increase their exercise frequency. However, such changes do not always immediately result in improvement in subjective well-being. These results may inform national policies, as well as health behavior and exercise psychology research on the importance of exercise promotion, and prediction of changes in exercise behavior during future pandemics.

Keywords: mood, motivation, physical activity, habit, health

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INTRODUCTION

Regular exercise and physical activity improve physical fitness and help reduce the incidence of various chronic diseases and physical disabilities (Warburton and Bredin, 2017). Although there are risks of injury associated with participating in certain sports, regular exercise and physical activity are recommended to be part of a healthy lifestyle. The World Health Organization (WHO) advises adults to accumulate at least 150 min of moderate-intensity aerobic physical activity during the week, and additional muscle strengthening activities on two or more days a week (WHO, 2018). These activities should be performed in bouts of at least 10 min in duration during most days of the week.

Exercise also has psychological benefits and is believed to lead to better subjective well-being (SWB). Although many people will understand the meaning of the concept "well-being" intuitively, there are different views about its conceptual makeup. In psychology, SWB is often defined as a multi-faceted construct composed of affective and cognitive components (Diener et al., 1999). Defining these components is important as they have often been used wrongly and interchangeably in the literature (Ekkekakis, 2011). At the core of the affective component is a valenced feeling (pleasure/displeasure) that is primitive and does not require cognitive processing (Russell and Feldman Barrett, 2009). Core affective feelings are always present in emotions and moods. Both emotions and mood imply cognitive appraisal, and a strong cultural influence is assumed on their formation. Emotional states (e.g., fear, guilt, and pride) are often short-lived, higher-intensity responses to identifiable stimuli; whereas, moods (e.g., irritation, cheerfulness, and grumpiness) are often less intense and longer-lived, and sometimes have less identifiable stimuli (Ekkekakis, 2011). There are chronic and acute effects of exercise on SWB. Both have been studied with the general population and in people living with chronic disease.

There are numerous studies on the chronic psychological benefits of exercise, and many of them relate to changes in mood. For example, data from genome-wide association studies with 611,583 adult participants show that physical activity (measured via accelerometry) is a protective factor against the risk of developing Major Depressive Disorder (Choi et al., 2019). A meta-analysis of prospective cohort studies suggests that the protective effects of physical activity against depression are comparable in youth, adults, and the elderly population across the globe (Schuch et al., 2018). The chronic effects of exercise on SWB are similar in healthy individuals (Diener et al., 2017; Panza et al., 2019), although studies in this area are sometimes of lower methodological quality than those related to depression.

Population-based survey studies for example showed that those who exercise at least two to three times a week, report significantly less stress, cynical distrust, and anger than less active individuals (Hassmén et al., 2000). Although the majority of the studies on chronic psychological benefits of exercise confirm that exercise can contribute to better SWB and mood (Wicker and Frick, 2017), and has protective effects against depression (Ekkekakis, 2015; Schuch et al., 2016), it would be wrong to claim that exercise always and automatically leads to more well-being. For example, an epidemiological study including 162 monozygotic twin pairs illustrated that a twin, although he or she claims to be an exerciser, will not necessarily report better well-being than his or her less active sibling (Stubbe et al., 2007). Although genetic factors influence both exercise behavior and well-being (Stubbe et al., 2007; Schutte et al., 2017), the relationship between the two variables is obviously mediated by other variables.

Actually, there are nuances with respect to how people feel with a single bout of exercise. While research findings on the acute effects on SWB and mood are often difficult to interpret, the evidence on the effects on core affect is very clear (Ekkekakis and Brand, 2019). During exercise, intensity is a moderating variable of eventual "feel better" effects. Positive affect is most likely to appear with low- and only sometimes with moderate-intensity exercise. During vigorous-intensity exercise negative changes in core affective valence become universal due to the dominance of aversive proprioceptive sensations (e.g., heavy breathing, intense sweating, and sore muscles) (Ekkekakis et al., 2011). Learned cognitive appraisals are needed to transform perceived negative core affect during and after exercise into a resulting overall state of positive SWB. Once such appraisal has been learned (Antoniewicz and Brand, 2016), exercise might begin to have its beneficial effects on mental health. Therefore, in order to benefit from these positive changes, exercise has to be performed regularly and consistently over a period of time.

According to a recent literature review initiated by the United Kingdom Economic and Social Research Council, exercise-induced improvements in well-being may even be considered as an effective measure to increase labor productivity on a national scale (Isham et al., 2020). Against the background of all these findings, it is not surprising that international health organizations and national governments have committed themselves to facilitating and promoting exercise for the public (Breda et al., 2018).

In the early months of 2020, COVID-19 pandemic reached a peak in many countries and by March and April, almost all countries around the world reinforced a certain type of lockdown restriction. The restrictions which can affect exercise behavior include closing of gyms and fitness clubs, as well as restricted access to parks and outdoor environments.

This brief period of time provided a unique opportunity to investigate the effects of externally imposed restrictions on exercise behavior and the respective changes in SWB (mood) on a very large and global scale. We expected to see an overall decrease in exercise levels with respective negative effects on mood. The study further aimed to establish a prediction model that can estimate the changes in exercise behavior during a lockdown depending on prepandemic exercise behavior. A model like this may be useful to predict changes in the future for conditions similar to the governmental lockdowns in the early months of 2020.

MATERIALS AND METHODS

This study used a cross-sectional design to investigate changes in exercise behavior during the lockdown restrictions of the current coronavirus pandemic and its relation to changes in mood. We used the brief period of lockdown restrictions and tried to reach participants all over the world. A mixed (fixed and random) effects model approach was used to analyze data. The study was conducted by the International Research Group on COVID and exercise (IRG). Data were collected between March 29, 2020 and May 7, 2020. The IRG is headed by the three authors of this article, and consists of 34 researchers who helped to make the questionnaire available in 18 languages (Arabic, simplified and traditional Chinese, English, Farsi, Filipino, Finnish, French, German, Greek, Icelandic, Italian, Malayan, Polish, Portuguese, Russian, Spanish, and Turkish). All IRG members are listed in the acknowledgments of this article.

Sample Size

No statistical methods were used to predetermine sample size. IRG members disseminated the link to the survey in their home countries (and possibly beyond) via personal networks, social media and press releases. Because different nations relaxed their COVID-related rules and regulations at different times in March, April, and May 2020, the IRG networkers were responsible to indicate when such changes would impact our research to the extent that would render the research question meaningless (e.g., opening of gyms, outdoor parks, etc.). For example, on April 19, restrictions in Germany were decisively relaxed; therefore, we decided to exclude the subsequent collected data from our statistical analyses. However, the sample size corresponds to the recommendations for sufficient power in hierarchical modeling (Nakagawa et al., 2017).

Participants

A total of 16,137 individuals from 99 countries filled out the questionnaire. Information on presence of COVID-19 symptoms or a diagnosis was collected to exclude these individuals from the statistical analyses (n = 1,085). No further information, for example on physical or mental disabilities, was collected in this study. For the mixed effect models (see below), only data from countries with more than 100 participants were used. The statistical analysis thus included data from participants in Europe, Asia, as well as South and North America. There were five countries with more than 1,000, 11 with more than 500, and 18 with more than 100 participants (countries and exact numbers of participants in countries are listed in **Table 1**). This resulted in a total sample of 13,696, who were on average 34.1 years old (SD = 14.4); men (39.1%), women (59.5%), and participants with other gender identities (1.4%). Of those, 13,673 participants provided full data for the exercise behavior change analysis and 13,500 for the analysis of the associations between exercise behavior and mood. Descriptive statistics on gender distributions and age in countries are summarized in **Table 1**.

TABLE 1 | Descriptive statistics on gender and age distribution across different nations.

Country	*n*	% female	Mean age (*SD*)
Austria	146	53	31.8 (±12.3)
Brazil	595	63	34.4 (±11.6)
China	821	55	26.4 (±10.3)
Finland	472	62	41.4 (±11.5)
Germany	2,061	61	37.5 (±13.5)
Greece	156	58	32.5 (±12.8)
Iceland	826	76	41.2 (±12.5)
Iran	206	68	34.0 (±9.6)
Italy	1,834	49	37.0 (±16.3)
Malaysia	379	62	32.2 (±12.5)
Philippines	1,202	58	32.4 (±13.2)
Russia	118	57	24.8 (±10.4)
Spain	592	54	31.3 (±12.5)
Switzerland	2,222	67	29.7 (±12.9)
Taiwan	1,103	57	35.9 (±15.1)
Turkey	680	62	30.4 (±20.1)
United Kingdom	102	59	41.1 (±13.2)
United States	181	70	39.3 (±13)
Analyzed data set	13,696	59	34.1 (±14.4)
Additional participants (not included in the analysis)	2,441	55	36.2 (±14.2)
Total	16,137	59	34.4 (±14.4)

Variables

The data were collected with an online survey by using the Unipark web-based survey software. Participants were able to skip any questions they did not want to answer or stop answering the questions entirely at any point.

Exercise Behavior

Exercise frequency during the pandemic was measured with the question "how often have you exercised lately (during COVID-19)?" Possible answers were "never," "once in a while," "once a week," "2 days a week," "3 days a week," "4 days a week," "5 days a week," "6 days a week," and "every day." We defined exercise for participants as any activity they choose to do as their exercise (e.g., workouts at home, running outside, etc.). Participants were also informed that any physical activity as part of their occupation must not be included unless they are a professional fitness coach or have a similar profession. For statistical analysis, the answers "once in a while" and "once a week" were combined as "1 day or less," the answers "2 days a week" and "3 days a week" were combined as "2–3 days," "4 days a week" and "5 days a week" were combined as "4–5 days" and "6 days a week" and "every day" were combined as "almost every day." Exercise frequency before the pandemic was measured and processed in the same format.

In addition, participants were also asked about their typical exercise intensity ("What would you say the intensity of this exercise was each time you did it?") and they could respond choosing "low," "moderate," "high," or "very high" intensity. The options "high" and "very high" intensity were combined to "high intensity" for the analysis, because the original distinction did not yield further insights. Participants were also asked about their exercise session length during the pandemic compared to prepandemic ("Were your exercise sessions during COVID-19 on average shorter or longer than before COVID-19?") and could choose between "shorter," "longer," or "they were of about the same duration."

Mood

Mood was measured with 16 items from the Profile of Mood Scale (POMS) (McNair et al., 1971). The POMS is a heavily used psychometric questionnaire that measures general well-being in the clinical field both with the general population and people with chronic disease as well as in sport and exercise psychology research (Leunes and Burger, 2000). In its original form it presents a list of 65 adjectives that describe feelings people have (e.g., "tense" and "active"). The participants are asked to rate each item (adjective) by indicating whether they experienced the respective feeling "not at all," "a little," "moderately," "quite a lot" or "extremely" now and/or in the past few days. In our study, participants were asked to report how they felt "in the last few days during COVID-19."

The POMS exists in various short versions and language formats, each with different combinations of items which results in different subscales. It is often impossible to match the items from the translated version to the English version with certainty, perhaps due to historic reasons and that there were different standards in transparency and reproducibility of research 20–40 years ago. For this study, we used the 16-item POMS from a German short screening version, which was psychometrically tested using data from a large national and representative sample (Petrowski et al., 2020). The German items were then matched with the English originals by the authors as thoroughly as possible, and translated from English into the respective survey language by the IRG networkers. These 16 items allow subscores for "depression/anxiety," "vigor," "fatigue," and "irritability"; however, we have only used the total score in our analysis. The higher values on POMS indicate a more positive mood. In our study, the 16-item POMS total score achieved an internal consistency (reliability) across all language versions of Cronbach's $\alpha = 0.89$. Mean total scores were calculated if at least 10 items of the scale were answered by the participants.

Statistical Analysis

Due to the hierarchically structured (i.e., participants nested in countries) and unbalanced (i.e., different numbers of participants in countries) data set, a mixed models regression approach was used for investigating the main research questions. All analyses were performed with the R software (R Core Team, 2019), and the lme4 (Bates et al., 2015) and the Ordinal (Christensen, 2019b) packages for mixed modeling.

Cumulative link mixed-models (CLMM) (Christensen, 2019a) were utilized to predict the probabilities of exercising at the five frequency levels ("never," "1 day or less," "2–3 days," "4–5 days," "almost every day") during the pandemic by the five frequency levels of "exercise before the pandemic" ("never," "1 day or less," "2–3 days," "4–5 days," "almost every day"). The variable "country of residence" was included as a random effect.

A linear mixed model (LMM) was used to analyze the influence of exercise behavior on mood. This model was run with mood as the numerical response variable and "exercise frequency before the pandemic" and "exercise frequency during the pandemic" as categorical fixed factors (with the five levels "never," "1 day or less," "2–3 days," "4–5 days," and "almost every day"). The variable "country of residence" was included as a random effect. All fixed effects were specified with sum contrasts. Therefore, the LMM returns the grand mean dependent variable as intercept and the fixed-effect parameters as deviations from the grand mean. Pairwise *post-hoc* tests were used to compare the mood differences between all exercise frequency levels during the pandemic (e.g., never exercising before and during vs. never exercising before and 2–3 days during). Multiple testing was adjusted with the "Holm" method (model formulations, fit indices and model coefficients are provided in **Supplementary Table 3**).

RESULTS

Exercise Behavior Change

The results show that 44.2% of the participants reported no change, 23.7% reported a decrease, and 31.9% reported an increase in their exercise frequency during the coronavirus pandemic (0.02% missing values; **Supplementary Table 1** for more descriptive information).

Of those who exercised during the pandemic, 52.3% reported being physically active at similar, 30.2% at lower, and 9.1% at higher exercise intensities. Also, 35.7% reported the same exercise duration, 31.4% reported shorter, and 24.5% reported longer exercise duration. This information is presented in **Figure 1** with more details.

A statistical model was created that can be used to predict changes in exercise frequency during similar lockdown conditions, depending on prelockdown exercise frequency. Exercise intensity and exercise duration were not included in this multilevel model because the combination of all exercise levels ("prepandemic" and "during the pandemic") with these two ordinally ranked additional variables would have multiplied the complexity of the model and would have made statistical effects uninterpretable.

Predicting exercise frequency during lockdown conditions with prelockdown exercise frequency significantly improved the model fit compared to the null model, χ^2_{pre} (4) = 3854.74, $p < 0.001$. Exercising more frequently before the pandemic significantly increased the log odds for exercising during the pandemic (b_{pre1-4} = 1.21–4.06, $p < 0.001$). Adding "country of residence" as a random effect significantly improved the model fit compared to the model without the random effect, $\chi^2_{country}$ (1) = 1197.26, $p < 0.001$, supporting the rationale for using a mixed model. In the next step, "exercise before the pandemic" was added to the model as a random slope. This resulted in significant improvement in model fit, $\chi^2_{pre|country}$ (14) = 108.75, $p < 0.001$, meaning that the probability of exercise frequency during the pandemic was dependent on exercise frequency before the pandemic and differed between the countries (see **Supplementary Table 2** for full model specification). This indicates that potential differences in lockdown policies may have subsequently affected the changes in exercise behavior. In the fitted model, the fixed effect and random effects together explain 31.5% of variance (conditional R^2) in the dependent variable. **Table 2** summarizes the complete statistical results.

Figure 2 is a heatmap that illustrates the exact predictions of our model for future similar governmental lockdowns. For example, those who exercise almost every day, 4–5 days per week, and 2–3 days per week before a lockdown will most likely maintain their exercise frequency during a lockdown. Specifically, those probabilities are 62%, 33.8%, and 33.2%, respectively. However, those who exercise 1 day or less or those who never exercise before a lockdown will most likely increase their exercise frequency. Those who exercise 1 day or less will most likely (34.5%) increase their exercise frequency to 2–3 days per week, and those who are inactive before a lockdown will most likely (35.9%) increase their exercise frequency to 1 day or less per week.

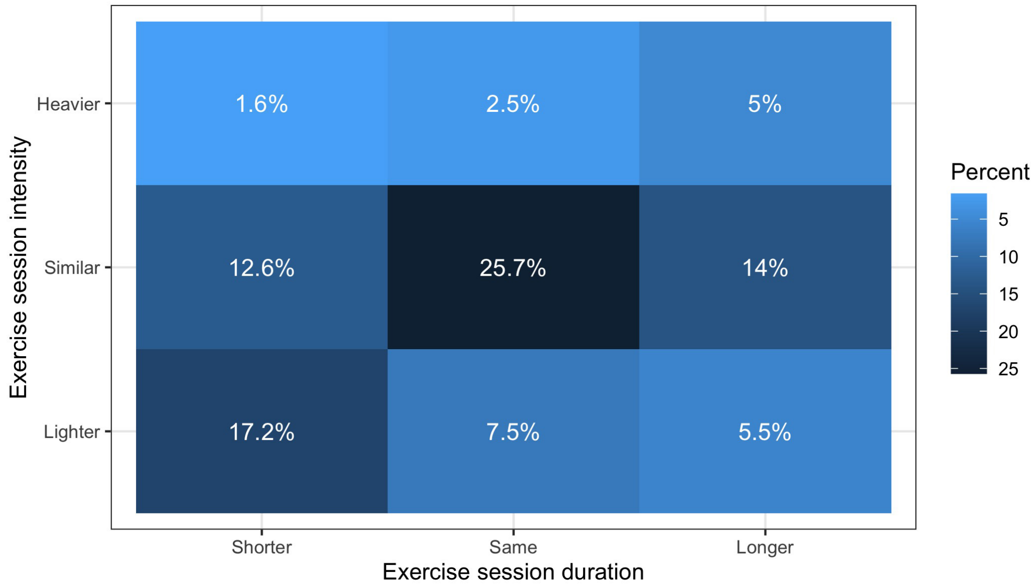

FIGURE 1 | Changes in exercise behavior during the COVID-19 pandemic in March/April/May 2020 compared to prepandemic. Lighter colors show lower percentages.

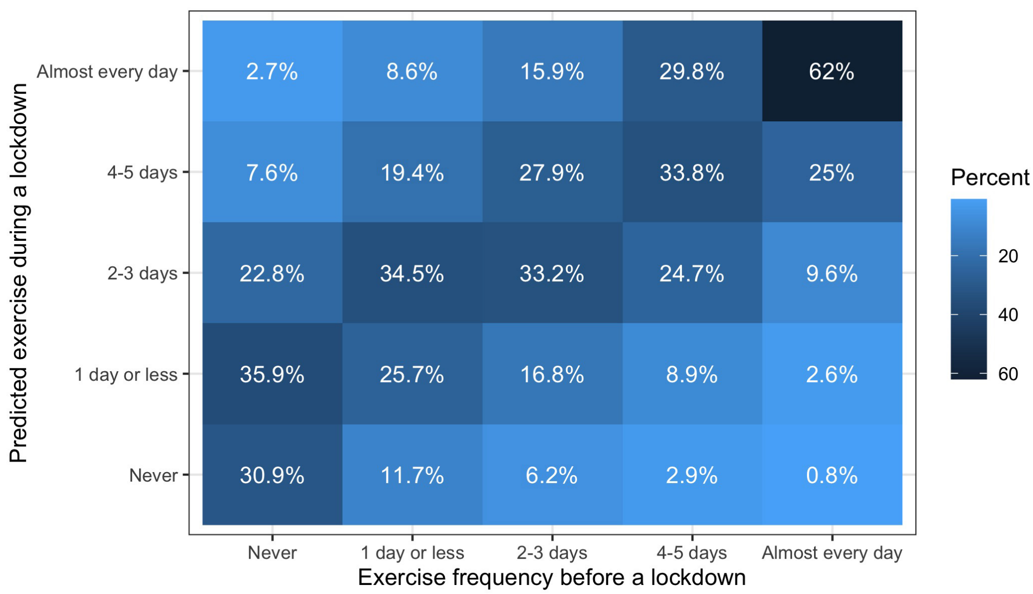

FIGURE 2 | Model predictions on the probabilities of exercising during similar lockdown conditions, depending on prelockdown exercise frequency. Lighter colors indicate smaller probabilities and darker colors indicate larger probabilities. If the darkest colors were all on the diagonal from bottom left to top right, this would mean that people who exercise at a specific frequency before a lockdown would be most likely to exercise at the same frequency during a lockdown.

Exercise and Mood

Results of the LMM show that during the coronavirus pandemic restrictions, exercise before the pandemic (χ^2_{pre} [4] = 67.38, $p < 0.001$), exercise during the pandemic (χ^2_{during} [4] = 426.44, $p < 0.001$), and the interaction of these two factors ($\chi^2_{pre \times during}$ [16] = 64.14, $p < 0.001$) explained significant variability in mood during the pandemic. This means that the relationship between exercise during the pandemic and mood is different depending on how much exercise was done before the pandemic. Modeling the influence of exercise frequencies during the pandemic with random slope substantially improved model fit, $\chi^2_{during|country}$ (14) = 35.38, p = 0.001. This means that correlations between exercise frequency during the pandemic and mood vary between countries (see **Supplementary Table 3**

TABLE 2 | Change in exercise behavior.

	Model: Exercise during the pandemic		
	Estimate (*SE*)	**OR [95% CI]**	***p***
Location Coefficients			
Exercise before the pandemic			
1: 1 day or less	1.21 (0.18)	3.36 [2.35–4.80]	<0.001
2: 2–3 days	1.91 (0.19)	6.75 [4.63–9.83]	<0.001
3: 4–5 days	2.71 (0.21)	15.07 [10.05–22.60]	<0.001
4: Almost every day	4.06 (0.24)	58.16 [36.38–92.98]	<0.001
Threshold Coefficients			
Never | 1 day or less	−0.81 (0.26)		
1 day or less | 2–3 days	0.70 (0.26)		
2–3 days | 4–5 days	2.15 (0.26)		
4–5 days | Almost every day	3.57 (0.26)		
Random effects			
σ^2	3.29		
$\tau_{00Country}$	0.88		
$\tau_{11Country.1\ dayorless}$	0.23		
$\tau_{11Country.2-3\ days}$	0.30		
$\tau_{11Country.4-5\ days}$	0.39		
$\tau_{11Country.Almosteveryday}$	0.60		
$N_{Country}$	18		
Observations	13,673		
Conditional R^2	0.315		

Statistical results for the CLMM predicting exercise frequency during a lockdown with prelockdown exercise frequency.

for full model specification), and that our model controls for this variation. In the fitted model, the fixed effect and random effects together explain 8.5% of variance (conditional R^2) of the dependent variable.

Figure 3 shows the predicted values for mood at each of the five exercise frequency levels during the pandemic (within the five columns), and grouped for each exercise frequency level before the pandemic (five columns). Those who exercised almost every day during the pandemic had the best mood regardless of whether or not they exercised before the pandemic ($b_{during4} = 0.23$, $p < 0.001$), and there seems to be an almost linear positive correlation between exercise frequency during the pandemic and mood.

Post-hoc tests revealed that of those who "never" exercised, exercised "1 day or less," or "2–3 days" before the pandemic, only those who increased their exercise frequency to "every day" during the pandemic (compared to those who maintained their pre-pandemic exercise frequency) reported significantly better mood states ($b_{pre0:during4-0} = 0.33$, $p = 0.03$; $b_{pre1:during4-1} = 0.21$, $p = 0.001$; $b_{pre2:during4-2} = 0.12$, $p < 0.001$). Those who reduced their exercise frequency reported worse mood states compared to those who maintained or increased their exercise frequency during the pandemic (e.g., $b_{pre2:during1-2} = -0.24$, $p = 0.001$; $b_{pre3:during2-3} = -0.16$, $p = 0.001$; $b_{pre4:during3-4} = -0.16$, $p < 0.001$). The only exception to the above is those who exercised "1 day or less" before the pandemic and were not physically active at all during the pandemic. Their mood did not differ from those who maintained their exercise frequency at "1 day or less" during the pandemic ($b_{pre1:during0-1} = -0.12$, $p = 0.09$). Results of all *post-hoc* tests are summarized in **Table 3**.

DISCUSSION

This study took advantage of the lockdown rules and regulations imposed by governments from around the world during the first wave of the COVID-19 pandemic in the months of March/April/May 2020 to examine how such changes in people's lives affect exercise behavior and SWB. We investigated mood as a component of SWB. Moreover, we have accounted for the differences between lockdown restrictions in each country which can ultimately affect exercise behavior in each nation. Using data from more than 13,000 individuals from 18 countries, we created a model that allows us to predict changes in exercise behavior during a lockdown based on prelockdown exercise behavior. According to this model we conclude that the probability of maintaining exercise frequency during a lockdown for those who exercise before a lockdown and the probability of adopting exercise for those who are inactive

TABLE 3 | *Post-hoc* tests comparing exercise levels during the coronavirus pandemic grouped by prepandemic exercise levels.

Contrast	*Estimate*	*SE*	*p*
Pre exercise = Never (0)			
During exercise: 1-0	−0.007	0.084	1.000
During exercise: 2–0	0.032	0.100	1.000
‘During exercise: 3–0	0.134	0.112	1.000
During exercise: 4–0	0.328	0.111	0.031
Pre exercise = 1 day or less (1)			
During exercise: 0–1	−0.122	0.052	0.090
During exercise: 2–1	0.041	0.047	0.385
During exercise: 3–1	0.111	0.056	0.193
During exercise: 4–1	0.214	0.056	0.001
Pre exercise = 2–3 days (2)			
During exercise: 0–2	−0.248	0.051	<0.001
During exercise: 1–2	−0.241	0.041	<0.001
During exercise: 3–2	0.020	0.028	0.964
During exercise: 4–2	0.121	0.029	<0.001
Pre exercise = 4–5 days (3)			
During exercise: 0–3	−0.338	0.073	<0.001
During exercise: 1–3	−0.370	0.056	<0.001
During exercise: 2–3	−0.158	0.029	<0.001
During exercise: 4–3	0.085	0.024	0.001
Pre exercise = Almost every day (4)			
During exercise: 0–4	−0.594	0.088	<0.001
During exercise: 1–4	−0.455	0.0662	<0.001
During exercise: 2–4	−0.321	0.046	<0.001
During exercise: 3–4	−0.164	0.031	0.001

*This is a selection of comparisons showing the differences in mood for different exercise frequency levels during the pandemic when compared to maintaining the same prepandemic exercise level (for all pairwise post-hoc tests see **Supplementary Table 4**). p value adjustment: Holm method; Exercise levels: 0 = "Never"; 1 = "1 day or less"; 2 = "2–3 days"; 3 = "4–5 days"; 4 = "Almost every day."*

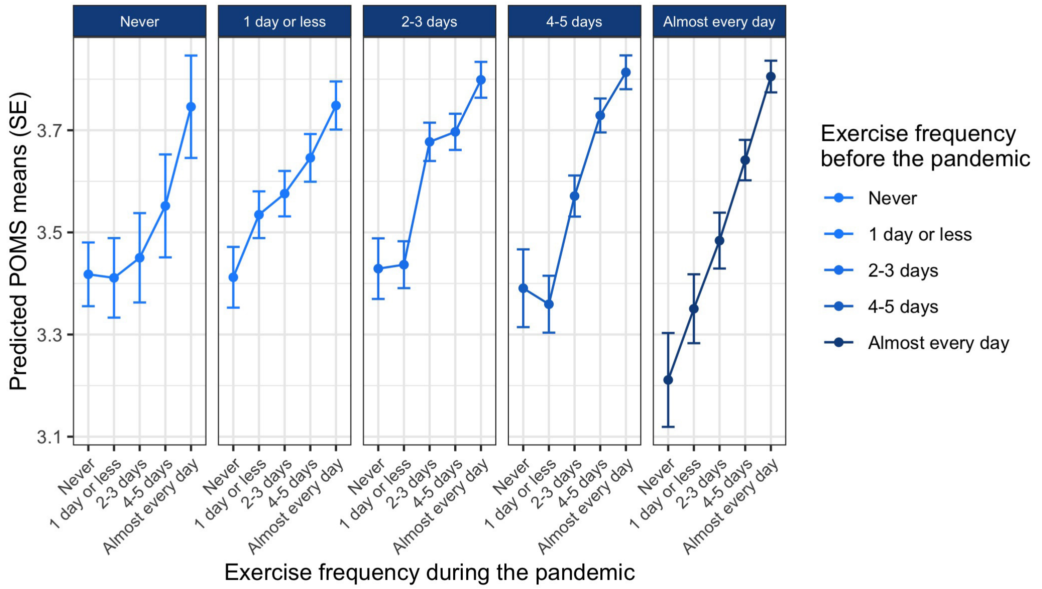

FIGURE 3 | The effect of exercise frequency during the pandemic on mood depending on prepandemic exercise frequency. Lines indicate values for mood during the pandemic (higher values are better mood). Each column indicates exercise frequency before the pandemic, and exercise frequency levels within each column are exercise frequency levels during the pandemic.

before a lockdown are both high. Meaning that lockdown restrictions (e.g., closing of gyms, fitness clubs, etc.) do not dramatically decrease exercise frequency for those who are frequent exercisers, and even lead to adoption of exercise for those who are inactive previous to a lockdown. We hypothesized that there will be a decrease in exercise frequency during the pandemic compared to prepandemic; however, the results show that many people maintained (44.2%), or increased (31.9%) their exercise levels, and only 23.7% reported a decrease in exercise frequency.

Interestingly, adoption of exercise or increase in exercise frequency during the pandemic for those who were inactive or rarely active before the pandemic was not associated with better mood (when compared to those who remained inactive) unless exercise frequency was drastically increased to almost every day. Importantly, those who exercised more always had better mood than those who exercised less (within the groups with different prepandemic exercise levels). Therefore, we suggest that exercising frequently during a pandemic helps with improvements in mood.

As mentioned above, we observed an almost linear dose-response relationship between exercise frequency and mood in a way that those who exercised more frequently during the pandemic also reported the most positive mood (note that in other exercise studies the dose of a particular exercise session is often more closely defined by the intensity, duration and type of exercise; this additional information was not collected in this study). Various theories, both psychological and biological, may be used to explain the connection found between exercise and mood (Landers and Arent, 2012). We consider that chronic psychological effects of exercise are more likely to explain this relationship compared to acute psychological effects as it is unlikely that acute affective responses to exercise have shaped all participants' ratings of mood under the lockdown.

A possible psychological explanation of the effect is self-efficacy theory (Bandura, 1989). Self-efficacy is described as an individual's belief that he/she is capable of performing a behavior with success or achieving a goal. If people see their goals realized, this can contribute to satisfaction and pride and has a positive effect on mood. Increased self-esteem and perceived physical fitness may play a role in this relation as well (Diener et al., 2017). Psychophysiological processes may also have been involved. For example, it is known that as a result of frequent exercise, there are durable changes in the activity of the hypothalamus-pituitary-adrenal axis ("stress axis") that enable people to cope better with acute experience of stress. These changes in stress axis are associated with, for example, enhanced density and efficiency of mineralocorticoid receptors, and lower cortisol levels and the inhibition of cortisol synthesis (Matta Mello Portugal et al., 2013; see Mandolesi et al., 2018, for a review of neuroplastic phenomena as a potential mechanism involved). Physiological explanations of this kind might explain why those who decided to increase their exercise frequency only a little bit during the pandemic, did not immediately benefit from their decision with regard to SWB. However, further studies are required to shed light on the mechanisms involved.

In terms of statistical effect size, the variance in mood explained by the multilevel regression model is rather small. General mood state is indeed influenced by much more than only exercise behavior, especially during extraordinary times like the COVID-19 pandemic and the associated lockdowns in early 2020. Furthermore, it is also important to know that mood scales tend to provide score averages above the scale mean in non-clinical samples (in the POMS, with a response scale from 1 to 5, the expected mean values are usually higher than 3; Morfeld et al., 2007). Also, by taking into account that achieving maximum scores on mood scales (near a mean value of 5 in POMS) is very unusual, the exercise effect found in our study, where the mood state of those who exercise very frequently increased to near 4, may well gain some practical significance (see **Figure 3**). Although we do not want to exaggerate the practical importance of the mood effect identified in our data, we do believe that it is relevant for public health decision making processes during future pandemic-related lockdowns.

From the perspective of the psychological theories and results on affective responses to exercise presented in the introduction, there is a rather straightforward explanation why exercising was not associated with immediate improvements in SWB for all (Brand and Ekkekakis, 2018; Ekkekakis and Brand, 2019). It is possible that for those who are new to exercise, exercising under the lockdown restrictions was as strenuous and accompanied by the same negative acute exercise-related affect that had prevented these people from adopting an exercise routine before the pandemic. Maybe the number of exercise sessions during the lockdown was not enough to learn to enjoy exercise (i.e., to learn the cognitive appraisals necessary to transform the eventually unpleasant interoceptive signals during higher intensity exercise into a more positive affective state).

Future studies should therefore examine why people who are usually inactive or rarely active before a lockdown, tend to increase their exercise frequency during it. A speculation would be that under these circumstances (i.e., lockdown restrictions), there is an increase in boredom which can lead to an increase in need for a change and perhaps adoption of a new behavior such as exercise. Importantly, future research should investigate whether human beings, if given a chance, have a tendency to become physically active (Pontzer et al., 2012), or on the other hand have a tendency to minimize their physical activity and save energy (Cheval et al., 2018). Increase in physical activity under the pandemic restrictions as seen in our data, might be a sign of potential predisposition to physical activity in human beings that was less likely to occur under the conditions of daily life routines before the restrictions (e.g., work, family, and personal interests).

Our data also suggests that about one third of the participants lowered exercise intensities (30.2%) and shortened exercise durations (31.4%) during the lockdown (24.5% of the participants reported to have increased session durations). Because our survey focused primarily on the changes in exercise frequency (we considered it more important to learn whether exercise was done at all), we are unfortunately not able to comment on the changes in exercise type that occurred as the consequence of the lockdown. Such phenomena should be analyzed and additional information should be collected with follow-up studies.

Among the strengths of this study is that it was initiated and conducted during the brief and unexpected period of time of the governmental lockdown restrictions related to the first wave of the 2020 coronavirus pandemic, using this difficult time as an opportunity to investigate changes in exercise behavior and their effects on mood on a very large scale. To overcome language barrier, the questionnaire was translated into 18 languages which made it possible for many non-English speakers across the globe to participate. In fact, we were able to reach more than 13,000 participants in a relatively short period of time (i.e., a month). The large sample size allowed us to adjust for national differences in our analysis, which accounts for both lockdown rules and regulations and cultural differences. Therefore, we can generalize the results to 18 countries included in the statistical modeling (see **Supplementary Table 3** for full model specification) knowing that different rules and regulations and cultural differences would not impact our results.

In order to collect data from a very large sample of participants all over the world during the limited time of governmental lockdowns, some compromises had to be made and therefore, limitations are present in this study. The study was cross-sectional and the data on exercise behavior was collected by self-report which might be subject to bias and poor memory recall. This may have particularly affected our measurement of prepandemic exercise frequency. Study participants are often inclined to overstate their own exercise levels in surveys (Brenner and DeLamater, 2014). The retrospective assessment of prepandemic exercise behavior may have increased this bias. Furthermore, because we did not ask participants about their current health status (except for a possible infection with COVID-19), some participants may have reduced their exercise frequency during the pandemic not because of the lockdown but because of other diseases or injuries. We also refrained from using a standardized, yet extensive physical activity questionnaire such as IPAQ (Hagströmer et al., 2006). Instead, we intended to avoid boredom and fatigue for the participants by presenting a very brief instrument, and using different logics to streamline the flow. Another limitation is that the nature of online data collection might limit the sample to certain groups (e.g., younger, tech-savvy/technophile); however, the demographic information of the participants shows a rather heterogeneous sample and an average age of 34 years (*SD* = 14.4 years) (**Table 3**, "Materials and Methods").

This study has several implications. First, it investigated mood as an important aspect of SWB and the results show that exercising during a lockdown contributes to positive SWB. This contributes to basic research in psychology investigating behavioral factors associated with SWB (Diener et al., 2017). Interventionists may feel encouraged to examine how SWB could be targeted during times of crisis specially for those who have always found exercise unattractive as a lifestyle element or those who live with a disability. Social marketing approaches may be particularly relevant here, because health behavior change messages in times of lockdowns would probably have to be communicated primarily through the media (Evans, 2006). Second, we created a model that predicts changes in exercise frequency during a lockdown based on prelockdown exercise frequency. These results could be of interest to behavioral researchers as they can use this model to elaborate on public health strategies for upcoming times with similar lockdown restrictions. Third, our results indicate that those who were inactive during a lockdown, had worse SWB compared to others. This is important as dampened mood states are associated with less self-control which in itself is shown to be an important determinant of complying with restrictive rules such as social distancing (Martarelli and Wolff, 2020; Wolff et al., 2020). Therefore, policy makers can use these results and promote exercise and physical activity in their countries to be able to benefit from its positive effects on mood under similar lockdown restrictions in the future. In fact, it is not entirely implausible that exercising in good times can help people get through the hard times easier (Silverman and Deuster, 2014).

CONCLUSION

This study investigated the changes in exercise behavior and the respective changes in SWB during the coronavirus pandemic lockdown restrictions in early 2020. The results show that the lockdown restrictions did not lead to decrease in exercise levels. Also, those who exercised more frequently during the pandemic reported the most positive mood states. Our prediction model (**Figure 2**) can inform policy makers how exercise behavior may change again during future epidemics with governmental restrictions or lockdowns. Interestingly, early positive effects on well-being for those who normally avoid exercise are likely to occur only if they try to exercise almost every day. These results contribute to basic research in psychology and may be of interest to behavioral researchers and interventionists as well.

DATA AVAILABILITY STATEMENT

The dataset used in this study is publicly available in the online repository here: https://osf.io/qh6et/.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.570567/full#supplementary-material

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Use of Data Mining to Determine Usage Patterns of an Online Evaluation Platform During the COVID-19 Pandemic

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MenPas is a psychosocial assessment platform[1] developed by the University of Malaga in 2008. There has been a significant increase in data traffic during the period of confinement by COVID-19 (March and April '20) compared to the same period in the previous year. The main goal to achieve in this work is to determine the patterns of use of this platform on both period of time. So, we want to respond to the following question: So, we the following question: Has the COVID-19 Pandemic changed the pattern of the Menpas users? In order to respond it, cluster analysis techniques (Data Mining) have been used to classify people taking surveys into quotient sets (cluster). This is a multivariate technique for dividing data into sets to that are as homogeneous as possible within themselves and heterogeneous among themselves. Specifically, the K-Means algorithm has been used for this analysis, which is based on the evaluation of the distance between data and the average of each variable. So, it is recommended to discover patterns or relationships among the data. Specifically, the use of the following questionnaires has been analyzed: Competitive State Anxiety Inventory-2 (CSAI-2), State Trait Anxiety Inventory (STAI), Profile of Mood State (POMS), Resilience Scale (RS), Sport Performance Psychological Inventory (IPED), Maslach Burnout Inventory (MBI) and Self-concept Form-5 (AF-5). The analyses have shown changes in cluster formation between 2019 and 2020 based on the variables gender, age, marital status or physical practice. Therefore, the analyses carried out have been sensitive to determine several profiles of people using the MenPas platform because there are changes in the characteristics of the user groups that have carried out the analyzed tests.

Keywords: menpas, COVID-19, data mining, clustering, human behavior

INTRODUCTION

SARS-CoV-2 (coronavirus 2019, COVID-19) has generated an exceptional situation (López and Rodó, 2020) in this year 2020. Although many other viruses had appeared years ago, that had not generated an emergency as globalized as it has happened this time (Sohrabi et al., 2020). This virus, originated in China according to official sources, has been spreading rapidly throughout the world.

[1] www.menpas.com

The World Health Organization (WHO) declared the pandemic on March 11, and a large number of countries have had to establish measures to cope with the spread of infections (Chinazzi et al., 2020; Parmet and Sinha, 2020; Studdert and Hall, 2020). For example, Spain declared the state of alarm on March 14th, 2020, by Royal Decree and published in the Official State Bulletin, establishing restrictive measures for mobility and limiting the activities that could be carried out.

This recent unprecedented situation has caused changes in people's habits and practices, modifying the way of living before. For example, educational centers have been closed, non-essential productive activities have had to stop, sports competitions have been canceled, or household supplies of basic consumer products have been carried out following strict security measures (e.g., Corsini et al., 2020; Viner et al., 2020; Zhang et al., 2020). This has forced to people modifying habitual routines and adapting to this new situation, which has meant reducing social contact, using new strategies to communicate with family and friends, modifying physical activity or feeding habits, as well as the way of studying and working (e.g., Basilaia and Kvavadze, 2020; Belzunegui-Eraso and Erro-Garcés, 2020; Butler and Barrientos, 2020; Martínez-Ferrán et al., 2020).

Along these months, the available technology has facilitated communication helping for educational or work activities to be carried out (Ting et al., 2020). Online platforms have been a useful alternative way for students to continue learning or for many companies to continue operating (Bao, 2020; Basilaia and Kvavadze, 2020). The use of new information and communication technologies is already a settled reality in many areas, but this period has meant an acceleration in the technological transition that will possibly mark a before and after in the use of this type of software (Belzunegui-Eraso and Erro-Garcés, 2020; Dong et al., 2020; Kousha and Thelwall, 2020).

The online evaluation platform MenPas (see footnote 1) (González-Ruiz et al., 2010, 2018) is a virtual platform that brings together a wide set of tools that are used for psychosocial assessment. Its use is very widespread along different countries and the number of users has been increased in recent years. MenPas has been used in multiple investigations to gather study data, which can be verified in the published literature (e.g., Aragón et al., 2017; Reigal et al., 2019; González-Guirval et al., 2020). Through this platform, groups of people in investigations can be managed and data can be gathered for further processing. It is an online platform with easy access, programed to be used from multiple devices, which facilitates its implementation.

The large amount of data that has been gathered in recent years by MenPas, allows us to obtain a lot of information about the type of user that connects to the platform, as well as the tools that are mostly used. In addition to knowing those aspects that generate the most interest among users, the global analysis of the data can provide information on population trends. That is, if there are changes in the needs, interests or habits of people. The pandemic declared by the WHO and the restrictions in mobility established in some countries have altered people's habits and have affected specific aspects of their mental health (Banerjee and Rai, 2020; Duan and Zhu, 2020; Li et al., 2020). Global usage data from March to May 2020 compared to the same period in 2019, shows that there has been a high increase in the number of MenPas users. The platform's internal event control, the associated Google Analytic account[2] (1800 vs. 3100 sessions) (**Figure 1**) and the added widget of ClustrMaps[3] (2400 vs. 5300 visits) (**Figure 2**) show clear information about this fact.

Specific online resources have had to be used to study and work, and people have had to change their way of living with others and his way of understanding his environment (Torales et al., 2020; Wang G. et al., 2020; Wang C. et al., 2020). The lack of studies that provide information on changes in uses and customs through the analysis of online platforms, joined to the fact that currently virtual platforms have significantly increased their use, provide essential information for understanding changes in the population's behavior. Therefore, platforms such as MenPas can

[2]https://analytics.google.com
[3]https://clustrmaps.com/site/19nkt

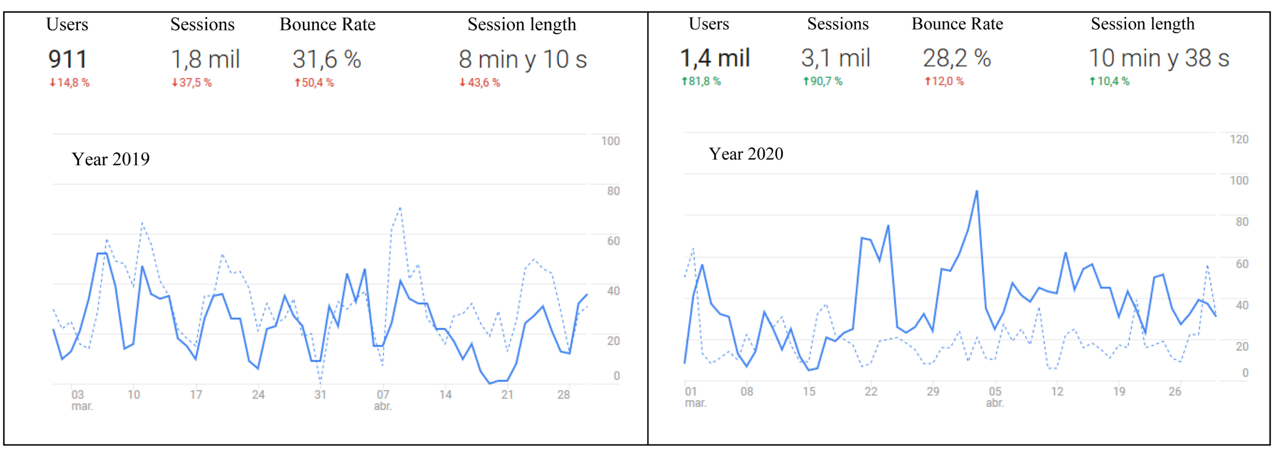

FIGURE 1 | MenPas users (March and April '19 vs. March and April '20) by Google analytic.

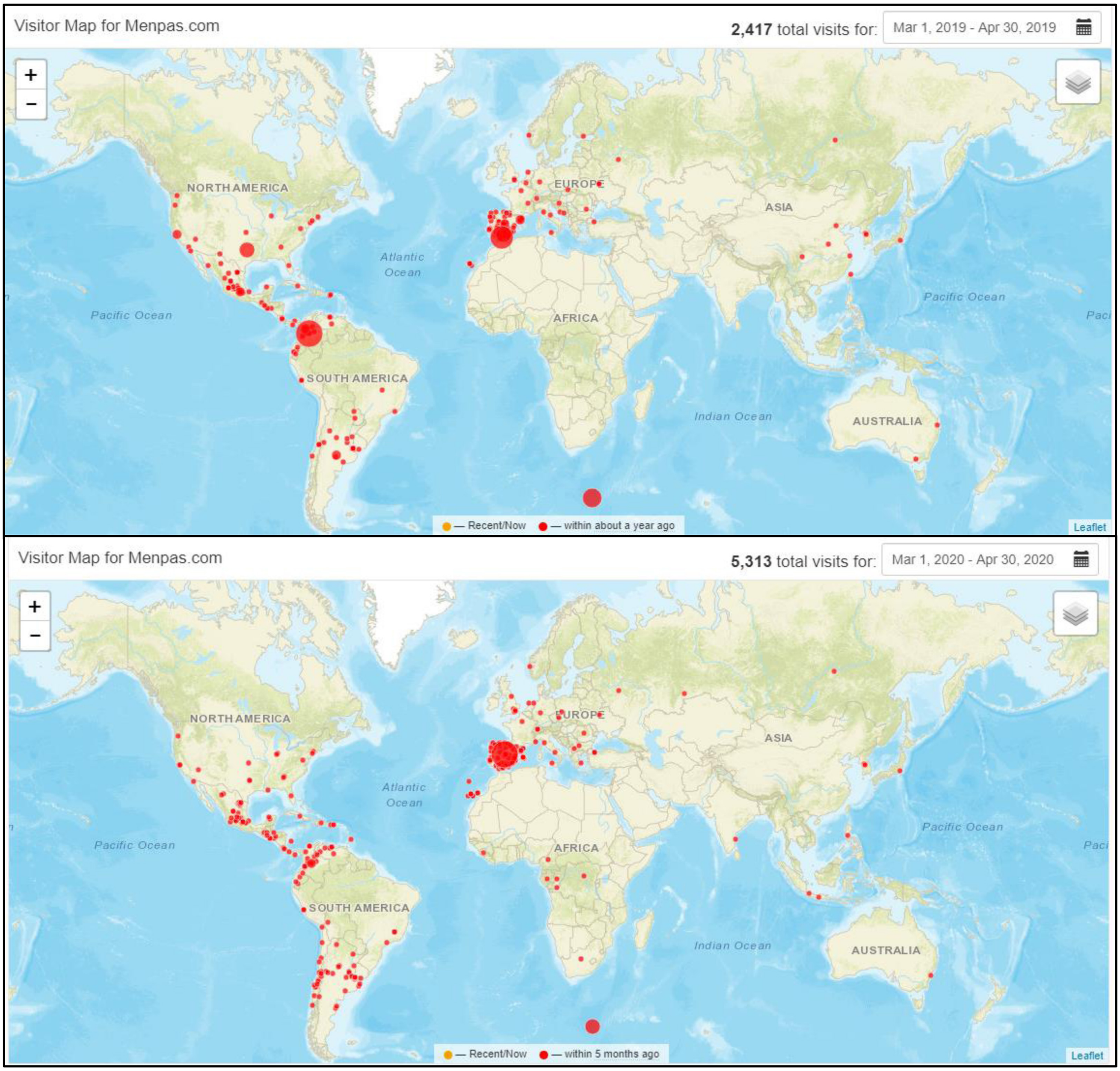

FIGURE 2 | MenPas users (March and April '19 vs. March and April '20) by ClustrMaps.

help to understand these changes by analyzing their use. The main goal of this study is to get a significant knowledge about patterns in the use of on-line platforms when a socio-economic and environmental situation changes. These patterns could show how the members of a society adapt their behavior and find a way to adapt and achieve their needs in that situation. So, the main objective was to determine if the COVID-19 Pandemic has changed the pattern of Menpas users. In order to determine this, the use of the following questionnaires was specifically explored: Competitive State Anxiety Inventory-2 (CSAI-2), State Trait Anxiety Inventory (STAI), Profile of Mood State (POMS), Resilience Scale (RS), Sport Performance Psychological Inventory (IPED), Maslach Burnout Inventory (MBI), and Self-concept Form-5 (AF-5). Two different anxiety questionnaires have been used because both are available at the platform and they consider different aspects on anxiety evaluation: CSAI-2 tests anxiety in sport and STAI tests general anxiety. The information from the following variables have been gathered each time a questionnaire has been taken by one user: his/her age, his/her gender, the sport played, how many hours has been playing that sport, his/her marital status, his/her educational level, his/her profession, the questionnaire taken and the date when it was taken.

MATERIALS AND METHODS

Participants

As shown in **Figure 3**, we have collected 11263 records from March the 1st to April the 30th in 2019 (Male: 3687 - 32,74% and Female: 7576 - 67,26%) and 20627 records from March the 1st to April the 30th in 2020 (Male: 7655 - 37,11% and Female: 12972 - 62,89%) of people who took any of the following questionnaires: Competitive State Anxiety Inventory-2 (CSAI-2), State Trait Anxiety Inventory (STAI), Profile of Mood State (POMS), Resilence Scale (RS), Sport Performance Psychological Inventory (IPED), Maslach Burnout Inventory (MBI) and Self-concept Form-5 (AF-5) in MenPas (see footnote 1). Menpas is an on-line software platform for psychosocial assessment (González-Ruiz et al., 2010, 2018). This study has been performed using data from 803 countries over the world (see footnote 3) where users are mainly from Spain, Colombia, United States, Mexico, Argentine, Guatemala, Chile, Costa Rica, El Salvador, Portugal, China, Ecuador, Russia, Peru, United Kingdom, Republic of Korea, Brazil, and Cuba.

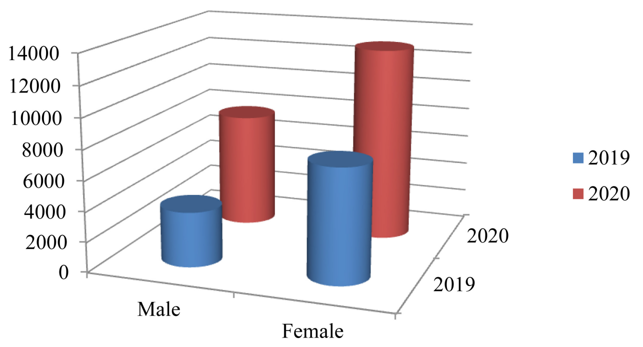

FIGURE 3 | Participants.

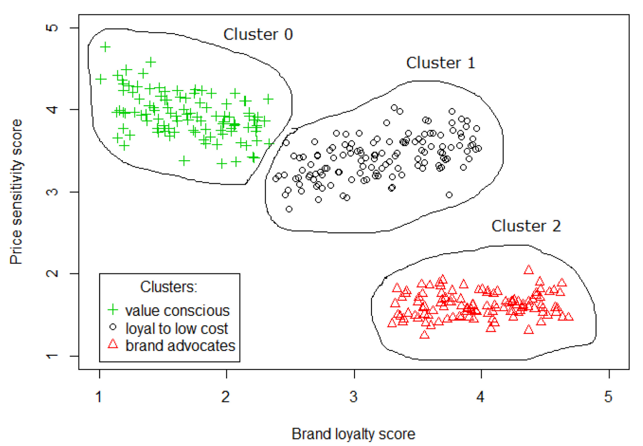

FIGURE 4 | Customers clustering based on their sensitivity to price and brand loyalty.

Instruments

(a) Competitive State Anxiety Inventory-2 (CSAI-2, Martens et al., 1990). This questionnaire allows evaluating anxiety competitive. It is made up of 27 items, which are structured in three factors: cognitive anxiety, somatic anxiety and self-confidence. This instrument is answered using a Likert-type scale from 1 (almost never) to 5 (almost always).

(b) State Trait Anxiety Inventory (STAI, Spielberg et al., 1970). This questionnaire allows evaluating state and trait anxiety. It consists of 40 items and two factors: state anxiety and trait anxiety. Scores in each can range from 0 to 60 points. Each item is answered based on 4 levels 0, 1, 2, and 3).

(c) Profile of Mood State (POMS, McNair et al., 1971). This questionnaire evaluates mood states. It is made up of 65 items and evaluates seven dimensions: tension, depression, anger, vigor, fatigue, confusion and friendship. The answers are answered on a scale from 0 (not at all) to 4 (very much)].

(d) Resilence Scale (RS, Wagnild and Young, 1993). This scale assesses the level of individual resilience, that is, the ability to resist various stressors and adapt to life before them. It is made up of 25 items and two factors: personal competence and acceptance of oneself and of life. This instrument is answered using a Likert-type scale from 1 (disagree) to 7 (totally agree).

(e) Sport Performance Psychological Inventory (IPED, Hernández-Mendo, 2006; Hernández-Mendo et al., 2014) is a Spanish adaptation of the Psychological Performance Inventory (PPI) (Loehr, 1986, 1990). It

TABLE 1 | 3 clusters got for CSAI-2 questionnaire in 2019 and CSAI-2 analysis for March to May 2019.

Attribute (536.0) 100%	Cluster #0 (142.0) 26%	Cluster #1 (277.0) 52%	Cluster #2 (117.0) 22%
Age	Between 18_and_35	Between 36_and_65	Between 18_and_35
Gender	Male	Female	Female
Sport	Unknown	Unknown	Unknown
Hours Doing Sport	14.8803	7.8267	13.5128
Marital Status	Single	Single	Single
Educational Level	Graduate	Graduate	Graduate
Profession	Student	Psychologist	Psychologist
Date	Mar_2020	Apr_2020	Mar_2020
Attribute (546.0) 100%	**Cluster#0 (47.0) 9%**	**Cluster#1 (110.0) 20%**	**Cluster#2 (389.0) 71%**
Age	Between 36_and_65	Under18	Between 18_and_35
Gender	Female	Female	Female
Sport	Unknown	Unknown	Unknown
Hours Doing Sport	8.0851	8.7455	12.9537
Marital Status	Married	Single	Single
Educational Level	Graduate	High_School	Graduate
Profession	Psychologist	Student	Psychologist
Date	Mar_2019	Mar_2019	Mar_2019

TABLE 2 | 3 clusters CSAI-2 analysis for March to May 2020.

Attribute (536.0) 100%	Cluster #0 (142.0) 26%	Cluster #1 (277.0) 52%	Cluster #2 (117.0) 22%
Age	Between 18_and_35	Between 36_and_65	Between 18_and_35
Gender	Male	Female	Female
Sport	Unknown	Unknown	Unknown
Hours Doing Sport	14.8803	7.8267	13.5128
Marital Status	Single	Single	Single
Educational Level	Graduate	Graduate	Graduate
Profession	Student	Psychologist	Psychologist
Date	Mar_2020	Apr_2020	Mar_2020

is used to evaluate several psychological skills used by athletes during competition. It consists of 42 items, divided into the following dimensions: self-confidence, negative coping control, attention control, visual-imagery control, motivational level, positive coping control, and attitude control. This instrument is answered using a Likert-type scale from 1 (almost never) to 5 (almost always).

(f) Maslach Burnout Inventory (MBI, Maslach and Jackson, 1981). This scale assesses the level of burnout at work. It is made up of 22 items and three factors: emotional exhaustion, depersonalization and lack of personal accomplishment. This instrument is answered using a Likert-type scale from 0 (never) to 6 (everyday).

(g) Self-concept Form-5 (AF-5, García and Musitu, 2001). This questionnaire evaluates the multidimensional self-concept. It is made up of 30 items and evaluates the following dimensions: academic/work, social, emotional, family and physical. Responds with a response scale with values from 1 (totally disagree) and 99 (totally agree).

Procedure

Data Mining clustering techniques have been used to classify people taking surveys into quotient sets (cluster). Clustering is an unsupervised Machine learning technique for automatic grouping of data whose most popular clustering algorithm is the K-Means. This is a multivariate technique for dividing data into sets to that are as homogeneous as possible within themselves and heterogeneous among themselves. Specifically, the K-Means algorithm has been used for this analysis, which is based on the evaluation of the distance between data and the average of each variable. So, it is recommended to discover patterns or relationships among the data. Specifically, the use of the following questionnaires has been analyzed: Competitive State Anxiety Inventory-2 (CSAI-2), State Trait Anxiety Inventory (STAI), Profile of Mood State (POMS), Resilence Scale (RS), Sport Performance Psychological Inventory (IPED), Burnout and Self-concept Form-5 (AF-5).

Figure 4 (got from https://select-statistics.co.uk/blog/customer-segmentation/) shows an example where a group of customers have been segmented based on their sensitivity to price and brand loyalty.

The most widely used clustering algorithm is K-Means because it has a very good scalability with the amount of data. The main problem for using K-Means is that you must specify the number of groups you want to find. This number of groups is called K.

K-Means algorithm follows these steps:

1. Initialization: the location of the centroids of the K groups is chosen at random.
2. Assignment: each data item is assigned to the nearest centroid.
3. Update: the centroid position is updated to the arithmetic mean of the items in the data assigned to the group.

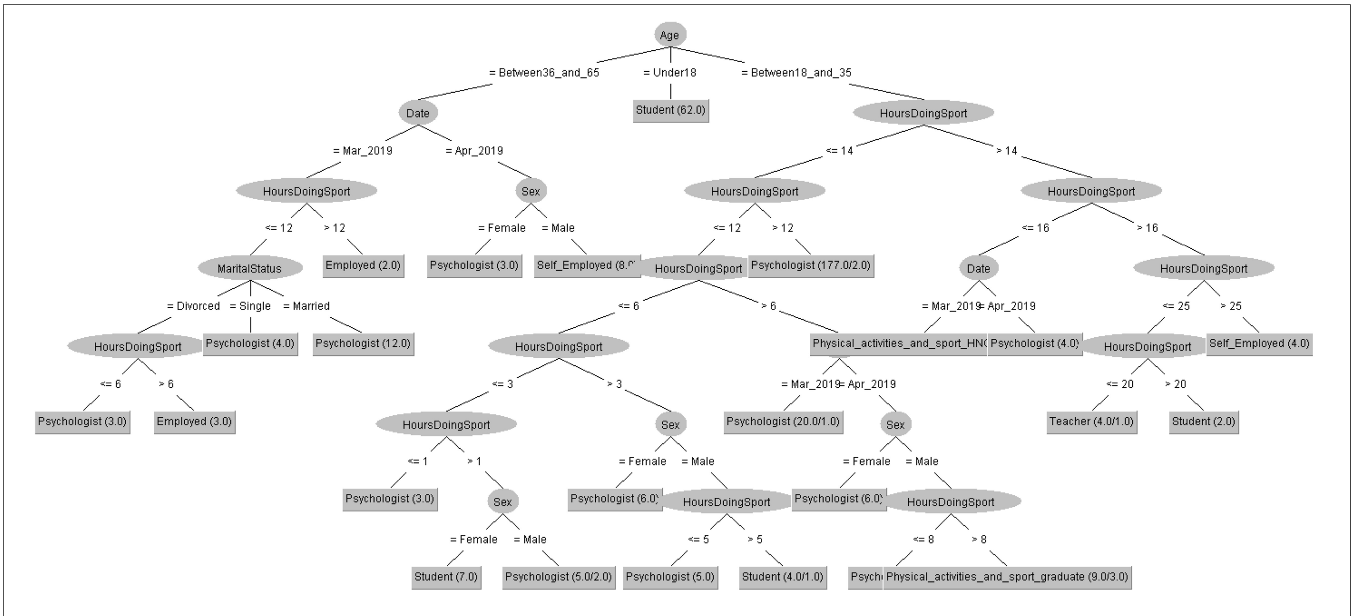

FIGURE 5 | Profession of people taking the CSAI-2 questionnaire in 2019 decision tree.

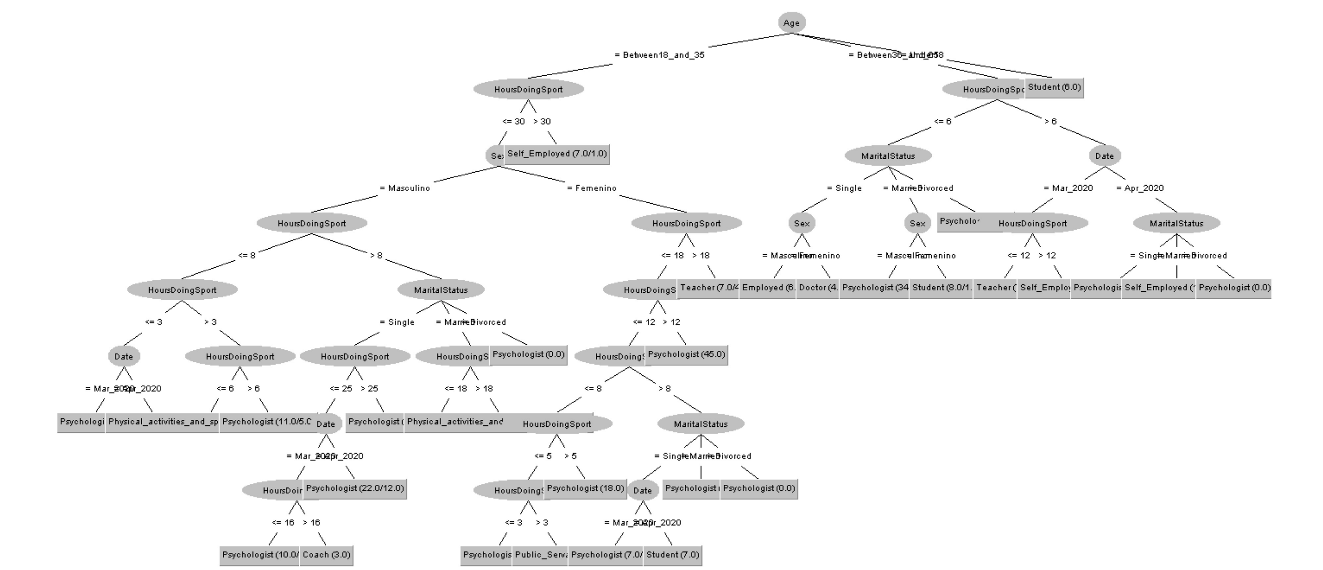

FIGURE 6 | Profession of people taking the CSAI-2 questionnaire in 2020 decision tree.

Steps 2 and 3 are followed iteratively until there are no more changes.

Data Analysis

Following questionnaires have been analyzed: Competitive State Anxiety Inventory-2 (CSAI-2), State Trait Anxiety Inventory (STAI), Profile of Mood State (POMS), Resilence Scale (RS), Sport Performance Psychological Inventory (IPED), Burnout and Self-concept Form-5 (AF-5).

We have made two clustering analyses for each type of questionnaire: 3 and 5 cluster analyses for 2019 and 2020. It has been taken in account the following attributes (variables): age, gender, sport, hours doing sport, marital status, educational level, profession and date.

In addition, a decision tree has been built to respond to the following question in 2019 and 2020: "What is the profession of those who have taken the test in terms of gender, age, hours spent doing sports, marital status and date of the questionnaire?"

TABLE 3 | 3 clusters STAI analysis for March to May 2019.

Attribute (24.0) 100%	Cluster#0 (6.0) 25%	Cluster#1 (14.0) 58%	Cluster#2 (4.0) 17%
Age	Between 18_and_35	Between 18_and_35	Between 18_and_35
Gender	Male	Female	Male
Sport	Athletics	Unknown	Tennis
Hours Doing Sport	10	5.2857	3.5
Marital Status	Single	Single	Single
Educational Level	Graduate	Graduate	Graduate
Profession	Psychologist	Psychologist	Psychologist
Date	Mar_2019	Mar_2019	Mar_2019

TABLE 4 | 3 clusters STAI analysis for March to May 2020.

Attribute (36.0) 100%	Cluster#0 (18.0) 50%	Cluster#1 (8.0) 22%	Cluster#2 (10.0) 28%
Age	Between 18_and_35	Between 18_and_35	Between 36_and_65
Gender	Male	Female	Male
Sport	Unknown	Unknown	Unknown
Hours Doing Sport	10.7222	14.75	5.7
Marital Status	Single	Single	Married
Educational Level	Graduate	Graduate	Graduate
Profession	Psychologist	Psychologist	Psychologist
Date	Apr_2020	Mar_2020	Apr_2020

RESULTS

Here we will show the results got grouped by questionnaire. As we told before, we will make the March to May 2019 versus 2020 comparison taking 3 and 5 cluster. So, we will get the 3 and the 5 most representative people taking the survey for each type of questionnaire in 2019 and 2020 and we will compare the main differences on their characteristics based on age, gender, sport, hours doing sport, marital status, educational level, profession and date they took the survey. The effect produced by selecting 5 clusters has been that the bigger groups have been split but keeping the same characteristics, so we will only present the 3 clusters table of results but 5 clusters results are available by any request.

In addition, we are also building a decision tree for each questionnaire to respond to the following question in 2019 and 2020: "What is the profession of those who have taken the test in terms of gender, age, hours spent doing sports, marital status and date of the questionnaire?"

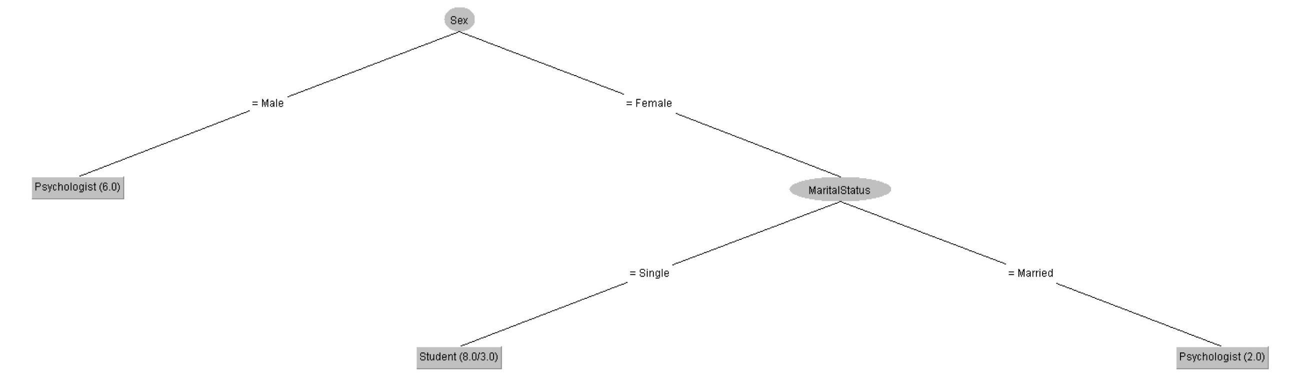

FIGURE 7 | Profession of people taking the STAI questionnaire in 2019 decision tree.

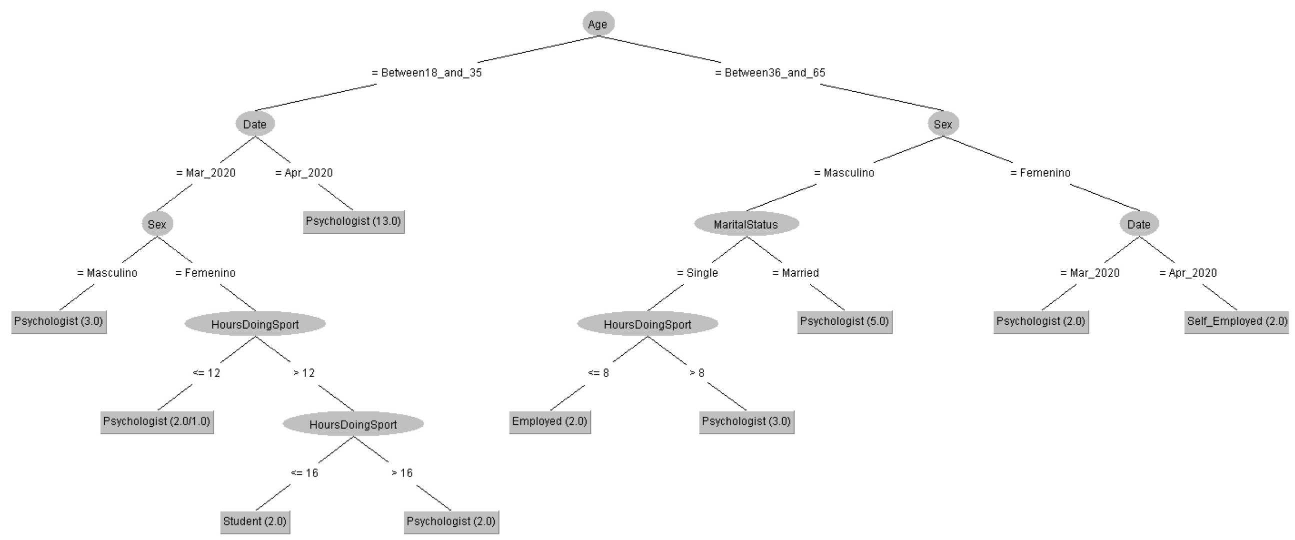

FIGURE 8 | Profession of people taking the STAI questionnaire in 2020 decision tree.

Competitive State Anxiety Inventory-2 (CSAI-2)

Table 1 shows the 3 clusters got for CSAI-2 questionnaire in 2019 and **Table 2** shows the 2020 results. Red columns represent the less significate cluster attending to the number of elements belonging to the cluster and green columns represent the most significate one. Each cluster also shows the number of people belonging to it and the per cent it represents.

It can be seen that 2020 groups are more homogeneous than 2019. Although they both mainly are women, single, graduates, psychologists, the predominant age in 2020 has gone from the interval 18-35 to the interval 36-65.

Another data of special interest lies in the Gender. While the number of men is not representative to be able to form a group in 2019, the increase of men who carry out the questionnaire in 2020 leads to the creation of a group of men who represent almost a quarter of the population studied. It is also significate how the number of hours doing sports has been increased during the quarantine.

In order to respond to the question raised before, **Figures 5**, **6** decision trees shows that most of people taking the CASI-2 questionnaire are Psychologist.

State Trait Anxiety Inventory (STAI)

Table 3 shows the 3 clusters got for STAI questionnaire in 2019 and **Table 4** shows the 2020 results. Red columns represent the less significate cluster attending to the number of elements belonging to the cluster and green columns represent the most significate one. Each cluster also shows the number of people belonging to it and the per cent it represents.

Results got in this questionnaire are similar to results got in CSAI-2. This is a coherent result because both of them are related to anxiety. It can be seen how the number of men has been increased in 2020 as well as the age has done, so older people took the anxiety questionnaires in the quarantine.

In order to respond to the question raised before, **Figures 7**, **8** decision trees shows that most of people taking the CASI-2 questionnaire are also Psychologist.

TABLE 5 | 3 clusters POMS analysis for March to May 2019.

Attribute (36.0) 100%	Cluster#0 (12.0) 33%	Cluster#1 (15.0) 42%	Cluster#2 (9.0) 25%
Age	Between 18_and_35	Between 18_and_35	Between 18_and_35
Gender	Male	Female	Male
Sport	Basketball	Unknown	Athletics
Hours Doing Sport	7.1667	5	12.6667
Marital Status	Single	Single	Single
Educational Level	Graduate	Graduate	Graduate
Profession	Physical_activities_and_sport_graduate	Psychologist	Psychologist
Date	Apr_2019	Apr_2019	Mar_2019

TABLE 6 | 3 clusters POMS analysis for March to May 2020.

Attribute (74.0) 100%	Cluster#0 (41.0) 55%	Cluster#1 (12.0) 16%	Cluster#2 (21.0) 28%
Age	Between 18_and_35	Between 18_and_35	Between 18_and_35
Gender	Male	Female	Female
Sport	Unknown	Unknown	Unknown
Hours Doing Sport	25.0244	8.9167	7.9524
Marital Status	Single	Single	Single
Educational Level	Graduate	Graduate	Graduate
Profession	Student	Psychologist	Psychologist
Date	Apr_2020	Mar_2020	Apr_2020

Profile of Mood State (POMS)

Table 5 shows the 3 clusters got for POMS questionnaire in 2019 and **Table 6** shows the 2020 results. Red columns represent the less significate cluster attending to the number of elements belonging to the cluster and green columns represent the most significate one. Each cluster also shows the number of people belonging to it and the per cent it represents.

Results got shows that there is a new type of person taking the POMS survey in 2020 that was not significate in 2019. It is a man between 18 and 35 years old, student and doing sport 25 h per week what it means a 100% more than 2019.

In order to respond to the question raised before, **Figures 9**, **10** decision trees shows that most of people taking the POMS questionnaire are either Psychologist or students. However, the profession is mostly influenced by the number of hours doing sport in 2019 but by the age in 2020.

Resilence Scale (RS)

Table 7 shows the 3 clusters got for RS questionnaire in 2019 and **Table 8** shows the 2020 results. Red columns represent the less significate cluster attending to the number of elements belonging to the cluster and green columns represent the most significate one. Each cluster also shows the number of people belonging to it and the per cent it represents.

One of the most significate facts in RS results is that the typical person taking the survey in 2019 was a man but in 2020 there was as male as female. It is also interesting that there was a cluster made by Divorced in 2019 but in 2020 every cluster represents to single people.

In order to respond to the question raised before, **Figures 11**, **12** decision trees shows that most of people taking the RS questionnaire are either Psychologist or students in 2019 depending on gender and hours doing sport. However, the profession is more heterogeneous in 2020 and the age is one of the most important points for the decision.

Sport Performance Psychological Inventory (IPED)

Table 9 shows the 3 clusters got for IPED questionnaire in 2019 and **Table 10** shows the 2020 results. Red columns represent the less significate cluster attending to the number of elements belonging to the cluster and green

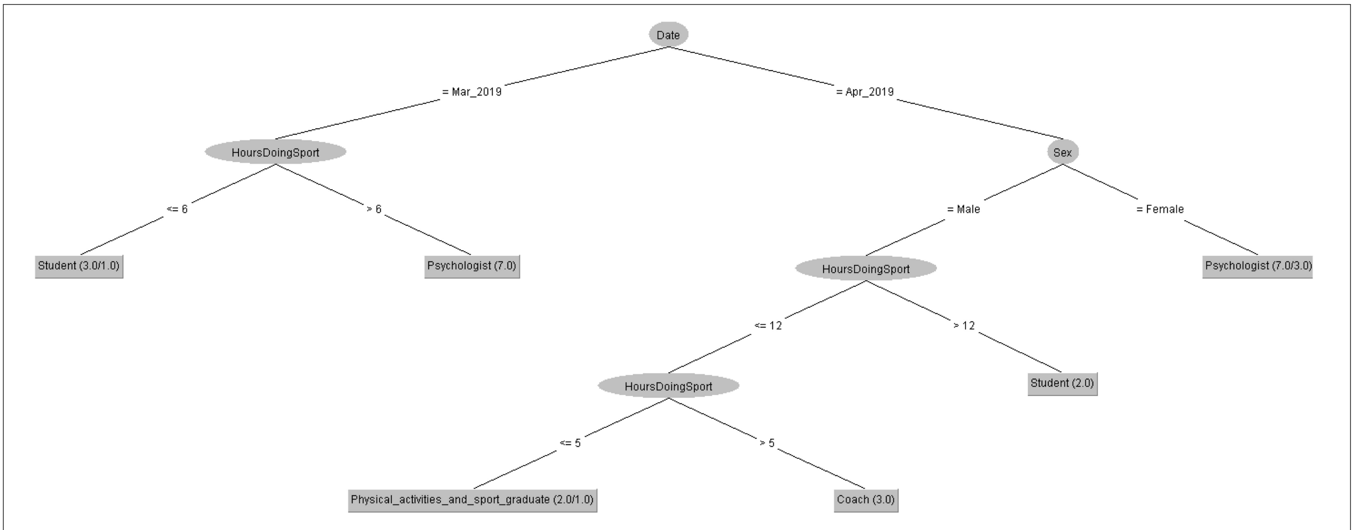

FIGURE 9 | Profession of people taking the POMS questionnaire in 2019 decision tree.

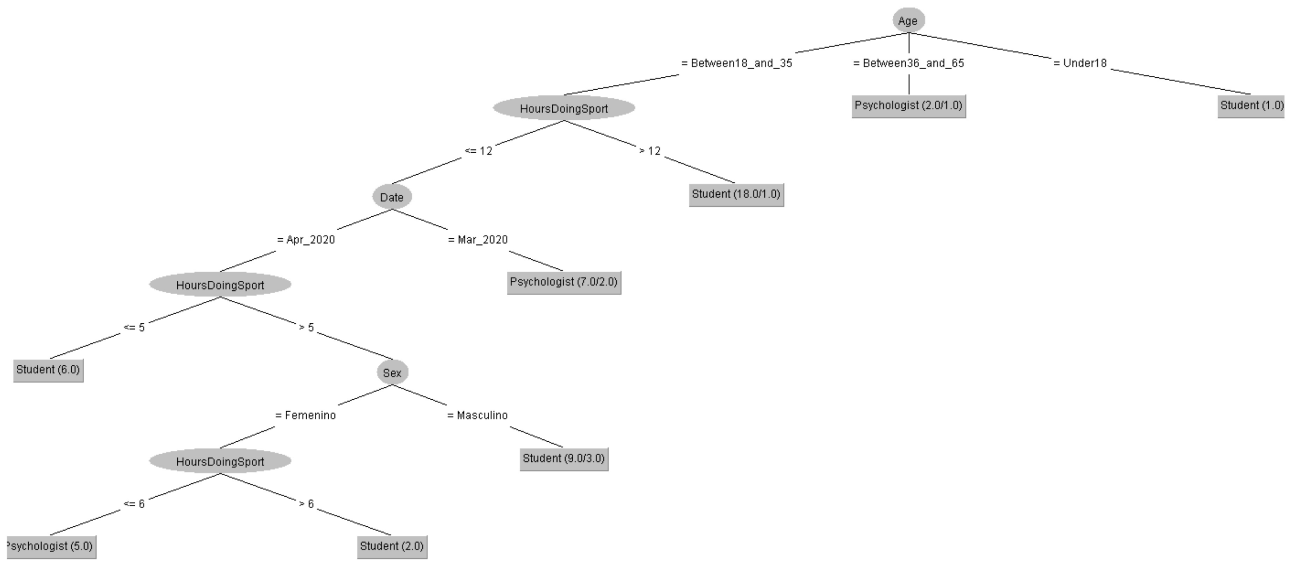

FIGURE 10 | Profession of people taking the POMS questionnaire in 2020 decision tree.

columns represent the most significate one. Each cluster also shows the number of people belonging to it and the per cent it represents.

There is one important change about the gender of people taking the IPED survey. In 2019, about 50% of people were male and 50% female. However, in 2020, all of them were female. It is also noted in 2020 people is older and they have a higher education level, being graduated all of them.

In order to respond to the question raised before, **Figures 13**, **14** decision trees shows that most of people taking the IPED questionnaire are either Psychologist or students but there is not a clear pattern.

TABLE 7 | 3 clusters RS analysis for March to May 2019.

Attribute (22.0) 100%	Cluster#0 (15.0) 68%	Cluster#1 (2.0) 9%	Cluster#2 (5.0) 23%
Age	Between 18_and_35	Between 18_and_35	Between 36_and_65
Gender	Male	Male	Male
Sport	Athletics	Athletics	Tennis
Hours Doing Sport	7.3333	16	30.4
Marital Status	Single	Single	Divorced
Educational Level	Graduate	Graduate	Graduate
Profession	Psychologist	Psychologist	Psychologist
Date	Apr_2019	Apr_2019	Mar_2019

TABLE 8 | 3 clusters RS analysis for March to May 2020.

Attribute (39.0) 100%	Cluster#0(16.0) 41%	Cluster#1 (12.0) 31%	Cluster#2 (11.0) 28%
Age	Between 18_and_35	Between 18_and_35	Between 36_and_65
Gender	Female	Male	Male
Sport	Unknown	Unknown	Tennis
Hours Doing Sport	6.3125	21.5	8.7273
Marital Status	Single	Single	Single
Educational Level	Graduate	Graduate	Graduate
Profession	Psychologist	Psychologist	Psychologist
Date	Apr_2020	Mar_2020	Apr_2020

Maslach Burnout Inventory (MBI)

Table 11 shows the 3 clusters got for RS questionnaire in 2019 and **Table 12** shows the 2020 results. Red columns represent the less significate cluster attending to the number of elements belonging to the cluster and green columns represent the most significate one. Each cluster also shows the number of people belonging to it and the per cent it represents.

There is one important increase of males taking the MBI survey from 2019 to 2020. In 2019, about 43% of people were male and 57% female. However, in 2020, 74% of people were male and 26% female. This fact is due to many people doing boxing took the survey, so the typical person taking the MBI survey goes from a young female doing around 4 or 5 h of any sport in 2019 to a young male doing 44 h boxing in 2020.

In order to respond to the question raised before, **Figures 15**, **16** decision trees shows that most of people taking the MBI questionnaire are either Psychologist or students being date and hours doing sport in 2019 and age and hours doing sport in 2020 as main factors but there is not a clear pattern.

Self-concept Form-5 (AF-5)

Table 13 shows the 3 clusters got for AF-5 questionnaire in 2019 and **Table 14** shows the 2020 results. Red columns represent the less significate cluster attending to the number of elements belonging to the cluster and green columns represent the most

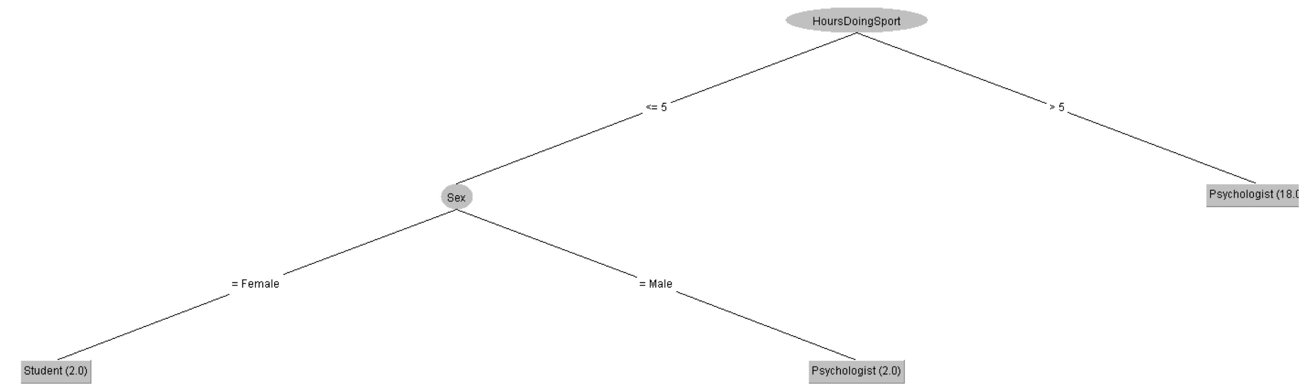

FIGURE 11 | Profession of people taking the RS questionnaire in 2019 decision tree.

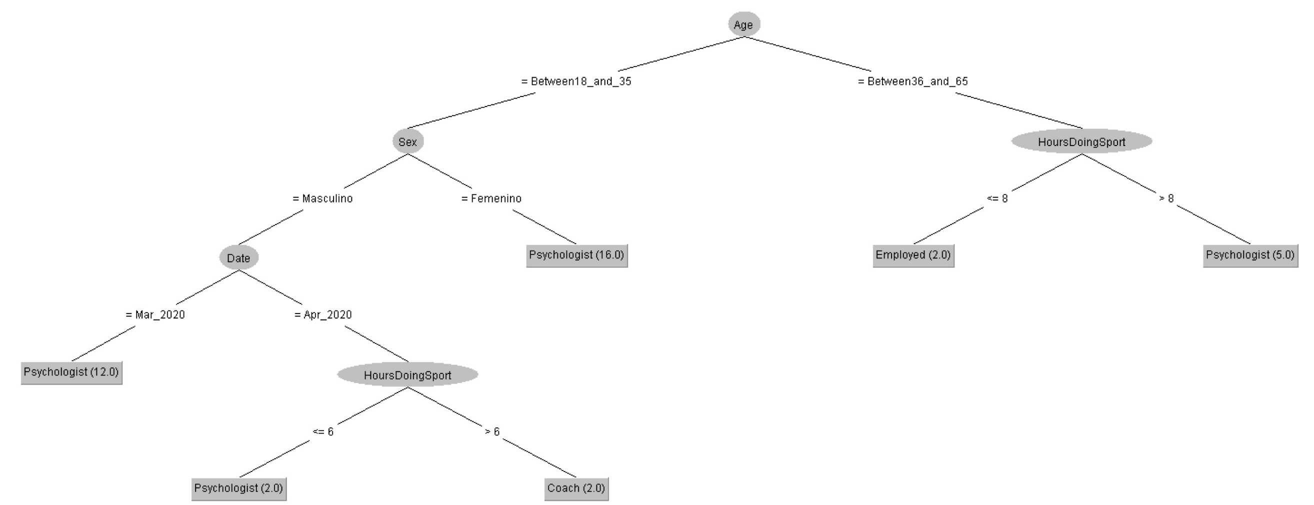

FIGURE 12 | Profession of people taking the RS questionnaire in 2020 decision tree.

significate one. Each cluster also shows the number of people belonging to it and the per cent it represents.

It can be seen a significate fact in gender because in 2019 there is no cluster representing males, but in 2020 we found one cluster that represents to the 20% of the people taking the survey of males between 18 and 35 years old. We also can see that the number of hours doing sport have been increased in 2020 as well as the education level.

In order to respond to the question raised before, **Figures 17**, **18** decision trees shows that most of people

TABLE 9 | 3 clusters IPED analysis for March to May 2019.

Attribute (533.0) 100%	Cluster#0 (136.0) 26%	Cluster#1 (164.0) 31%	Cluster#2 (233.0) 44%
Age	Between 18_and_35	Between 18_and_35	Between 18_and_35
Gender	Male	Male	Female
Sport	Unknown	Unknown	None
Hours Doing Sport	8.5074	7.1585	5.3133
Marital Status	Married	Single	Single
Educational Level	Graduate	High_School	Graduate
Profession	Psychologist	Student	Psychologist
Date	Apr_2019	Apr_2019	Mar_2019

TABLE 10 | 3 clusters IPED analysis for March to May 2020.

Attribute (743.0) 100%	Cluster#0 (76.0) 10%	Cluster#1 (315.0) 42%	Cluster#2 (352.0) 47%
Age	Between 18_and_35	Between 18_and_35	Between 18_and_35
Gender	Female	Female	Female
Sport	Athletics	Unknown	Unknown
Hours Doing Sport	17.1053	5.8063	11.1534
Marital Status	Single	Single	Single
Educational Level	Graduate	Graduate	Graduate
Profession	Student	Student	Psychologist
Date	Apr_2020	Apr_2020	Mar_2020

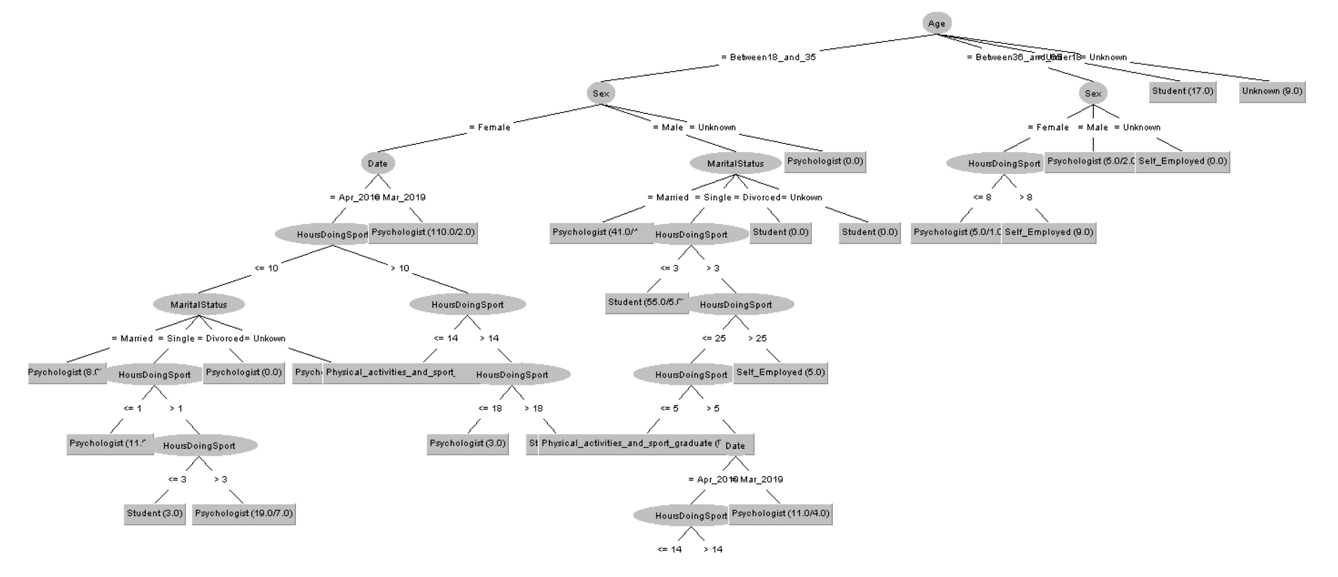

FIGURE 13 | Profession of people taking the IPED questionnaire in 2019 decision tree.

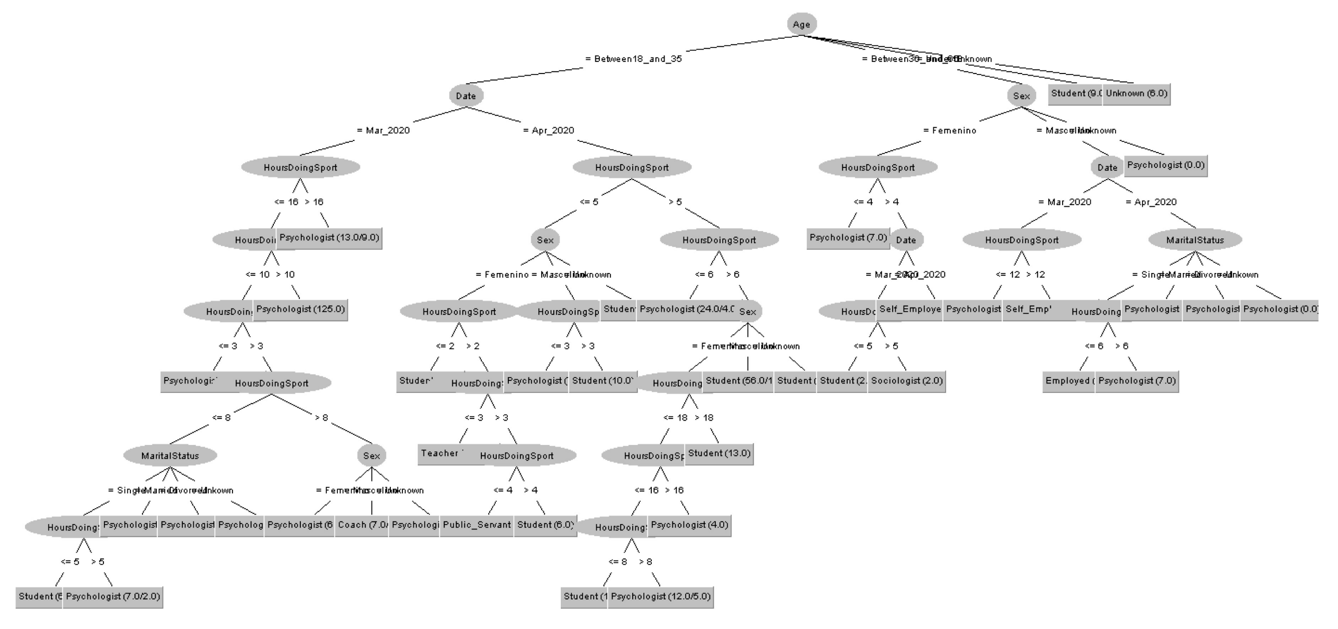

FIGURE 14 | Profession of people taking the IPED questionnaire in 2020 decision tree.

taking the AF-5 questionnaire are either Psychologist or teachers being date and hours doing sport in 2019 and marital status, age and hours doing sport in 2020 as main factors but there is not a clear pattern.

DISCUSSION

The main objective was to determine if the COVID-19 Pandemic has changed the pattern of Menpas users. In order to check this, the following questionnaires taken by people all over the world, have been explored: Competitive State Anxiety Inventory-2 (CSAI-2), State Trait Anxiety Inventory (STAI), Profile of Mood State (POMS), Resilence Scale (RS), Sport Performance Psychological Inventory (IPED), Maslach Burnout Inventory (MBI) and Self-concept Form-5 (AF-5). First, a noticeable increase in the number of users has been observed, going from 11263 records from March the 1st to April the 30th in 2019 to 20627 records from March the 1st to April the 30th in 2020. Second, the pattern of MenPas users has also changed, indicating that there have been changes in the way the platform is used and in the type of user that MenPas has implemented.

TABLE 11 | 3 clusters MBI analysis for March to May 2019.

Attribute (104.0) 100%	Cluster#0 (13.0) 13%	Cluster#1 (45.0) 43%	Cluster#2 (46.0) 44%
Age	Between 18_and_35	Between 18_and_35	Between 18_and_35
Gender	Female	Male	Female
Sport	Unknown	Unknown	Unknown
Hours Doing Sport	5.0769	8.3778	4.4348
Marital Status	Single	Single	Single
Educational Level	High_School	Graduate	Graduate
Profession	Monitor	Psychologist	Teacher
Date	Apr_2019	Mar_2019	Mar_2019

TABLE 12 | 3 clusters MBI analysis for March to May 2020.

Attribute (293.0) 100%	Cluster#0 (72.0) 25%	Cluster#1 (91.0) 31%	Cluster#2 (130.0) 44%
Age	Between 18_and_35	Between 18_and_35	Between 18_and_35
Gender	Female	Male	Male
Sport	Weightlifting	Unknown	Boxing
Hours Doing Sport	1.4722	9.3516	44.1231
Marital Status	Single	Single	Single
Educational Level	High_School	Graduate	Graduate
Profession	Psychologist	Psychologist	Student
Date	Mar_2020	Apr_2020	Mar_2020

The increase in the use of MenPas highlights how online platforms have been one of the ways in which many activities have been going on (Basilaia and Kvavadze, 2020; Belzunegui-Eraso and Erro-Garcés, 2020). The technological transition, possibly, has been accelerated due to this pandemic situation and generates a paradigm shift in the strategies to approach productive or formative procedures, etc., (Dong et al., 2020; Kousha and Thelwall, 2020). Educational and research activities are, among others, those that have caused a greater amount of data traffic through MenPas in recent years (e.g., Aragón et al., 2017; Reigal et al., 2019; González-Guirval et al., 2020). Therefore, these same factors could also be those that have caused a great increase in the use of the months of 2020 analyzed. In addition, this platform contains tools that are commonly used in the field of applied psychology for different issues (González-Ruiz et al., 2010, 2018), such as evaluations in athletes. This could be other reasons why its use has exploded.

For the CSAI-2, it was observed that the most representative cluster in 2019 was made up of people from 18 to 35 years old, female, single and psychologist. In 2020 some of these characteristics are maintained, although the most representative group is now made up of men aged between 36 and 65. For STAI, it was observed that the most representative cluster in 2019 was made up of people from 18 to 35 years old, female, single and psychologist. In 2020 the most representative cluster consisted of single male psychologists aged between 18 and 35 years. For POMS, something similar is also highlighted. The age range and marital status are maintained, although the most representative cluster goes from female psychologists in 2019 to male students in 2020. For RS it occurs as for STAI in characteristics such as age or marital status, although in this case the most representative cluster goes from men in 2019 to women in 2020.

For IPED there are no changes in the most representative cluster, although the least representative changes from male married psychologists in 2019 to single female students in 2020, all between 18 and 35 years old. For AF5 there are no changes in the most representative cluster either, but for the least. In 2019, they were single female students but in 2020 single male psychologists, all between 18 and 35 years old. For MBI, the most representative cluster changes. In 2019 it is formed by

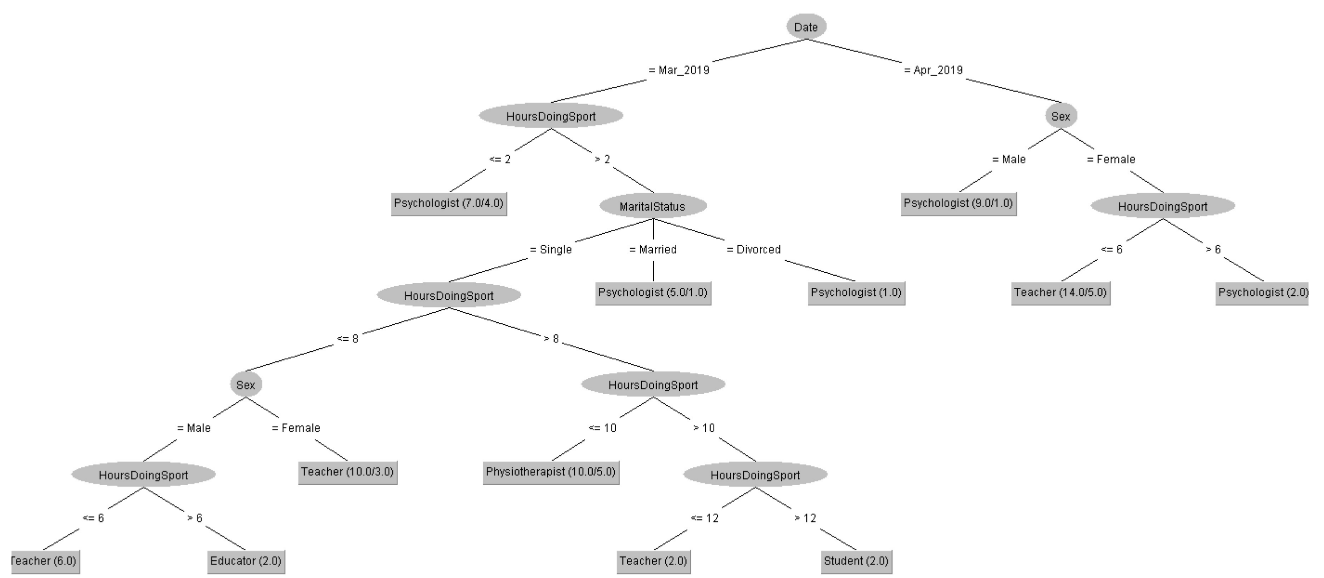

FIGURE 15 | Profession of people taking the MBI questionnaire in 2019 decision tree.

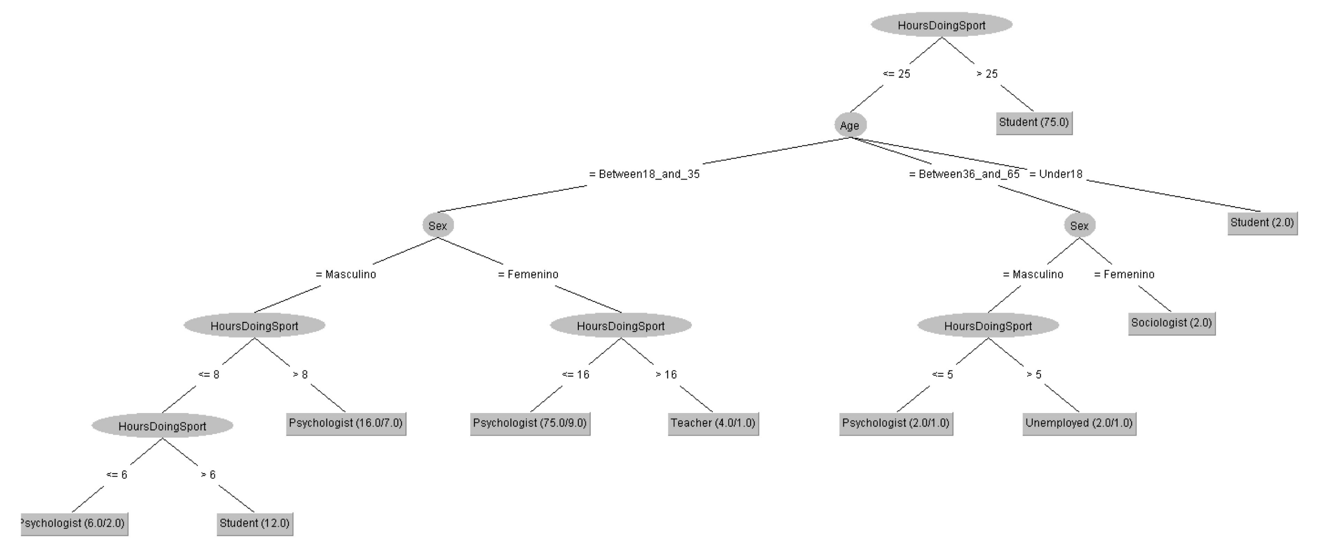

FIGURE 16 | Profession of people taking the MBI questionnaire in 2020 decision tree.

women between the ages of 18 and 35, single professors by profession. In 2020, it is made up of single men and students, aged between 18 and 35.

The results found do not allow obtaining a clear pattern of use. However, some important elements can be highlighted. First, there has been an increase in the number of users and changes in the characteristics of the users. This already constitutes a relevant fact and highlights changes in the way the platform is used. For example, the CSAI-2 has been used more by people between 36 and 65 years, which could indicate that a greater number of professionals in sports psychology have been able to use this instrument in their applied work (Belzunegui-Eraso and Erro-Garcés, 2020). In Spain the limitation on mobility was imposed during this time, but in other countries the restrictions have been different. For this reason, it is considered that in other countries MenPas could have been used as a way of having less personal contact, even while maintaining possible competitions for athletes. In addition, the CSAI contains a self-confidence scale, which could be used to monitor the athlete's psychological state during confinement (Martens et al., 1990).

Secondly, it is seen in some questionnaires, such as POMS, IPED, AF5, or MBI, that students constitute the most representative group in 2020, without being in 2019, or that the least representative group ceases to be that of students. This constitutes perhaps the most relevant fact of this study, which shows that numerous educational institutions have been able to increase the use of this type of platform for the education of their students (Bao, 2020; Basilaia and Kvavadze, 2020; Belzunegui-Eraso and Erro-Garcés, 2020). These questionnaires are widely used in the field of psychology, both in education and in research (González et al., 2019; Chen et al., 2020; Ramírez-Siqueiros et al., 2020). Therefore, it is consistent to think that they have been used during this period to maintain this type of activities.

TABLE 13 | 3 clusters AF5 analysis for March to May 2019.

Attribute (127.0) 100%	Cluster#0 (58.0) 46%	Cluster#1 (43.0) 34%	Cluster#2 (26.0) 20%
Age	Between 18_and_35	Between 18_and_35	Between 18_and_35
Gender	Female	Female	Female
Sport	Unknown	Unknown	Unknown
Hours Doing Sport	6.8448	4.7907	10.6923
Marital Status	Single	Single	Single
Educational Level	Graduate	Graduate	High_School
Profession	Psychologist	Psychologist	Student
Date	Mar_2019	Apr_2019	Apr_2019

TABLE 14 | 3 clusters AF5 analysis for March to May 2020.

Attribute (145.0) 100%	Cluster#0 (61.0) 42%	Cluster#1 (26.0) 18%	Cluster#2 (58.0) 40%
Age	Between 18_and_35	Between 18_and_35	Between 36_and_65
Gender	Female	Male	Male
Sport	Unknown	Unknown	Unknown
Hours Doing Sport	13.8033	18.9615	6.7759
Marital Status	Single	Single	Single
Educational Level	Graduate	Graduate	Graduate
Profession	Psychologist	Psychologist	Psychologist
Date	Apr_2020	Mar_2020	Apr_2020

Limitations and Future Works

Although there is a significant increase in the use of MenPas, there are aspects that are difficult to estimate. For example, in the months studied, not all countries have carried out the same measures in the face of the pandemic caused by SARS-CoV-2 (coronavirus 2019, COVID-19) because of the different evolution of the pandemic and how the virus has been spread

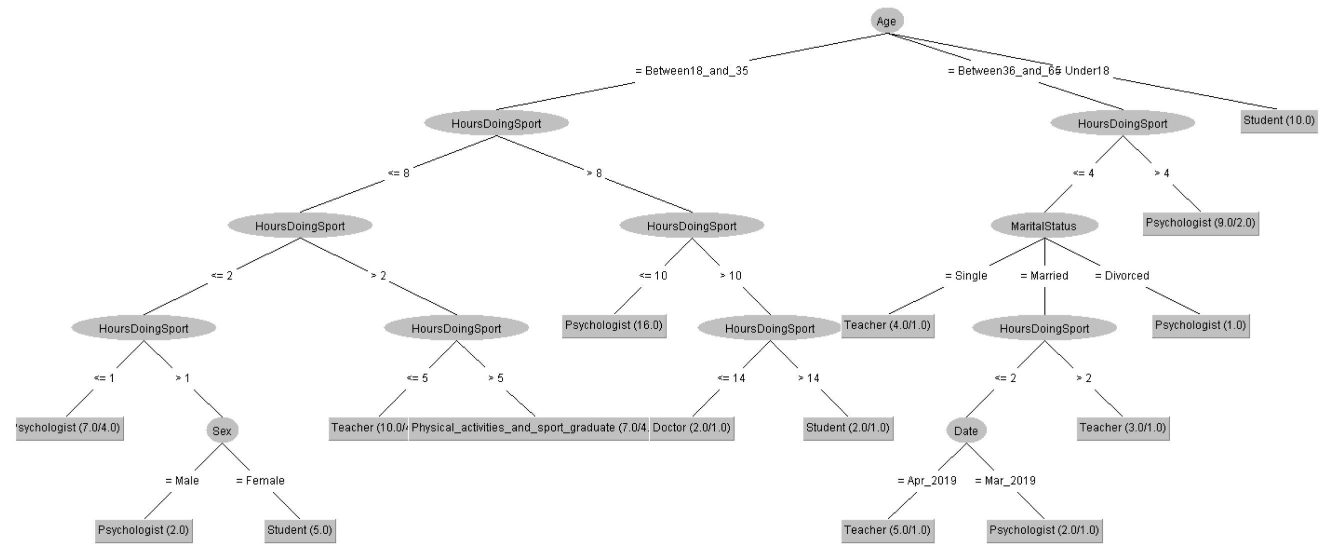

FIGURE 17 | Profession of people taking the AF5 questionnaire in 2019 decision tree.

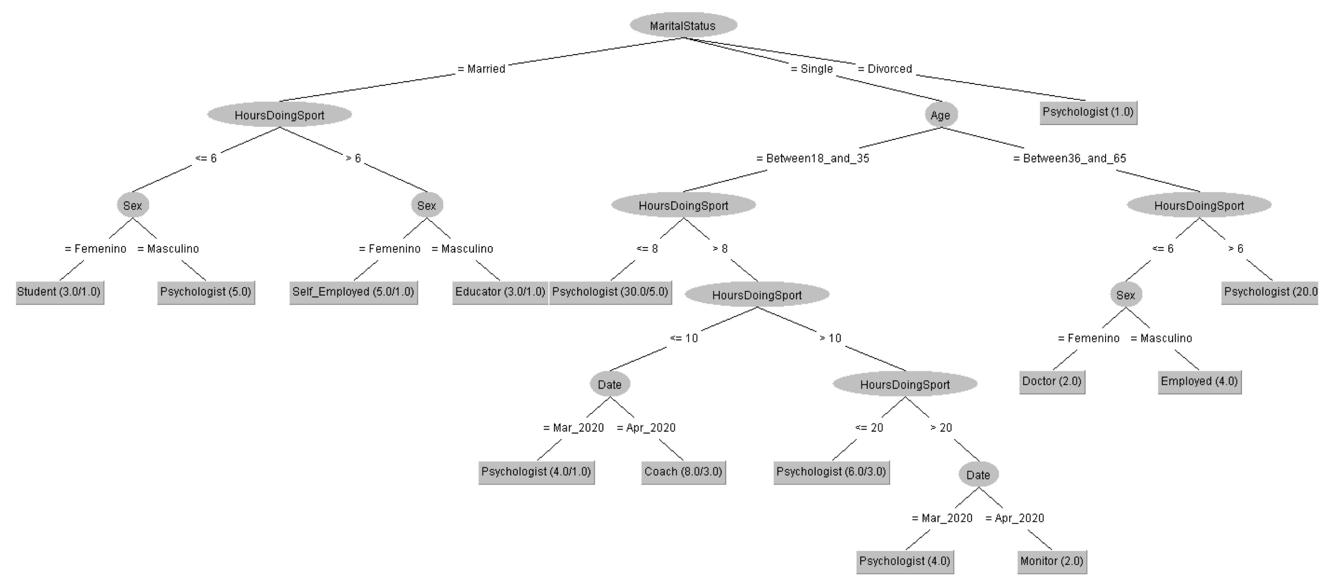

FIGURE 18 | Profession of people taking the AF5 questionnaire in 2020 decision tree.

over the world. Therefore, it would be interesting to assess the specific situations of confinement or alarm states in the different countries. In this way, it could be specified how each socio-political context affects the use of online technological resources. Likewise, it would be relevant to know the objective for which MenPas has been used. Although this can be relatively inferred, it is not precisely known. If we had that data, it could generate a more accurate profile of the users who use this resource and better understand how these instruments are used in each area but the main goal of this study is to get a significant knowledge about patterns in the use of on-line platforms when a socio-economic and environmental situation changes, so why users have used the platform is not so relevant to this study.

On the other hand, no data from similar platforms have been found because the known similar platforms like Online Psychology Research,[4] Social Psychology Network[5] or Psicoactiva[6] does not provide that kind of data. As soon as they appear, the results will be compared to assess the use that people make of this type of tools in a more precise way. Although

[4]http://www.onlinepsychresearch.co.uk/
[5]http://www.socialpsychology.org
[6]http://www.psicoactiva.com

changes are seen in user profiles, it is difficult to establish a unique pattern. Therefore, more data would be necessary to determine how each stratum of the population has changed their habits and to know what their needs may be in situations like this. We have been monitoring Menpas use after the study and the number of new users in 2020 (95) are around ten times more than 2019 (8) and 25 times more than 2018 (4). So, that means we have to analyze new data in the future checking use and patterns evolution.

CONCLUSION

Data gathered in this study reveals a significant increase in data traffic and the number of MenPas users during the months of March and April 2020 due to the coronavirus pandemic. Furthermore, the characteristics of users have changed, highlighting changes in people's habits. This fact shows that people change and modify their behavior and find a way to adapt and achieve their needs when there is a suddenly and hard change in the socio-economic and environmental situation where and when they live. However, more data is necessary to establish specific profiles and determine needs that can be addressed through this type of online platform.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

AH-M, VM-S, RR, SG-R, JP-B, and JM-B participated in the study design and data collection, performed statistical analyses and contributed to the interpretation of the results, wrote the manuscript, approved the final manuscript as submitted, and reviewed and provided feedback to the manuscript. All authors made substantial contributions to the final manuscript.

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Socio-Cognitive Factors Associated With Lifestyle Changes in Response to the COVID-19 Epidemic in the General Population: Results From a Cross-Sectional Study in France

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Background: The aims of the present study were to assess changes in lifestyles in the general population in response to coronavirus disease 2019 (COVID-19) lockdown and the influence of COVID-19 perceptions, as assessed by the Extended Parallel Process Model (EPPM), on these changes.

Methods: Data were collected from 4005 individuals through an online survey conducted 3–4 weeks after the nationwide lockdown implementation in France. Participants were asked whether they practiced five behaviors (i.e., screen watching, snacking, eating fruits and vegetables, exercising, and walking) less often, as often as, or more often than prior to the lockdown. Beliefs and expectations toward the COVID-19 epidemic were also assessed using an adapted version of Witte's EPPM, together with sociodemographic and environmental variables. Among the respondents consuming regularly alcohol and tobacco, logistic regressions were performed to estimate the Odds ratios (ORs) of increase (yes/no) and decrease (yes/no) in drinking and smoking since the lockdown.

Results: More than 8 in 10 respondents reported unhealthy changes in lifestyle since the lockdown, mostly in relation to physical activity. The unhealthy changes were positively associated with male sex (RR = 1.17; confidence interval [95% CI] = 1.10–1.24), living urban density, having a garden (RR = 1.16 [1.07–1.26]), financial difficulties because of COVID-19 (RR = 1.09 [1.02–1.18]), and lack of fear control (RR = 1.04 [1.01–1.09]) and negatively with cognitive avoidance (RR = 0.92 [0.89–0.95]). Less than 4 in 10 respondents reported healthy changes over the same period, mostly in relation to better eating habits. They were positively associated with living with more than two persons (RR = 1.22 [1.02–1.45]), having a terrace (RR = 1.14 [1.02–1.29], and perceived efficacy (RR = 1.11 [1.04–1.08]) and negatively with being aged 40 or higher. Alcohol consumption overall declined in regular drinkers, while a slight increase in tobacco use was observed in regular smokers.

Discussion: The COVID-19 pandemic and lockdown resulted in frequent and mostly unhealthy changes in lifestyle among the general population. These changes were

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related to individual and environmental characteristics but also to EPPM appraisals in the wake of fear appeal from COVID-19 campaigns. Communication and preventive measures should include messages and initiatives toward the maintenance of healthy lifestyles during pandemics such as the adaptation of physical activity and eating guidelines to the particular contexts of mobility restriction and infection control.

Keywords: COVID-19, confinement, physical activity, stress, coping strategics, barriers, eating habits

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has affected many countries, with more than ten million cases worldwide and more than 500,000 deaths by July 1st 2020 (ECDC, 2020). Several measures were implemented in order to prevent further spread of the disease in the early stages of the pandemic. Nationwide confinement, the restriction of individuals to their homes, was one of the measures enforced in many countries, including France on March 17, 2020 (Augeraud-Veron, 2020). In addition, global and local health authorities used media campaigns to inform about the virus spreads and the number of daily cases and deaths and to promote the recommended actions to prevent infections in mass populations (Lasbeur et al., 2020; Raude et al., 2020). These include regular handwashing, social distancing, avoiding crowed places, and covering mouth and nose, among others.

Though these measures have been vital for preventing the spread of COVID-19, they may have alsoresulted in adverse health effects. Firstly, the ensuing reduction in social (collective training sessions or sport events) and physical (barred access to exercise facilities, or parks)opportunities to exercise may have had a direct effect onsedentary behaviors (Ammar et al., 2020). It must be noted however that each person in France had a 1-hour authorization to exercise locally (Legifrance, 2020). Secondly, prevention campaigns that promoted the recommended actions to prevent infections and intensive press coverage in such a novel and uncertain situation inevitably used fear appeal, which is associated with negative health outcomes, to raise awareness towards the health threat (Tannenbaum et al., 2015). If fear appeal campaigns may motivate adaptive danger control actions such as message acceptance, theymay also generate maladaptive fear control actions such as defensive avoidance or reactance (Witte and Allen, 2000), and unhealthy behaviors in response to chronic stress (Schneiderman et al., 2005; Peters et al., 2013).

According to the extended parallel process model (EPPM), two appraisals typically occur when individuals are exposed to fear appeals (Witte, 1992). The threat appraisal consists of assessing how much threat the fear appeal poses, in terms of severity and susceptibility, while the other assesses perceived efficacy and both self-efficacy (i.e., person's belief about his/her ability to follow the recommended suggestions successfully) and response efficacy (i.e., beliefs about the effectiveness of the recommended suggestions to avert the threat). When individuals are exposed to a fear appeal, they engage either in danger control, where they cognitively process the message and take action to avoid the threat, or in fear control, where they emotionally repress the message and ignore the threat. A third alternative is to ignore the message, which typically occurs because the threat is perceived as low (Witte, 1994; Maloney et al., 2011; Lewis et al., 2013). The EPPM has advanced understanding of how fear appeals operate, and constitutes a relevant theoretical framework to assess the perceptions of COVID-19 in the general population and why they engage or not in behavioral recommendations.

Health consequences of the COVID-19 pandemic and lockdown are still to be determined comprehensively (Ifdil et al., 2020; Kutlu et al., 2020; Mattioli et al., 2020), but they may concern lifestyles and behaviours (Stanton et al., 2020). Better knowledge of the factors affecting lifestyles amid lockdown may contribute greatly in designing education campaigns and in organizing optimum counseling during and after pandemics. The aims of the present study were to assess changes in lifestyles among the French general population in response to COVID-19 lockdown and the influence of COVID-19 perceptions, as assessed by the EPPM, on these changes.

MATERIALS AND METHODS

Participants and Procedures

Our data was collected through an online survey conducted among 4,005 adults residing in France. The respondents were recruited among 5,000 panelists from the Arcade Research Institute[1], who agreed to participate regularly to surveys of customer attitudes and experiences in exchange for financial compensation (valid response rate = 80.1%). The objective of the research was to assess the emotional, cognitive, and behavioral response of the French people to the COVID-19 epidemic during the full lockdown. The respondents to this survey were enrolled on the basis of a stratified sampling method to reflect the distribution of the French general population regarding sex, age, occupation, and region. For the present study, we analyzed data from a 2 weeks survey, which were administered 3–4 weeks after the implementation of the lockdown (between 8 and 20 April 2020). The research protocol was registered by the Ecole des Hautes Etudes en Sante Publique (EHESP) School of Public Health Office for Personal Data Protections and approved by the Institutional Review Board of the University Hospital Institute "Mediterranee Infection" (Marseille, France).

[1] www.panelia.fr

Measures

Lifestyle Variable

The dependent variable for the analyses was self-reported change in lifestyle in response to the COVID-19 pandemic in France. Participants were asked whether they practiced five health behaviors (i.e., screen watching, snacking, eating fruits and vegetables, exercising, and walking) less often, as often as, or more often than prior to the lockdown, using first-person questions (e.g., "Since the lockdown, I exercise [less than/as much as/more than] before"). To facilitate the treatment of the behavioral data, responses obtained from these items were added to generate a cumulative score (range 0–5) that enables to measure participants' positive and negative change in lifestyle behaviors related to the COVID-19 epidemic.

Socio-Cognitive Factors

To assess participants' beliefs and expectations related to the COVID-19 epidemic, we used a range of constructs and variables from the Witte's EPPM. Items related to these constructs were drawn from the Risk Behavior Diagnosis Scale[2], adapted to the COVID-19, and translated to French (see **Table 4** for the details). This includes perceived susceptibility [3 items, e.g., "It is likely that I will get infected with coronavirus (COVID-19)"] to and severity [3 items, e.g., "I believe that coronavirus infection (COVID-19) is severe"] of the coronavirus infection, fear (3 items, e.g., "The risk of being infected by coronavirus is frightening me"), perceived response efficacy (3 items, e.g., "Measures recommended by the health authorities are effective in preventing coronavirus infection," and self-efficacy (3 items e.g., "I can easily apply the recommended measures to prevent coronavirus infection"). For each of them, the participants were asked to rate on a Likert-type response scale ranging from 1 ("totally disagree") to 5 ("totally agree"), and for which the meaning of each value was explicitly indicated.

Sociodemographic and environmental variables were also collected, such as age, gender, level of education, occupational status (active, unemployed, or retired), household income (in euros), size of household, surface area in m^2, layout (garden, terrace), population density (urban; more than 100,000 inhab; urban; 20,000–100,000 inhab; urban; 2000–20,000 inhab; rural zone), risk factors (alcohol; tobacco; obesity), and financial difficulties (no; yes, unrelated to covid; yes, in relation to covid).

Data Analysis

Categorical data were expressed as numbers (*N*) and percentages (%), while numerical data were expressed as means ± standard deviations. EPPM factors were estimated using an unweighted least-square factorial analysis, followed by a Promax rotation, a non-orthogonal (oblique) solution in which the factors are allowed to be correlated. This method provides accurate and conservative parameter estimates when using ordinal data (Lee et al., 2012). This item reduction method established which of the 18 items belonged to domains or conceptual areas and which items should be maintained. Items are deleted if they loaded on two or more factors or if they exhibited a correlation coefficient of less than 0.40 with their own factor. Internal consistency reliability was assessed by computing Cronbach's alpha coefficient (considered satisfactory if higher than or equal to 0.70). Interscale correlations were computed with the non-parametric Spearman's correlation test. The factors raw scale scores were transformed to a 0–100 scale [((raw score−lowest possible raw score)/possible raw score range) × 100] and compared with one-way analysis of variance. Since our study outcomes were count variables (number of unhealthy/healthy changes in lifestyles since lockdown), we used generalized linear Poisson regression models to estimate the rate ratios (RRs) of changes in lifestyles as a function of sociodemographic variables and factors' scores of COVID-19, as assessed by the EPPM. Estimates in univariate analysis (model 1) were expressed as rate ratios with 95% confidence intervals (RR [95% CI]). Significant estimates from model 1 were analyzed in a multivariate model (model 2). Among the respondents consuming regularly alcohol and tobacco, logistic regressions were performed to estimate the odds ratios (ORs) of increase (yes/no) and decrease (yes/no) in drinking and smoking since the lockdown. Statistical analyses were performed using the SPSS statistical package, version 19 (SPSS, Chicago, Illinois, United States).

RESULTS

Of the 4005 individuals who completed the survey (**Table 1**), a majority were women (55.4%) professionally active (41.8%) or retired (21.6%) with a net income above 3000 euros per month (53.8%). Most of them lived in urban environments (75.9%), in multi-person households (78.0%), with a living area of 80 m^2 or more (78.0%) with a garden (66.3%) or/and a terrace (58.2%). A majority of respondents were alcohol drinkers (60.1%) while 26.5% were smokers and 3.9% had obesity. More than 1 in 5 participants (22.7%) reported financial difficulties related to lockdown. More than 8 in 10 respondents reported unhealthy changes in lifestyle since the lockdown (**Table 2**), while less than 4 in 10 reported healthy changes. Although 4.3% of the participants reported that they tested positive for COVID-19, there were no significant difference between the non-infected and infected participants regarding lifestyles changes under study. The most frequently reported unhealthy changes (**Table 3**) were decreased walking (60.0%) and exercising (45.4%) and increased screen watching (59.0%). The most frequently reported healthy changes were decreased snacking (18.2%), increased FV consumption (13.1%), and exercising (11.3%).

Of the 4005 respondents, 2121 (52.9%) completed the EPPM items without missing values. Respondents particularly discarded items with vague wording (e.g., "I am at risk for getting the COVID-19") in a context where scientific knowledge on COVID-19 varied from day to day. Unweighted least-square exploratory factorial analysis, followed by a Promax rotation, was performed on the 18 items (**Table 4**). Eigenvalues for the first six factors were 4.97, 3.30, 1.78, 1.46, 1.14, and 0.81, suggesting a five-factor solution explaining 69.9% of the common variance of the data. Factor #1 included six items related to response efficacy and self-efficacy and was interpreted as expressing efficacy;

[2]https://msu.edu/$\sim$wittek/rbd.htm

TABLE 1 | Participants' characteristics (*N* = 4005).

Variables		*N* (%)
Female sex		2051 (51.2)
Age in years	60 and older	1032 (25.8)
	40–59	1484 (37.1)
	18–39	1489 (37.2)
Professional status	Active	2715 (67.8)
	Retired	867 (21.6)
	Unemployed	423 (10.6)
Net income (in euros)	More than 4000	1150 (28.7)
	2000–3999	1758 (43.9)
	1500–1999	550 (13.7)
	<1500	547 (13.7)
People in the household	Three or more	1644 (41.0)
	Two	1479 (36.9)
	One	882 (22.0)
Surface area in m^2	100 and more	1644 (41.0)
	80–100	1564 (39.1)
	<80	882 (22.0)
Layout	Garden	2657 (66.3)
	Terrace	2330 (58.2)
Population density	Urban; more than 100,000	750 (18.7)
	Urban; 20,000–100,000	1049 (26.2)
	Urban; 2000–20,000	1241 (31.0)
	Rural zone	965 (24.1)
Risk factors	Alcohol use	2409 (60.1)
	Tobacco use	1062 (26.5)
	Obesity	158 (3.9)
Financial difficulties	Yes, related to covid	894 (22.3)
	Yes, unrelated to covid	700 (17.5)
	None	2411 (60.2)

TABLE 2 | Number of healthy and unhealthy changes in lifestyle since lockdown (*N* = 4005).

	Type of behavior change	
	Healthy	Unhealthy
Number	*N* (%)	*N* (%)
0	2453 (61.2)	649 (16.8)
1	1069 (26.7)	795 (19.9)
2	376 (9.4)	1068 (26.7)
3	89 (2.2)	937 (23.4)
4	17 (0.4)	455 (11.4)
5	1 (0)	101 (2.5)

TABLE 3 | Participants' reported changes in lifestyle amid lockdown (*N* = 4005).

	Change since lockdown		
	Decrease	Unchanged	Increase
Behaviors	*N* (%)	*N* (%)	*N* (%)
Screen watching	145 (3.6)	1498 (37.4)	2362 (59.0)
Snacking	727 (18.2)	2318 (57.9)	960 (24.0)
Eating fruits and vegetables	525 (13.1)	2957 (73.8)	523 (13.1)
Exercise	1818 (45.4)	1736 (43.3)	451 (11.3)
Walking	2402 (60.0)	1288 (32.2)	315 (7.8)

Factor #2 included four items related to lack of fear control; Factor #3 included three items expressing perceived COVID-19 severity; Factor #4 included three items expressing perceived vulnerability to COVID-19; and Factor #5 included items related to cognitive avoidance. Factors showed satisfactory internal validity (Cronbach's coefficient > 0.70). Interscale correlations between scores of severity, vulnerability, and lack of fear control (**Table 5**) were low to moderate (ranging from 0.19 to 0.58), showing that these factors were related but distinct. On the other hand, correlations between avoidance and others factors were low to absent (ranging from 0.07 to 0.10), suggesting that cognitive avoidance was the standalone coping strategy. The raw scale scores were transformed to a 0–100 scale [((raw score−lowest possible raw score)/possible raw score range) × 100]. Higher T-scores in the respective scales are indicative of greater perceived efficacy, lack of fear control, severity, vulnerability, or avoidance. Efficacy (81.9 ± 13.2) and severity (82.7 ± 16.6) reached highest scores on a 100-point scale, followed by lack of fear control (69.4 ± 19.5), perceived vulnerability (63.1 ± 21.5), and avoidance (59.7 ± 18.9). Differences between T-scores were significant, except for efficacy and severity.

Estimate of unhealthy changes in univariate analysis (**Table 6**) increased with male sex, COVID-19-induced financial difficulties, having a garden or terrace, living in urban environments, obesity, and level of fear, perceived severity, and vulnerability and decreased with age older than 60 years, surface area, and level of avoidance. In multivariate analyses, estimates of unhealthy changes increased with male sex, COVID-19-induced financial difficulties, having a garden, living in urban environments, and elevated level of fear and decreased with age older than 60 years, surface area, and level of avoidance.

Estimates of healthy changes in univariate analysis (**Table 7**) increased with COVID-19-induced financial difficulties, living in a household with 3 or more persons, having a terrace, and levels of adherence, fear, perceived severity, and avoidance and decreased with age and income between 2000 and 3999 euros per month. In multivariate analyses, estimates of healthy changes increased with living in a household with 3 or more persons, having a terrace, and levels of adherence and decreased with older age.

Alcohol and Tobacco Consumption

Of the 2409 regular drinkers, 356 (14.8%) increased and 508 (21.1%) decreased alcohol consumption since the lockdown. In multivariate analyses, estimates of higher drinking increased with having a terrace (OR = 1.76 [1.14–2.71)] and decreased with age (60 years or older: OR = 0.56 [0.34–0.91], 40–59 years: OR = 0.61 [0.43–0.87]; reference: 18–39 years). Estimates of lower drinking increased with living in dense urban area (> 100 000 inhabitants) as compared to rural areas (OR = 1.66 [1.07–2.58]), and level of efficacy (OR = 1.27 [1.09–1.48]), and decreased with age 40–59 years (OR = 0.64 [0.47–0.88)]. Of the 1062 regular smokers, 231 (21.8%) increased and 177 (16.7%) decreased their tobacco consumption. These changes were unrelated to factors under study.

TABLE 4 | Factor matrix: items and factor loadings for the five-factor solution of the extended parallel process model applied to COVID-19 (*N* = 2121).

	Factors				
Items	**Efficacy**	**Lack of fear control**	**Severity**	**Vulnerability**	**Avoidance**
Measures recommended by authorities are effective in preventing the COVID-19	0.606				
Actions recommended by scientists work in preventing the COVID-19	0.686				
If I follow expert advices, I am less likely to get the COVID-19	0.680				
I am able to follow authorities recommendations to prevent getting the COVID-19	0.767				
I have the skills/time/money to apply recommended measures to prevent COVID-19	0.712				
I can easily apply the recommended measures to prevent COVID-19	0.809				
The risk of being infected worries me particularly		0.907			
The risk of being infected is frightening me		0.882			
The risk of being infected make me nervous		0.848			
When I go for a walk, I always keep in mind that I can be infected		0.529			
I believe that COVID-19 is severe			0.874		
I believe that COVID-19 has serious negative consequences for health			0.766		
I believe that COVID-19 is extremely harmful			0.872		
It is likely that I will get the COVID-19 in the next weeks				0.896	
I am at risk for getting the COVID-19				0.370	
It is possible that I will get the COVID-19 in the next weeks				0.861	
When I go shopping, I tend to avoid thinking about the risk of being infected					0.703
When I come across others people outside, I tend to avoid thinking about the risk of being infected					0.887
Eigenvalue	4.97	3.30	1.78	1.46	1.14
% of explained variance	27.6	18.3	9.9	8.1	6.3
Cronbach's alpha	0.86	0.88	0.88	0.74	0.77

TABLE 5 | Spearman correlations between factors of the extended parallel process model applied to COVID-19 (*N* = 2121).

	Efficacy	**Lack of fear control**	**Severity**	**Vulnerability**	**Avoidance**
Efficacy	1				
Lack of fear control	0.13	1			
Severity	0.34	0.58	1		
Vulnerability	−0.06	0.35	0.19	1	
Avoidance	0.09	0.07	0.08	0.10	1

DISCUSSION

More than 8 in 10 respondents reported unhealthy changes in lifestyle since the lockdown, mostly in relation to unhealthy changes in lifestyles which were common amid COVID-19 confinement, affecting especially physical activity. The unhealthy changes were positively associated with male sex, living in dense urban areas, having a garden, financial difficulties because of COVID-19, and lack of fear control and negatively associated with cognitive avoidance. Less than 4 in 10 respondents reported healthy changes over the same period, mostly in relation to better eating habits. They were positively associated with associated with living with more than two persons, having a terrace, and perceived efficacy and were negatively related to being aged 40 or higher.

The implementation of confinement and physical distancing, including mobility restrictions, banning of mass gatherings, closure of schools and work activities, isolation, and quarantine, helped control the first wave of the COVID-19 pandemic but resulted in overall unhealthy changes in lifestyle in France and elsewhere (Stanton et al., 2020). Expectedly, a majority of respondents reported increased sedentary and decreased walking

TABLE 6 | Rate ratios and 95% confidence intervals (RR [95% CI]) of the number of unhealthy changes in lifestyle since lockdown (*N* = 2196); Poisson regression.

Variables		Univariate RR [95% CI]	Multivariate RR [95% CI]
Male sex		**1.19 [1.12–1.26]**	**1.17 [1.10–1.24]**
Age in years	60 and older	**0.99 [0.84–0.99]**	0.94 [0.86–1.03]
	40–59	1.04 [0.97–1.11]	1.03 [0.96–1.10]
	18–39	1	1
Professional status	Active	1.03 [0.93–1.15]	
	Retired	0.93 [0.82–1.05]	
	Unemployed	1	
Net income (in euros)	More than 4000	1.02 [0.92–1.12]	
	2000–3999	0.94 [0.86–1.04]	
	1500–1999	1.01 [0.90–1.14]	
	< 1500	1	
Financial difficulties	Yes, related to covid	**1.13 [1.06–1.22]**	**1.09 [1.02–1.18]**
	Yes, unrelated to covid	0.98 [0.90–1.074]	0.96 [0.87–1.05]
	None	1	1
Number of household bers	Three or more	0.95 [0.88–1.03]	
	Two	0.93 [0.86–1.01]	
	One	1	
Surface area in m^2	100 and more	**0.85 [0.78–0.91]**	0.95 [0.87–1.03]
	80–100	**0.90 [0.83–0.97]**	0.95 [0.87–1.05]
	<80	1	1
Layout	Garden	**1.23 [1.15–1.30]**	**1.16 [1.07–1.26]**
	Terrace	**1.10 [1.04–1.17]**	0.97 [0.90–1.05]
Population density	Urban; more than 100000	**1.30 [1.19–1.42]**	**1.18 [1.07–1.31]**
	Urban; 20 000–100 000	**1.20 [1.10–1.31]**	**1.11 [1.01–1.22]**
	Urban; 2000–20000	**1.14 [1.05–1.24]**	**1.10 [1.01–1.20]**
	Rural zone	1	1
Risk factors (yes/no)	Obesity	**1.16 [1.01–1.34]**	1.13 [0.98–1.31]
	Alcohol	0.96 [0.91–1.02]	
	Tobacco	0.95 [0.89–1.02]	
Factor score	F1: efficacy	1.00 [0.97–1.03]	
	F2: lack of fear control	**1.09 [1.06–1.12]**	**1.04 [1.01–1.09]**
	F3: severity	**1.06 [1.03–1.10]**	1.02 [0.97–1.06]
	F4: vulnerability	**1.05 [1.02–1.09]**	1.03 [0.99–1.06]
	F5: avoidance	**0.92 [0.89–0.95]**	**0.92 [0.89–0.95]**

Significant results are marked in bold.

in response to lockdown. As four times more respondents reported decreased than increased exercising, the 1 h permission daily given to go out on exercise failed to compensate for mobility restriction. It must be noted that grounds for sport activities were also shut down, making impossible all forms of exercise besides walking and running. The picture is more mitigated when it comes to eating habits, since healthy changes nearly compensated unhealthy changes.

According to EPPM, if people assume that they are strongly exposed to a disease (threat appraisal), the efficacy appraisal of coping strategies will change their attitudes and behaviors. In the present study, factor analysis revealed a five-factor structure underlying perceptions about the COVID-19. Response efficacy and self-efficacy formed together the "perceived efficacy appraisal," which reached a high score in our study sample, indicating a sound adherence to recommended preventive measures. Respondents also reported high scores of severity, showing they were well aware of the seriousness of the COVID-19 consequences amid communication campaigns. This perception theoretically forms the "threat appraisal" together with vulnerability in the EPPM but correlated more to the "lack of fear control" score possibly due to respondents' strong reactions to the fear appeal communication about COVID-19, without necessarily considering themselves as highly vulnerable. Altogether, response efficacy seemed to equal the threat appraisal, which indicates a "danger control" process, in which individuals are motivated to take action to lessen the threat. Nevertheless, cognitive avoidance was reported as a standalone coping strategy to provide some distance from the steady stream of information about COVID-19 (Park et al., 2020).

The relationships observed between severity, vulnerability and unhealthy changes in the univariate analysis becomes

TABLE 7 | Rate ratios and 95% confidence intervals (RR [95% CI]) of the number of healthy change in lifestyle since lockdown (*N* = 2196); Poisson regression.

Variables		Univariate RR [95% CI]	Multivariate RR [95% CI]
Male sex		1.05 [0.94–1.17]	
Age in years	60 and older	**0.74 [0.63–0.87]**	**0.77 [0.65–0.92]**
	40–59	**0.80 [0.71–0.90]**	**0.80 [0.71–0.91]**
	18–39	1	1
Professional status	Active	1.08 [0.90–1.31]	
	Retired	0.91 [0.72–1.15]	
	Unemployed	1	
Net income (in euros)	More than 4000	0.91 [0.76–1.09]	0.92 [0.75–1.13]
	2000–3999	**0.84 [0.71–0.99]**	0.83 [0.69–1.01]
	1500–1999	0.96 [0.78–1.18]	0.98 [0.80–1.21]
	< 1500	1	
Financial difficulties	Yes, related to covid	**1.20 [1.05–1.36]**	1.12 [0.97–1.28]
	Yes, unrelated to covid	0.90 [0.75–1.05]	0.90 [0.75–1.08]
	None	1	
Number of household bers	Three or more	**1.17 [1.01–1.36]**	**1.22 [1.02–1.45]**
	Two	1.09 [0.93–1.28]	1.19 [1.00–1.42]
	One	1	1
Surface area in m^2	100 and more	0.98 [0.87–1.11]	
	80–100	0.97 [0.83–1.13]	
	< 80	1	
Layout	Garden	1.01 [0.90–1.14]	
	Terrace	**1.13 [1.01–1.26]**	**1.14 [1.02–1.29]**
Population density	Urban; more than 100000	1.15 [0.97–1.36]	
	Urban; 20 000–100 000	1.07 [0.92–1.25]	
	Urban; 2000–20000	0.98 [0.77–1.05]	
	Rural zone	1	
Risk factors (yes/no)	Obesity	1.11 [0.85–1.45]	
	Alcohol	0.91 [0.82–1.02]	
	Tobacco	1.12 [0.99–1.26]	1.07 [0.95–1.21]
Factor scores	F1: efficacy	**1.12 [1.06–1.20]**	**1.11 [1.04–1.08**]
	F2: lack of fear control	**1.06 [1.01–1.13]**	1.00 [0.92–1.08]
	F3: severity	**1.08 [1.02–1.15]**	1.07 [0.98–1.16]
	F4: vulnerability	0.95 [0.90–1.01]	
	F5: avoidance	**1.05 [0.99–1.12]**	1.03 [0.97–1.10]

Significant results are marked in bold.

non-significant when entered together with lack of fear control in the multivariate model. This finding indicates that threat appraisal may negatively influence changes in lifestyles through uncontrolled fear responses, precluding going out for exercise/walking or prompting emotional overeating. In addition, unhealthy changes were higher among men and respondents with financial difficulties – which may indicate a maladaptive response to stress (Park et al., 2020; Verma and Mishra, 2020). Previous research has reported that fear appeal campaigns are effective when the communication depicts relatively high amounts of fear, stresses severity, and susceptibility of the threat, and recommends one-time only behaviors and includes an efficacy message (Tannenbaum et al., 2015). However, in a context of public health and economic uncertainty such as the early stages of the COVID-19 crisis, fear appeal may also induce negative side effects among vulnerable individuals. In contrast to other studies (Soga et al., 2017; Saltzman et al., 2020), living in densely populated areas and having a garden had negative effects on health behaviors. In the context of COVID-19 epidemic and mobility restrictions, rural residents possibly had greater access to outdoor exercise areas than urban dwellers, while garden owners could enjoy open air without much effort, which fostered sedentary. Conversely, avoiding thinking about the COVID-19 (Umucu and Lee, 2020) somewhat limited unhealthy changes in lifestyles, probably by reducing the fear to go out.

A minority of respondents took advantage of the lockdown to improve their habits, especially toward food. The relationships observed between severity, fear control, and healthy changes in the univariate analysis become non-significant when entered together with efficacy in the multivariate model. This could indicate that some respondents in "danger control appraisal" (high efficacy, high threat) improved their behaviors in response to the COVID-19, when obesity was considered a risk factor for disease mortality. Healthy changes were also related to the size of household, may be in relation to increased family and social support (Hempler et al., 2016; Saltzman et al., 2020) and to the need to protect close relatives. On the other hand, these positive evolutions were less frequent in respondents aged 40 and older for unclear reasons, although aging often entails the need to make changes in lifestyle (US National Research Council Committee on Aging Frontiers in Social Psychology, Personality, and Adult Developmental Psychology, 2006).

Finally, analyses conducted among regular drinkers revealed that alcohol consumption overall declined in regular drinkers. One possible explanation is that the lockdown precluded most – if not all – social activities, which often involve alcohol in France (INSERM Collective Expert Reports [Internet], 2003). Higher drinking decreased with age, which is in line with previous findings (Chodkiewicz et al., 2020), probably because the threat of contracting COVID-19 might have motivated vulnerable populations to minimize adverse health outcomes. However, being aged 40–59 years was also associated with higher drinking, which may reflect the high rate of alcohol problem in this age group (Constant et al., 2017). Conversely, a slight increase in tobacco use was observed in regular smokers, showing that stress related to the COVID-19 pandemic affected risk behaviors in different ways (Bommele et al., 2020). While the threat of contracting COVID-19 might have motivated a minority of regular smokers to improve their health, boredom, and restrictions in movement might have fostered smoking in others.

This study must be interpreted in light of its limitations. Firstly, the assessment of lifestyle changes in this study was suboptimal, since it was based on individual recall methods, without reproducibility assessment. Secondly, the cross-sectional design does not allow causal inferences about relationships between variables to be determined. Furthermore, missing data precluded the investigation of EPPM appraisal in the total study sample. Thirdly, personality variables such as anxiety trait and pessimism may have a pivotal influence on appraisals and were not assessed. Finally, data were collected in a cohort including a minority of individuals with deprived socioeconomic backgrounds, which may limit the generalizability of our results. Since the monitoring of lockdown adverse effects is suboptimal, the large size of our cohort and the inclusion of diverse professions and socioeconomic groups nevertheless have offered an interesting opportunity to assess threat appraisals and behavioral changes amid the COVID-19 pandemic in the general population.

Our findings suggest that the coronavirus disease pandemic and lockdown resulted in frequent and mostly unhealthy changes in lifestyle in the general population. These changes were related to individual and environmental characteristics but also to EPPM appraisals in the wake of fear appeal COVID-19 campaigns. Communication and preventive measures should include messages and initiatives toward the maintenance of healthy lifestyles during pandemics. This goes through the adaptation of physical activity and eating guidelines to the particular contexts of mobility restriction and infection control.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Institutional Review Board of the University Hospital Institute “Mediterranee Infection” (Marseille, France). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AC, DC, KG-M, and JR contributed to the conception and design of the study and interpreted the data and drafted the final manuscript. KG-M suggested the theoretical framework. AC performed the statistical analysis and wrote the first draft of the manuscript. All authors read and approved the manuscript.

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OPINION
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COVID-19 and Quarantine: Expanding Understanding of How to Stay Physically Active at Home

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CURRENT SCENARIO

The coronavirus disease 2019 (COVID-19) is today the biggest public health challenge in the world (Park, 2020). The first case of COVID-19 was diagnosed on December 8, 2019, in Hubei province, China. From that day, in just over 3 months, the virus has spread to more than 177 countries/areas/territories around the world, with more than 266,073 confirmed cases and 11,184 deaths, according to WHO on March 21, 2020 (WHO, 2020). The most common clinical manifestations of COVID-19 are mild flu-like illness, potentially lethal acute respiratory distress syndrome, or fulminant pneumonia. As a result, numerous countries have decided to implement (some by government decrees, as well as martial laws) the establishment of mandatory social distance in a family environment, closing non-essential commercial environments, in an attempt to reduce the peak of the infection curve (Lewnard and Lo, 2020).

We know that a large part of the world population is far from the minimum conditions of physical exercise recommended by the American College of Sports Medicine (ACSM) to improve the health component (Katzmarzyk et al., 2019). This fact would give important relevance to the level of physical activity exercised by the population throughout the day. However, once the extreme hypokinetic behavior is implemented as a result of the quarantine, a cycle of perverse events begins, making part of the population more vulnerable to the deleterious effects of acute and chronic diseases, including respiratory tract infections (Hall et al., 2020).

In a recent position paper presented by Chen et al. (2020), the authors try to propose to the general population to continue exercising regardless of the current moment the world is living. In fact, as the authors mention, based on other researchers, "anything is better than nothing," and the sedentary lifestyle is something that should not be encouraged, i.e., any energy expenditure added to the routine of these people would be significant. Recommendations for the population to keep regularly active highlight only a minimum applicable technical basis, without presenting any

TABLE 1 | Recommendations for exercising at home.

	Aerobic exercises	Strength exercises
Conception	Prolonged or short term exercises using large muscle groups	Localized exercise with body weight, or free weight Exercises (include all major muscle)
Configuration	Merging one or more strength component with an aerobic component (see **Table 2**)	
Frequency	3–5 days/week (consecutive days for high levels of fitness)	
Time	10–30 min a day. This can be accumulated continuously or in shorter 10-min blocks	
Intensity	Moderate effort (40–59% of heart rate—HR) for long workouts (RPE 3–4) or for lower levels of conditioning; Moderate to high effort (60–85% of HR)—for intermediate workout times (RPE 4–6); High effort (>85% of HR)—for short workouts (RPE >7)	
Volume	150 or more min/week are required. 4–6 sets of 6–20 repetitions for selected exercise. 3–5 exercises for workout	
Workout form	(a) Mobility and warm up (5–10 min); (b) core or strength (5–10 min); (c) multimodal workout (5–20 min)	

TABLE 2 | Proposal of exercises for workouts configuration.

Upper body	Lower body
Push up (or adapted)	Hip trust (on the ground)
Pull ups (or adapted)	Squat or split squat
Handstand push up (or inverse press on chair)	Sumo squat
Ball throw (or adapted)	Lunge (or walking lunge)
Dips on chair or box	Pistol (advanced)
Shoulder push up (on the ground)	Good morning
Adapted bent over row (pulling a towel)	Adapted deadlift or single leg deadlift
Aerobic demand	**Core**
Jumping jacks	Hollow body (or hold)
Jump rope (single or double under)	Arch body (or hold)
Burpees	Sit ups
Box jump (stairs jump)	Plank or side plank
Box jump over (on chair)	Turkish get up
Skipping (performed in a hallway)	Russian twist
Sprawl	Mountain climber

suitable parameters for carrying them out. From the initial positioning of Chen et al. (2020), the ACSM *via* publication on the website of the journal *Medicine* & *Science in Sports* & *Exercise* (ACSM, 2020; WHO, 2020), as well as other institutions (ACSM, 2020; WHO, 2020), expanded the proposal about the practice of physical exercise to be performed at home. Tasks such as brisk walking, up and down stairs, dance, jump rope, yoga exercises, and bodyweight strength training are also recommended for indoor workout (**Table 1**).

EXPANDING RECOMMENDATIONS FOR PRACTICING EXERCISE AT HOME

The suggestions proposed by the ACSM (2020), WHO (2020), although more consistent, still do not offer a concrete logic to be applied and controlled. Moreover, the statement "Some activity is better than none" makes more sense when we talk about people practicing any physical activity at a beginner level, therefore merely minimally physically active (Chen et al., 2020). Thus, for practitioners of physical exercise at levels that require moderate to high metabolic and strength demand, or even athletes, these would be susceptible to detraining. According to the basic premises related to training, an ideal stimulus must be administered for the adaptation to occur properly, and that condition may not be prioritized with such positions.

Considering the theoretical rationale prevalent in the literature, we believe that the suggestions proposed can be expanded in order to integrate groups of individuals who have moderate to high physical conditioning and not only sedentary individuals, providing better guidance on how to proceed during the quarantine period and offering the possibility of follow-up training even after the quarantine has ended. For such, the conviction that traditional strategies of aerobic endurance exercise may not be a suitable strategy for application in the residential environment (understanding that majority of the population does not have stationary bikes, arm or rowing ergometers at home), so the interval exercise pattern should be primarily stimulated, with or without the use of any viable resource of overload implementation. In combination with this proposal, the concomitant increase in intensity (vigorous to high intensity) is also essential to promote adaptive results independently of the initial fitness level.

The effects of high-intensity interval training (HIIT) are well-established in the literature for healthy people (Gormley et al., 2008) and those with some comorbidity (obesity, heart disease, diabetics) (Ballesta Garcia et al., 2019; Taylor et al., 2019). More recently, the effects of HIIT have been presented in sedentary individuals, suggesting that the application of interval exercises would be viable, consolidating itself as an important strategy for health promotion (Dorneles et al., 2019; Reljic et al., 2019). The literature shows significant physiological responses derived from different types of interval protocols (Paoli et al., 2012; Buckley et al., 2015; Box et al., 2019), and the improvement in performance seems to be related to the physiological mechanism of inducing mitochondrial biogenesis from the expression of the PGC-1 alpha transcription co-activator, as well as catalyzing enzymes of both the glycolytic

TABLE 3 | Examples of training session configurations based on intensity control from internal load.

Lower body program			Upper body program		
Warm up	**(5 min)**	**RPE 3–4**	**Warm up**	**(5 min)**	**RPE 3–4**
2 sets	Specific mobility (hip)		2 sets	Specific mobility (shoulders)	
	30×	Jumping jacks		50×	Single under
	50×	Jump rope		50×	Skipping
Core	(10 min)	RPE 4–6	Strength	(10 min)	RPE > 7
3 sets	15×	Hollow body	3 sets	8–10×	Adapted handstand push up
	30 s	Arch hold		8–10×	Pull up
Workout	(15 min)	RPE 4–6	Workout	(15 min)	RPE > 7
AMRAP	20×	Walking lunges	MAX RFT	20×	Push up
	20×	Sprawl		20×	Dip on box
	20×	Split squat		20×	Mountain climbers
	50×	Double under		20×	Burpees

and oxidative systems (Gibala et al., 2006; Gibala, 2009). Such adaptations promote greater efficiency metabolic rate in energy production and buffering capacity.

In a new perspective, evidence indicates that HIIT performed with body weight can promote significant adjustments in strength, hypertrophy (Kikuchi and Nakazato, 2017), and the cardiorespiratory system. For instance, the Tabata protocol would fit as an interesting tool to be performed at home (Tabata et al., 1996). Basically, it consists of performing stimulus 8×20 s interspersed with 10-s recovery, a total of 4 min. The protocol is still performed more than once during an exercise session and with different exercise compositions. Emberts et al. (2013) reported mean values of 74% of VO_{2max} [rate perceived exertion (RPE) averaged 15.4 ± 1.3] and 86% of HR_{max} (156 ± 13 bpm) during two types of Tabata workouts (e.g., mountain climbers, push-ups, split squat, box jumps, burpees, squats, lunges, Russian twist). This level of workout is a sufficient stimulus to generate adaptations to the cardiorespiratory component, and these data are superior to the recommendations proposed by the ACSM. Moreover, the increase in intensity seems to be the key to maintain the gains obtained before COVID-19 (Hickson et al., 1985).

To better target the perspective postulated here in our article, as well as to better interpret the designs positioned in **Table 2**, Buckley et al. (2015) proposed a high-intensity multimodal training format as a way to reduce the time required for multiple adaptations. For this, the authors compared the physiological responses of the traditional HIIT performed in a rowing ergometer versus multimodal training, involving analysis of different manifestations of strength, in addition to maximum aerobic power and anaerobic capacity. Thirty-two recreational trained participants performed 60 s "all out" and a 3-min recovery (total of 4 min per series). The multimodal HIIT protocol was configured as follows: a strength exercise for 4–6 repetitions, an accessory movement for 8–10 repetitions, and a metabolic component conducted all out for the remainder of the 60 s. The results were significantly promising, resulting in similar responses in aerobic and anaerobic performance tests; however, multimodal HIIT showed significant improvement in all parameters of different manifestations of strength.

It is suggested, therefore, that the configuration of multimodal workouts be constructed in a similar way to that reported in the literature, and the control of exercise overload (internal load) would be performed based on the RPE (0–10 in combination with session time (Foster et al., 2001). **Table 2** shows a coherent exercise division format, and **Table 3** shows examples of training session configurations.

CAN EXERCISE INTENSITY COMPROMISE THE IMMUNE SYSTEM?

Finally, establishing the relationship between the stresses generated from physical exercise at home and the immune system is an important point to be considered during this quarantine period (Amatriain-Fernandez et al., 2020a,b). Nieman (2007) proposes an open window of alteration of the immune system after physical exercise, and such manifestation would occur with significant magnitude in the face of long-lasting endurance, such as in a marathon, or also in the face of extremely heavy efforts. However, little is known about the immune responses to short interval exercise, but current evidence suggests that HIIT seems to be beneficial for the immune system (Bartlett et al., 2017, 2018; Born et al., 2017; Durrer et al., 2017; Dorneles et al., 2019; Steckling et al., 2019; Khammassi et al., 2020), although evidence still points to a higher increase in the percentage of leukocytosis after HIIT exercise (Jamurtas et al., 2018).

So, Bartlett et al. (2017) investigated in 27 sedentary adult individuals the potential of immune response induced by continuous aerobic training of moderate intensity (MICT) and HIIT (volume 57% smaller). After 10 weeks, there was a significant improvement in the capacity of bacterial phagocytosis by neutrophils (+16 vs. +15%, respectively, for HIIT and MICT) and monocytes (14 vs. 19%, respectively, for HIIT and MICT) for both training groups. Also with a more recent perspective, Born et al. (2017) demonstrated that HIIT, in addition to the superior adaptive responses on the ability to perform exercise (time to

TABLE 4 | Main positive and negative results from the perspective of HIIT and the changes resulting from this training model.

Durrer et al. (2017)	
Objective:	To determine the impact of a single session of HIIT on cellular, molecular, and circulating markers of inflammation in individuals with Type 2 Diabetes (T2D)
Participants:	Participants with T2D ($n = 10$) and healthy (HC) age-matched controls (HC; $n = 9$)
Intervention:	Acute bout of HIIT (7 × 1-min at 85% maximal aerobic power output), separated by 1-min recovery on a cycle ergometer
Measures:	Blood samples Pre, Post, and 1-h Post. Inflammatory markers on leukocytes and tumor necrosis factor (TNF)-α
Outcome:	(a) significantly ↓ levels of toll-like receptor (TLR); expression on both classical and $CD16^{+}$ monocytes assessed at Post and 1-h Post compared with Pre; (b) significantly ↓ LPS-stimulated TNF-α release in cultures at 1-h Post; (c) significantly lower levels of plasma TNF-α at 1-h Post. There were no differences between T2D and HC except for a larger decrease in plasma TNF-α in HC vs. T2D
Bartlett et al. (2018)	
Objective:	Determine whether 10 weeks of a walking-based HIIT program would be associated with health improvements. Assess whether HIIT was associated with improved immune function, specifically antimicrobial/bacterial functions of neutrophils and monocytes
Participants:	Twelve physically inactive adults
Intervention:	3 × 30-min sessions/week of 10 ≥ 60-s intervals of high intensity (80–90% $VO_{2reserve}$), and rest of 50–60% $VO_{2reserve}$
Measures:	Pre- and post-aerobic and physical function; self-perceived health; C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR); plasma interleukin (IL)-1β, IL-6, chemokine (C-X-C motif) ligand (CXCL)-8, IL-10, and tumor necrosis factor (TNF)-α concentrations; and neutrophil and monocyte phenotypes and functions
Outcome:	VO_{2max} ↑9%; Neutrophil migration toward CXCL-8, phagocytosis of Escherichia coli, and ROS production all increased following training. The frequency of differentiation 14-positive ($CD14^{+}$)/$CD16^{+}$ monocytes was reduced, with both non-classical ($CD14^{dim}$/$CD16^{bright}$) and intermediate ($CD14^{bright}$/$CD16^{positive}$) monocytes being reduced; Expression of Toll-like receptor 2 (TLR2), TLR4, and HLA-DR was reduced and monocyte phagocytosis of E. coli increased
Bartlett et al. (2017)	
Objective:	Compared the impact of HIIT and moderate-intensity continuous training (MICT) on immune function in sedentary adults
Participants:	Twenty-seven healthy sedentary adults
Intervention:	HIIT (>90% maximum heart rate) or MICT (70% maximum heart rate) group training program
Measures:	VO_{2peak}, neutrophil and monocyte bacterial phagocytosis and oxidative burst, cell surface receptor expression, and systemic inflammation were measured before and after the training
Outcome:	Total exercise time was 57% less for HIIT; Significantly improved VO_{2peak} for both; Oxidative burst and monocyte phagocytosis and percentage of monocytes producing an oxidative burst were ↑ by training similarly; Expression of monocyte but not neutrophil CD16, TLR2, and TLR4 was ↓ by training similarly in both groups; No differences in systemic inflammation were observed for training
Khammassi et al. (2020)	
Objective:	Compare the effects of HIIT and moderate-intensity continuous training (MCT) on hematological biomarkers in active young men (9 weeks/3 training per week)
Participants:	Sixteen men aged 18–20 years were randomly assigned to HIIT or MCT group
Intervention:	HIIT: (30 s at 100% of maximum aerobic velocity/30 s rest at 50%); MCT sessions were matched for workload based on the total distance in HIIT
Measures:	VO_{2max}; red blood cell, hemoglobin, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, leukocyte, neutrophil, lymphocyte, monocyte, and eosinophil count
Outcome:	No significant change was observed in maximal aerobic velocity and estimated VO_{2max} in both groups; Leukocyte, lymphocyte, neutrophil, and monocyte count showed significant improvements in response to the MCT; The MCT intervention favored an increase in the number of immune cells
Jamurtas et al. (2018)	
Objective:	Evaluated the effects of HIIT on hematological profile and redox status compared with those following traditional continuous aerobic exercise (CET)
Participants:	Twelve healthy young men participated in a randomized crossover design under HIIT and CET
Intervention:	HIIT: 4x 30-s sprints on a cycle-ergometer/4 min of recovery. CET: 30-min cycling on a cycle ergometer at 70% of their VO_{2max}
Measures:	Blood was measured at baseline, immediately after, 24, 48, and 72 h post-exercise and was analyzed for complete blood count and redox status (thiobarbituric acid reactive substances, [TBARS]; protein carbonyls, [PC]; antioxidant capacity total, [TAC]; catalase and uric acid)
Outcome:	White cells ↑ immediately post-exercise (HIIT: 50% and CET: 31%, respectively); HIIT ↑ +22% PC post-exercise compared to CET; HIIT ↑ +16% TAC immediately post-exercise and at 24 h post-exercise (11%), while CET ↑ TAC only post-exercise (12%, $p < 0.05$); Both HIIT and CET ↑ uric acid immediately post- (21 and 5%, respectively) and 24 h (27 and 5%, respectively); There were no significant changes for TBARS and catalase following either exercise protocol
Born et al. (2017)	
Objective:	Evaluate the mucosal immune function and circadian variation of salivary cortisol, Immunoglobin-A (sIgA) secretion rate and mood during a period of high-intensity interval training (HIIT) compared to long-slow distance training (LSD)
Participants:	28 Recreational male runners
Intervention:	9 sessions (3 weeks); HIIT: 4 × 4 min of running at 90–95% of max HR/3 min rest; LSD: continuous running at 70–75% of max HR for 60–80 min

(Continued)

TABLE 4 | Continued

Measures:	Salivary cortisol and immunoglobin-A (sIgA); VO_{2Peak} and Performance
Outcome:	HIIT = longer time-to-exhaustion and ↑VO_{2peak} compared to LSD, sIgA secretion rate was higher on the last day of training, as well as the area under the curve (AUCG) higher on the first and last day of training and follow-up compared to the LSD. The AUCG for cortisol remained unaffected on the first and last day of training but increased on the follow-up day with both, HIIT and LSD. sIgA secretion rate with the HIIT indicates no compromised mucosal immune function
Bartlett et al. (2020)	
Objective:	Determine if neutrophil functions could be improved in association with changes in fitness and metabolic parameters in older adults at risk for Type 2 Diabetes Mellitus using 10-weeks of low volume high-intensity interval exercise training (HIIT)
Participants:	Ten older sedentary adults with prediabetes completed 10 weeks of a supervised HIIT program
Intervention:	10x 60 s intervals at 80–90% Heart rate reserve/50–60% HRR rest
Measures:	Before and after training, VO_{2peak}, glucose and insulin sensitivity, neutrophil chemotaxis, bacterial phagocytosis, reactive oxygen species (ROS) production, and mitochondrial functions were assessed (VO_{2peak} and neutrophil functions were compared to six young (23 ± 1 years) healthy adults)
Outcome:	Significant ↓ in fasting glucose and insulin were accompanied by ↑ glucose control and insulin sensitivity; VO_{2Peak} ↑ 16 ± 11%; Following training, chemotaxis phagocytosis and stimulated ROS ↑ while basal ROS ↓ similar to levels observed in the young controls; mitochondrial functions ↑ toward those observed in young controls, ↓ the deficit of the young controls between
Dorneles et al. (2019)	
Objective:	To verify the effect of 1 week of high-intensity interval training (HIIT) on the peripheral frequency of T helper subsets and monocyte subtypes
Participants:	Seven sedentary obese men
Intervention:	One week of HIIT (3×/week)−10 bouts of 60 s (85–90%HR_{max}) alternated with 75 s of recovery (50%HR_{max})
Measures:	Blood samples before and 24 h after the last session for phenotypic analysis of T cells and monocytes
Outcome:	After 1 week of HIIT, an ↑ in VO_{2Peak}. Short-term HIIT ↑ Treg ($CD4^+$ $CD25^{high}$ $CD127^{low}$); and mTreg cells ($CD4^+$ $CD25^+$ $CD39^+$); No statistical difference was observed in other immune cell phenotypes analyzed
Steckling et al. (2019)	
Objective:	Effects of HIIT on systemic levels of inflammatory and hormonal markers in postmenopausal women with metabolic syndrome (MS)
Participants:	Fifteen postmenopausal women with MS
Intervention:	Treadmill running 3× per week, for 12 weeks. 4× 4 min intervals at 90% HR_{max}, with 3 min active recovery at 70% HR_{max}
Measures:	Body composition, VO_{2max}, serum plasma levels of cytokines (levels of IL-1b, IL-6, IL10, IL-18, TNF-a, interferon-gamma—IFN-c), nitrate and nitrite (NOx) levels, and adiponectin, resistin, leptin, and ghrelin were determined along the intervention
Outcome:	VO_{2max} and anthropometric parameters were ↑ after HIIT, while ↓ levels of proinflammatory markers and ↑ levels of interleukin-10 (IL-10) were also found. Adipokines were also modulated after 12 weeks or training. The mRNA expression of the studied genes was unchanged after HIIT
Kaspar et al. (2016)	
Objective:	To compare effect of single-bout endurance (ET) and HIIT on the plasma levels of 4 inflammatory cytokines and C-reactive protein and insulin-like growth factor
Participants:	Seven healthy untrained volunteers
Intervention:	HIIT: 6 sets of 30 s of all-out supramaximal intensity cycling; ET: 45 min of ergometer cycling at a moderate intensity, which was calculated at 62.5% of Max HR
Measures:	Plasma samples for the interleukins (IL), IL-1β, IL-6, and IL-10, monocyte protein-1 (MCP-1), insulin growth factor 1 (IGF-1), and C-reactive protein (CRP)
Outcome:	ET: significant acute and long-term inflammatory response with ↓ decrease at 30 min after exercise in the IL-6/IL-10 ratio (−20%) and a ↓ of MCP-1 (−17.9%); There were no significant changes in the plasma levels of CRP, IL-1, and IGF-1 from baseline to either 30 min or 2 days after the intervention

exhaustion—$p = 0.02$; VO_{2Max}–$p = 0.01$), induced functional immunoglobin-A adaptations following 4 days of training in recreational adult runners. Furthermore, HIIT promotes similar inflammatory responses after exercise compared to traditional endurance training, suggesting its viability as a training strategy (Kaspar et al., 2016; Bartlett et al., 2017). However, an adequate progression of intensity is suggested to avoid deleterious effects due to high doses of exercise. In the workout model recommended here, despite the fact that it is called high-intensity interval exercise, the effective physiological impact (product of volume vs. intensity) is reasonably small (main workout). Moreover, such proposals mainly focus on recreational trained people. In line with this, several studies have shown significant findings in favor of HIIT protocols when compared to moderate-intensity exercise, showing how the immunological system responds to vigorous to high-intensity training with very short duration (**Table 4**).

FUTURE PERSPECTIVES

It is reasonable to think that HIIT can also be adjusted to improve physical fitness and health in individuals with low levels of fitness (Gormley et al., 2008), as well as for overweight and obese people, according to the trend facing this pandemic (Wewege et al., 2017). First, it is important to understand that the term high intensity should not necessarily be interpreted as a high effort (that would generate limiting condition), since the effort depends on the ratio between intensity and time. In the case of protocols with neuromuscular characteristics, it is possible to establish a suitable threshold for each fitness pattern, mainly controlling the pace with which the movements are performed or the time spent in each stimulus. For cyclic aerobic exercise, the external load, related to the percentage level of VO_{2Max} required by the coach, is in high physical demand, while the internal load, referring to internal perceptions and changes, can modulate a perceived effort to tolerable levels (Foster et al., 2001). Thus, considering the non-prolonged exposure to high-intensity stimuli, we were able to produce significant results for the cardiorespiratory component (Buchheit and Laursen, 2013), as well as important functional adaptations to the immune system (Bartlett et al., 2017), and promote greater adherence to exercise by individuals with a lower level of fitness (Hartman et al., 2019). Therefore, HIIT is expected to be recognized from a safe and effective dose–response perspective (Taylor et al., 2019) as a potential tool for the improvement of the immune system and consequently for the prevention of respiratory diseases.

AUTHOR CONTRIBUTIONS

AS participated in the conception of the idea and complete writing of the article, along with SB, CdP, and TM. SM, DT, DM, LC, and CI participated in numerous reviews of this study. CI, TY, and SA participated in the suggestions and the final writing of the article and the adequacy and submission of the study. HB, EM-R, and SM were the main advisers and tutors of all trajectory of studies and designing all phases of the study. All authors contributed to the article and approved the submitted version.

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Mood Responses Associated With COVID-19 Restrictions

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The COVID-19 pandemic resulted in more than half the world's population being placed in lockdown to stem the spread of the virus. The severe restrictions imposed in many nations had the potential to significantly influence the physical and psychological well-being of those affected. The aim of the current study was to investigate mood responses during the period of restrictions from March to June, 2020. Mood responses of 1,062 participants (386 male, 676 female) were collected using the Brunel Mood Scale, hosted on the *In The Mood* website www.moodprofiling.com. The mean pattern of mood responses reflected an inverse iceberg profile, characterized by significantly elevated scores for tension, depression, anger, fatigue, and confusion, and below average scores for vigor; a profile associated with increased risk of mental health issues. Females reported more negative mood scores than males. Participants in the ≤25 age group reported the most negative profiles whereas those in the ≥56 age group reported the least negative profiles. Mood differences related to education status were also evident. Finally, mood scores fluctuated over time, with profiles being most negative during April and June. Overall, results confirmed significant mood disturbance during the period of COVID-19 restrictions, representing increased risk of psychopathology.

Keywords: affect, emotion, COVID-19, pandemic, mood profiling, BRUMS

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INTRODUCTION

On the 30th January 2020, the World Health Organisation (WHO) declared the novel coronavirus 2019-nCoV (COVID-19) to be a "public health emergency of international concern" (World Health Organization, 2020a, p. 1)[1]. By the end of September 2020, COVID-19 had been contracted by over 35 million people globally and had caused more than 1 million deaths (Centre for Systems Science and Engineering, 2020)[2]. To interrupt the flow of transmission, significant restrictions were introduced, impinging on a large proportion of the world's population. International traffic was affected, with many countries closing national borders and introducing overseas travel bans. Citizens were required to reduce daily contact and remain indoors for extended periods,

[1]https://www.who.int/news-room/articles-detail/updated-who-recommendations-for-international-traffic-in-relation-to-covid-19-outbreak
[2]https://coronavirus.jhu.edu/map.html

colloquially referred to as "lockdown" (Hale et al., 2020), many small businesses were forced to close, financial markets retreated, and unemployment soared (Pak et al., 2020).

Given the unprecedented consequences of this global health crisis, investigating the effects of such wide-ranging restrictions on indicators of mental health is critically important. COVID-19 and other strains of coronavirus have been shown to inflict adverse mental health effects, not only on those who contract the disease (Rogers et al., 2020), but also on those placed in precautionary quarantine (Brooks et al., 2020), on health caregivers (Pappa et al., 2020), and on individuals whose daily lives are severely impacted (Ammar et al., 2020c).

A meta-analysis of 65 independent studies (Rogers et al., 2020) showed that individuals who had contracted but recovered from a severe coronavirus infection, including Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS), were susceptible to mental health issues in the longer-term, including depression, anxiety, fatigue, and post-traumatic stress disorder (PTSD), sometimes years after being discharged from hospital. Moreover, an investigation of psychiatric complications among COVID-19 patients confirmed that the effects of the disease extend beyond respiratory issues in many cases, prompting a range of adverse cerebral events that include psychosis and affective disorders (Varatharaj et al., 2020).

A review of 24 studies investigating the psychological impact of being in quarantine (Brooks et al., 2020) also identified several negative effects, including PTSD symptoms, confusion, and anger. Fear, frustration, and boredom were among the stressors listed as contributing to mental health issues. Several predictions of a looming mental health crisis associated with COVID-19 have been promulgated (e.g., Pfefferbaum and North, 2020), along with a range of publications outlining the likely psychosocial effects of the pandemic with accompanying advice on how to manage mental health (e.g., World Health Organization, 2020b)[3]. A large-scale investigation of the psychosocial impacts of home confinement, involving 35 research organizations globally, identified significantly decreased life satisfaction associated with dramatic reductions in social participation through family, friends, and entertainment (Ammar et al., 2020b).

A systematic review and meta-analysis of 13 studies conducted since the COVID-19 pandemic commenced, covering a combined total of 33,062 healthcare workers (Pappa et al., 2020), found the prevalence of mental health issues, particularly depression and anxiety, to be significantly elevated compared to population norms, especially among females. Further, a multicenter study of the emotional consequences of COVID-19 lockdown, involving 35 research organizations globally, reported reduced overall mental well-being and increased depressive symptoms triggered by enforced home confinement (Ammar et al., 2020c). Moreover, a national survey of 13,829 respondents in Australia during the first month of COVID-19 restrictions (Fisher et al., 2020) concluded that mental health problems were at least twice as prevalent as in non-pandemic circumstances.

The effects of COVID-19 on the mood responses of individuals is an important indicator of how well society is coping with the pandemic. The YouGov website in the United Kingdom provides a weekly assessment of the mood of the nation, which showed that the percentage of those reporting feeling "happy" had plummeted from 50% in early March 2020 to 26% a month later, whereas those feeling "scared" had risen from a norm of 11 to 34%, feeling "bored" from 19 to 34%, and feeling "stressed" from 41 to 48% (YouGov, 2020)[4]. These data offer clear signs that the collective mood of the country deteriorated once lockdown measures were introduced into the United Kingdom.

Using a similar research paradigm to the YouGov approach, our study focused on assessing the mood responses of individuals during the period when movement and gathering restrictions were in place, and comparing the observed mood scores with well-established normative values developed prior to the COVID-19 outbreak (Terry et al., 1999, 2003a; Terry and Lane, 2010). For the purpose of our investigation, mood is defined as "a set of feelings, ephemeral in nature, varying in intensity and duration, and usually involving more than one emotion" (Lane and Terry, 2000, p. 17).

Several distinct mood profiles have been identified, based on the Profile of Mood States (McNair et al., 1971) or derivative measures, such as the Brunel Mood Scale (Terry et al., 1999, 2003a). For example, Morgan (1985) proposed that the *iceberg* profile, a pattern of mood responses characterized by above average scores for vigor and below average scores for tension, depression, anger, fatigue, and confusion, was associated with psychological well-being, whereas negative moods are associated with increased risk of psychopathology. Subsequently, Morgan et al. (1987) and others have highlighted the *inverse iceberg* mood profile, characterized by above average scores for tension, depression, anger, fatigue, and confusion, and below average scores for vigor, as indicative of increased risk of a range of pathologies, including chronic fatigue, overtraining syndrome, PTSD, and eating disorders (e.g., Budgett, 1998; Terry and Galambos, 2004; van Wijk et al., 2013).

More recent studies (Parsons-Smith et al., 2017; Quartiroli et al., 2018; Han et al., 2020) have identified new profiles, referred to as the *inverse Everest*, *shark fin*, *submerged,* and *surface* profiles. The inverse Everest profile is characterized by low vigor scores, high scores for tension and fatigue, and very high scores for depression, anger, and confusion. The shark fin profile is characterized by below average scores for tension, depression, anger, vigor, and confusion, combined with a high score for fatigue. The submerged profile is characterized by below average scores for all six mood dimensions. The surface profile is characterized by average scores for all six mood dimensions. In the present study, it was hypothesized that during the period of COVID-19-related restrictions there would be increased prevalence of inverse iceberg and inverse Everest profiles and decreased prevalence of iceberg and submerged profiles.

[3]https://www.who.int/docs/default-source/coronaviruse/mental-health-considerations.pdf?sfvrsn=6d3578af_10

[4]https://yougov.co.uk/topics/science/trackers/britains-mood-measured-weekly

TABLE 1 | Sample demographics (*N* = 1,062).

Source	*n*	%
Sex		
Male	386	36.3
Female	676	63.7
Age band (years)		
≤25	243	22.9
26–35	263	24.8
36–45	232	21.8
46–55	167	15.7
≥56	157	14.8
Ethnicity		
African	16	1.5
Asian	87	8.2
Caucasian	853	80.3
Indigenous	18	1.7
Middle Eastern	19	1.8
Other	69	6.5
Education level		
≤High school graduate	238	22.4
TAFE[1]/Trade qualification	197	18.5
University qualification	316	29.8
Postgraduate qualification	311	29.3

[1] *TAFE, Technical and Further Education.*

MATERIALS AND METHODS

Participants

A total of 1,062 individuals participated in an online study. A range of age bands, ethnicities, and education levels were represented (see **Table 1**). Age bands were represented relatively evenly, but sex (64% female), ethnicity (80% Caucasian), and education level (59% university educated) were unevenly distributed.

Measures

Participants reported relevant demographic information (sex, age band, ethnicity, education level) and completed the Brunel Mood Scale (BRUMS; Terry et al., 1999, 2003a). The BRUMS is a 24-item scale of basic mood descriptors, with a standard response timeframe of "How do you feel right now?" Participants rated their moods on a five-point Likert scale (0 = *not at all*, 1 = *a little*, 2 = *moderately*, 3 = *quite a bit*, and 4 = *extremely*). The BRUMS has six subscales (i.e., anger, confusion, depression, fatigue, tension, and vigor) each with four items. Total subscale scores range from 0 to 16. Raw scores are transformed into standard scores with reference to established tables of normative data (see Terry et al., 2003a). The BRUMS has been validated across diverse cultures (e.g., Terry et al., 2003b; Zhang et al., 2014; Han et al., 2020) and situational contexts (e.g., van Wijk et al., 2013; Sties et al., 2014). Good internal consistency has been demonstrated for the six subscales, with Cronbach alpha coefficients ranging from 0.74 to 0.90 (Terry et al., 1999).

Procedure

All data were collected via the *In The Mood* website (Terry et al., 2013). The BRUMS takes approximately 2 min to complete. The website database has almost 28,000 completed BRUMS profiles. Data collected during the current study were compared with established norms. The study was conducted in accordance with the Australian Code for the Responsible Conduct of Research. The protocol was approved by the Human Research Ethics Committee at the University of Southern Queensland (approval number: H19REA100).

Data Screening

As the website does not allow participants to submit the BRUMS for scoring unless all items have been answered, there were no missing values. Consistent with previous samples (e.g., Parsons-Smith et al., 2017; Quartiroli et al., 2018), univariate non-normality was evident for some subscales (e.g., depression, anger, and tension). As is typical of mood measures, negative scores tended toward higher numbers at the lower end of the scoring range, and lower numbers at the upper end (Terry et al., 1999, 2003a). Frequency distributions for skewness and kurtosis were examined and it was concluded that deviations from normal distribution were unlikely to make a substantive difference to the analyses, thus no data were removed. Using the Mahalanobis distance test ($p < 0.001$), a total of 13 multivariate outliers were identified, although a case-by-case inspection found no examples of response bias in the form of acquiescent, extreme, or straight line responding (Meisenberg and Williams, 2008; Leiner, 2019). Hence, all outliers were retained in the sample of 1,062 respondents.

RESULTS

Mean Mood Profile During COVID-19 Restrictions

The full range of raw scores (0–16) was observed for all six subscales. Once the raw scores were transformed into standard scores (T-scores), the mean mood profile of the whole sample, when plotted against relevant norms, represented an inverse iceberg profile (see **Figure 1**). The observed mean scores for all mood dimensions were significantly different from the normative mean score of 50 ($p < 0.001$; see **Table 2**). Effect sizes were small for tension scores ($d = 0.28$) and moderate-to-large for depression, anger, vigor, fatigue, and confusion scores ($d = 0.54$–0.70).

Cluster Analysis

A seeded k-means cluster analysis with a prescribed six-cluster solution clearly identified the same six mood profiles previously reported in the literature (e.g., Parsons-Smith et al., 2017; see **Figure 2**). However, although the profiles were identical to those found in previous investigations, their prevalence was markedly different. Prevalence of the shark fin profile (12.9%) and surface profile (17.3%) was consistent with previous studies (∼15.1 [range = 13.0–17.3%] and ∼17.0 [range = 14.8–21%],

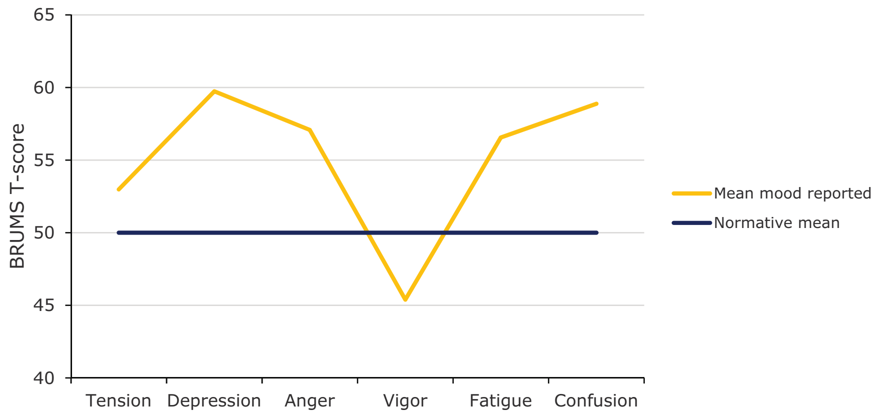

FIGURE 1 | Mean mood profile reported during COVID-19 restrictions (N = 1,062).

respectively). However, as hypothesized, there were significantly fewer iceberg profiles (20.2 vs. ~27.6% [range = 23.3–30.0%]) and submerged profiles reported (16.2 vs. ~24.8% [range = 18.0–31.4%]). Most notably, and again as hypothesized, the inverse iceberg was the most commonly reported profile in the present investigation (21.2 vs. ~11.9% [range = 9.3–14.0%]) and the inverse Everest profile was reported by 12.2% of participants compared to the typical ~3.8% (range = 2.4–5.0%; Han et al., 2020; Parsons-Smith et al., 2017; Quartiroli et al., 2018; Terry and Parsons-Smith, 2019). Both the inverse iceberg and inverse Everest profiles reflect increased risk of psychopathology (e.g., Terry and Galambos, 2004; van Wijk et al., 2013).

Demographic Influences on Mood Responses

Single-factor MANOVAs were used to investigate the influence of sex, age band, level of education, and month on mood responses and univariate analyses were used to identify significant between-group differences. Ethnicity was excluded from analyses due to unequal sample sizes (Tabachnick and Fidell, 2019). Significant multivariate variability at $p < 0.001$ was found for each variable analyzed (see **Table 3**).

Univariate differences were assessed using a Bonferroni-adjusted alpha level of $p < 0.008$. Females reported higher scores for tension, depression, fatigue, and confusion, and lower scores for vigor, compared with males. Those aged ≤25 years reported higher scores for tension and confusion compared with those aged from 46 to 55 years. Participants in the ≥56 category scored lower for tension, depression, anger, fatigue, and confusion compared with the ≤25 and 26–35 age bands, as well as lower scores for anger and fatigue compared with individuals aged 36–45 years. For education, participants with a TAFE/trade qualification scored higher for depression and fatigue compared with those with a postgraduate qualification, and lower for vigor in comparison to individuals with either a university or postgraduate level of education. In terms of trends over time, participants scored lower for depression and fatigue in March compared with April and June. Lower vigor and higher fatigue scores were reported in April compared with May. Higher anger scores were reported in June compared with March and May.

TABLE 2 | Comparison of mean BRUMS scores vs. norms (N = 1,062).

Mood dimension	*M*	*SD*	Range	*t*	*d*
Tension	52.98	10.80	[40–83]	8.99†	0.28
Depression	59.74	14.83	[44–106]	21.40†	0.66
Anger	57.08	12.21	[45–98]	18.90†	0.58
Vigor	45.39	8.47	[31–71]	17.74†	0.54
Fatigue	56.56	10.55	[40–79]	20.26†	0.62
Confusion	58.88	12.76	[43–99]	22.68†	0.70

t, t-test for difference between observed mean and normative mean of 50; d, effect size; †p < 0.001.

Distribution of Mood Profiles by Demographic Variable

Chi-squared tests were used to assess the distribution of mood profile clusters by demographic variables of interest. Significant associations between the six mood profiles and sex, age group, and education level were found (see **Table 4**). Adjusted residuals were assessed against the critical values of ±1.96, ±2.58, and ±3.29 (Field, 2009) to identify the source of differences.

Sex

The distribution of mood profiles varied significantly by sex, with males generally reporting more positive profiles. Males were over-represented in the iceberg profile whereas females were over-represented in the shark fin profile, consistent with previous studies (Parsons-Smith et al., 2017; Quartiroli et al., 2018; Han et al., 2020). Males were over-represented in the surface profile compared with females, consistent with Han et al. (2020). Although females reported a higher prevalence of inverse iceberg profiles, the distribution did not vary significantly, mirroring the findings of Quartiroli et al. (2018). The distributions of the inverse Everest and submerged profiles were independent of sex.

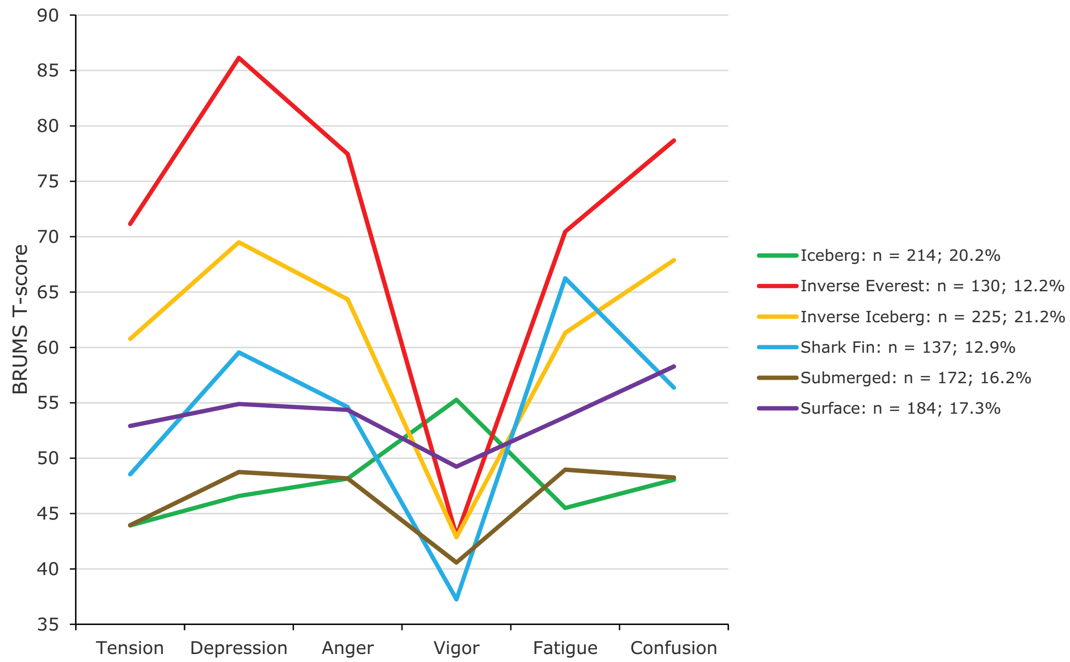

FIGURE 2 | Prevalence of mood profile clusters (N = 1,062).

TABLE 3 | MANOVA of BRUMS subscales by demographic variables.

	Tension		Depression		Anger		Vigor		Fatigue		Confusion	
Source	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
Sex [T^2 = 0.13, F(6,1055) = 23.04†]												
Male (n = 386)	$51.27^{\dagger}$	10.08	58.02^{*}	14.13	57.91	12.72	$48.46^{\dagger}$	8.09	$54.05^{\dagger}$	9.05	$57.23^{\dagger}$	12.24
Female (n = 676)	53.96	11.08	60.72	15.13	56.61	11.89	43.63	8.19	58.00	10.85	59.82	12.97
Age band [T^2 = 0.08, F(24,4202) = 3.60†]												
≤25 years^{a} (n = 243)	$55.24^{\dagger e}$	11.87	$62.03^{\dagger e}$	15.50	57.80^{*e}	12.05	45.65	7.99	$58.63^{\dagger e}$	10.39	$62.27^{\dagger de}$	13.36
26–35 years^{b} (n = 263)	$54.04^{\dagger e}$	10.74	60.94^{*e}	15.34	57.96^{*e}	13.06	45.08	8.94	$57.27^{\dagger e}$	10.60	$59.90^{\dagger e}$	12.84
36–45 years^{c} (n = 232)	53.06	10.15	60.09	14.15	$58.42^{\dagger e}$	12.07	44.48	8.54	$57.68^{\dagger e}$	10.66	58.80	12.08
46–55 years^{d} (n = 167)	51.25^{*a}	10.51	58.05	14.94	56.19	13.28	45.24	8.39	55.22	10.34	56.50	12.57
≥56 years^{e} (n = 157)	49.44	9.20	55.46	12.69	53.46	8.94	46.99	8.23	51.95	9.25	54.57	11.21
Education level [T^2 = 0.05, F(18,3155) = 2.92†]												
≤High school^{a} (n = 238)	52.86	10.94	60.72	14.96	57.48	12.28	44.69	8.29	57.06	10.63	58.96	12.33
TAFE^{1}/Trade^{b} (n = 197)	53.88	11.59	61.82^{*d}	15.41	58.06	12.36	43.24^{*c}	7.86	$59.49^{\dagger d}$	11.45	60.50	12.99
University^{c} (n = 316)	53.36	10.85	60.07	15.10	57.06	12.58	45.80	8.28	56.61	10.45	59.67	13.58
Postgraduate^{d} (n = 311)	52.12	10.07	57.33	13.79	56.17	11.66	$46.86^{\dagger b}$	8.88	54.28	9.46	56.99	11.89
Month [T^2 = 0.06, F(18,3155) = 3.65†]												
March 2020^{a} (n = 33)	51.45	8.34	$50.67^{\dagger bd}$	10.13	51.36	8.03	48.24	7.55	$49.61^{\dagger bd}$	8.20	54.82	9.29
April 2020^{b} (n = 633)	53.23	10.99	60.50	15.12	57.14	12.05	$44.66^{\dagger c}$	8.19	57.26^{*c}	10.69	59.23	13.07
May 2020^{c} (n = 185)	51.63	10.14	56.82	13.67	54.83	11.07	47.54	9.45	54.42	9.79	56.52	11.95
June 2020^{d} (n = 211)	53.65	11.06	61.44	14.77	$59.76^{\dagger ac}$	13.48	45.22	8.20	57.45	10.48	60.52	12.65

T^2, Hotelling's T-squared; $^{\dagger}p < 0.001$; $^{*}p < 0.008$; [1]TAFE, Technical and Further Education. Superscript letters a–e are used to indicate sub-group differences.

Age Band

A general trend of mood profiles being more positive among older age groups was evident, largely consistent with previous age group comparisons (Parsons-Smith et al., 2017; Quartiroli et al., 2018). Younger participants (≤25 years, 26–35 years) were under-represented and older participants (≥56 years) over-represented in the iceberg profile. Younger participants (≤25 years) were over-represented and older participants (≥56 years) under-represented in the inverse Everest profile. Participants aged 36–45 years were over-represented in the

TABLE 4 | Distribution of clusters by demographic variables.

Source	Cluster 1	%	2	%	3	%	4	%	5	%	6	%
Sex [χ^2(5,1062) = 52.07†]												
Male (*n* = 386)	$111^{\dagger+}$	28.8	38	9.8	71	18.4	$27^{\dagger-}$	7.0	55	14.2	$84^{\S+}$	21.8
Female (*n* = 676)	$103^{\dagger-}$	15.2	92	13.6	154	22.8	$110^{\dagger+}$	16.3	117	17.3	$100^{\S-}$	14.8
Age band [χ^2(20,1062) = 80.13†]												
≤25 years (*n* = 243)	$31^{\dagger-}$	12.8	39^{*+}	16.0	52	21.4	36	14.8	27^{*-}	11.1	$58^{\S+}$	23.9
26-35 years (*n* = 263)	41^{*-}	15.6	37	14.1	58	22.1	35	13.3	43	16.3	49	18.6
36-45 years (*n* = 232)	39	16.8	30	12.9	61^{*+}	26.3	28	12.1	40	17.2	34	14.7
46-55 years (*n* = 167)	41	24.6	15	9.0	31	18.6	21	12.6	$39^{\S+}$	23.4	20	12.0
≥56 years (*n* = 157)	$62^{\dagger+}$	39.5	$9^{\S-}$	5.7	23^{*-}	14.6	17	10.8	23	14.6	23	14.6
Education level [χ^2(15,1062) = 28.99*]												
≤High school (*n* = 238)	43	18.1	32	13.4	51	21.4	36	15.1	41	17.2	35	14.7
TAFE[1]/Trade (*n* = 197)	29^{*-}	14.7	34^{*+}	17.3	41	20.8	32	16.2	31	15.7	30	15.2
University (*n* = 316)	56	17.7	36	11.4	73	23.1	35	11.1	52	16.5	64	20.3
Postgraduate (*n* = 311)	$86^{\dagger+}$	27.7	28^{*-}	9.0	60	19.3	34	10.9	48	15.4	55	17.7

1, Iceberg; 2, Inverse Everest; 3, Inverse Iceberg; 4, Shark Fin; 5, Submerged; 6, Surface; $^+$, over-represented, $^-$, under-represented; $^{\dagger}p < 0.001$; $^{\S}p < 0.01$; $^*p < 0.05$;
[1] TAFE, Technical and Further Education.

inverse iceberg profile, whereas those ≥56 years were under-represented. Individuals aged 46–55 years were over-represented in the submerged profile, whereas those ≤25 years were under-represented. The distribution for the shark fin profile was independent of age.

Level of Education

Participants with a TAFE/trade qualification were under-represented in the iceberg profile and over-represented in the inverse Everest profile. The reverse was true for those with a postgraduate level of education. Distributions for the inverse iceberg, shark fin, submerged, and surface profiles were independent of level of education.

DISCUSSION

The mean mood profile for the participant group collectively, compared to normative scores, was characterized by elevated tension, depression, anger, fatigue, and confusion, and reduced vigor. Significant mood disturbance was further reflected in the prevalence of mood profile clusters, when compared to prevalence rates reported in previous studies. For example, the inverse iceberg was reported by 21.2% of participants and the inverse Everest profile by 12.2% of participants, compared to the typical prevalence of 11.9% and 3.8%, respectively (Parsons-Smith et al., 2017; Quartiroli et al., 2018; Terry and Parsons-Smith, 2019; Han et al., 2020). This suggests that ∼33% of our sample were at increased risk of experiencing some form of clinically diagnosable mood-related disorder, whereas the global point prevalence of mood disorders based on the results of 148 studies is 5.4% (Steel et al., 2014). Our findings align with those of Fisher et al. (2020) who found that 25% of participants reported mild to moderate depressive symptomology during the first month of COVID-19 restrictions.

There are several plausible explanations for the observed increase in negative feeling states. The pandemic has undoubtedly caused fear and loss for many individuals; health fears for self and loved ones, fear of isolation, loss of income, social support, and a sense of normality, the list is extensive. The notion of disenfranchised grief (Doka, 2002) offers a potential explanation for the widespread mood disturbance evident among participants. Grief at the loss of someone or something dear to an individual is said to be disenfranchised when the grief is perceived to be unacknowledged or unworthy. During the pandemic, many individuals have lost livelihoods, relationships and opportunities, or been denied access to simple things that give them pleasure, such as physical contact with friends and family, a trip to the local café, or interacting with work colleagues. Although such losses can trigger a genuine grief response, knowledge of countless pandemic-related deaths may create a perceived obligation to minimize the outward expression of loss because others are in far worse circumstances. A reluctance or inability to share grief and loss with others may be associated with mood decrements and increased potential for psychopathology (Fisher et al., 2020).

Mood disturbance may also be explained by reduced physical activity and increased sedentary behaviors during COVID-19 restrictions. The antidepressant effect of exercise has a strong evidence base (Dunn et al., 2005; Siqueira et al., 2016) and exercise as a treatment for mood disorders is also well established (Hearing et al., 2016). The National Physical Activity Guidelines for Adults advocates a simple message of *moving more and sitting less*, with a recommendation to accumulate 150–300 min/week of moderate intensity physical activity or 75–150 min/week of vigorous exercise (Department of Health, 2019)[5]. Unfortunately, since COVID-19 restrictions have come into force, many people have been *moving less and sitting more*

[5] https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-strateg-phys-act-guidelines

(Ammar et al., 2020a). Moreover, reduced exercise duration during the pandemic has been associated with higher scores for depression, anxiety, and stress (Stanton et al., 2020). Encouragingly, some recently published papers have offered guidelines and practical recommendations for staying physically active during quarantine and/or self-isolation (e.g., Bentlage et al., 2020; Chtourou et al., 2020).

Trait characteristics may also play an important role in determining mood responses to COVID-19 restrictions. An Italian study conducted during the early stages of the pandemic in Europe (February–March, 2020) among a sample of 2,886 participants (Pagnini et al., 2020) showed that negative feeling states in response to movement restrictions were more common among those with greater cognitive rigidity and emotional instability.

Results of between-group comparisons identified similar findings to those reported previously. Compared to males, females reported significantly higher levels of tension, depression, fatigue, and confusion, together with lower levels of vigor, replicating the findings of Han et al. (2020). Research on the six mood profile clusters has consistently found an increased prevalence of the more negative mood profiles for females compared with males (Parsons-Smith et al., 2017; Quartiroli et al., 2018; Han et al., 2020), and the Australian Bureau of Statistics (2008)[6] notes that females are almost twice as likely as males to be affected by a mood disorder (8.4 vs. 4.3%).

Several explanations have been advanced to explain sex differences in mood responses. From a chronobiological perspective, there is evidence to support a sex-specific predisposition to depressive states. Many sub-threshold depressive symptoms, and indeed mood disorders, have been tentatively linked to dramatic hormonal fluctuations relating to reproductive-related events (e.g., menarche, menstruation, pregnancy, postpartum, menopause; Soares, 2013). Such "windows of vulnerability" (Soares, 2013, p. 677) are thought to predispose women to depressive symptoms via estrogen-serotonin interactions (Miller et al., 2002; Amin et al., 2005). Estrogen has been found to play an important mechanistic role in mood regulation (Halbreich and Kahn, 2001; Miller et al., 2002), although the specific pathophysiological pathways remain poorly understood (Soares, 2013). Other explanations are psychological in nature, including sex differences in ability to downregulate negative feeling states through the implementation of effective strategies (Nolen-Hoeksema, 1991, 2012), and a greater willingness among females to report mood disturbance (Bogner and Gallo, 2004).

Regarding age, it is evident globally that those in the 18–25 age group have been disproportionately affected materially by the pandemic, in terms of reduced employment and income (Belot et al., 2020). Logically, such detrimental effects would act as a catalyst for mood disturbance among younger individuals. However, nuanced differences in the adoption of effective emotion-regulation strategies may also underlie age-related variations in reported mood. Consistent with previous findings (Parsons-Smith et al., 2017; Quartiroli et al., 2018; Han et al., 2020), younger participants reported higher scores for tension, depression, anger, fatigue, and confusion compared with their older counterparts, and were more likely to report negative mood profiles, rather than the iceberg profile more frequently reported by those aged ≥56 years. Associations between maladaptive coping strategies and psychopathology symptom development have been reported (McLaughlin et al., 2011). Younger adults are more likely to utilize rumination, avoidance, and suppression, all of which are associated with poorer mental health outcomes (Aldao et al., 2010). Further, a reciprocal relationship exists between rumination and development of depression and anxiety symptomology (McLaughlin and Nolen-Hoeksema, 2011).

Given the saturation of negative COVID-19 information in the media, younger adults may find it difficult to employ cognitive distraction and avoidance strategies and more likely to engage in maladaptive emotion-regulation strategies, such as rumination and suppression of feelings. Conversely, adaptive strategies such as acceptance, reappraisal, and problem solving, which are associated with more positive outcomes, are techniques more often adopted by older adults (Aldao et al., 2010). Additionally, older adults are more likely to have built a repertoire of effective and flexible coping strategies from which to draw that may better suit challenging situations (Livingstone et al., 2020). Older adults may therefore be inclined to put COVID-19 restrictions into a broader and more manageable perspective. In general, active as opposed to passive emotion-focused strategies tend to be more adaptive and likely to be associated with reduced mood disturbance in the current climate.

In terms of level of education, participants with a postgraduate qualification reported lower scores for depression and fatigue and higher scores for vigor compared to those with a TAFE/trade qualification. These mean differences also translated into the postgraduate group being over-represented for the iceberg profile and under-represented for the inverse Everest profile, with the reverse being true for the TAFE/trade group. A clear link between education, income, and financial stress has been identified in the literature. In Australia, individuals with a doctoral degree are up to six times more likely to be in the top 10% of income earners, even after controlling for age, occupation, labor force status, and gender. Further, those with higher levels of education are more likely to be employed, and less likely to experience financial stress (Department of Education, Skills and Employment, 2020)[7].

Variations in mood scores were also evident over time. Participants scored lower for depression and fatigue in March compared with April and June. Lower vigor and higher fatigue scores were also reported in April compared with May. A study from India conducted during the early stages of the COVID-19 pandemic provided insights into the mood of the population derived from the emotional content of more than 86,000 Twitter posts (Venigalla et al., 2020). The emotional content of tweets varied according to specific trigger events, such as the introduction and extension of lockdown restrictions. The mood fluctuations over time evident in our study appear to similarly reflect an emotional rollercoaster among participants, triggered

[6] https://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4326.0Main+Features32007?OpenDocument

[7] https://docs.education.gov.au/collections/benefits-educational-attainment

by events such as the varying geographical spread and control of the virus, the dramatic economic fallouts, and the differential tightening and easing of restrictions.

Some limitations of our study are acknowledged. Online surveys require access to a computer with internet access and, in our case, fluency in English, which tends to reduce participation by those from lower socio-economic and marginalized groups, and non-English speakers. Further, the demographic characteristics of our sample showed an over-representation of females, Caucasians, and university-educated participants, which may limit the generalizability of the findings. It should also be noted that the BRUMS, as a brief measure of current mood, is not a diagnostic tool and hence, although our results may signal an increased risk of clinical psychopathology among participants, they could equally be seen in terms of challenging but essentially normal psychological adjustments to, in most people's experience, unprecedented societal restrictions.

In summary, evidence regarding the economic impact of COVID-19, suggests that females, younger people, and lesser educated, lower paid individuals are at "the epicenter of the crisis" (Gustafsson and McCurdy, 2020, p. 9). Our findings indicate that these same groups are also experiencing the greatest emotional burden, in terms of mood disturbance.

CONCLUSION

Clear evidence of elevated tension, depression, anger, fatigue, and confusion, and reduced vigor were identified, representing significant mood disturbance, and increasing the prospect of a forthcoming mental health crisis. An important implication of our findings is that urgent measures should be considered to ameliorate the negative impact of the COVID-19 pandemic on mental health.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Human Research Ethics Committee, University of Southern Queensland, Australia (approval number: H19REA100). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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Impact of COVID-19 Social Distancing Restrictions on Training Habits, Injury, and Care Seeking Behavior in Youth Long-Distance Runners

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Purpose: The COVID-19 pandemic impacted the sporting and exercise activities of millions of youth. Running is an activity that could be maintained while social distancing restrictions were implemented during the pandemic. If running-related injuries do occur, these restrictions may also influence the access to care or care seeking behavior of this population. Therefore, the purpose of this study was to determine if the social distancing restrictions during the 2020 COVID-19 pandemic influenced training habits, injury, and care seeking behavior in youth long-distance runners.

Methods: A customized, open online questionnaire was provided to runners 9–19 years of age who participated in long-distance running activities including team/club cross-country, track and field (distances $\geq$800 m), road races, or recreational running. Participants responded to questions about demographics, running habits, RRIs, and health care provider visits 6-months before as well as during social distancing restrictions due to COVID-19. Wilcoxon signed rank tests compared differences for ratio data and Chi-square tests were used to compare proportions before and during COVID-19 social distancing restrictions. Statistical significance was set at $p \leq 0.05$.

Results: A total of 287 youth long-distance runners (male = 124, female = 162, unspecified = 1; age = 15.3 ± 1.7 years; running experience = 5.0 ± 2.3 years) participated. Compared to their pre-COVID-19 responses, youth long-distance runners reported lower distances run per week ($p < 0.001$), fewer runs per week ($p < 0.001$), fewer hard runs per week ($p < 0.001$), fewer number of injuries ($p < 0.001$), and fewer injuries per 1,000 km ($p = 0.002$) during the COVID-19 social distancing restrictions. A lower proportion of participants reported in-person health care provider visits ($p < 0.001$) and a lower proportion of visits were made to an athletic trainer during COVID-19 social distancing restrictions compared to prior to COVID-19 ($p < 0.001$).

Conclusion: The COVID-19 pandemic resulted in significant decreases in both training and injuries which were different compared to previous reports in an adult population. Many of the runners who sustained an injury during COVID-19 social distancing restrictions did not seek care, with the most prominent reduction in visits to an athletic trainer. This could impact future injury and chronic pain.

Keywords: adolescent, track and field, cross-country, overuse, health care provider, athletic trainer

INTRODUCTION

On March 11th, 2020, the World Health Organization (WHO) declared Coronavirus Disease 2019 (COVID-19) a pandemic (World Health Organization, 2020). In response to the pandemic, and in an effort to minimize the rate of new infections, policies of social distancing and shelter in place became commonplace in many national, regional, and local locations. Schools at all levels canceled in-person classes, as well as extracurricular social and athletic activities. Non-essential businesses that offered a high risk of transmission like gyms and exercise facilities also closed. Millions of youth who are typically physically active through interscholastic or club sports were suddenly required to stay at home. Running is a mode of exercise that may be performed outside of facilities and with appropriate social distancing. Thus, while youth runners could have potentially maintained their pre-COVID-19 running habits, it is unknown if they maintained their running activities during the COVID-19 restrictions.

Partly due to its ease and accessibility, running is one of the most popular forms of physical activity in youth (Fakhouri et al., 2014). Track and field and cross-country constitute the first and sixth most popular high school sports (respectively) in the United States, totaling over 1.5 million combined participants (National Federation of State High School Associations, 2019).They also have the greatest number of participants in middle school athletics (Beachy and Rauh, 2014). While running provides benefits to both physical and mental health (Baghurst et al., 2015), high participation rates in running are concomitant with high rates of running-related injury (RRI). More than one out of every three high-school runners sustains a RRI during the course of a cross-country season (Rauh et al., 2006) and 59–68% of runners report a history of RRI (Tenforde et al., 2011). Given the cancelation of practices and competition seasons during the COVID-19 pandemic, it seems likely that injury risk would be impacted by reduced training volume. While the risk of RRI in adults appears to have been heightened during the COVID-19 social distancing restrictions (DeJong et al., 2020), to our knowledge, there are no reports on its impact in youth long-distance runners.

The most common type of injury in youth long-distance runners are overuse injuries (Tenforde et al., 2011). These injuries are often linked to excessive training volumes, higher training intensities, and other training-related errors (Tenforde et al., 2011). If not appropriately managed, many of these injuries have the potential to increase in chronicity. Therefore, access to healthcare providers and care seeking behavior are important considerations in youth long-distance runners. The closure of schools limited students' access to school-based athletic trainers, and due to the COVID-19 pandemic, many health care provider offices closed or transitioned to a telemedicine-based model (e.g., phone or video calls). While telehealth in sports medicine is feasible and patients have reported a positive experience during COVID-19 (Tenforde et al., 2020), it is unknown if youth long-distance runners have utilized telehealth to seek care for RRIs sustained during social distancing restrictions.

The purpose of this study was to determine if the social distancing restrictions during the 2020 COVID-19 pandemic influenced training habits, injury, and care seeking behavior in youth long-distance runners. We hypothesized that (1) self-reported weekly running distance, frequency, and intensity would decrease during restrictions, (2) social distancing restrictions would result in fewer injuries, and (3) injured long-distance runners would report more telehealth appointments and fewer in-person appointments with health care providers; athletic trainers would see the greatest reduction in health care encounters.

MATERIALS AND METHODS

Participants

Youth long-distance runners were recruited via emails sent to middle- and high-school athletic directors or coaches across the United States and previous participants in youth long-distance running studies from two institutions. Recruitment materials were initially sent May 2020 through June 2020 with a secondary invitation sent between 10 and 14 days after the initial invitation. The survey link was also shared on various social media platforms and others were encouraged to share the survey. Participants were eligible for study inclusion if they were 9–19 years of age and participated in long-distance running activities including team/club cross-country, track and field (distances ≥800 m), road races, or recreational running. Participants were excluded if their primary sport was not cross-country or track and field and they did not participate in long-distance running activities and/or if they resided outside of the United States. Study procedures were approved by the Institutional Review Boards at the University of Toledo and Cincinnati Children's Hospital Medical Center. Prior to study enrollment, consent was obtained for participants 18 or 19 years of age while parental permission and child assent were obtained for those 9–17 years-old. The participants received no incentives for participating.

Questionnaire

A customized, open online questionnaire was provided to the participants through a password-protected Qualtrics (SAP SE, Germany) or Research Electronic Data Capture (REDCap, Vanderbilt University, TN) instrument. The Checklist for Reporting Results of Internet E-Surveys (CHERRIES) was used to ensure study quality (Eysenbach, 2004). Questions were exactly the same for both instruments and institutions. The questionnaire required ∼10 min to complete and consisted of 83 items, split up among a minimum of 13 screens, related to demographics (age, sex, state, years of running experience, recreational/competitive runner), running habits, RRIs, and health care provider visits 6-months before as well as during social distancing restrictions due to COVID-19 (DeJong et al., 2020). Questions were presented in a consistent order with adaptive questioning dependent on participant responses. Participants were given as much time as necessary to complete the survey. Participants had the opportunity to review and change their responses prior to submitting them. Once the submission was made, no changes to their responses were allowed.

Running habits questions included self-reported average weekly running distance (miles), average number of runs per week, and average number of higher intensity runs per week (defined as heavy breathing, and difficulty talking while running) (Persinger et al., 2004). RRIs were assessed by asking participants if they had incurred or were presently experiencing a RRI (yes/no) during this time period, and if so, report the number of RRIs sustained. Injured runners were asked to complete a matrix with the body location (toe, foot, ankle, lower leg, knee, thigh, hip/pelvis, groin, abdomen, back, other) and injury type. Injury types included muscle injury (i.e., "pulled" muscle, muscle strain), tendon injury (i.e., tendonitis, tendon tear), bone injury (i.e., stress fracture, fracture), and ligament injury (i.e., sprain).

Participants who indicated that they had sustained an injury were presented with follow-up questions regarding their health care provider visit(s). Injured runners were asked about the type of health care visit they sought (in-person, telehealth, or no visit). Telehealth visits included remote video or audio calls. Respondents were also asked about the provider specialty that the participant visited for the injury (pediatrician, podiatrist, chiropractor, physical therapist, athletic trainer, sports medicine primary care physician, orthopedic surgeon, none, other).

Incomplete responses were excluded and completed surveys were used for analysis. The IP address was recorded for each response. If duplicate IP addresses were identified, the responses were checked for originality and responses from the same IP address were only used if the responses were clearly different. Weekly running distance was reported in miles and then converted to kilometers (km). The number of injuries for each person were normalized to 1,000 km to reduce the impact that running volume could have on the injury rate.

Statistical Analyses

Data analysis was conducted using SPSS statistical software (version 26, IBM Inc., Armonk, NY). Data were found to be non-normally distributed (Kolmogorov-Smirnov, $p \leq 0.05$). Wilcoxon signed rank tests compared differences before and during COVID-19 social distancing restrictions for distance run per week, number of runs per week, number of hard runs per week, number of injuries and number of injuries per 1,000 km. For participants that reported ≥1 RRI before and/or during COVID-19 social distancing restrictions, chi-square tests compared differences in proportions of health care providers and visit types before and during COVID-19 social distancing restrictions. Statistical significance was set at $p \leq 0.05$.

RESULTS

Of the 576 survey attempts, 287 (male = 124, female = 162, unspecified = 1; age = 15.3 ± 1.7 years; running experience = 5.0 ± 2.3 years) met inclusion criteria and were fully completed (completion rate = 49.8%; **Figure 1**). The majority of the excluded responses were due to being outside the age range of the current study. In total, 235 (81.9%) and 52 (18.1%) participants reported they were competitive and recreational runners, respectively. Participants resided in 20 different states with a majority coming from the Midwest United States (**Table 1**). Compared to their pre-COVID-19 responses, youth long-distance runners reported lower distances run per week (*p*

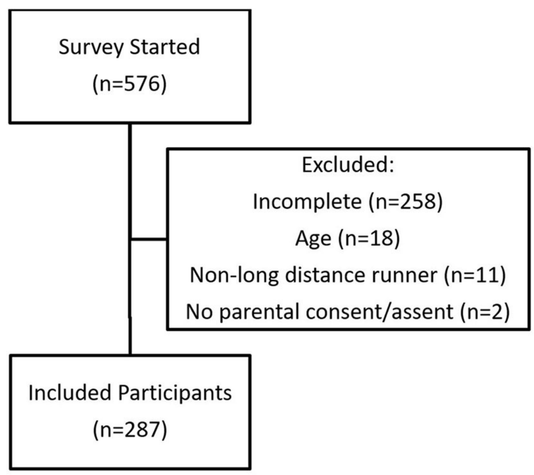

FIGURE 1 | Flow chart of study participants.

TABLE 1 | Number and percentage of completed responses by state.

State	*N*	Percent of responses
OH	82	28.6%
IL	43	15.0%
WI	41	14.3%
ID	18	6.3%
WA	17	5.9%
KY	17	5.9%
NC	16	5.6%
Other*	53	<5% each

*AR, AZ, CA, CT, KS, MN, NE, NV, NY, SC, TN, UT, WV.

TABLE 2 | Running habits and injury incidence before and during COVID-19 social distancing restrictions.

Variable	Median [25th, 75th percentile]		Mean [Standard deviation]		*P**
	Pre-COVID-19	During-COVID-19	Pre-COVID-19	During-COVID-19	
Weekly distance run [km]	37.0 [24.1, 56.3]	31.4 [12.0, 48.3]	38.6 [22.0]	33.2 [24.2]	<0.001
Runs per week [*n*]	5.0 [5.0, 6.0]	5.0 [3.0, 6.0]	5.0 [1.4]	4.3 [2.0]	<0.001
Hard runs per week [*n*]	3.0 [2.0, 3.0]	2.0 [1.0, 3.0]	2.6 [1.2]	1.9 [1.5]	<0.001
Injuries [*n*]	0.0 [0.0, 0.0]	0.0 [0.0, 0.0]	0.3 [0.6]	0.2 [0.4]	<0.001
Injuries [*n*/1,000 km]	0.0 [0.0, 0.0]	0.0 [0.0, 0.0]	11.4 [36.5]	6.5 [26.2]	0.002

**Wilcoxon signed rank statistical significance.*

TABLE 3 | Number of self-reported injuries before and during COVID-19 social distancing restrictions by location and injury type.

		Muscle injury		Tendon injury		Bone injury		Ligament injury		Total injuries	
		Before	During	Before	During	Before	During	Before	During	Before	During
Toe		3	0	1	1	2	0	3	2	9 [7.5%]	3 [3.7%]
Foot		2	1	4	5	3	2	3	1	12 [10.0%]	9 [11.0%]
Ankle		4	2	4	4	1	2	4	4	13 [10.8%]	12 [14.6%]
Lower leg		7	5	5	4	11	5	0	0	23 [19.2%]	14 [17.1%]
Knee		6	5	10	8	1	0	5	2	22 [18.3%]	15 [18.3%]
Thigh		10	6	1	0	0	0	0	0	11 [9.2%]	6 [7.3%]
Hip/pelvis		9	7	5	4	4	1	1	3	19 [15.8%]	15 [18.3%]
Groin		4	2	0	0	0	0	0	0	4 [3.3%]	2 [2.4%]
Abdomen		1	1	0	0	1	0	0	0	2 [1.7%]	1 [1.2%]
Back		4	4	0	1	0	0	0	0	4 [3.3%]	5 [6.1%]
Other		0	0	0	0	1	0	0	0	1 [0.8%]	0 [0.0%]
Total	*n*	50	33	30	27	24	10	16	12	120 [100.0%]	82 [100.0%]
	%	41.7	40.2	25.0	32.9	20.0	12.2	13.3	14.6		

< 0.001), fewer runs per week ($p < 0.001$), and fewer hard runs per week ($p < 0.001$) during the COVID-19 social distancing restrictions (**Table 2**).

Youth long-distance runners also reported fewer number of injuries ($p < 0.001$) and fewer injuries per 1,000 km ($p = 0.002$) than pre-COVID-19 social distancing restrictions (**Table 2**). Prior to COVID-19 social distancing restrictions, 61 (21.3%) participants reported 120 RRIs while 41 (14.3%) participants reported 82 RRIs during COVID-19. Pre-COVID-19, the most common injury locations were the lower leg (19.2%), knee (18.3%), and hip/pelvis (15.8%); whereas during COVID-19 social distancing restrictions, the most common injury locations were the knee (18.3%), hip/pelvis (18.3%), and lower leg (17.1%) (**Table 3**).

COVID-19 social distancing restrictions impacted the proportion of youth long-distance runners seeking care for their injuries compared to pre-COVID-19 behaviors. A lower proportion of participants reported in-person health care provider visits ($p < 0.001$) and a higher proportion of not visiting a health care provider ($p < 0.001$), while the proportion of telehealth visits did not change ($p = 0.81$, **Table 4**). Although the proportion of visits to most healthcare providers did not change (**Table 5**), a significantly lower proportion (22% of visits; $p < 0.001$) of visits were made to an athletic trainer during COVID-19 social distancing restrictions compared to prior to COVID-19 (56% of visits).

DISCUSSION

The purpose of this study was to determine if the social distancing restrictions during the 2020 COVID-19 pandemic influenced training habits, injury, and care seeking behavior in youth long-distance runners. We found that COVID-19 social distancing restrictions significantly impacted youth long-distance runners' training habits, injuries, and care seeking behaviors. These changes, which supported our hypotheses, could have implications for the health and well-being of this population in the short and long-term, which requires further investigation.

Youth long-distance runners decreased their weekly running distance, number of weekly runs, and number of weekly hard runs during COVID-19 social distancing restrictions. Due to the COVID-19 pandemic, the track and field seasons in the spring of 2020 were canceled. This running population is likely strongly influenced by intrinsic psychological and social factors such as the desire to compete and run with their teammates

TABLE 4 | Proportion of health care provider visit types before and during COVID-19 social distancing restrictions in injured runners.

Variable	Pre-COVID-19 $n = 63$	During-COVID-19 $n = 42$	P*
In-person visit, *n* [%]	**51 [80.9]**	**17 [40.5]**	**<0.001**
Telehealth visit, *n* [%]	2 [3.2]	1 [2.4]	0.81
No visit, *n* [%]	**10 [15.9]**	**24 [57.1]**	**<0.001**

*Chi-square statistical significance. **Bold**=$p \leq 0.05$.

TABLE 5 | Proportion of health care provider visits before and during COVID-19 social distancing restrictions in injured runners.

Variable	Pre-COVID-19	During-COVID-19	P*
Athletic trainer, *n* [%]	**40 [59.7]**	**9 [22.0]**	**<0.001**
Chiropractor, *n* [%]	10 [14.9]	6 [14.6]	0.97
Orthopedic surgeon, *n* [%]	9 [13.4]	4 [9.8]	0.57
Pediatrician, *n* [%]	5 [7.5]	4 [9.8]	0.68
Physical therapist, *n* [%]	21 [31.3]	14 [34.1]	0.76
Sports medicine physician, *n* [%]	28 [41.8]	17 [41.5]	0.97
Podiatrist, *n* [%]	3 [4.5]	2 [4.9]	0.92

*Chi-square statistical significance. **Bold**=$p \leq 0.05$.

(Yan and McCullagh, 2004), as well as extrinsic factors such as motivation provided by their coaches and parents (Goose and Winter, 2012). The absence of these motivating factors may have contributed to the reduced training volume and intensity. The responses by youth long-distance runners in our study are different than the responses of adult runners during the COVID-19 pandemic, which observed an increase in running volume (DeJong et al., 2020). This increase in running among adults was largely thought to be influenced by a desire to maintain health instead of competition (DeJong et al., 2020). Youth long-distance runners may have a strong desire to return to pre-COVID-19 volume and intensity levels with the goal of returning to competition in the fall of 2020; however, sudden changes in these variables could have led to overuse injury (Nielsen et al., 2012, 2013, 2014). Coaches and health care providers who interact with this population should be aware that motivators in this population may make youth long-distance runners vulnerable to overuse injury as they return to a competitive season.

The number of reported injuries significantly decreased in youth long-distance runners during the COVID-19 pandemic. However, even when normalized to running distance, self-reported injuries were significantly decreased. This injury reduction may have been influenced by the decrease in training volume and intensity since injury has been linked to these variables in youth long-distance runners (Tenforde et al., 2011). Contrary to our results, adult runners experienced an increase in running injury risk during COVID-19 (DeJong et al., 2020). While novice adult runners have demonstrated excellent specificity and sensitivity for self-reporting injury location compared to physician-reports (Smits et al., 2019), it has not been reported whether youth runners are also able to accurately self-report RRIs. Youth are less likely to report an injury that is chronic pain/overuse-related. Thus, they may have been more likely to report injuries that were more traumatic or acute in nature (Rathleff et al., 2013), thereby decreasing the overall number of injuries reported. Due to the cross-sectional design of this study, we were unable to further elucidate if this decrease in injury was actual or spurious due to other factors.

Health care provider visits and care seeking behavior changed during the COVID-19 pandemic, with a decrease in visits to health care providers. Prior to the COVID-19 social distancing restrictions, youth long-distance runners reported that most (83.6%) of their visits were in-person and only a small amount of injuries were not brought to the attention of a health care provider (16.4%). Youth runners significantly reduced their visits to health care providers during the COVID-19 restrictions (41.5%) and were 3.6 times more likely to not visit a health care provider (58.5%) for their injury. Young runners may rely on their parents for transportation or assistance with provider interactions, creating an additional burden to care seeking behaviors. Telehealth appointments are a feasible alternative to in-person appointments (Tenforde et al., 2020) and could reduce these barriers to youth. However, very few of the youth runners in this study participated in telehealth appointments before (3.3%) or during (2.4%) the COVID-19 pandemic. Many of these injuries, if not treated, are thought to lead to long-term, chronic conditions (Thomas et al., 2010) and this could be further exacerbated by the COVID-19 pandemic (Clauw et al., 2020). These data also suggest the need to develop plans to maintain access to medical services in the event of similar future sport activity (running) stoppages and/or restrictions. An interdisciplinary team, including policy makers, school administrators, and/or national associations, should consider developing these plans in advance to ensure access to care. Further, coaches and health care professionals may want to devise safe return-to-running protocols that may minimize the risk of running-related injuries.

The reduction in visits were primarily evident in reported visits to athletic trainers. Injured youth long-distance runners utilized an athletic trainer significantly less for their health care needs during the COVID-19 pandemic. Youth runners sought care from athletic trainers 2.7 times less during this period, though care seeking behavior from other providers did not change. Approximately 76% of high schools employ an athletic trainer (Huggins et al., 2019); however, as sports seasons were canceled early, access to these providers were potentially limited to these injured runners. Increased utilization of telemedicine by athletic trainers and other health care providers could improve access to care for this population during restrictions or in rural/remote environments (McLeod et al., 2013). Further research is needed to determine the specific reasons that youth long-distance runners seek care, the mediums by which they seek care, and which provider(s) they choose to seek care from.

The primary limitation of the current study is the cross-sectional design of an online survey where recall bias could influence the reporting of training habits and injuries. We attempted to minimize the impact of this bias by limiting the recall period to 6 months prior to COVID-19. Social distancing restrictions also differed in extent and timeline based on state government decisions, leading to likely variability in the stay-at-home orders affecting each participant. This study is also limited in that we only assessed the runners' responses at one time point. Future research should prospectively investigate training habits and injuries in a larger group of youth runners in the season following the COVID-19 restrictions to provide evidence of a long-lasting impact in this running population. Finally, even though we attempted to get a broad sense of the COVID-19 impact on the runners, the responses were weighted more heavily among a few US states which could also have introduced a geographic bias. Future research should attempt to capture a more balanced sampling of responses of youth runners in different regions of the US to better examine any geographic influence. In regard to COVID-19, future research should follow individuals over time to determine the influence of social distancing, reduced running, and reduced care-seeking behavior has on long-term running health and habits.

Within the context of these limitations, this study provides novel information about the effects that a large-scale cancellation of a sports season and social distancing restrictions may have on youth long-distance runners. Following social distancing requirements from the COVID-19 pandemic, youth long-distance runners reported significant decreases in both training and injuries, which were different compared to previous reports in an adult population (DeJong et al., 2020). Many of the runners who sustained an injury during COVID-19 social distancing restrictions did not report seeking care, with the most prominent reduction in visits to an athletic trainer. This could impact future injury risk and chronic pain if appropriate care is not provided for this young population.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Toledo Institutional Review Board and Cincinnati Children's Hospital Medical Center Institutional Review Board. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

DB-J, MG, JT-H, JL, MR, MP, and KF designed the study, contributed to data collection and analysis, and critically reviewed the manuscript before submission. All authors contributed to the article and approved the submitted version.

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Teacher's Physical Activity and Mental Health During Lockdown Due to the COVID-2019 Pandemic

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The COVID-19 pandemic has led teachers to an unpredictable scenario where the lockdown situation has accelerated the shift from traditional to online educational methods, and relationships have been altered by the avoidance of direct contact with the others, with implications for their mental health. Physical activity seemed to be a factor that could prevent mental disorders such as anxiety or depression in this peculiar situation. Therefore, the aims of this study were to explore how teachers have been affected by the lockdown with respect to their mental health and their relationships in three main fields: work, family, and social relationships, and to know which is the role of physical activity in the mentioned variables. For that purpose, an online survey was designed to collect quantitative and qualitative data. Results showed that indoor physical activity acts as preventive in lockdown situations, whereas the level of activity does not affect mental health. Also, teachers have experienced higher levels of distress due to the workload generated during the lockdown. In conclusion, to prevent health problems among teachers in future similar situations, it would be important to facilitate the practice of physical activity at home. Furthermore, teacher training in blended or online educational methods would be crucial for their favorable work development.

Keywords: COVID-19, mental health, physical activity, teacher, lockdown

INTRODUCTION

The global expansion of the COVID-19 pandemic disease has carried out many consequences that may affect people's general health. On the one hand, the virus itself creates personal situations in which, in addition to the disease's symptoms, human emotions such as fear (Asmundson and Taylor, 2020), worry, panic, anxiety, or depression-related distress (Bao et al., 2020) can appear more commonly among people. Indeed, in recent studies about the psychological impact of this pandemic disease on the general population, an increase in depression and stress levels between the first days and the third week of the lockdown has been found (Ozamiz-Etxebarria et al., 2020; Rodríguez-Rey et al., 2020). Furthermore, anxiety has been related to impaired sleep in many studies (Rajkumar, 2020). On the other hand, social situations have changed due to the disease and the subsequent quarantine (Zhang et al., 2020), as well as due to attending to dependent or infected persons or those under other medical conditions at home or nearby. Also, it was due to the preventive measures applied by the government such as confinement or lockdown (Liu et al., 2020). In previous pandemics, individual differences seem to play an important role (Asmundson and Taylor, 2020). In any case, broader and more specific research of the impact on mental health is still needed (Mahase, 2020).

Moreover, people worldwide have found themselves coping with new professional scopes (Zhang et al., 2020). Some of them have completely stopped their work, and in brief, they will have to face their future with uncertainty; others have found their work hours increased and have managed risky situations (e.g., health and social workers, or product suppliers). This health crisis is also triggering an economic crisis at a global level and within a few weeks (UNESCO, 2020a).

Another factor influencing adults' personal, social, and professional fields is that related to the lockdown of children at home because, many times, parents have been involved in many roles and tasks at a time (Orte et al., 2020). Meanwhile, educational administrations have not stopped the scholar year, so that teachers have found themselves coping with online education at any level (Wang and Zhao, 2020) while attending to other personal issues. Furthermore, it should be mentioned that Spanish teachers' working conditions before this pandemic situation were already tight due to the teacher/student ratio from 25 to 36 per teacher (Education Youth Policy Analysis Unit in the Education Audiovisual Culture Executive Agency, 2020a) and the high amount of lessons (30–32 per week) they have to give (Education Youth Policy Analysis Unit in the Education Audiovisual Culture Executive Agency, 2020b). Also, all teachers should be prepared in all teaching roles for inclusive education and thus to work with all learners or students in individualized and close relationships, so that they must play a great role in a daily-based work and face-to-face with them. The work becomes even more difficult when this direct contact must be replaced by an online relationship, and many other factors should be considered. Teachers, in general, are not trained for e-learning programs and activities since this is not included in the curriculum of primary and secondary education (Education Youth Policy Analysis Unit in the Education Audiovisual Culture Executive Agency, 2020c). In addition, it should be emphasized that, in crisis situations, teachers may play an additional and crucial role. They can provide psychosocial support to learners. Firstly, teachers can create a safe and supportive interaction where students may express their emotions and experiences; secondly, they can include specific structured psychosocial activities in the teaching/learning process that can strongly help vulnerable students (Inter-Agency Standing Committee, 2007a). Therefore, teachers' workload can be considered quite high, and consequently, the teaching profession can be characterized by high levels of stress and physical complaints (Bogaert et al., 2014).

In the current situation, national governments all around the world are implementing new precautionary and responsive measures on a daily basis to contain the spread of the COVID-19 pandemic and to address this crisis that they have established a lockdown situation, social distancing advice, and educational measures such as temporary educational institutions' closures [European Agency for Special Needs and Inclusive Education, (n.d.)]. These global school closures are impacting over 60% of the world's student population, and in several countries, the implemented localized closures could impact millions of additional learners (UNESCO, 2020b). Moreover, school closures bring to people of many communities high social and economic costs, impacting mainly the most vulnerable and marginalized children and their families and exacerbating the already existing disparities not only within the education system but also in other aspects of their lives. Teachers also experience an important impact. Firstly, their students are concerned because of the interrupted learning and other collateral effects (disadvantages, lack of opportunities, poor nutrition, social isolation, or lack of care), and this makes even more difficult the teaching–learning process, mainly when parents are not prepared for distance and home schooling or they are not available to attend to their children. Secondly, teachers experience confusion and stress because they are often unsure of their obligations and how to maintain connections with students to support learning. Transitions to distance learning platforms tend to be messy and frustrating, even in the best circumstances. In many contexts, school closures lead to furloughs or separations for teachers. Thirdly, moving learning from classrooms to homes at scale and in a hurry presents enormous challenges, both human and technical (i.e., creating, maintaining, and improving distance learning, or measuring and validating learning) (UNESC, 2020c). In sum, from 1 day to the next, teachers have found themselves creating and managing virtual classrooms, communicating with their students and their parents over social media platforms, and learning by doing as they provide distance education to over 1.5 billion students affected by school closures all over the world due to the COVID-19 pandemic (UNESCO, 2020d). Despite governments' efforts to provide training and resources to support teachers in adapting to this new learning environment, turning from face-to-face to virtual classroom in such a short time has been a challenge as only a few teachers have strong digital and ICT skills. Therefore, in such unprecedented and uncertain times, it is normal for teachers to experience higher levels of stress and anxiety. Teachers need, indeed, socio-emotional support to face the extra pressure being put on them to deliver learning in a time of crisis (UNESCO, 2020d). Moreover, providing support for teachers' own psychosocial well-being is an essential component of supporting students (Inter-Agency Standing Committee, 2007b).

Nevertheless, the great changes in students', teachers', and parents' lives around the world caused by COVID-19 have brought to society an opportunity to test its capacity to adapt to sudden stressful situations in which people have been involved in new personal, social, educational, and professional environments and tasks. This health crisis will likely have long-term effects on education, so that it could become an opportunity to rethink the curriculum, teaching–learning assessment processes, and the development of students' competencies while strengthening their learning skills and sustaining their motivation. Moreover, the after-crisis period must be already previewed for the curriculum and learning continuity to be preserved (Daniel, 2020; UNESCO, 2020e).

This health and, consequently, economic crises caused by a pandemic that is reaching almost all countries in the world within a few weeks are unprecedented in the recent past. But lessons might be drawn from previous epidemics and economic crises (UNESCO, 2020a). It can be concluded from previous experiences that physical activity and exercise could help to mitigate the effects caused by the current pandemic on the mental and physical health of citizens worldwide. Being physically active should be highly recommended (Amatriain-Fernández et al., 2020) considering that physical activity could help in preventing psychological or mood disorders (Kwan et al., 2012) and improving the quality of life by decreasing the negative psychosocial effects of lockdown due to the COVID-19 pandemic (Slimani et al., 2020). In the same way, the role of physical activity in general health and well-being of teachers during lockdown should be important also, as it has been found that those teachers performing more exercise during leisure time, or in a more autonomous way, may prevent easier physical and mental health problems (Bogaert et al., 2014). In order to lead toward an after-crisis scenario and to prevent negative effects in future possible crises, it is worthy to know how these factors act in this lockdown situation. Therefore, this study aims to explore how teachers have been affected by the lockdown with respect to their mental health and their relationships in three main fields, such as work, family, and social relationships. Another objective followed by the study is to know which is the role of physical activity in the mentioned variables.

MATERIALS AND METHODS

Method and Design

A mixed methods design, known as the third paradigm (Johnson and Onwuegbuzie, 2004; Denscombe, 2008), has been used. It is characterized for including in the same research both quantitative and qualitative methods, specifying in the design the weight and the sequence of each part and explaining how both approaches are linked (Creswell and Plano Clark, 2011). The applied design, the so-called concurrent triangulation, gives the same weight to qualitative and quantitative data (Smith et al., 2016).

Participants

The sample of this research was composed of 345 teachers with a mean age of 44.62 years ($SD = 9.53$; 264 women; 80 men; 1 preferred not to say) currently teaching in Spain in primary and secondary education (see **Table 1**). Most of the teachers were working in public schools (n = 258), while 52 were in private schools and 35 in state-funded private schools.

TABLE 1 | Participants' frequencies considering the educational levels in which they teach.

Educational Level	Frequency	%
Primary education (6–12 years old)	71	20.58
Secondary education (12–16 years old)	77	22.32
Postcompulsory secondary education (16–18 years old)	17	4.93
Others (i.e., languages, sports, arts)	53	15.36
More than one level	127	36.81

Instruments

Data were collected using a questionnaire that included information about sociodemographic variables, teaching working conditions, and outdoor and indoor physical activities by using specific questions that were analyzed as quantitative variables. The Spanish version of the GHQ-12 (Sánchez-López and Dresch, 2008) was applied to measure mental health with the permission of the authors. This one-dimensional 4-point (0–3) Likert scale is composed of 12 items measuring aspects related to social dysfunction, anxiety, and depression. The questionnaire has acceptable psychometric properties, being its internal consistency acceptable ($\alpha = 0.76$). Its external validity has been assessed by correlating with the ISRA's anxiety questionnaire, being the correlation with the whole scale medium ($r = 0.57$) and the correlation with the ISRA's factors high: Factor I $r = 0.82$; Factor II $r = 0.70$; and Factor III $r = 0.75$ (Sánchez-López and Dresch, 2008). Finally, open questions were applied to collect qualitative data about working conditions, family, and relationships.

Procedure

Once the University of La Laguna's Ethics Committee's (CEIBA) approval [CEIBA2020-0401] and the permission of the authors of the Spanish version of GHQ-12 were obtained, a Google Form questionnaire with the mentioned sociodemographic, work, and physical activities' variables, the GHQ-12 scale, and the open questions (in this order) was created and sent to the participants. These were recruited by following a non-probabilistic snowball sampling procedure. For that purpose, social network was used, and corporate emails were sent in the first 3 weeks of the lockdown to Spanish teachers so that data were collected between the last week of April and the first week of May in 2020, during the lockdown and the 0 Phase when people had strong restrictions for outdoor activities and after 6 weeks that online education was established at all educational levels. All participants provided the informed consent to participate in the study. Therefore, the study fulfills the Declaration of Helsinki and the Organic Law 3/2018, of the 5th December, about Personal Data Protection and digital rights' warranty.

Data Analyses

Firstly, descriptive statistics were performed. Secondly, Cronbach's alpha was estimated to analyze the reliability index of the GHQ-12 scale. Thirdly, to analyze the effect of physical activity with t-test, the participants were divided into two groups, differentiating between those who performed less and more physical activity. The first group was composed of those who practice little physical activity, that is, 3 h maximum per week; the second group was composed of those who practice more than 4 h of physical activity per week. Quantitative analyses were carried out by using the JASP software (JASP Team, 2020). Fourthly, quantitative information was triangulated to explore which were the best predictors of mental health by analyzing the contribution that the variables physical activity hours (outdoor and indoor) and teaching performance hours, as

TABLE 2 | Descriptive statistics of the GHQ-12 scale.

	GHQTotal	GHQ1	GHQ2	GHQ3	GHQ4	GHQ5	GHQ6	GHQ7	GHQ8	GHQ9	GHQ10	GHQ11	GHQ12
Mean	22.05	1.96	2.08	1.66	1.74	2.25	1.88	2.02	1.87	1.91	1.71	1.39	1.58
Std. Deviation	5.26	0.62	0.89	0.87	0.75	0.93	0.82	0.83	0.67	0.90	0.82	0.93	0.89

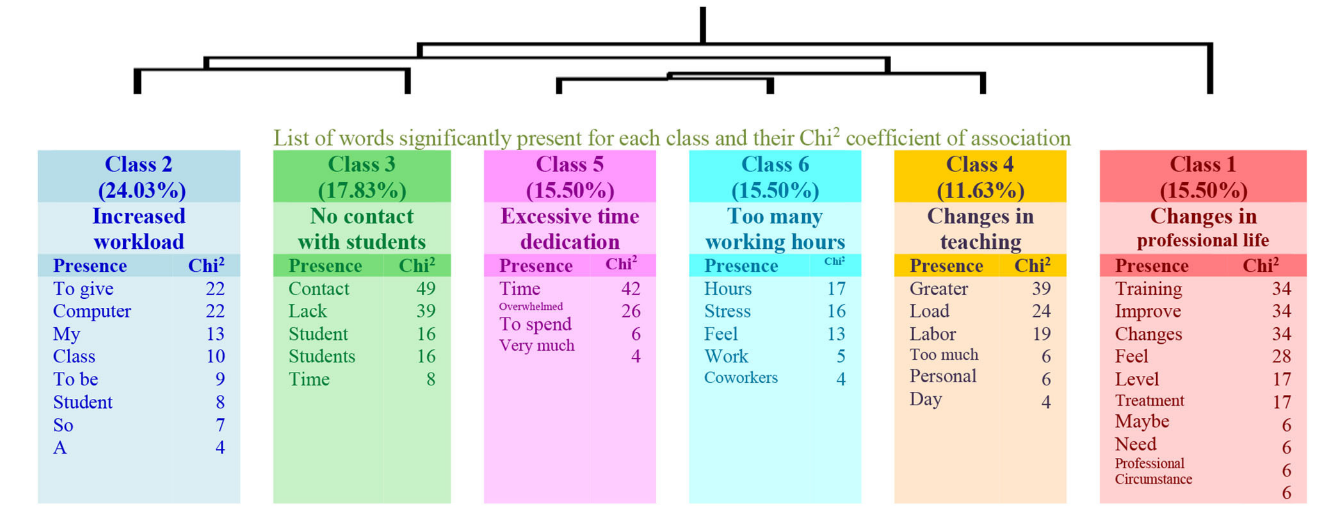

FIGURE 1 | Dendrogram for Question 1: "What changes do you observe regarding your professional performance? How do you feel about it?" (Low physical activity).

well as the number of students, have into the teachers' mental health with a Bayesian regression model. Fifthly, the perception that participants of both groups had about the changes that the lockdown situation had brought to the family, work, and social relationships was studied. Qualitative data obtained from the open questions were analyzed with the ALCESTE software (Lexical Analysis of Co-occurrences in Simple Text Statements; Reinert, 2001). This software uses statistical procedures to extract essential information from a text by receiving essential information, quantifying its strongest lexical structures, and grouping the co-occurrence, this last being the association by proximity of various words (nouns, adjectives, or verbs) using the chi-square statistic, with the aim of differentiating the most significant lexical words. Those words showing chi-squares higher than 3.841 were retained, following Camargo and Bousfield (2009) criterion. The analyzed unit is the elementary context unit (ECU), which corresponds to the idea of a sentence or a set of between 8 and 20 words (De Alba, 2004). One of the advantages of this approach is that it avoids the subjectivity involved in the construction of categories by the researcher, since the computer program establishes the connections using statistical procedures (Bauer, 2003).

RESULTS

Descriptive Results of Teaching and Physical Activities and Reliability of the GHQ-12 Scale

On the one hand, participants admitted that they spent an average mean of 38.34 h (SD = 19.28 h) per week doing teaching activities. Regarding online activities, 64.34% ($n = 182$) manifested to have previously none or a little training in virtual teaching, and 56.81% ($n = 196$) participants claimed to do quite or much training on how to teach online during the lockdown.

On the other hand, in relation to physical exercise, 80% of the participants ($n = 276$) stated that they did physical exercise at home ($M_{\text{Hours/week}} = 4.12$; $SD = 4.063$), and 57.39% ($n = 198$) admitted that they went for a walk ($M_{\text{Hours/week}} = 1.69$; $SD = 2.381$).

Considering the teachers' general health, the average mean of the GHQ-12 total scores was 22.05 ($SD = 5.26$) (see descriptive statistics in **Table 2**). Moreover, the GHQ-12 scale showed an acceptable reliability index (Cronbach's $\alpha = 0.77$). Finally, when comparing the GHQ-12 total scores between teachers doing high physical activity ($n = 141$; $M = 21.596$; $SD = 5.426$) and low activity ($n = 204$; $M = 22.368$; $SD = 5.128$), statistically significant differences were not found ($t(343) = 1.34$; $p = 0.1809$). The effect size was small (Cohen's $d = 0.1468$).

Predictors of Mental Health: Bayesian Linear Regression

A Bayesian linear regression was carried out considering as predictors of the GHQ-12 score the amount of hours of physical activity performed at home, the hours dedicated to teaching performance, the number of students, and the number of hours spent walking away from home. An uninformed uniform prior [P(M)] of 0.063 was set for each possible model. The results suggest that the best regression model is the one including the time of physical activity at home and the hours dedicated to teaching work (BF10 = 11.07) compared to the null model. The

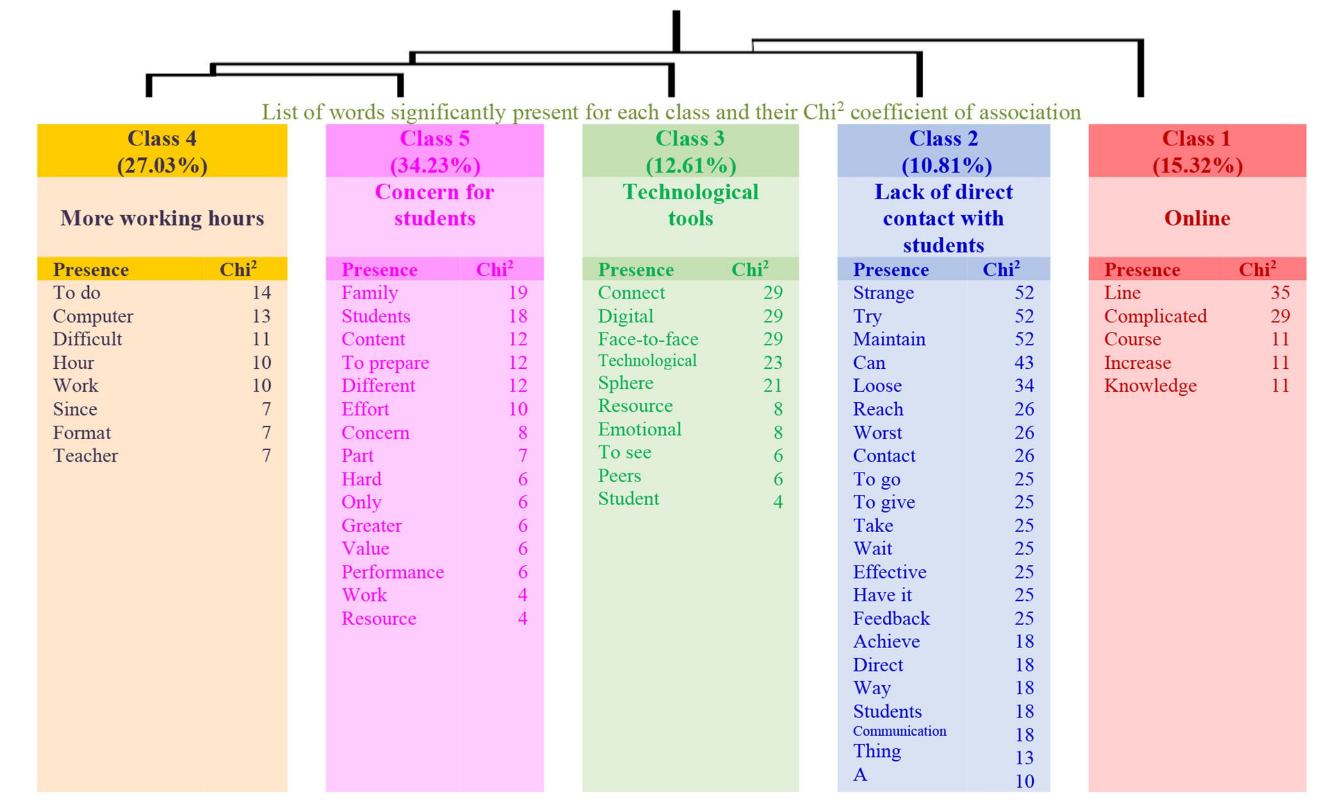

FIGURE 2 | Dendrogram for Question 1: "What changes do you observe regarding your professional performance? How do you feel about it?" (High physical activity).

regression coefficient for hours of physical activity at home is $b_1 = -0.096$ and for teaching work $b_2 = 0.039$. The constant of the model is $b_0 = 22.052$. For instance, a teacher that is doing 5 h of physical activity a week and working for 39 h a week will have a mental health score of 21.9929 (see the equation below) measured with the GHQ-12.

$$y = 22.052 + (-0.096 \times [5 - 4.118])$$
$$+ (0.039 \times [39 - 38.345]) = 21.9929$$

Perception of the Changes Experienced Due to the Lockdown Situation

The responses given about the changes found in the lockdown situation have been analyzed through the ALCESTE program in three areas: work, family, and social relationships. Considering that we have not found statistically significant differences in mental health between teachers with high and low levels of physical activity, and aiming to know what teachers from different levels say about the before mentioned areas, answers to three open questions have been analyzed on the basis of the high and low levels of physical activity, as presented below.

Question 1: Changes Observed by Teachers Regarding Their Professional Performance ("What Changes Do you Observe Regarding Your Professional Performance? How Do you Feel About It?")

On the one hand, in the analysis made for the low physical activity group, six factors or classes explaining 59% of the textual units were obtained (see the dendrogram in **Figure 1**). The first class (Changes in professional life) shows a more general content and connects with other two classes, 2 (Increased workload) and 3 (No contact with students), that are related to the way of teaching and to the contact with the students. The link between classes 2 and 3 connects with class 4 (Changes in teaching) and the link between classes 5 (Excessive Time Dedication) and 6 (Too many working hours). These classes have in common the shared complaint of working in excess and dedicating more hours due to the changes in teaching strategies.

On the other hand, in the analysis made with the answers given by the teachers with higher levels of physical activity to the same question, a different structure emerges, this time composed of five factors or classes that explain 54% of the textual units but that are also organized in a more hierarchical structure. In this respect, the first class (Online) connects with class 2 (Lack of direct contact with students). The second connects with class 3 (Technological tools), and the third connects with

TABLE 3 | Information of Question 1: "What changes do you observe regarding your professional performance? How do you feel about it?"

Class	χ^2		ECU	%	Word
Low physical activity group					
1		*Changes in professional life*	20	15.50	Train *[Forma]*
Sentences	36	Obviously, the treatment with coworkers and students is different, I feel that I need them to improve as a professional, I also see this circumstance as a challenge in order to improve at a professional level *[evidentemente, el trato con los compañeros y el alumnado es diferente, me siento que necesito de ellos para mejorar como profesional, además veo esta circunstancia como un reto a nivel profesional para poder mejorar]*			
	30	Need for online training. Maybe we are closer *[necesidad de formación online. estamos más unidos igual]*			
	28	All changes unleashed at a professional level are negative, because I feel that I have lost what gives meaning to my work: dealing with students *[los cambios que ha desencadenado a nivel profesional son todos negativos, pues siento que he perdido lo-que da sentido a mi trabajo: el trato con el alumnado]*			
2		*Increased workload*	31	24.03	To give *[Dar]*
Sentences	11	The workload has increased greatly. In some groups the way of teaching is quite ineffective, so that they require a live and in-person explanation *[la carga de trabajo se ha intensificado muchísimo. la manera de dar clase es bastante inefectiva en algunos cursos, ya que requieren de una explicación en directo y en persona]*			
	11	Care for my children, give more, prepare them more *[la atención a mis niños, dar más, prepararlos más]*			
	10	Full-time online teaching is an activity that requires being in front of the computer for 10 h a day. It is horrible *[la docencia online a jornada completa es una actividad que requiere estar delante del ordenador 10 horas diarias. es horroroso]*			
3		*No contact with students*	23	17.83	Contact *[Contacto]*
Sentences	15	Lack of contact with students *[falta de contacto con los alumnos]*			
	14	Overflowed with so much work. There is no time limit. Given the lack of information, with uncertainty about how I will address the end of the course as a counselor *[desbordada con tanto trabajo. no hay límite horario. con incertidumbre respecto de cómo voy a abordar el final de curso como orientadora dada la falta de información]*			
	11	Isolation, less teamwork, lack of student contact. Sometimes frustrated *[aislamiento, menos trabajo en equipo, falta de contacto alumnado. frustrada a veces]*			
4		*Changes in teaching*	15	11.63	Greater *[Mayor]*
Sentences	17	Extension of the working day. Cancellation of days off, holidays. Exploited *[extensión de la jornada laboral. anulación de días libres, vacaciones. explotado]*			
	17	More teamwork, generates a feeling of greater personal worth *[más trabajo en equipo, generando sensación de mayor valía personal]*			
	13	Greater labor disorganization and greater tension due to both legislative and lockdown time uncertainty *[mayor desorganización laboral y mayor tensión debido a la incertidumbre tanto legislativa como de tiempo de confinamiento]*			
5		*Excessive time dedication*	20	15.50	Time *[Tiempo]*
Sentences	23	I feel that I have to spend much more time. Overwhelmed *[siento que tengo-que dedicar mucho más tiempo. agobiada]*			
	21	I keep spending a lot of time *[le sigo dedicando mucho tiempo]*			
	13	I spend much more time. Overwhelmed by not having that time for personal issues *[empleo mucho más tiempo. agobiada por no contar con ese tiempo para temas personales]*			
6		*Too many working hours*	20	15.50	Hour *[Hora]*
Sentences	7	More working hours *[más horas de trabajo]*			
	7	I work 24 h. I started to dose them *[trabajo las 24 horas. estoy empezando a dosificarlo]*			
	7	I work many more hours and I feel that I cannot disconnect my work sphere from the family *[trabajo muchas más horas y siento que no puedo desconectar mi ambito laboral del familiar]*			
High physical activity group					
1		*Online*	17	15.32	Online
Sentences	107	I have been able to increase my knowledge about online courses. I feel good *[he podido aumentar mi conocimiento con cursos en línea. me siento bien]*			
	67	Online education is complicated. Quiet *[lo complicado de la educación online. Tranquila]*			
	16	Online life, always at computer *[vida online, siempre ordenador]*			
2		*Lack of direct contact with students*	12	10.81	Strange [extraño]
Sentences	31	Not maintaining direct contact makes you see things differently, and you try to manage everything differently. It is a bit strange to teach children without being them in front of you *[no mantener contacto directo hace ver las cosas de otra manera, y se intenta gestionar todo de manera distinta. resulta un poco extraño dar clases a niños sin poder tenerlo en frente]*			
	26	Not going to school is strange. Sometimes I feel like losing time, even when I try to maintain communication with the students, it is not even possible to reach 50(%) *[no ir a la escuela es extraño. A veces lo siento como tiempo perdido aun cuando se intenta mantener comunicación con los estudiantes no se logra llegar ni-siquiera a un 50]*			
	18	Not being able to have contact with the students is what I take the worst. Feedback is not immediate, so you have to wait them to read and write, it is less effective for them *[el no poder tener contacto con los alumnos es lo-que peor llevo. el feedback no es al momento, sino que hay que esperar a que lo lean y escriban, es menos efectivo para ellos]*			

(Continued)

TABLE 3 | Continued

Class	χ^2		ECU	%	Word
3		*Technological tools*	14	12.61	Connect [Conecta]
Sentences	46	Obstacles for connecting emotionally with adolescent students and competitiveness among peers to see who is the most technological, intoxication due to digital resources *[obstáculos a la hora de conectar en el plano emocional con los alumnos adolescentes y competitividad entre compañeros por ver quién es el más tecnológico/ a, intoxicación de recursos digitales]*			
	11	The development of the non-face-to-face session and trying to cover as much as possible with technological and strategic tools that allow me to achieve compliance effectively *[el desarrollo de la sesión no presencial y tratando de abarcar lo más posible con herramientas tecnológicas y estratégicas que me permitan lograr cumplir de manera eficaz]*			
	9	Material resources and the face-to-face part *[recursos materiales y la parte presencial]*			
4		*More working hours*	30	27.03	To do [Hacer]
Sentences	17	More hours at the computer, more working hours *[más horas al ordenador, más horas de trabajo]*			
	11	Complicated to correct activities since I am a plastic art teacher and the technical drawing exercises take me hours to correct when they could be corrected in much less time in print format *[me es muy complejo corregir las actividades ya que soy de plástica y el dibujo técnico me lleva horas corregir ejercicios que se podrían corregir en mucho menos tiempo de forma impresa]*			
	11	More eyestrain since hours in front of the computer have increased *[más cansancio visual ya que han aumentado las horas delante del ordenador]*			
5		*Concern for students*	38	34.23	Family [Familia]
Sentences	14	You work for more hours and sometimes you feel overwhelmed not only for preparing the classes, but for finding different resources to support a better understanding of the content and for helping families emotionally. Sometimes it is hard *[se trabaja más horas y a veces te sientes agobiada pues no solo preparar las clases, sino buscar distintos recursos para apoyar un mejor entendimiento de los contenidos y ayudar a las familias emocionalmente a veces es duro]*			
	14	My main concern is the assessment of students *[Mi mayor preocupación es la evaluación de alumnado]*			
	8	The effort is not valued and it is better valued to be more a bum who sends and corrects a task and does not worry about students learning or doing well *[que no se valora todo el esfuerzo y que se valora ser más un vago que manda una tarea y su corrección y no se preocupa porque su alumnado aprenda o esté bien]*			

the link of classes 4 (More working hours) and 5 (Concern for students). Therefore, teachers who have higher levels of physical activity express opinions about the consequences of online teaching during the lockdown, but these are weakly linked (see the dendrogram in **Figure 2**).

Table 3 presents the analyses carried out in the two groups, specifying the name of each class, the number of the elementary context units (ECUs) and their explained percentage, as well as the more representative word. The three examples with the highest χ^2 are also shown for each class.

Question 2: Changes Observed by Teachers in Their Family Lives Due to the Lockdown ("What Changes do you See in Your Family Life? How do you Feel About it?")

Teachers were asked about the changes they observed in family life as a consequence of the newly applied online teaching methods due to the pandemic. In the group with a low physical activity, a structure of three classes explaining 48% of the textual units emerges (see the dendrogram in **Figure 3**). The first class (Little time for the family) is connected to the link between the classes 2 (Telecommuting) and 3 (Less contact with the family). Therefore, teachers perceive a decrease in the contact with their family member that could be related to telecommuting and the consequent increase in the workload.

Regarding those teachers with higher levels of physical activity, the changes observed in family life were explained in three classes with 45% of the textual units (see the dendrogram in **Figure 4**). Class 1 (Dedication to the family) connects with the link established by classes 2 (Isolation from the family) and 3 (Changes in family life). Thus, teachers with higher levels of physical activity manifest a decrease in the contact with family members but do not relate to the workload.

The results related to the analyses carried out regarding the changes observed in family life are shown in **Table 4**. The table specifies the name of each class, the number of the elementary context units (ECUs) and their explained percentage, as well as the more representative word. The three examples with the highest χ^2 are also shown for each class.

Question 3: Changes Observed by Teachers in Their Interpersonal Relationships ("What Changes do you See in Your Interpersonal Relationships? How do you Feel About it?")

Regarding the answers to Question 3 in the group of lower levels of physical activity, four classes explaining 45% of the textual units have been obtained (see the dendrogram in **Figure 5**). In this structure, class 1 (Need for physical contact) connects with class 2 (Online relationships), and with the link between classes 3 (Distance relationships) and 4 (Distance with friends). Thus, teachers perceive distance despite the online relationship, and they miss physical contact in their relationships.

As for the group with higher levels of physical activity, the answers are grouped into four classes explaining 38% of the textual units (see the dendrogram in **Figure 6**). In this structure, class 1 (Difficulties to contact friends) connects with class 2 (Quality of interpersonal relationships), and with the link between classes 3 (Greater contact) and 4 (Greater online

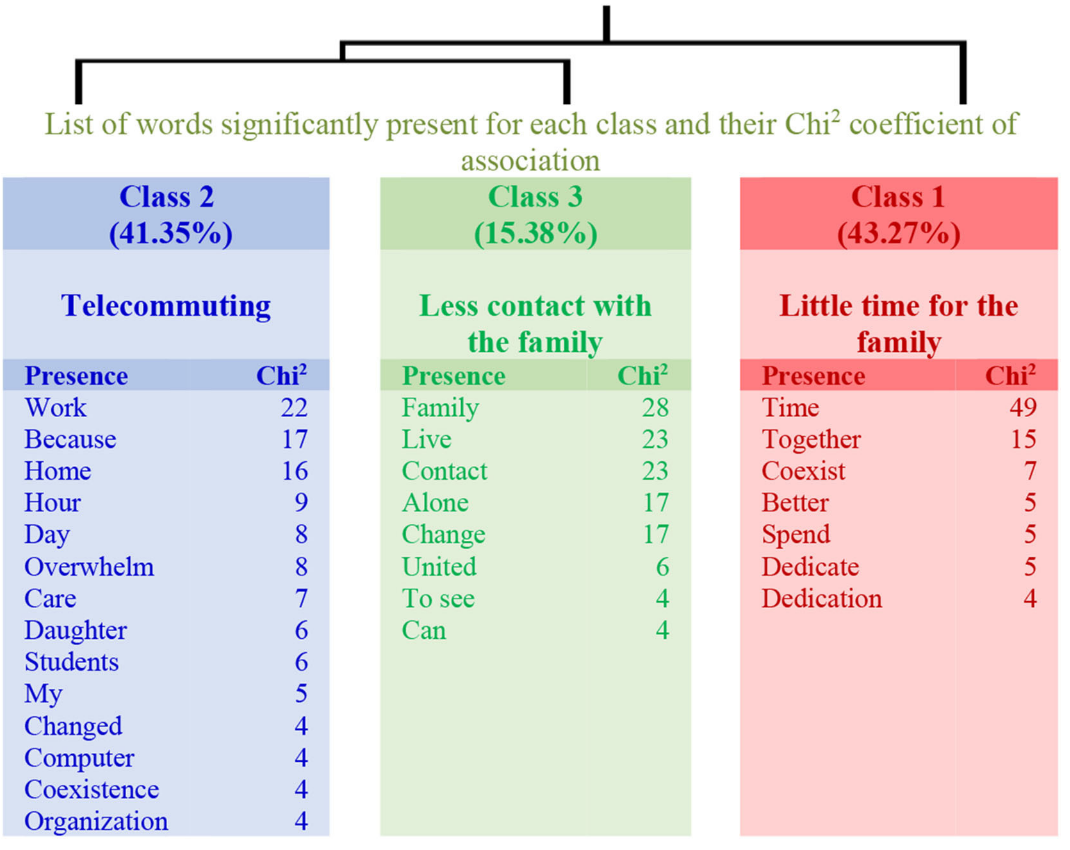

FIGURE 3 | Dendrogram for Question 2: "What changes do you see in your family life? How do you feel about it?" (Low physical activity).

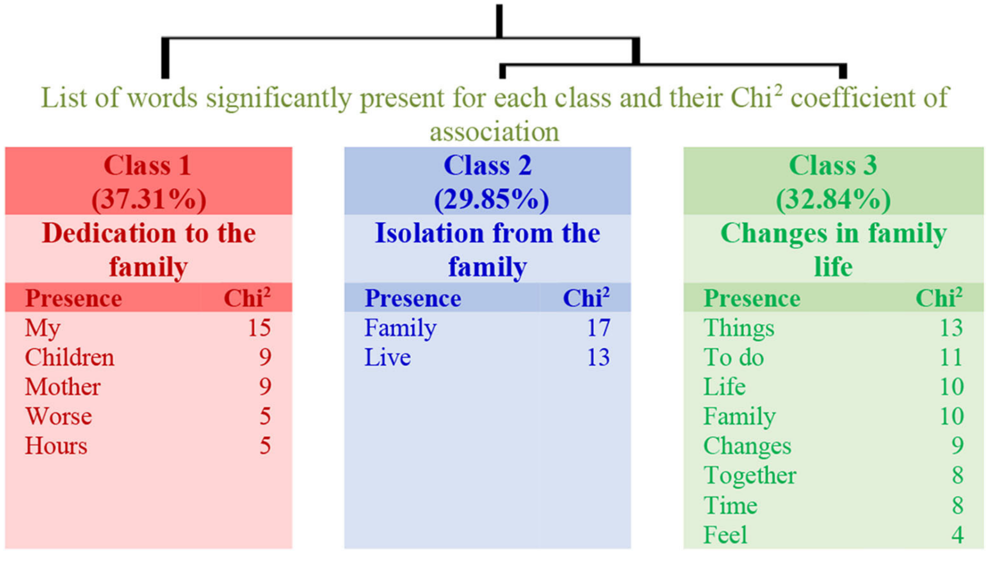

FIGURE 4 | Dendrogram for Question 2: "What changes do you see in your family life? How do you feel about it?" (High physical activity).

contact). Therefore, teachers with higher levels of physical activity perceive greater contact but also difficulties and a loss of quality in their relationships.

Table 5 presents the detail of the analyses carried out in terms of the name of each class, the number of the ECUs and their explained percentage, and the more representative

TABLE 4 | Information of Question 2: "What changes do you see in your family life? How do you feel about it?"

Class	χ^2		ECU	%	Word
Low physical activity group					
1		*Little time for the family*	45	43.27	Time *[Tiempo]*
Sentences	5	We are more irascible and I have little time to dedicate to them. Thank goodness I do not have small children *[Estamos más irascibles y tengo poco tiempo para dedicarles. menos mal que no tengo hijos pequeños]*			
	5	Less time, we spend more time glued to the screen, I feel sad *[menos tiempos, pasamos más pegados a la pantalla, me siento triste]*			
	5	Much more busy and barely able to dedicate to them as much time as I would like *[mucho más atareado y sin poderles apenas dedicarles todo el tiempo que me gustaría]*			
2		*Telecommuting*	43	41.35	Work *[Trabajo]*
Sentences	10	I have the impression that I do not take care of my daughter well because I am all day in front of the computer and I blame myself for it *[tengo la impresión de que no atiendo a mi hija en condiciones porque estoy todo el día delante del ordenador y me culpo por ello]*			
	8	I'm almost all the day working, although we are all at home *[que estoy casi todo el día trabajando, aunque estemos todos en casa]*			
	8	Nothing has changed, only that we are working from home *[nada ha cambiado, solo que estamos trabajando de casa]*			
3		*Less contact with the family*	16	15.38	Family *[Familia]*
Sentences	29	No change except not being allowed to see the whole family *[ningún cambio, excepto por no poder ver a toda la familia]*			
	29	I live alone. The only change is that I can not go on weekends to see my family *[vivo sola. el único cambio es q no puedo ir los fines de semana a ver a mi familia]*			
	11	Well, I live alone, thus it has little effect on my family unit *[bueno, vivo sola y entonces afecta poco a mi unidad familiar]*			
High physical activity group					
1		*Dedication to the family*	25	37.31	My *[mis]*
Sentences	12	My children are always with me. Well *[mis hijos están siempre conmigo. bien]*			
	11	I have more time to be with my children, but in worse conditions. it is very difficult to combine my work with my children *[tengo más tiempo para estar con mis hijos, pero en condiciones peores. hay mucha dificultad para compaginar mi trabajo con mis hijos]*			
	9	Having a dependent mother, I lack hours during the day to combine professional and personal life *[al tener a una madre dependiente, me faltan horas al día para compaginar vida profesional y personal]*			
2		*Isolation from the family*	20	29.85	Family *[Familia]*
Sentences	24	Need to see my family. I live on another island *[necesidad de ver a mi familia. vivo en otra isla]*			
	15	I can not see my family, I live alone and it is already beginning to weigh on me *[no puedo ver a mi familia, vivo sola y ya está empezando a pesar en el ánimo]*			
	7	I live alone. I keep on touch with my family more than usual *[vivo sola. mantengo mayor contacto del habitual con mi familia]*			
3		*Changes in family life*	22	32.84	Things *[Cosas]*
Sentences	10	Now we have time to do many things together. That feeling is fantastic *[ahora tenemos tiempo para hacer muchas cosas juntos. esa sensación es fantástica]*			
	7	As for my family life I have had no changes *[en-cuanto-a mi vida familiar no he tenido cambios]*			
	7	Many changes. I feel nostalgic of what we could do before lockdown *[muchos cambios. siento nostalgia de lo-que podiamos hacer antes del confinamiento]*			

word, together with three examples of the highest values of χ^2.

DISCUSSION

The GHQ-12 scale measures state and not trait because items refer to how the participant perceives itself these days. In some studies, scores above 12 have been considered as indicating the existence of an emotional disorder (Ruiz et al., 2017). The average score of the sample (M =22.05; SD = 5.26) indicates symptoms of emotional problems. In case we were not experiencing the special situation of lockdown and the stress that this implies, a detailed clinical evaluation would be recommended.

These emotional problems are predicted negatively by the time devoted to physical activity weekly and positively with the number of hours working on teaching activity. Physical activity has been seemed to be a protector in developing emotional problems in this study and in previous (Kwan et al., 2012; Bogaert et al., 2014; Amatriain-Fernández et al., 2020), but in this study, the level of activity in general does not make the difference, while it seems that the type of activity, specifically indoor physical activity, explains part of the variance on mental health; thus, it should be enhanced in order to improve teachers' mental health. However, other possible stressors such as the number of students seem to have no relationship with mental health. Nonetheless, the predictor power of these variables is weak, so other variables

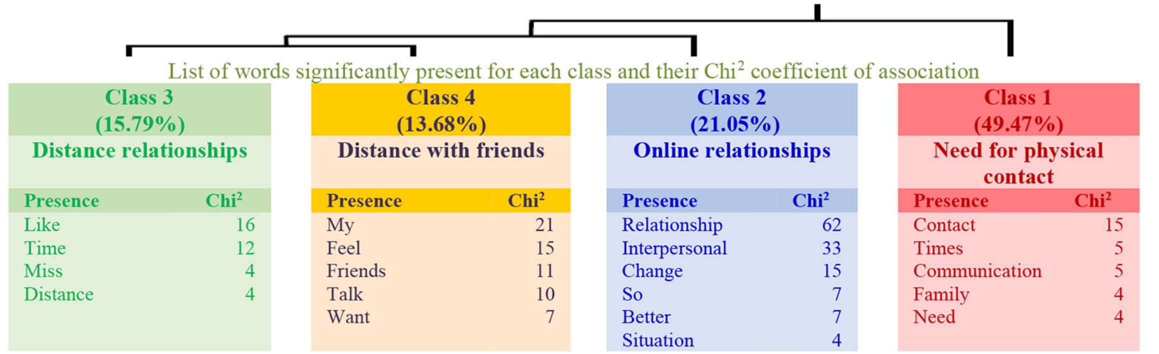

FIGURE 5 | Dendrogram for Question 3: "What changes do you see in your interpersonal relationships? How do you feel about it?" (Low physical activity).

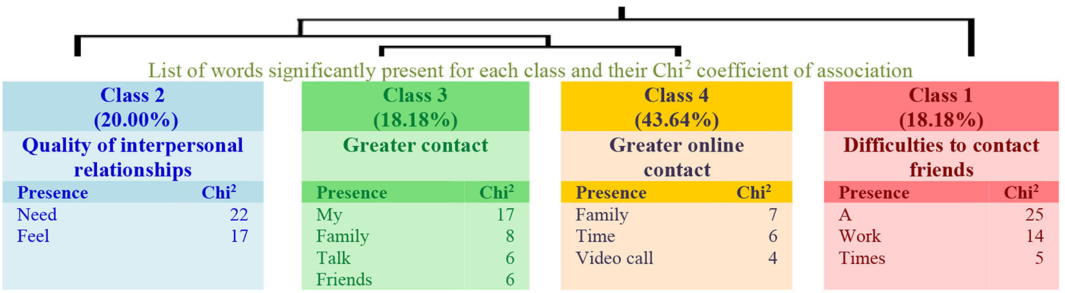

FIGURE 6 | Dendrogram for Question 3: "What changes do you see in your interpersonal relationships? How do you feel about it?" (High physical activity).

should also be considered to be studied as predictors of mental health in teachers.

The results extracted from the qualitative responses show differences related to the observed changes in teachers' lives due to lockdown. Clear differences are observed in the discourse of the two groups of teachers. On the one hand, those who report having low physical activity point out changes in their professional lives and in their relationship with students and focus on showing their concern for the greater dedication and longer working time required by online teaching. On the other hand, teachers who have more time to develop physical activity show a greater dispersion in their responses. In this respect, two classes are related to their relationship with students, the other two have to do with changes or challenges in their teaching performance (the change to online teaching and the need to master technological strategies), and the last one is related to the expression of opinions regarding the increased workload. This aspect has already been included in the literature, since telecommuting is more demanding in hours, due to the fact that the environment does not change, along with having to put into play new skills that they were lacking on a regular basis (Santillán, 2020).

Despite the fact that work changes determinate modifications in family life, which are included in two classes in the low physical activity group and in three classes in the other group, in both groups, to spend more time with the family has been considered as a positive indicator. In other words, both groups regret the difficulty they have to meet with the family due to the lockdown.

Social relationships have also been affected by the lockdown. In this section, the opinions expressed by the group with greater physical activity are more optimistic than those manifested by the group with little physical activity. In the first group, the distance feeling is mentioned only in one class, while the other expressions indicate a positive attitude, considering the value of maintaining online relationships. Meanwhile, the group with lower levels of physical activity manifests complaints related to the lack of relationships in all classes. Further research should be addressed to know more about the type of physical activity or other variables that improve mental health.

The main limitation of this work is that it has not been possible to cover a more specific regional and a broader international perspective. Another limitation is that other variables related to working and personal conditions during the lockdown should be addressed to assess their impact on mental health, aspects that were not afforded due to length limitations of the study. The last limitation to be considered is that classes explained a medium percentage of the textual units. Thus, these results should be confirmed with further research.

In summary, this situation of lockdown has led to major problems in teachers' lives, as evidenced by the pressure that online educational methods have placed on them: many hours of work and difficulties due to the lack of physical contact or due to the obstacles created on combining personal life with family.

TABLE 5 | Information of Question 3: "What changes do you see in your interpersonal relationships? How do you feel about it?"

Class	χ^2		ECU	%	Word
Low physical activity group					
1		*Need for physical contact*	47	49.47	Contact *[Contacto]*
Sentences	14	I need physical contact *[necesito contacto físico]*			
	14	They are so virtual. I need physical contact *[son tan virtuales. necesito el contacto físico]*			
	14	It has been increased the contact via online and sometimes overwhelms me *[aumenta el contacto vía online y me agobia a veces]*			
2		*Online relationships*	20	21.05	Relationship *[Relación]*
Sentences	15	What an interpersonal relationship. The only way we communicate is through diverse electronic media. whatsapp, mail, some facetime. I prefer the face to face relationship, this situation seems me very cold and unproductive *[que relación interpersonal. como único nos comunicamos es por medios electrónicos de diversa índole. whatsapp, mail, algún facetime. prefiero la relación cara a cara, esta situación me parece muy fría y poco productiva]*			
	7	I begin to consider the importance and need of some interpersonal relationships, to value some and lose interest in others *[empiezo a plantearme la importancia y necesidad de algunas relaciones interpersonales, a valorar algunas y desinteresarme por otras]*			
	7	Changes in relationships, they have become phone or videoconference relationships. Not totally satisfied, I prefer face-to-face relationships *[cambios en las relaciones, han pasado a ser telefónicas o por videoconferencia. no totalmente satisfecha, prefiero presencial]*			
3		*Distance relationships*	15	15.79	To like *[Gusta]*
Sentences	21	I don't miss anyone. I like social distance. In fact, I don't care about social and nobody complains because it is normal *[no echo de menos a nadie. me gusta la distancia social. de hecho, paso de lo social y nadie se queja porque es lo normal]*			
	14	I would like to dedicate to them more time *[me gustaría dedicarles más tiempo]*			
	10	Better. Because I have free time and I'm not overwhelmed by work and distance *[mejor. por-que tengo tiempo libre y no estoy agobiada por el trabajo y la distancia]*			
4		*Distance with friends*	13	13.69	My [Mis]
Sentences	12	I feel further far away from my friends and colleagues. Lockdown is getting us away little by little *[me siento más alejada de mis amigos y compañeros. el confinamiento nos está alejando poco-a-poco]*			
	12	Wanting to see my friends *[con ganas de ver a mis amigos]*			
	6	I feel good, I keep talking to both my friends and my girlfriend on a daily basis and I try to make video calls regularly *[me siento bien, sigo hablando tanto con mis amigos como con mi novia a diario e intento hacer videollamadas con regularidad]*			
High physical activity group					
1		*Difficulties to contact friends*	10	18.18	A *[un]*
Sentences	18	Dependence on social networks. Not knowing for sure how to receive a written message in the working groups. Stressed by videoconferences *[la dependencia de las redes sociales. no saber con certeza como se recibe un mensaje escrito en los grupos de trabajo. estresada en las videoconferencias]*			
	9	Communication is not easy. After working all day online, you don't feel like continuing to depend on an electronic device to talk to others *[no es fácil comunicarse. después de estar todo el día trabajando online no apetece seguir dependiendo de un aparato electrónico para hablar más]*			
	7	Sometimes a little far away from friends and parents because I don't visit them as much as I would like *[A veces un poco alejada de amigos y padres porque no los visito tanto como quisiera]*			
2		*Quality of interpersonal relationships*	11	20.00	Need *[Necesidad]*
Sentences	6	We value more those who have always been there and you need to see them. I feel nostalgic *[que valoramos más a quienes siempre han estado ahí y tienes la necesidad de verlos. me. siento nostálgica]*			
	6	Less and less contact, less joy and I feel sad *[cada vez menos contacto, menos alegría y me siento triste]*			
	3	I feel good, because I am satisfied with my interpersonal relationships and the relationship remains the same, we remain the same *[me siento bien, porque estoy satisfecha con mis relaciones interpersonales y la relación sigue siendo la misma, seguimos igual]*			
3		*Greater contact*	10	18.18	My *[Mis]*
Sentences	21	It is strange to talk to my neighbors or to someone apart from my partner and children. I miss my other family and friends *[se me hace extraño hablar con mis vecinos o con alguien al margen de mi pareja e hijos. echo de menos a mi demás familia y amigos]*			
	15	I have more time to talk to my friends and I see more often my family, so this point has been positive *[tengo más tiempo para hablar con mis amigos y veo más a la familia, así-que este punto ha sido positivo]*			
	11	they have improved, I even talk to my parents more often than I ever did before *[han mejorado, incluso hablo con mis padres más de lo que lo hacía antes]*			

(Continued)

TABLE 5 | Continued

Class	χ^2		ECU	%	Word
4		*Greater online contact*	24	43.64	Family member *[Familiar]*
Sentences	10	More disagreements as there is much more contact and less time for outdoor activities *[más roce al haber mucho más contacto y menos tiempo para actividades al aire libre]*			
	10	I make long calls with family and colleagues; these usually combine professional and personal aspects. We usually make a video call with friends, but personal direct contact is missed *[hago largas llamadas con familiares y con colegas; en estas se suelen compaginar aspectos profesionales y personales. con los amigos solemos hacer alguna videollamada, pero el contacto personal se echa de menos]*			
	6	I have more contact than before with some people thanks to the free time of both and the social networks *[hay personas con las que ahora contacto más-que antes gracias al tiempo libre de ambos y a las redes sociales]*			

Obviously, we will have to learn from this experience in several ways. On the one hand, it is essential to study which digital competences both teachers and students have, as well as parents, since in the vast majority of cases, they have had to act as a bridge to facilitate the teaching–learning process of their children (Cuetos et al., 2020). This is already invariable whether the health requirements force a new lockdown or not. On the other hand, the situation created by the COVID-19 pandemic disease has evidenced the advantages of online training and its drawbacks because it can help in expanding borders and bringing education to every home. But for this to become possible, many limitations, mostly technical (lack of computers, not enough for all family members, inadequate or non-existent internet connections), have to be overcome as teachers' concerns have manifested, which will have to be taken into account by universal digitization policies, by the rulers, and by public policies that prevent the digital gap. Other limitations could be those related to knowledge and skills, and teachers have mentioned that they might have to be trained in the didactic and instructional value that each resource and each strategy has, since there is not a direct translation from what is done in the classroom to what has to be done online. Considering this difficult situation, it is also necessary to design better-structured teacher training plans, which do not generate an excessive workload, as it has been reflected in the results of this research. Obviously, no one was prepared to make the leap from classroom to online teaching from 1 day to another.

Another point that should be considered is that in some countries, as in the case of Spain, the hardest moment of lockdown prevented from leaving home except for very justified reasons. Therefore, it is not surprising to find out low physical activity scores. Given the importance that physical activity has in mental health (Fuentes-Barria et al., 2018), it would be convenient to establish support programs to encourage physical activity for similar situations in the future, in the case that health requirements force citizens to return to lockdown.

In conclusion, the hard lesson that has involved alleviating the difficult situation of the pandemic disease leads to three action points: the establishment of measures to facilitate the online teaching resources; the design of teaching strategies that favor teaching–learning processes based on blended or online methods; and the development of support programs to foster physical activity among citizens.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because we didn't ask participants any permission and informed consent to share the data. Requests to access the datasets should be directed to taguirre@ull.edu.es.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Universidad de La Laguna ULL. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

Authors in this manuscript contributed as stated in this section. On the one hand, LA, LC, TA, and ÁB were involved in the conceptualization of the project and in the acquisition of the data. On the other hand, EV and ÁB were involved in the analysis and interpretation of the data. Finally, all authors were involved in the drafting and revision of the work for intellectual content, provided approval for submission of the contents for publication, and agreed to be accountable for the accuracy and integrity of the project.

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Physical Exercise and Immune System in the Elderly: Implications and Importance in COVID-19 Pandemic Period

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Physical exercise is seen as the main ally for health promotion, preventing and protecting the organism from several diseases. According to WHO, there is a tendency of constant growth in the elderly population in the coming years. The regular practice of exercises by the elderly becomes relevant to minimize the deleterious effects of the aging process and to increase the fitness index. Recently, the world population started a confrontation against Corona Virus Disease (COVID-19), which is the most significant public health challenge globally. Although social isolation is a reasonable measure in an attempt to stop contamination by COVID-19, this measure has limited the ability of individuals to exercise outdoors or in gyms and health clubs, which increased the risk of developing chronic illnesses related to a sedentary lifestyle. The critical point is that the recent recommendations on exercise prescription to combat the potentially harmful effects of COVID-19 failure to adequately address resistance exercise interventions as home-based exercise strategy. Thus, in this paper, we discussed the physical exercise as medicine if the training status is enough to protect the elderly against COVID-19 infection, about the role of physical activity on immunosuppression. Possible risks for COVID-19 infection, and the old training methods, such as no-load resistance training as possible resistance exercise strategies and high-intensity interval training, as new proposals of home-based exercise interventions, could perform during the current COVID-19 pandemic.

Keywords: COVID-19, elderly, health promotion, immune system, physical exercise

INTRODUCTION

Physical exercise is seen as the main ally for health promotion, preventing and protecting the organism from several diseases (Garber et al., 2011). According to World Health Organization (2018), there is a tendency of constant growth in the elderly population in the coming year. Additionally, it is well-established that the practice of physical exercise is essential for well-being in the elderly population (Fletcher et al., 2018; Lavie et al., 2019; Sant'Ana et al., 2020).

Recently, the world population started the confrontation against (COVID-19), which today is the most significant public health challenge in the world (Park, 2020). Its high transmission capacity, even during the asymptomatic phase and the relatively low virulence, resulted in the rapid transmission of the virus in several continents, giving it a prominent role mainly due to its capacity for easy transmission through the airways and mucous membranes, and its significant lethality (Liu et al., 2020; Müller et al., 2020), in addition to the high mortality rate worldwide (Huang et al., 2020).

Determined as a pandemic (when on a large scale of severity in most parts of the world), organizations responsible for the prevention, maintenance, and treatment standards related to human health outlined some measures: social distancing (Team, 2020; WHO, 2020). Since then, this has been the primary strategy in the fight against COVID-19 in several countries in the world (Gasmi et al., 2020). As a result, the limited practice of physical exercise became a significant concern for the elderly population.

According to the WHO (2020), the elderly are considered a risk of contagion from COVID-19 due to vulnerability and death due to physiological fragility caused by the aging process. And physical exercise in this situation becomes an essential tool for the efficiency of immune function during aging (Bartlett et al., 2018; Schroeder et al., 2019).

The main cardiovascular changes associated with aging occur in the myocardium, in the sinoatrial node, and in the heart valves and blood vessels, characterizing both anatomical and functional changes (Affiune, 2002; Liberman, 2005).

The respiratory system undergoes a series of morphological and physiological changes, such as the accentuation of dorsal kyphosis, an increase in the anteroposterior diameter of the chest, a decrease in wall mobility, and atrophy of the respiratory muscles (Powers and Howley, 2015). There is a progressive loss of lung function (Ruivo et al., 2009), which is related to the loss of muscle mass manifested systemically, as well as the respiratory system, which occurs associated with a decrease in mobility and of thoracic compliance, with efficiency and pulmonary function (Salicio and Botelho, 2018).

However, physical exercise is a powerful ally for improving health (Schroeder et al., 2019), as it acts efficiently on the elderly immune function. It was reflected in better systemic functioning (Walsh and Oliver, 2016), mainly preventing infectious diseases (Walsh et al., 2011). Thus, in sedentary individuals, the capacity of the immune system is more deficient (Gleeson, 2004), but individuals who go into detraining have significant physiological losses (Reis et al., 2017; Blocquiaux et al., 2020), mainly in the immune function (Ferreira et al., 2020) increasing immunoprotective deficiencies.

Physical exercise is recommended in this pandemic period, which is complicated, mainly due to the high spread index of COVID-19 (Oliveira et al., 2020; Amatriain-Fernandez et al., 2020a,b); however, there is still no consensus or recommendations in the literature on this theme for the elderly population. Thus, in this opinion, we approach the importance of physical exercise in aging to maintain or improve the immune system, to protect against possible infections such as COVID-19, as well as to discuss the potential use of some methods of neuromuscular and cardiopulmonary training, as possible interventions that can be performed during the current pandemic period.

EXERCISE IS MEDICINE FOR HEALTH PROMOTION

The act of staying at home without performing activities of daily living can involuntarily increase sedentary behavior and decrease the level of physical activity, which can cause negative health consequences. The reduction in levels of physical activity will decrease mechanical load, metabolic rate, and energy expenditure, resulting in decreased physical conditioning and excess energy. All of these risk factors are well-documented in the literature as they are the cause of several diseases, leading to a higher economic burden on society in the near future, besides, to be a severe public health problem (Owen et al., 2010; Malm et al., 2019).

It is well-known that a large part of the world population is very far from the minimum levels of physical exercise (Garber et al., 2011) recommended by institutions responsible for organizing and filing information related to the practice of physical activities, such as the ACSM (Katzmarzyk et al., 2019). However, due to the forced isolation and hypokinetic behavior experienced due to quarantine, a cascade of disastrous events can occur, such as respiratory tract infections (Hall et al., 2020).

A high level of physical inactivities, such as sitting for a long time, and low levels of physical activity are closely associated with increased risk of developing diseases such as depression (Huang et al., 2020), cancer and type 2 diabetes (Patterson et al., 2018), and coronary vascular disease and mortality (Stamatakis et al., 2019). For example, a 2-week reduction in physical activity levels causes a decrease in cardiorespiratory fitness (Bowden Davies, 2018) and a week of sedentary behavior, which leads to impairment in mood and depression (Edwards and Loprinzi, 2016). Also, sedentary behavior, for example, screen time, is a vital risk factor for venous thromboembolism (Kubota et al., 2018). However, the regular practice of physical activity and decreased levels of sedentarism are associated with reduced risk for morbidity and mortality (Ekelund et al., 2019).

Covid-19 causes several garve effects, such as lung damage, pneumonia (Liu et al., 2020), abnormal coagulation characteristics (Tang et al., 2020), and heart and kidney damage (Chen et al., 2020). Thus, prevention on the part of physical activity is of great interest. In this sense, some points are important. First point, the regular practice of physical activity promotes the improvement of cardiovascular functioning (Pinckard et al., 2019), coagulation and fibrinolytic homeostasis (Lippi and Maffulli, 2009), and protective effects against cellular stress (Narasimhan and Rajasekaran, 2016). Second point, the practice of physical activity increases cardiorespiratory conditioning (McKenzie et al., 2012), as well as the immune system (Dorneles et al., 2020), acting against the immunosenescence generally observed during aging (Weyh et al., 2020) and thus, increasing the immune response to viral antigens, reducing the incidence of viral infections throughout life (Campbell and Turner, 2018).

Physical activity during aging acts by promoting the activity of the immune system, including T and B lymphocytes (Bertucci et al., 2016). An example would be the release of interleukin-15 (IL-15) in muscle fibers after exercise, a crucial protein for the activation and proliferation of T and natural killer (NK) cells (Nielsen and Pedersen, 2007). This release induced by physical exercise can act in favor of the immune system, due to the many protective effects caused by exercise, such as the prevention of mild inflammation generally observed in central obesity (Collao et al., 2020), with a strong association with diabetes type 2 and coronary vascular disease.

And finally, the practice of physical activity also plays an essential role in mental health and cognitive functioning, since exercise promotes positive effects in the prevention and relief of symptoms of depression (Schuch et al., 2016), in reducing symptoms of anxiety (Stubbs et al., 2017), in improving learning (Winter et al., 2007), in addition to improving the cognitive functioning of the elderly (Bangsbo et al., 2019). In addition, the practice of physical activity and sports provides the practitioner with greater social interaction, important for the development of a social network (Holt et al., 2017). With limited social activities due to mandatory restrictions, physical and sports activities will remain considerably reduced during the outbreak of the virus. Therefore, the practice of regular physical activity is invaluable to maintain good physical and mental health when facing the current challenges imposed by COVID-19.

IS THE TRAINING STATUS ENOUGH AS PROTECTION AGAINST COVID-19 INFECTION?

COVID-19, according to Carda et al. (2020), has different clinical manifestations that present themselves as mild, moderate, and severe. The most observed are without dyspnea and low oxygen saturation in the blood ($SatO_2$), with or without feverish spikes, loss of smell and taste; dyspnea at small and medium efforts $SatO_2$ 94–98% and radiological signs of pneumonia; dyspnea, $SatO_2$ ≤93%, with the respiratory rate (RR) > 30/min, a radiological progression of the lesions, need for O_2 supplementation, possibly with non-invasive ventilation; and finally, patients require mechanical ventilation, respectively.

It is already well-known that the practice of physical exercises acts as a positive measure in improving the individual's chronic immune system (Brolinson and Elliott, 2007; Ranieri et al., 2009; Nieman and Wentz, 2019; Peake, 2020). In the general population, many protective immune responses are impaired in old age, leading to an increased risk of infection (Venkatraman and Fernandes, 1997). It is evident that a decline in the function of T cells occurs gradually, and this affects the whole immune system (Makinodan and Kay, 1980; Yan et al., 2001; Jeurissen et al., 2003; Ranieri et al., 2009; de Assis et al., 2018).

The immune system's response to exercise is multifaceted, depending on its nature (Civinski et al., 2011; Nieman and Wentz, 2019). However, its regular and systematic practice acts in the prevention and complementary treatment for chronic diseases and viral infections such as the new coronavirus (Campbell and Turner, 2018; Ferreira et al., 2020; Halabchi et al., 2020; Wu et al., 2020; Zbinden-Foncea et al., 2020). It is becoming an indispensable factor in the protective effect of the immune system to respond to the threat of COVID-19 adequately.

In theory, exercise should help reverse the adverse effects of aging on the immune system, increasing the production of endocrine hormones that can contribute to less accumulation of autoreactive immune cells, improving programed cell death (Maughan et al., 2000; de Oliveira et al., 2010; Civinski et al., 2011). Besides, initial reports on COVID-19 show that elderly comorbidities are more likely to develop severe complications after COVID-19 infection and have an increased risk of mortality (Emami et al., 2020). These observations indirectly indicate that low fitness, obesity, and an altered immune system can be harmful to an individual exposed to the coronavirus, SARS-CoV-2. The effects of COVID-19 on patients with obesity have not been well-described; however, several reports have identified obesity as a risk factor for hospitalization (Dietz and Santos-Burgoa, 2020).

EXERCISE, IMMUNOSUPPRESSION, AND POSSIBLE RISKS FOR COVID-19 INFECTION

Starting a sudden state of confinement implies a change in the lifestyle of the population. These lifestyles and behaviors, in many cases, include a certain level of physical activity and exercise to maintain a good state of health (Jiménez-Pavón et al., 2020) to counteract the negative consequences of certain diseases (Sugiyama et al., 2008) or even to ensure active aging, reducing the risk of frailty, and illnesses associated with aging (Biswas et al., 2015; Fletcher et al., 2018).

Exercise is considered beneficial based on epidemiological evidence in disease prevention (Decoster et al., 2005; Kaminsky et al., 2019; Rognmo and Wisløff, 2019; Hall et al., 2020). In this sense, the saving older woman deserves special attention since physical activity and exercise have an impact on the harmful effects of Aging (Ranieri et al., 2009; Owen et al., 2010; ACSM, 2020) not being lifestyle change is convenient.

The main question that permeates in the health area regarding the practice of physical exercise is whether it is adequate and responds positively to the viral respiratory tract epidemic or not (Halabchi et al., 2020). In an integrative review on precautions and recommendations for the practice of physical exercise in the face of COVID-19, Nogueira et al. (2020) found that physical activity performed with moderate intensity has positive effects on the responses of the immune system against respiratory infections viral and is associated with several anti-influenza benefits, including reduced risk and increased rates of vaccine efficacy.

Miles (2009) stated that exercises with moderate intensity could increase the count of neutrophil cells, NK, and the increase in salivary IgA concentrations. In addition to increasing hormones of stress-reducing excessive inflammation and leading to increased immunity against viral infections by altering the responses of Th1/Th2 cells, influencing the immune response. Thus, the benefits of regular physical activity improve immune function, reduce the risk, duration, or severity of viral infections (ACSM, 2020; Hall et al., 2020).

OLD TRAINING METHODS AS NEW PROPOSALS OF HOME-BASED EXERCISE INTERVENTIONS

Regarding the regular practice of physical exercises, it is well-established that regular physical training is important for improving neuromuscular (Fragala et al., 2019), cardiovascular (Lavie et al., 2015) and cardiorespiratory capacities (Ferreira, 2017), cognitive function (Northey et al., 2018), and thus generating several other systemic improvements in older people (Nelson et al., 2007; Fletcher et al., 2018). Neuromuscular training enables more significant muscle responses to support the different functional capacities of this population (Fragala et al., 2019). Also, improvement of aerobic capacity is essential for the aging process (Molmen et al., 2012), enabling greater cardiovascular (Soares-Miranda et al., 2014), and cardiorespiratory functioning (Ferreira et al., 2012). Public health entities consider the elderly as a risk group during the COVID-19 pandemic. It is not recommended that they go to clubs, gyms, squares, and other locations to practice physical exercise, which can also aggravate (Mitchell et al., 2019).

However, in a period when social distance has recommended in all nations, the practice of physical exercises that do not require specific places and/or devices seems to be a positive and essential proposal in times of extreme health care, thus making it possible to maintain or gain physical conditioning (Nelson et al., 2007). However, physical exercises using body weight can be an efficient strategy for the elderly. Regarding the exercise intensity, the American College of Sports Medicine (ACSM) recommends moderate intensity with 150–300 min per week (ACSM, 2020). But it seems that high-intensity interval training (HIIT) with 75 min weekly, that is, short periods of length, can be a great strategy to achieve optimal levels of immunity in the elderly (Nieman et al., 1993; Nemoto et al., 2007; Adamson et al., 2019).

Using bodyweight exercises can also be an option of HIIT composed by sets of short stimuli (below 1 min) or few repetitions (up to 12 repetitions) but with higher execution speeds (according to motor capacity). However, following these guidelines, HIIT, with up to 10 min (total volume), can be an effective strategy for positive physiological adaptations in older people (Tjønna et al., 2018). Besides, HIIT of short volume does not seem to promote damage to the clinical status of elderly individuals, as soon as it does not seem to negatively affect the immune system (Taylor et al., 2019). The recovery time, to preserve the body from physiological stress, using intervals longer than the stimuli is more beneficial to the body (e.g., 1:2; 1:3; 1:4; Winett and Ogletree, 2019).

However, it is necessary to monitor the intensity during and after the training sessions mainly. Thus, the subjective perception of effort (SPE) is more indicated to be used during the practice of exercise, even for older people (Borg, 1982), as well as percentages of heart rate (HR; Tanaka and Melo, 2001), to achieve the better intensity control. In HIIT, monitoring by PSE can offer better responses (Laursen and Buchheit, 2019). Regarding the training monitoring, the use of the OMNI-RES scale can be an excellent tool to control intensity (Silva-Grigoletto et al., 2013). For the elderly, another factor that may offer inefficiency of training monitoring is the use of medications that interferes in cardiac behavior, such as beta-blockers, widespread in this population (Taylor et al., 2019).

Additionally, the practice of exercises to improve overall health condition, the control of training responses (internal load) is important to avoid possible stresses and negative effects on the immune system (Meeusen et al., 2013), mainly in elderly individuals (Nieman et al., 1993). Therefore, the method of monitoring internal load through SPE (Foster et al., 2001) is effective and can be an important ally in preventing metabolic stress, which directly interferes with the immune functions (Joisten et al., 2019). Another important method of monitoring the internal load is through the baseline HR, where constant changes (for more) of the baseline HR values can be considered probable stress and, thus, changes in training prescription must be done (Schneider et al., 2018).

CONCLUSION

Staying physically active during social restriction is essential in promoting health and preventing future chronic conditions resulting from a sedentary lifestyle. In this period of social isolation, medical care and vital social services must be a priority. Thus, the prevention of physical and mental suffering should be a priority on the part of governments and public health authorities, encouraging the maintenance of physical activity during the COVID-19 pandemic.

Summarizing, all physical activity is beneficial, and any practice is better than doing nothing. It is also essential to reduce the sedentary lifestyle and accumulate at least 150 min of moderate-intensity physical activity or 75 min of vigorous-intensity physical activity per week is mandatory.

AUTHOR CONTRIBUTIONS

FS, LS, and SM developed the study concept and wrote the first draft of the manuscript, and the later drafts of the manuscript were adjusted by FS, LS, EM-R, TY, CI, HB, JV, and SM in collaboration. All authors contributed to the article and approved the submitted version.

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BRIEF RESEARCH REPORT
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The Rebooting in Sports and Physical Activities After COVID-19 Italian Lockdown: An Exploratory Study

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The lockdown imposed in Italy to reduce the spread of COVID-19 posited unusual challenges to people practicing sports and physical activities. The rebooting of activities highlighted the need to cope with new behaviors and routines, such as wearing a face mask while exercising. We conducted a web-based survey in Italy at the start of physical activities' rebooting, to investigate how people reacted to the new norms. Participants completed the questionnaires assessing insomnia, regulatory self-efficacy, optimism, mood states, and mental toughness. Age, gender, and environment were assumed as design variables. Results showed that in outdoor activities, the younger females as compared to the older manifest less regulatory self-efficacy, while the younger males manifest more regulatory self-efficacy than the older. In indoor activities, a reversed pattern of regulatory-self-efficacy was observed. Regarding life orientation, younger participants showed less optimism and positive expectation for the future and seem to be more exposed to the unexpected effects of the restrictions: they showed more sleep disturbances, confusion, depression, anger, and fatigue and less vigor and mental toughness than older participants. An understanding of the psychological implications of the rebooting phase can support the enactment of more appropriate behaviors to practice sports and physical activities when living at the time of the coronavirus.

Keywords: COVID-19, physical activity, sports, lockdown, regulatory self-efficacy

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INTRODUCTION

In winter 2019, a new coronavirus (COVID-19) appeared in the world. It is an infectious respiratory disease caused by the airborne SARS-Cov2 virus. The clinical manifestations of COVID-19 are not specific, ranging from asymptomatic infection to severe respiratory failure. An infected person may experience symptoms such as fever, cough, myalgia, fatigue, and dyspnea after an incubation period that can range from about 2 to 14 days. During this time, some infected persons can be contagious. COVID-19 caused hundreds of thousands of deaths and millions of infected people, leading the World Health Organization to classify it as a pandemic in March 2020. Across the world, preventive measures have been taken to limit the spread of the virus, some more restrictive, others more permissive, depending on the nation and on the spread of the disease.

Italy has adopted a series of public health measures aimed at restraining the spread of the virus and limiting contagions, such as self-isolation and social distancing. To ensure these preemptive measures and restrict the movement of the citizens, schools, public places, and businesses were shut down. People have been forced to stay at home to mitigate the transmission of the virus.

The population was allowed to go out only for reasons of primary necessity, for example, to accomplish specific activities (health visits, purchasing medicines or food) or to perform essential work (healthcare and social care operators, police and armed forces, firefighters).

The lockdown affected the life habits of people who unexpectedly have had to change behaviors, commitments, and ways of living and working (Chen et al., 2020; Favieri et al., 2020; López-Bueno et al., 2020a). Sports and physical activities were involved too: gyms, stadiums, pools, dance and fitness studios, physiotherapy centers, parks, and playgrounds were closed, compelling people to find in-home alternatives to exercise (Lesser and Nienhuis, 2020; Maugeri et al., 2020).

Many studies have documented the impact of these prolonged restrictions on the mental and physical health of Italian citizens (Conversano et al., 2020; Di Giuseppe et al., 2020; Favieri et al., 2020; Flesia et al., 2020; Moccia et al., 2020; Rossi et al., 2020; Somma et al., 2020). Most of the studies have highlighted an increase in distress, which affected principally women, younger citizens, patients already suffering from one or more chronic pathologies such as diabetes and cardiovascular disease, or people more exposed to the risk of contagion (i.e., health workers). Insomnia, anxiety, depression, confusion, anger, fear of contagion, and financial insecurity were the symptoms more frequently reported by interviewed participants (Brooks et al., 2020; Casagrande et al., 2020; Mazza et al., 2020; Rossi et al., 2020; World Health Organization [WHO], 2020), in a similar way to people suffering from post-traumatic stress disorder (PTSD) (Brooks et al., 2020; Forte et al., 2020).

During the lockdown, an animated debate has developed about the opportunity to completely prohibit outdoor physical activity or limit it in the neighboring places to home. On one side, safety procedures, such as physical distancing or using personal protective equipment (i.e., mask and gloves), should suggest limiting physical activity only to home-based exercise or to outdoor individual fitness activities as jogging, running, and biking. On the other side, an unintended consequence of the rigid application of the safety measures may be the reduction of physical activity tout court, associated with the mental and physical risks of increased sedentary behavior (Ekelund et al., 2019).

Physically active individuals generally experience less anxiety, stress, depression, and PTSD (Rosenbaum et al., 2011, 2014; Vancampfort et al., 2017; Chekroud et al., 2018). Moreover, a moderate-intensity physical activity can exert a protective role against bacterial and viral infections (Martin et al., 2009) and may enhance the immune function (Dixit, 2020), mainly in less fit subjects or sedentary population. Indeed, physical activity can also prevent some chronic diseases such as diabetes, cancer, cardiovascular diseases, and reduce their more harmful complications (Guicciardi et al., 2019a,b).

The growing scientific evidence related to COVID-19 underlines the importance of maintaining a regular physical activity even during the lockdown, regardless of the age and type of activity previously carried out (Chen et al., 2020; López-Bueno et al., 2020b). Physical activity may promote the release of stress hormones responsible for reducing excessive local inflammation within the respiratory tract. It may also induce the secretion of anti-inflammatory cytokines, modulate T-helper cell population activity, and minimize cell damage and necrosis (Ravalli and Musumeci, 2020).

Some scholars have documented the adverse effects of lockdown in Italian athletes and in the more active population (Chirico et al., 2020; Di Fronso et al., 2020; Maugeri et al., 2020). During the prolonged lockdown, the levels of physical activity of people classified before the COVID-19 as highly and moderately active drastically decreased; instead, individuals classified before the COVID-19 as low active significantly increased total weekly physical activity energy expenditure during the quarantine (Di Fronso et al., 2020). This pattern could be probably due to the greater housework activities carried out by people forced to stay at home. More active people, females and younger adults, reported more psychological discomfort associated with the reduction of levels of physical activity (Maugeri et al., 2020). Comparing the perceived stress and the psychobiosocial states of Italian athletes before and during the lockdown, Di Fronso et al. (2020) found that female and novice athletes reported scores on perceived stressors and dysfunctional psychobiosocial states higher than male and elite/expert athletes, respectively.

Using an integrated approach, Chirico et al. (2020) investigated psychological determinants of the physical activity behavior, when the first official lockdown was adopted in Italy (March 11, 2020), which had permitted about a dozen of days to perform outdoor physical activities and sports while maintaining social distancing.

In May 2020, after 2 months of lockdown, Italy, like the rest of the world, was also allowed to resume sports and physical activities. This rebooting phase was conditioned by various restrictions such as physical distancing, the use of personal protective equipment (mask and gloves), sanitizers, and the need to isolate personal equipment and clothes in closed bags. These restrictions helped to understand that the rebooting phase could be problematic as it is not merely a matter of restoring usual sport and physical activities but adapt old habits to the new regulation, also during sport or leisure activities. Sports and physical activities, regardless of the type and level at which they were previously practiced affect multiple psychological variables related to changing circumstances and habits due to COVID-19. The "new normality" requires a subtle and implicit change in everyday routines, which affects the resumption of sports and physical activities (Drury et al., 2020; Hughes et al., 2020). For example, having to train in a gym, pool, or fitness studio by sharing space with other people who may be contagious can affect the individual's self-regulatory efficacy, anxiety, or the fear of contagion, enhanced by physical proximity.

The objective of this study is to gain an understanding of the impact of sports and physical activities rebooting in an Italian sample of adult individuals. Specifically, we aim to explore differences due to the gender, age, and environment on multiple psychological variables. Notably, we hypothesize that females, younger individuals, and individuals who practice indoor physical activities have more remarkable difficulties in rebooting of sports and physical activities than males, older individuals and those who practice outdoor physical activities.

Starting from these hypotheses, we investigated these differences in sleep disturbances, regulatory self-efficacy, optimism, mood states, and mental toughness. We expected that a good rebooting of physical activities could be associated with low levels of insomnia, high levels of regulatory self-efficacy, positive moods, optimism, and mental toughness.

MATERIALS AND METHODS

Sample

To take part in the study, participants had to be over the age of 18 and had to read and write in Italian to complete the online survey. Participants were recruited through snowball sampling using social media, email, and informal network.

The link allowing access to the survey broadcasted through forums, personal blogs, and social networks (Twitter, Whatsapp, Facebook, and Linkedin) and people that were practicing different sports and physical activities were invited to complete it. Participants were informed about the aims of the research and chose to participate voluntarily and anonymously. Data were collected from June 1 to 30, 2020. All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the Ethics Committee of the University of Cagliari approved the protocol (n.0161970/2020). The completion of the online survey lasted about 10 min.

Although 405 participants enrolled in the online survey, 72 questionnaires (18%) were incomplete and therefore removed from the dataset. The study consisted of the resultant participant sample of 333 active Italian adults, practicing different sports and physical activities, as soccer, basket, dance, running, and bodybuilding prevalently for at least 2 years with a frequency of two or more times a week. Of those 333, 41% were females, 61% were younger adults (under 30), and 64% were individuals practicing indoor sports and physical activities (**Table 1**).

TABLE 1 | Descriptive statistic of the sample.

Characteristics	Group	*N*(%)
Gender	Male	195 (59%)
	Female	138 (41%)
Age range	Younger (<30)	202 (61%)
	Older (≥30)	131 (39%)
Environment	Indoor	214 (64%)
	Outdoor	119 (36%)
Area	Countryside	103 (30.9%)
	Suburban area	37 (11.1%)
	Urban city	192 (57.7%)
	Missing	1 (0.3%)
Occupation	Student	161 (48.4%)
	Unemployed	15 (4%)
	Employed	149 (44.7%)
	Retired	8 (2.4%)
Sports and physical activity practice	<2 years	38 (11.4%)
	≥2 years	295 (88.6%)
Training	Once a week	17 (5.1%)
	2–3 times a week	146 (3.8%)
	More than 3 times a week	170 (51.1%)
Covid examination	Yes	38 (11.4%)
Covid positive	Yes	3 (0.9%)
Deaths among infected acquaintances	Yes	19 (5.7%)

Measures

Participants completed questionnaires using an online survey software (Lime Survey) at the beginning of phase 2 ("Rebooting"), which followed the Italian lockdown lasting almost 3 months (from March to May 2020). The survey consists of two parts: the first one provided sociodemographic data (gender, age, province of residence, occupation) and some information about the physical activity performed before and during the lockdown. The second one comprised several scales now detailed.

The *Insomnia Severity Index* (ISI) is a short questionnaire developed for an easy and brief clinical assessment of insomnia severity (Bastien et al., 2001). The ISI comprises six items rated on a point Likert scale, ranging from 0 to 4 and anchored differently to the content of the item: for example, from "no problem" to "very severe" (items 1, 2, 3), from "very satisfied" to "very dissatisfied" (item 4), and from "not at all" to "very much" (items 5, 6, 7). The ISI assesses the severity of sleep onset, the severity of sleep maintenance, early morning awakenings, satisfaction level with current sleep pattern, interference with daily living, noticeability of impairment due to sleep difficulty, and level of distress caused by the sleep problem. The total score of the questionnaire is partitioned in the following categories: 0–7, no significant insomnia; 8–14, subthreshold insomnia; 15–21, moderate insomnia; and 22–28, severe insomnia. The cutoff value of 15 represents the threshold for a diagnosis of clinically relevant insomnia. The ISI is a worldwide instrument used for the assessment of insomnia; we used the Italian validated version of the ISI (Castronovo et al., 2016). In our study, the Cronbach's alpha was 0.75.

The *Life Orientation Test-Revised* (LOT-R) (Scheier et al., 1994) assesses individual differences in generalized optimism and positive expectations for future outcomes. The LOT-R comprises three positively worded items measuring optimism (Items 1, 4, 10), three negative framed items measuring pessimism (Items 3, 7, 9), and four fillers (Items 2, 5, 6, 8). The items were measured on a five-point Likert scale ranging from 1 "strongly disagree" to 5 "strongly agree." The scores related to negatively worded items that measured pessimism were reversed. We used the Italian validated version of LOT-R (Giannini et al., 2008). In our study, the Cronbach's alpha was 0.78.

The *Italian Mood Scale* (ITAMS) was developed by Quartiroli et al. (2017) for use in sport and exercise to evaluate six mood states: anger, confusion, depression, fatigue, tension, and vigor. The ITAMS comprises 24 words expressing feelings. The feelings are rated on a five-point Likert scale, ranging from 0 "not at all" to "extremely." Each mood state is assessed through six items: anger (items 7, 11, 19, 22), confusion (items 3, 9, 17, 24), depression (items 5, 6, 12, 16), fatigue (items 4, 8, 10, 21), tension (1, 13, 14, 18), and vigor (items 2, 15, 20, 23). In our study, the Cronbach's alpha was 0.91.

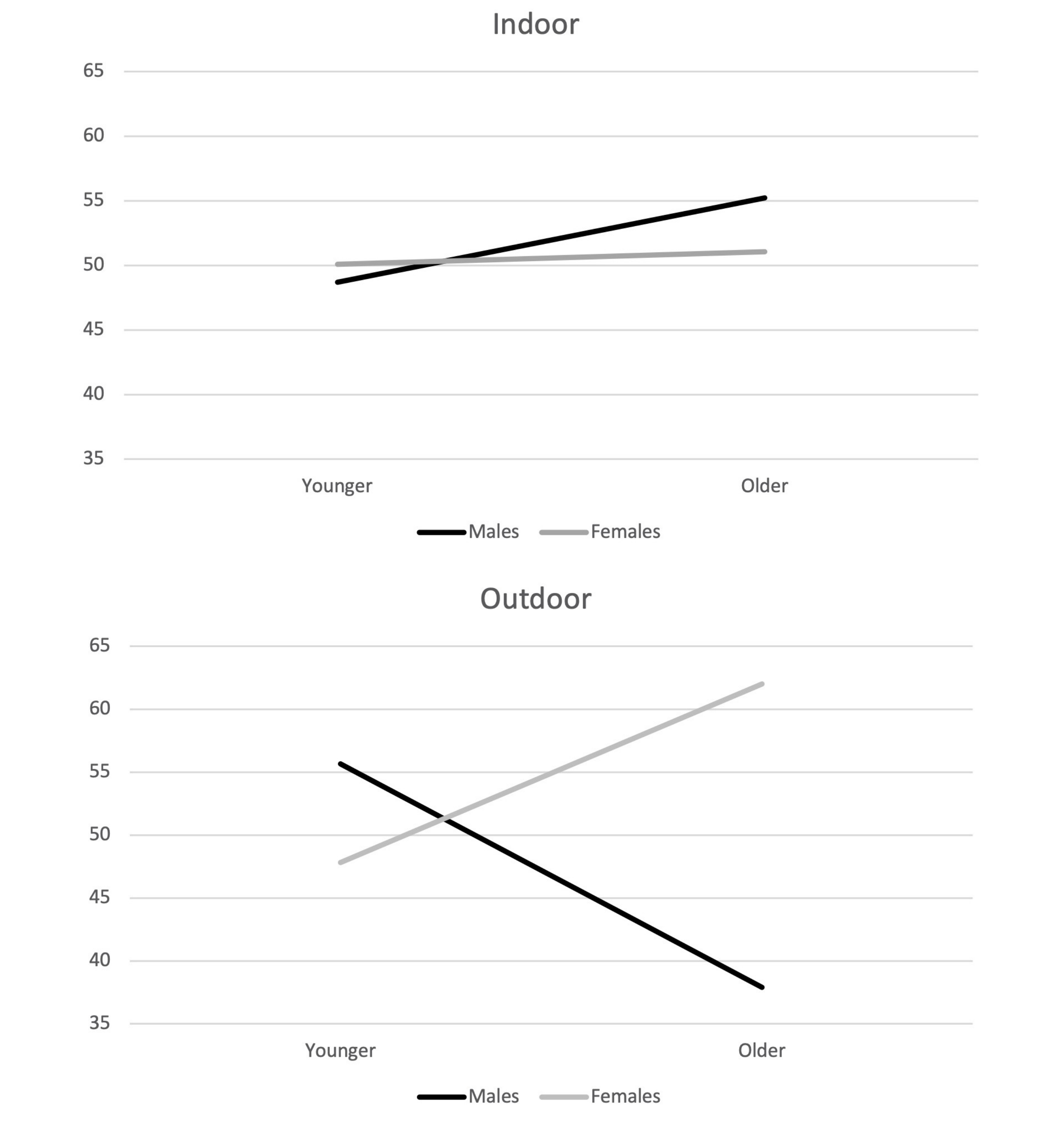

FIGURE 1 | Mean differences in regulatory self-efficacy, based on environment, gender, and age.

The *Mental Toughness Questionnaire* (MTQ-10) assesses mental toughness and its facets: challenge, commitment, control, and confidence (Papageorgiou et al., 2018). The questionnaire comprises 10 items that assess, respectively: challenge (items 3, 6), commitment (items 2, 7), control (items 1, 8, 9), and confidence (4, 5, 10). All items are rated on a five-point Likert scale ranging from 1 "strongly disagree" to 5 "strongly agree". The Italian version of MTQ-10 was used (L. Girelli, personal communication, May 28, 2020). In our study, the Cronbach's alpha was 0.80.

The *Regulatory Self-Efficacy Scale for Sport Rebooting* (RSE-SR) was purposely developed by the research team, to assess the regulatory self-efficacy of athletes facing the rebooting of sports activities after lockdown. Based on Bandura's recommendation

(Bandura, 1986), RSES-SR comprises 11 items stemming with "I am confident that I can regularly practice physical or sporting activity when . . .". The items depict different situations where safe and healthy behaviors must be performed in sports facilities (i.e., "I must avoid using the locker room" or "I don't have enough time to follow the safety procedures"). The complete list of the original items is reported in the **Supplementary Material**. All items are rated on a 10-point Likert scale ranging from 1 "not at all confident" to 10 "fully confident." In a pilot study conducted by the research team through a focus group, the RSES-SR showed good content validity. In our study, the Cronbach's alpha was 0.88.

Data Analysis

We used SPSS software Version 25.0 (SPSS Inc., Chicago, IL, United States) for all statistical analyses. The data were initially checked for multivariate outliers and normal distribution through the Kolmogorov–Smirnov test, with the Lilliefors correction. A MANOVA was used to assess if gender (male vs. female), age (younger vs. older), and environment (indoor vs. outdoor) affect sleep, regulatory self-efficacy, optimism, mood, and mental toughness. Effect sizes were calculated using partial eta square (η_p^2) (Lakens, 2013), with 0.01, 0.06, and 0.14 considered small, medium, and large effects, respectively (Cohen, 1988). Significance was set at $p < 0.05$.

RESULTS

Table 1 displays the demographic and descriptive characteristics of the sample.

About the regulatory self-efficacy, a statistically significant interaction between gender, age, and environment emerged [$F_{(1,321)} = 8.87$, $p = 0.003$] (**Figure 1**).

In outdoor physical activities, younger females showed less regulatory self-efficacy than older females, while younger males showed more regulatory self-efficacy than older males. In indoor physical activities, both genders showed similar scores of regulatory self-efficacy related to age, but the patterns between males and females were slightly inverted. A statistically significant interaction between environment and age emerged in optimism and positive expectations for future [$F_{(1,321)} = 5.74$, $p = 0.017$] (**Figure 2**).

Older individuals practicing indoor physical activities showed more optimism and positive expectations for the future, compared to younger ones. No age differences in life orientation emerged in individuals practicing outdoor physical activities.

Moreover, main statistically significant effects were found only for age in insomnia, mental toughness, and mood states (**Table 2**).

Younger adults, compared to older ones, showed more insomnia and less mental toughness. In mood states, younger ones showed more anger, confusion, depression, fatigue, tension, and less vigor (**Table 3**).

However, all statistically significant effects appeared as a small size, excluding the impact of age in mental toughness, confusion, and fatigues that showed a medium effect size.

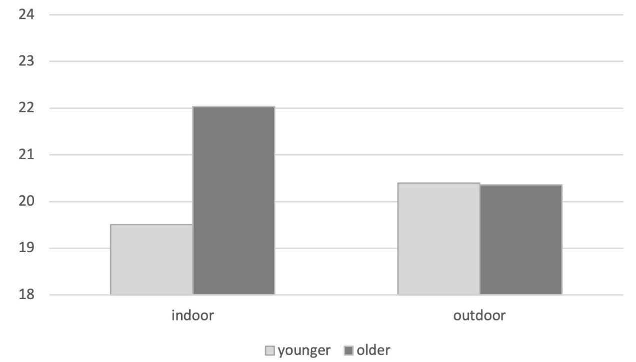

FIGURE 2 | Mean differences in optimism and positive expectations for the future, based on environment and age.

TABLE 2 | Main effects of age (estimated means and standard error).

Psychological variables	Younger	Older	p-value	Effect size
Insomnia	7.37 ± 0.32	5.92 ± 0.52	**0.018**	0.017
Life orientation	19.92 ± 0.36	21.22 ± 0.59	0.754	0.000
Mental toughness	29.65 ± 0.42	33.47 ± 0.69	**0.000**	0.065
Mood states	55.28 ± 1.03	47.22 ± 1.70	**0.000**	0.048
Regulatory self-efficacy	50.55 ± 1.63	51.54 ± 2.69	0.062	0.011

The bold font indicates the significance of the result.

TABLE 3 | Mean differences (and standard deviation) in mood states by age.

Mood states	Younger	Older	p-value	Effect size
Anger	8.08 ± 3.56	6.96 ± 2.96	**0.003**	0.026
Confusion	8.78 ± 3.82	6.72 ± 3.08	**0.000**	0.075
Depression	7.05 ± 3.50	5.79 ± 2.50	**0.000**	0.037
Fatigue	9.08 ± 3.75	7.09 ± 2.75	**0.000**	0.076
Tension	9.47 ± 4.17	7.51 ± 3.20	**0.001**	0.059
Vigor	12.57 ± 3.08	13.65 ± 2.65	**0.001**	0.032

The bold font indicates the significance of the result.

DISCUSSION

The main aim of our study was to evaluate the contribution of different psychological variables to the rebooting of sports and physical activities. To achieve this goal, gender, age, and environment were tested separately, and in their interactions, to assess their effects on insomnia, regulatory self-efficacy, optimism, mood states, and mental toughness. The results of our study partially confirm the initial hypotheses.

Regulatory self-efficacy seems to be a useful predictor of the involvement in sports and physical activities in the rebooting phase. However, its contribution appears to act differently among males and females, in relation to age and to the environment where people regularly performed physical activities. In outdoor physical activities, younger females showed lower regulatory self-efficacy than older females, while younger males showed higher self-efficacy than older males. These differences are reduced and inverted in indoor physical activities. Different explanations could be advanced about these results, based on motivational and situational variables. Males practice physical activity mainly for social and competitive reasons and prefer to practice sports, outdoor and indoor physical activities in public places like the gym and fitness clubs. Females are more inclined to exercise in home-setting, practicing aerobics, yoga dancing, Pilates or circuits with planks, squats, and jumping jacks (Maugeri et al., 2020). Younger females, compared to older ones, might have considered outdoor physical activities and public spaces as unsafe places to practice sports and physical activity during the rebooting phase. Indeed, at the beginning of the resumption phase, even though outdoor physical activities were allowed, it was necessary to avoid gatherings, keep social distances, and use personal protective equipment like masks and gloves. These safety measures may have heightened the young women's sense of personal insecurity in open environments. On the indoor physical activities, older people showed more optimism and positive expectations than younger people, independently from gender. This result can be explained by the different experience related to age, but also through a higher fear of contagion, which affected the younger people than older people, during the Italian lockdown (Casagrande et al., 2020; Moccia et al., 2020). In the rebooting phase, indoor physical activities required more precautions than outdoor physical activities because of the interdiction of showers or access to locker rooms to limited numbers of people at the same time. These new habits may have reduced the positive expectations of younger people who tend to be more inclined to share experiences, clothes, and spaces than older people.

Contrary to our hypothesis, only age affected most of the psychological variables considered. Younger adults showed more sleep disturbances, confusion, depression, anger, and fatigue, and less vigor and mental toughness than older people. While these differences were expected and confirmed by previous findings (Forte et al., 2020; Somma et al., 2020), we have to notice the absence of gender differences repeatedly found in previous studies conducted in Italy or Spain in the confinement context (López-Bueno et al., 2020a,b; Mazza et al., 2020; Rossi et al., 2020). Sports and physical activities can reduce gender gap also in reported symptoms other than in positive functioning (Health, 2019).

The present research has a few limitations: our exploratory study, based on a self-administered web survey, restricted the participation to the survey only to a convenience sample of people equipped with an Internet connection (Couper, 2000). Furthermore, self-report questionnaires evaluate subjective characteristics and, as is well known, can be biased from social desirability and acquiescence (Meleddu and Guicciardi, 1998). However, the anonymity and the short duration of the survey may have limited these biases. These limitations notwithstanding, to our knowledge, this is the first study investigating the contribution of psychological variables just at the resumption of sports and physical activity in Italy, after a prolonged lockdown, lasting about 3 months.

COVID-19 is not only a novel outbreak circulating worldwide but represents one of the most extensive and most lasting natural experiments conducted to date (Petticrew et al., 2005). It affected the lives of thousands in profound ways and is driving multiple changes in life habits, as wearing or not a face mask or complying with tracing strategies (Jetten et al., 2020). We focused on change in sports and physical activity's practices and in the psychological variables that can predict a better fit to the new routines. The rebooting phase made it clear that the barriers to keep an active lifestyle were raised. Activities previously experienced as salutary, for example, those conducted in natural environments, now raise concerns and fears, especially for younger women. Indoor physical activities often practiced to increase friendships and sociability have become a cause for apprehension, especially by the younger people, males and females, who have grasped a reason for pessimism in the limitations of the spaces of activity, in the regulation of accesses, and the prohibition of exchanges of equipment. It is too early to understand whether these reactions are temporary or permanent, but at present, young people, as a whole, seem to be more exposed to the unexpected effects of the restrictions implemented to limit the spread of the virus during the rebooting of sports and physical activities. These results confirm the needs to harness psychology as a critical element to understand and incentive health and physical activity behaviors in a changing world. Considering these differences can help to support new habit formation and to enact more appropriate actions to practice sports and physical activities when living at the time of Coronavirus.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of the University of Cagliari. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MG and RP were responsible for the study, design, methodology, data analysis, and drafting and editing of manuscript. Both authors have read and agreed to the published version of the manuscript.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.607233/full#supplementary-material

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Chinese College Students Have Higher Anxiety in New Semester of Online Learning During COVID-19: A Machine Learning Approach

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The COVID-19 pandemic has caused tremendous loss starting from early this year. This article aims to investigate the change of anxiety severity and prevalence among non-graduating undergraduate students in the new semester of online learning during COVID-19 in China and also to evaluate a machine learning model based on the XGBoost model. A total of 1172 non-graduating undergraduate students aged between 18 and 22 from 34 provincial-level administrative units and 260 cities in China were enrolled onto this study and asked to fill in a sociodemographic questionnaire and the Self-Rating Anxiety Scale (SAS) twice, respectively, during February 15 to 17, 2020, before the new semester started, and March 15 to 17, 2020, 1 month after the new semester based on online learning had started. SPSS 22.0 was used to conduct *t*-test and single factor analysis. XGBoost models were implemented to predict the anxiety level of students 1 month after the start of the new semester. There were 184 (15.7%, Mean = 58.45, SD = 7.81) and 221 (18.86%, Mean = 57.68, SD = 7.58) students who met the cut-off of 50 and were screened as positive for anxiety, respectively, in the two investigations. The mean SAS scores in the second test was significantly higher than those in the first test ($P < 0.05$). Significant differences were also found among all males, females, and students majoring in arts and sciences between the two studies ($P < 0.05$). The results also showed students from Hubei province, where most cases of COVID-19 were confirmed, had a higher percentage of participants meeting the cut-off of being anxious. This article applied machine learning to establish XGBoost models to successfully predict the anxiety level and changes of anxiety levels 4 weeks later based on the SAS scores of the students in the first test. It was concluded that, during COVID-19, Chinese non-graduating undergraduate students showed higher anxiety in the new semester based on online learning than before the new semester started. More students from Hubei province had a different level of anxiety than other provinces. Families, universities, and society as a whole should pay attention to the psychological health of non-graduating undergraduate students and take measures accordingly. It also confirmed that the XGBoost model had better prediction accuracy compared to the traditional multiple stepwise regression model on the anxiety status of university students.

Keywords: COVID-19, college students, anxiety, new semester, machine learning, XGBoost model

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INTRODUCTION

COVID-19 has spread rapidly around the world and the number of people who were affected has increased dramatically since early 2020 (World Health Organization, 2020). The unprecedented swift and strict quarantine measures starting from late January in China have kept a huge number of people in isolation or socially distancing, and hence has influenced their mental health and psychological resilience (Brooks et al., 2020; Wang et al., 2020a; Xiang et al., 2020). Many studies have noted the psychological impact of COVID-19 such as post-traumatic stress symptoms, confusion, anger, helplessness, fear, depression, and anxiety, etc., in the general population during the initial phase of the COVID-19 outbreak in China (Chew et al., 2020; Li et al., 2020; Qiu et al., 2020; Wang et al., 2020a,b).

During school closures, college students were quarantined and attended their new semester remotely through online learning, and experienced different levels of psychological pressure (Cao et al., 2020; Wang and Zhao, 2020). Bruffaerts et al. (2018) found that university students were more vulnerable and easily affected by a pandemic. Previous studies have reported a higher level and prevalence of anxiety among college students during an epidemic (Jia et al., 2003; Chen et al., 2004; Li et al., 2011; Yang et al., 2015). Chang et al. (2020) investigated 3881 college students in Guangdong province in China during the epidemic of COVID-19 and found that 26.6% of students had different levels of anxiety (23.19% mild, 2.71% moderate, and 0.70% severe) and depression was detected in 21.16% of them. Cao et al. (2020) also reported that 24.9% of medical college students experienced different levels of anxiety during COVID-19. However, there was no research on how their psychological stress and anxiety changed during the outbreak.

There were many factors found to be related to anxiety, Wheaton et al. (2012) reported that health anxiety, contamination fears, and disgust sensitivity were significant predictors of swine flu-related anxiety during the H1N1 influenza pandemic of 2009–2010. Social distancing, worries about their own health and the health of their families, stay-at-home orders, and limited physical interaction with others all counted toward their anxiety and stress (Zuckerman, 1989; Martin, 2010; Cao et al., 2020). Faramarzi et al. (2014) demonstrated that moral intelligence and identity status both contributed to the mental health problems of healthcare students. They used regression analysis or a stepwise model of multiple regression analysis to assess the correlation between different variables to investigate psychological characteristics. However, the predictor variables only accounted for 34% or 22.7% of the variance (Wheaton et al., 2012; Faramarzi et al., 2014). In this article, we also aim to use machine learning to predict the nonlinear relationship between independent and dependent variables in the prediction of psychological status.

Machine learning can deal with big data in high velocity and a variety of forms, so it has been widely implemented in accurately predicting mental health problems, such as anxiety, depression, obsessive-compulsive disorder (OCD), and post-traumatic stress disorder (PTSD) (Kumar et al., 2020; Silveira et al., 2020; Tennenhouse et al., 2020; Xing et al., 2020); classification or diagnosis (Peng et al., 2013; Thabtah, 2018); predicting self-harm and imputing its presence as a missing phenotype (Kumar et al., 2020); and also in distinguishing patients with bipolar disorder from healthy individuals with neuroimaging (Mwangi et al., 2016), neurocognitive data (Wu et al., 2016, 2017a,b), and serum biomarkers (Pinto et al., 2017). This technique includes pattern recognition through the use of complex computational algorithms fed by large data and has the potential to create a paradigm shift in the prediction and stratification of clinical outcomes (Passos et al., 2016; Librenza-Garcia et al., 2017; Silveira et al., 2020). As reported by Ge et al. (2020), machine learning can be used in predicting later clinical outcomes by combining multiple pieces of information from different domains in an effective way and allowing the identification of the most predictive combination of domains. Compared to the traditional statistical prediction models, machine learning approaches may also have advantages in accounting for complex relationships between variables that may not have been previously identified and preventing potentially inaccurate model specifications (Tennenhouse et al., 2020). When there are larger and more complex variables, machine learning becomes a useful technique to disentangle variables associated with outcomes (Iniesta et al., 2016; Dwyer et al., 2018).

This article aims to investigate the prevalence and severity of anxiety among Chinese non-graduating college students and compare the difference between the anxiety status before and 1 month after the start of the new semester of online learning during COVID-19. We also test the ability of the XGBoost model to predict the anxiety level and change of anxiety level 4 weeks after the start of new semester based on the student scores we collected at the start of the new semester. This study is the first to compare the anxiety level of college students before and after the start of a new semester during the COVID-19 pandemic. Our hypothesis is that more non-graduating college students will have a higher level of anxiety in the new semester during COVID-19.

MATERIALS AND METHODS

Participants

A total of 3800 non-graduating college students aged between 18 and 22 from a top multidisciplinary and research-oriented university directly under the jurisdiction of the Ministry of Education in North China were invited to attend two studies during February 15 to March 17, 2020. In total, 1172 students (female: male = 1.56:1) responded to both studies and the response rate was 30.84% (3611 students attended the first study, however, only 1172 participated in the second one). The students were from 26 colleges and schools within the university which were then categorized into arts or sciences institutions. The participants came from 34 provincial-level administrative units and 260 cities in China, which also represented the distribution of the enrolled students from different regions of China at this university. There were also 36 students from Hubei province and one from Wuhan city, where the majority of cases with COVID-19 were identified during the pandemic in China.

Measures

The questionnaire package used in these two studies consisted of three components: a sociodemographic questionnaire that required each student to provide their gender, year of study, city or province they were living in, major and colleges or schools; a measure of student anxiety (the Self-Rating Anxiety Scale); and an open question about their most recent concerns.

The Self-Rating Anxiety Scale (Zung, 1971)

The Self-Rating Anxiety Scale (SAS), developed by Zung (1971), was used to assess the subjective feeling of anxiety in the two studies. The SAS is a 20-item self-report assessment device built to measure anxiety levels. Each question is scored on a Likert-type scale of 1–4 (based on these replies: "a little of the time," "some of the time," "a good part of the time," and "most of the time"). Some questions were negatively worded to avoid the problem of set response. The overall assessment was calculated by the total score. Among the 20 items, 5 were reverse scored. The total raw scores ranged from 20 to 80 and then needed to be converted to an "Anxiety Index" score which was equal to 1.25 × raw score and became the standard score which was then used to determine the clinical interpretation of the level of anxiety. The validity and reliability of the instrument has been found to be adequate among Chinese participants. According to the research on the 1158 participants, the levels of anxiety were classified as 25–49 = normal range; 50–59 = mild anxiety levels; 60–69 = moderate anxiety levels; and 70 and above as severe anxiety levels. The mean and standard deviation (SD) of the participants in the two studies were calculated and listed with the number of participants in each group in **Table 1**.

Procedure

This research was registered and approved by the related ethical committee at the university. The non-graduating college students were invited to participate in the two studies, respectively, during February 15 to 17, 2020, right before the new semester started and March 15 to 17, 2020, 1 month after the new semester based on online learning started. The content of the two studies were the same. Those who agreed in writing to participate were each given an online questionnaire package to complete and return to the researchers.

Statistical Analysis

Statistical analysis was performed using the SPSS 22.0 software. The participating students were divided into different groups according to their SAS scores. Measurement data were expressed as mean and SD. Counting data were expressed by the number of people (%). The descriptive statistics were conducted to illustrate the demographic and other selected characteristics of the participants. The analysis of the relationship between sex, major, grade, region, and anxiety initially used the two-sample t-test. The correlation between the SAS scores and confirmed affected cases in different regions were analyzed by Pearson's product-moment correlation analysis, and $P < 0.05$ on double sides was statistically significant.

We also used XGBoost (Chen and Guestrin, 2016), a scalable machine learning system for tree boosting, to establish the prediction model of student anxiety. XGBoost is a tree ensemble model using K additive functions to predict the output. The base classifier of XGBoost are classification and regression trees (CART). The trees are learned by defining an objective function and optimizing it. The objective function is determined by the following equation: $Obj = \sum_{i=1}^{n} l\left(y_i, \hat{y}_i^{(t)}\right) + \sum_i^t \Omega\left(f_i\right)$. It contains a training loss and a regularization. In our model, there were 20 items in SAS and three variables: gender, major, and grade. We also used stepwise multiple regression to establish the prediction model, and compared the prediction performance.

RESULTS

Overall SAS Mean Scores in the Two Tests

The results demonstrated in **Table 1** show that the mean SAS score in the second study was significantly higher than in the first study ($P \leq 0.001$). There were 184 (15.7%, Mean = 58.45, SD = 7.81) and 221 (18.86%, Mean = 57.68, SD = 7.58) students who met the cut-off of 50 and were screened as positive for anxiety, respectively, in the two investigations. Both males ($P < 0.05$) and females ($P \leq 0.001$) had a significantly higher level of anxiety in the second study, however, there were no differences on the level of anxiety for those who were identified as anxious in the two studies ($P > 0.05$). It was also found that students majoring in arts and sciences had a significantly higher level of anxiety in the second study than in the first study ($P \leq 0.001$), but there were not any statistically significant differences among those who were identified as anxious ($P > 0.05$), though the numbers of participants who were screened as positive in the second study were more than in the first study.

Group Comparisons in the Two Tests

Table 1 also shows the comparison of the SAS mean scores in different grades in the two studies. Among freshmen, their mean SAS scores were significantly higher in the second study than in the first study ($P \leq 0.001$), and it was also true in females ($P = 0.001$) and those majoring in sciences ($P \leq 0.001$) but not in males ($P = 0.15$) and those majoring in arts ($P = 0.32$). Among sophomore students, their mean SAS scores were significantly higher in the second study than in the first study ($P = 0.001$), and also among those majoring in arts ($P < 0.05$) but not in males ($P = 0.395$), females ($P = 0.325$), and those majoring in sciences ($P = 0.394$). Among junior students, there were no significant differences in the mean SAS scores between the two studies ($P > 0.05$). For those who were identified as anxious in both studies, there were no statistically significant differences in the SAS mean scores among participants in each grade ($P > 0.05$).

SAS Score Ranges in the Two Tests

The SAS score ranges of the participants in the two tests were also calculated. There were 184 (15.7%) and 221 (18.86%) students who met the cut-off of 50 and had different levels of anxiety,

TABLE 1 | *T*-test in the first and second tests.

		1st test mean (SD) subtotal	2nd test mean (SD) subtotal	*T*-test	*P*-value
Total	Subtotal	40.39 (9.98) 1172	40.77 (10.51) 1172	−11.829054	0.000*
	Anxious	58.45 (7.81) 184	57.68 (7.58) 221	2.2251471	0.034*
Males	Subtotal	40.10 (10.88) 458	40.84 (11.28) 458	−2.5731238	0.015*
	Anxious	59.98 (8.93) 74	58.09 (8.81) 96	0.53502706	0.345
Females	Subtotal	40.57 (9.36) 714	40.73 (10.00) 714	−5.500983	0.000*
	Anxious	57.42 (6.81) 110	57.37 (7.14) 125	0.07180205	0.397
Arts	Subtotal	40.73 (9.82) 581	41.25 (10.17) 581	−10.136612	0.000*
	Anxious	58.46 (7.63) 90	57.81 (7.00) 108	0.5537752	0.342
Sciences	Subtotal	40.05 (10.13) 591	40.31 (10.83) 591	−4.5404517	0.000*
	Anxious	58.44 (8.03) 94	57.56 (8.16) 113	0.53794686	0.345
Freshmen		40.07 (09.91) 729	40.44 (10.30) 729	−9.71069	0.000*
	Males	39.95 (10.98) 276	40.48 (11.09) 276	−1.39987	0.150
	Females	40.14 (09.20) 453	40.42 (09.79) 453	−3.65373	0.001*
	Arts	40.79 (10.17) 381	40.89 (10.04) 38111111	−0.66332	0.320
	Sciences	39.29 (09.56) 348	39.95 (10.56) 348	−4.3897	0.000*
Sophomore		40.77 (09.92) 312	41.42 (10.89) 312	−3.60757	0.001*
	Males	40.26 (10.94) 125	40.48 (11.81) 125	−0.13441	0.395
	Females	41.12 (09.18) 187	41.36 (10.26) 187	−0.64179	0.325
	Arts	40.75 (09.01) 157	41.89 (10.30) 157	−2.15881	0.039*
	Sciences	40.80 (10.79) 155	40.95 (11.47) 155	−0.1488	0.394
Junior		41.22 (10.51) 131	41.09 (10.81) 131	0.124503	0.396
	Males	40.46 (10.39) 57	40.48 (11.09) 57	−0.00369	0.399
	Females	41.81 (10.64) 74	41.06 (10.66) 74	0.222458	0.389
	Arts	40.15 (09.63) 43	42.09 (10.90) 43	−0.29124	0.382
	Sciences	41.75 (10.93) 88	40.60 (10.79) 88	0.4133	0.366
Those anxious	Freshmen	58.30 (7.94) 112	57.35 (7.04) 131	1.113449	0.214
	Sophomore	58.23 (8.04) 50	57.64 (7.96) 70	0.122947	0.395
	Junior	59.72 (6.80) 22	60.00 (9.63) 20	−0.00658	0.396

**P < 0.05.*

respectively, in the two studies. Such as, there were more students identified with mild anxiety in the second study (N = 151, 12.88%) than in the first study (N = 117, 9.98%); roughly the same number of students with moderate anxiety; but more students with severe anxiety in the second study (N = 18, 1.54%) than the first one (N = 13, 1.11%). A total of 109 students (9.30%) were identified as anxious in both studies. Among male students, there were 74 (16.16%) in the first test and 96 (20.96%) in the second test that met the cut-off of 50; and among females, 110 (15.41%) and 125 (17.51%) were identified as anxious, respectively, in the two tests, which showed an increase of males and females who were anxious 1 month after the start of the new semester. Similar results were also found among students who were majoring in arts and sciences, among freshmen and sophomore, but not junior students.

As mentioned in *Participants,* there were 36 students from Hubei province, among whom one was from Wuhan city. The student from Wuhan city was screened as positive for anxiety in the second study (SAS = 51.25) but not in the first study (SAS = 40). Among all the 36 students from Hubei province, where the majority of affected cases of COVID-19 were confirmed in China, eight students (22.22%) had SAS scores higher than 50 (6 at the mild and 2 at the moderate level) in the first study and 12 students (33.33%) met the cut-off of 50 (10 at the mild, 1 at the moderate, and 1 at the severe level) in the second study. Seven students (19.44%) were identified as anxious in both studies and one had a moderate level of anxiety in the first study but was normal in the second study. Fourteen students (38.89%) had higher SAS scores in the second study than in the first study.

TABLE 2 | Self-Rating Anxiety Scale (SAS) mean scores of participants who were identified as anxious in the two tests (number, mean, and SD).

Mean (SD)	Grade	Freshmen	Sophomore	Junior	Total
Total	1st subtotal	112	50	22	184
	1st	58.30 (7.94)	58.23 (8.04)	59.72 (6.80)	58.45 (7.81)
	2nd subtotal	131	70	20	221
	2nd	57.35 (7.04)	57.64 (7.96)	60.00 (9.63)	57.68 (7.58)
Males	1st subtotal	44	20	10	74
	1st	60.17 (9.03)	60.50 (9.94)	58.13 (6.67)	59.98 (8.93)
	2nd subtotal	57	29	10	96
	2nd	57.63 (7.59)	58.58 (9.17)	59.25 (8.82)	58.09 (8.81)
Females	1st subtotal	68	30	12	110
	1st	57.10 (6.95)	56.71 (6.21)	61.04 (6.91)	57.42 (6.81)
	2st subtotal	74	41	10	125
	2nd	57.13 (6.59)	56.98 (7.02)	60.75 (10.80)	57.37 (7.14)
Arts	1st subtotal	64	22	4	90
	1st	58.75 (8.12)	57.05 (6.23)	61.56 (6.32)	58.46 (7.63)
	2st subtotal	65	35	8	108
	2nd	58.00 (6.97)	57.18 (6.23)	59.06 (7.90)	57.81 (7.00)
Sciences	1st subtotal	48	28	18	94
	1st	57.71 (7.74)	59.15 (9.22)	59.31 (7.01)	58.44 (8.03)
	2st subtotal	66	35	12	113
	2nd	56.70 (7.10)	58.11 (8.89)	60.63 (10.93)	57.56 (8.16)

SAS Scores of Participants Who Were Identified as Anxious in the Two Tests

Table 2 demonstrates the SAS mean scores and numbers of participants who were identified as anxious. The SAS mean scores were significantly lower in the second study (Mean = 57.68, SD = 7.58) than in the first study (Mean = 58.45, SD = 7.81) ($P < 0.05$), though the numbers of anxious participants in the second study (N = 221) were more than in the first study (N = 184). There were more males, females, and students majoring in arts and sciences who met the cut-off of anxiety in the second study than in the first study, though their mean SAS scores, respectively, were not significantly different in the two studies ($P > 0.05$). As shown in **Table 2**, the majority of participants (N = 729, 62.2%) were freshmen. The number of sophomore and junior students who were anxious were 312 (26.62%) and 131 (11.18%) respectively, however, there were no significant differences found in the SAS mean scores among the anxious participants in each grade ($P > 0.05$). In both the first and second academic year, there were more students identified as anxious in the second study than in the first study, but roughly the same numbers of anxious participants among junior students.

XGBoost Prediction Model

Scikit-learn, also known as sklearn, is an open source library for machine learning based on Python that supports four machine learning algorithms: classification, regression, reduction, and clustering. We applied the XGBClassifier function of the XGBoost module in the sklearn library.

In this prediction model, the features of participants in the first test can forecast the anxiety levels (normal, mild, moderate, and severe) and changes of anxiety levels (increased, decreased, and unchanged) in the second test. We ranked predictive variables in the model by applying the plot_importance function in the XGBoost module. The feature importance is calculated by gain. The importance of the 20 items in the SAS in the first and second prediction models were both above 95%. So we built two XGBoost classifier prediction models. In one model, we used the 20 items of SAS in the first test together with gender, major, and grade (23 variables altogether) as the feature matrix (X) and in the other model, we only used the 20 items of SAS in the first test as the feature matrix (X). The anxiety levels in the second test and the changes of the anxiety levels were, respectively, used as the labels (y) to train the model and make the prediction. The training set and test set were divided on a scale of 7:3. We adjusted the parameters to construct the best model. We set XGBoost to do multiclass classification using the softmax objective and respectively, set num_class to 4 and 3. We specified the evaluation metrics as merror which was the multiclass classification error rate. The parameter settings are shown in **Table 3**, and all other parameters that are not in the table were the default values.

The XGBoost model prediction results are shown in **Table 4**. The accuracy rate was approximately 80%, an ideal result. Therefore, the anxiety levels of the participants can be accurately predicted and it can be possible to implement effective measures before the anxiety levels increase.

TABLE 3 | Adjusted parameters.

Parameter	Meaning	Value
n_estimators	Number of boosting rounds	1000
max_depth	Maximum tree depth for base learners	8
learning_rate	Boosting learning rate	0.1
Objective	The learning task and the corresponding learning objective or a custom objective function to be used	multi:softmax
Subsample	Subsample ratio of the training instance	0.8
colsample_bytree	Subsample ratio of columns when constructing each tree	0.8
early_stopping_rounds	Activates early stopping	10
eval_metric	Evaluation metrics for validation data	merror

TABLE 4 | XGBoost prediction results.

Models	Prediction methods	Accuracy rate
Model 1 (23 items)	Anxiety levels (normal, mild, moderate, and severe)	83.81%
	Changes of anxiety level (increased, decreased, and unchanged)	79.26%
Model 2 (20 items of SAS)	Anxiety levels (normal, mild, moderate, and severe)	82.10%
	Changes of anxiety level (increased, decreased, and unchanged)	84.38%

We also conducted multiple linear stepwise regression analysis. The prediction results of multiple linear stepwise regression on the anxiety levels (normal, mild, moderate, and severe) are demonstrated in **Table 5** and the prediction results of multiple linear stepwise regression on the changes of anxiety levels (increased, decreased, and unchanged) are shown in **Table 6**. **Table 6** shows that there was linear association between the items listed in the table, Nos. 11, 6, 19, 4, 14, 9, 16, 17, 10, 20, 15, and 18 in the first test and the anxiety levels in the second test ($P < 0.05$). Among these items, the level of No. 6 “My arms and legs shake and tremble” affected the anxiety level in the second test most, which was 12%. Besides, the explanation rate of the regression equation to the anxiety level in the second test was 27.6% ($R^2 = 0.28$, $R^2{}_{adj} = 0.276$).

Table 6 also shows that there was linear association between the items listed in the table, Nos. 8, 4, 18, 2, 13, 11, 5, 14, 7, 3, and 17 in the first test and the anxiety levels in the second test ($P < 0.05$). Among these items, the level of No. 8 “I feel weak and get tired easily” affected the anxiety level in the second test most, which was −14.7%. Besides, the explanation rate of the regression equation to the anxiety level in the second test was 32.1% ($R^2 = 0.327$, $R^2{}_{adj} = 0.321$).

DISCUSSION

Overall Anxiety Is Higher 1 Month After the Start of the New Semester of Online Learning

Consistent with our hypothesis, the non-graduating undergraduate students had an overall higher level of anxiety and more students were identified as anxious 1 month after the new semester based on online learning started, which was also true among each group such as males, females, and students majoring in arts and sciences. College students are at the early stage of adulthood, lack analytical and decisive abilities and experiences, have unstable emotions and hence are inclined to have impulsive behaviors and be affected by public emergencies (Tan, 2003; Taylor, 2006; Li, 2007; Mei et al., 2011).

In China, the pandemic was first detected in December 2019, reached its peak in mid-February, and then from mid-March when the daily news confirmed that patients reached almost zero, the whole COVID-19 situation was under control (Chinese Center for Disease Control and Prevention, 2020). Many previous studies have focused on the initial stage or more general psychological states during the outbreak, while how anxiety levels and severity changed during this time were still unknown. In this article, we collected data on the psychological status of college students in mid-February when COVID-19 was most prevalent and 4 weeks later in mid-March when the pandemic was stable and under control. At the time of the second test, COVID-19 was assumed to have less of an impact on students. But their anxiety level became higher. This may be due to school closure, social distancing or isolation, and online learning. For college students, especially, a lack of social activities and peer interaction, prolonged holidays, and confounded academic planning, etc., would all account for higher risks of anxiety, fear, stress, and depression (Chang et al., 2020). Unlike China, the pandemic began to boost around early March in other countries and newly confirmed cases were still increasing dramatically in mid-July (World Health Organization, 2020). It would be interesting to compare the differences of psychological consequences on college students before and after the start of a new semester based on online learning in China and the rest of the world where the pandemic was still prevalent.

Group Comparisons

Consistent with previous studies, the younger college students (freshmen and sophomore) had an increased level of anxiety in the new semester but not among junior students as the older the students the more experience they have, and hence their better social adaptive abilities and psychological resilience. It was also proposed in previous research that more prevention measures should be taken to protect the mental health of young students in universities (Yi et al., 2010; Chang et al., 2020). The findings on males and females also confirmed findings from previous studies that females were more vulnerable and more easily affected psychologically. Therefore, female students were found to have a higher level of anxiety in the second test than in the first test, but not among males. Students majoring in arts and sciences both showed higher anxiety in the new semester. However, no differences in the anxiety level of students majoring in arts or sciences between the two tests were found among junior students, which confirmed the findings about the differences of students in the junior grades or more senior grades.

TABLE 5 | The prediction results of multiple linear stepwise regression on the anxiety levels (normal, mild, moderate, and severe).

Factors	β	S_x	β′	*t*	*P*
Items	0.776	0.118		6.577	0.000
11. I am bothered by dizzy spells	0.103	0.033	0.095	3.103	0.002
6. My arms and legs shake and tremble	0.189	0.046	0.120	4.134	0.000
19. I fall asleep easily and get a good night's rest	−0.062	0.018	−0.097	−3.476	0.001
4. I feel like I'm falling apart and going to pieces	0.070	0.028	0.075	2.520	0.012
14. I get feelings of numbness and tingling in my fingers and toes	0.192	0.051	0.114	3.746	0.000
9. I feel calm and can sit still easily	−0.056	0.019	−0.085	−2.993	0.003
16. I have to empty my bladder often	0.076	0.024	0.084	3.132	0.002
17. My hands are usually dry and warm	−0.053	0.017	−0.085	−3.191	0.001
10. I can feel my heart beating fast	0.095	0.030	0.093	3.141	0.002
20. I have nightmares	0.065	0.025	0.072	2.605	0.009
15. I am bothered by stomach aches or indigestion	0.062	0.026	0.067	2.420	0.016
18. My face gets hot and blushes	−0.076	0.032	−0.067	−2.346	0.019

TABLE 6 | The prediction results of multiple linear stepwise regression on the changes of anxiety levels (increased, decreased, and unchanged).

Factors	β	S_x	β′	*t*	*P*
Items	2.196	0.107		20.489	0.000
8. I feel weak and get tired easily	−0.103	0.022	−0.147	−4.692	0.000
4. I feel like I'm falling apart and going to pieces	−0.121	0.027	−0.132	−4.410	0.000
18. My face gets hot and blushes	−0.159	0.030	−0.143	−5.265	0.000
2. I feel afraid for no reason at all	−0.058	0.027	−0.076	−2.140	0.033
13. I can breath in and out easily	0.048	0.012	0.098	3.940	0.000
11. I am bothered by dizzy spells	−0.130	0.032	−0.123	−4.045	0.000
5. I feel that everything is all right and nothing bad will happen	0.049	0.019	0.073	2.526	0.012
14. I get feelings of numbness and tingling in my fingers and toes	0.137	0.046	0.083	2.988	0.003
7. I am bothered by headaches, neck, and back pains	−0.053	0.023	−0.069	−2.310	0.021
3. I get upset easily or feel panicky	−0.057	0.026	−0.079	−2.187	0.029
17. My hands are usually dry and warm	0.034	0.016	0.056	2.160	0.031

Correlation of SAS Scores and Confirmed Affected Cases or Regions

Different from a previous study that found no correlation between SAS scores and confirmed affected cases (Wang and Zhao, 2020), this study showed that students from Hubei province, where most cases of COVID-19 were confirmed, had a higher percentage of participants with anxiety. This could be explained by the fact that in the new semester the pandemic had a prolonged influence on college students, even though the newly confirmed cases in each city or province had been close to zero. This gave us a hint that even if their anxiety level was not significantly high during the outbreak, the impact of COVID-19 on the psychological states of college students would remain high for quite a while, therefore, measures should be taken to protect and prevent.

XGBoost Prediction Model

Comparing the two XGBoost models, model 1 performed better on the prediction of anxiety level with an accuracy rate of 79.26%, however, model 2 had higher prediction accuracy on the changes of anxiety levels (84.38%). It demonstrated that variables such as gender, grade, and major improved the prediction accuracy on anxiety level but not on the changes of anxiety levels. The results also showed that the performance of the multiple linear regression models was much lower than that of the XGBoost prediction model, as the former could only explain 27.6% of the anxiety level in the second test and 32.1% of the change of anxiety levels in the second test. Hence this article successfully tested the feasibility of the XGBoost model in predicting anxiety level and change of anxiety level in the new semester (Chen and Guestrin, 2016).

Limitations of This Study

This research has several limitations. Firstly, our sample was small and would find it hard to reflect the actual pattern of general non-graduating undergraduate students, given the limited resources available and time-sensitivity of the coronavirus outbreak. The response rate in the first study was 99.86%, however, the majority of the students were not interested in participating in the same test for a second time. In future studies, we propose that we need to make it clear when starting the first test that the research consists of two parts and that one will take place 1 month later to increase the faithfulness of students to this study. Secondly, the self-reported levels of psychological impact, such as anxiety, may not always be consistent with the assessments of professionals. Thirdly, due to the length requirement, we did not collect information on whether the participants had family members who were suspected of or had confirmed cases of COVID-19 which could affect their level of anxiety to a great degree, independent of the time of the tests.

CONCLUSION

It was concluded that Chinese non-graduating undergraduate students showed higher anxiety in the new semester based on online learning than before the new semester started during the COVID-19 pandemic. More students from Hubei province had different levels of anxiety than from other provinces. Families, universities, and society should pay attention to the psychological health of non-graduating undergraduate students and take measures accordingly. In addition, as this research was the first to compare the impact of COVID-19 on the anxiety of undergraduate students before and after the start of a new semester based on online learning, this study provides invaluable information on the initial psychological anxiety among university students during the early stage of the COVID-19 pandemic from participants across 260 cities in China and the data could also be used as a baseline to further explore the changes and causes of and strategies to reduce their anxiety.

Besides, this article applied XGBoost models to successfully predict the anxiety level and the changes of anxiety levels 4 weeks later based on their SAS scores in the first test. It also confirmed that the XGBoost model had better prediction accuracy compared to the traditional multiple stepwise regression model on the anxiety status of university students.

This research demonstrated the potential of traditional statistical and machine learning models for identifying predictors of anxiety disorder in college students, and has provided insight into which items are most predictive. Areas for future work include external validation of prediction model results, exploration of the predictive ability of the top items for each instrument separately, and subgroup analyses in external datasets with larger and more complex sample sizes, to further assess machine learning model performance among individuals with anxiety conditions. And this XGBoost model could also be implemented in contexts like the global pandemic and the new needs institutions have to address.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Qiang Li, Chairman of Nankai University, Department of Social Psychology Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CW and HZo co-designed the study. HZo conducted the study and analyzed the data. CW interpreted the data, and wrote and revised the manuscript. HZn helped with the data analysis of XGBoost. All authors contributed to the article and approved the submitted version.

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The Influence of Factors Such as Parenting Stress and Social Support on the State Anxiety in Parents of Special Needs Children During the COVID-19 Epidemic

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Objectives: The study aims to investigate the state anxiety of parents of special needs children during the 2019 coronavirus disease (COVID-19) epidemic and the influence of parental stress, social support, and other related variables on the anxiety of parents.

Methods: Bespoke questionnaires of children's and parent's mental and behavioral problems during the epidemic were used in the study. We also used the State Anxiety Inventory (S-AI), the Parenting Stress Index—Short Form-15 (PSI-SF-15), the NEO Five-Factor Inventory (NEO-FFI), and the Multidimensional Scale of Perceived Social Support (MSPSS). The data used in the study were pooled from an online survey of parents of special needs children and analyzed by one-way analysis of variance (ANOVA) and multiple linear regression.

Results: Overall, 1,451 individuals were included, of which 402 were fathers (27.71%) and 1,049 were mothers (72.29%). ANOVA results showed that educational background, family monthly income, and type of their child's disability made parents' state anxiety significantly different. The results of multiple linear regression showed that during the epidemic, social support negatively predicted parents' state anxiety ($B = -0.15$, $p < 0.001$), whereas parenting stress ($B = 0.07$, $p = 0.001$) and parental mental and behavioral problems ($B = 0.37$, $p < 0.001$) positively predicted parents' state anxiety.

Conclusions: During the outbreak of COVID-19, parents of special needs children suffered mental and behavioral problems, together with parenting stress and social support, which influenced their state anxiety. These findings can be used to develop relevant psychological interventions to improve the mental health of vulnerable groups during a pandemic like COVID-19.

Keywords: parents of special needs children, state anxiety, COVID-19, parenting stress, social support

INTRODUCTION

The 2019 coronavirus disease (COVID-19) began to spread in China in January 2020. Travel restrictions were then imposed in most areas of the country. The Spring Festival holiday was extended, enterprises stopped, work was put on hold, and schools closed. People stayed at home and socially isolated in order to avoid being threatened by the virus (Wang et al., 2020). Some studies believe that for people staying at home, although it can effectively cut-off the spread of the virus, the isolation also harms people's mental health, causing psychological problems, such as anxiety, insomnia, depression, and stress-related symptoms (Liu et al., 2020). Special needs children cover children with chronic conditions as well as children with disabilities ranging from mild to severe impairment (Caicedo, 2014). There are mainly three kinds of special education schools in China: schools for visually impaired students, schools for hearing impaired students, and schools for intellectual disability, including intellectual disabled and autistic students. In this study, we selected the parents of children with autism, intellectual disability, visual impairment, and hearing impairment as valid participants. During the epidemic period, parents of special needs children might face more hardships and exert more effort to take care of their children's learning and living conditions than parents of typically developing children. Therefore, we should investigate the psychological situation of parents of special needs children to help them through this difficult period.

State anxiety is a form of anxiety that differs in each individual. It is a temporary, anxious emotional state or reaction triggered by a specific situation. Its intensity and volatility also change with time (Spielberger and Gorsuch, 1983). The study posits that the level of parental anxiety affects the physical and mental development of infants and children (Ramchandani et al., 2005). There is an epidemiological relationship between anxiety, depression, mental illness, negative life events, and the poor quality of a relationship with a partner (Pripp et al., 2010). A study of health care workers during the COVID-19 outbreak showed that a significant number of people reported symptoms of anxiety, especially for health care workers in areas, such as Wuhan, that were severely affected by the epidemic (Lai et al., 2020). There have been many studies reporting the anxiety of medical staff and ordinary people during the epidemic, but few studies have focused on vulnerable groups. Under the policy of suspension of work and school, schools and rehabilitation training institutions are closed, and special needs children stay at home. Normal school education, rehabilitation training, individualized interventions, and even treatment cannot be carried out, and some children inevitably experience behavior regression. Living at home also causes the child to have difficulty adapting and brings about more behavioral and emotional problems that need to be dealt with by the parents. Parents of special needs children have to undertake the tasks of child care, training, rehabilitation, and learning during the epidemic that poses a very big challenge for them. Exploring their anxiety under stress and the corresponding influencing factors will help to carry out targeted guidance and assistance.

Parenting stress is defined as a special type of stress that stems from the requirement to be a good parent. Parenting stress is caused by children's needs and emotional conditions, as well as parents' health characteristics, which determine the overall level of stress a parent can feel in their parenting role (Abidin, 1992). Behavioral problems of children and the parenting stress felt by parents are interrelated (Puff and Renk, 2014). A longitudinal study conducted by Neece and Baker (2008) showed that children's behavioral problems are an effective predictor of parenting stress. Compared with typically developing children, special needs children, such as with intellectual disability (Chan and Lam, 2017) and autism (Kim et al., 2016), have more behavioral problems, which may bring more parenting stress to their parents. On the other hand, a study on parents of preschool children by Skreden et al. (2012) found that the parents' anxiety was related to their parental stress. A study of parents of diabetic children also found that parental stress predicts their anxiety level. The higher the parenting stress, the higher the anxiety level (Streisand et al., 2008). It is reasonable to believe that parents of special needs children have to bear more parenting stress than usual during the epidemic because they have to take care of their children's education and overall well-being, which eventually leads to an increase in the anxiety level of the parents. Therefore, investigating parenting stress during the epidemic and exploring its influence on their anxiety have special significance for helping them achieve good mental health during the epidemic.

Perceived social support refers to the emotional experience and satisfaction that individuals feel respected, supported, and understood in society (Norris and Kaniasty, 1996). Perceived social support affects people's behavior and development through the psychological reality of the subjective perception of support and is more likely to show the beneficial function for individual mental health. Perceived social support serves as a buffer between stress and mental health. People can get the beneficial effects of reducing anxiety levels or solving problems from the support of family, friends, or neighbors (Zhou et al., 2013). A study conducted by Xiao et al. (2020) found that the anxiety of medical staff treating patients with COVID-19 infection was negatively correlated with their social support level from January to February 2020. The higher the level of social support, the lower the self-reported anxiety. During the epidemic, parents of special needs children may want to get help and support from others to solve their child care problems. This study sought to explore the influence of social support on anxiety of parents during the epidemic period, in order to provide parents with targeted social support and help them to reduce anxiety.

All in all, we conducted a social survey on the anxiety, parenting stress, and perceived social support under the COVID-19 epidemic to understand the anxiety of parents of special needs children and its related influencing factors. At the same time, we also investigated the mental and behavioral problems encountered by special needs children and parents during the epidemic. We want to provide more targeted theoretical basis for family support services and help special needs children and their parents have better mental health in their home life during the epidemic.

MATERIALS AND METHODS

Participants and Procedures

The online survey targeted the parents of special needs children in Guangdong Province of China and was conducted from February 18 to February 22, 2020. Participants were sampled by stratified random sampling method and recruited through special education schools and special education agencies in Shenzhen, Guangzhou, Shaoguan, Dongguan, Foshan, Huizhou, and other 21 cities or regions. A total of 1,898 responses were received, of which 1,750 were valid, with a valid rate of 92.20%. Participants of the current study were 1,451 parents of children with autism, intellectual disability, visual impairment, and hearing impairment, of which 402 were male respondents (M_{age} = 42.79, *SD* = 5.58, *Range* = 18–60), accounting for 27.71%, and 1,049 were females (M_{age} = 39.63, *SD* = 5.31, *Range* = 18–60), accounting for 72.29%.

Measures

Demographic Information and General Situation Under COVID-19

The demographic information of the study included gender, age, region, educational background, family monthly income, employment situation before the epidemic, current work situation, and other information of special needs children's parents. Information about the child's gender, age, type of special barriers, grade level, and caregivers was also collected.

Mental and Behavioral Problems of Children During COVID-19

Special needs children's Mental and Behavioral Problems (CMBP) during the epidemic was a bespoke questionnaire, which was used to measure the problems of special needs children during home isolation. The questionnaire contained six questions, such as reluctance to wear masks, reluctance to wash hands, request to go out, sleep problems, eating problems, mood swings, etc. Each question was answered on a 4-point Likert scale, ranging from 1 (none) to 4 (many). In this study, the internal consistency reliability of the questionnaire was 0.76. A confirmatory factor analysis of the questionnaire showed that the model fits well (χ^2/df = 4.89, *CFI* = 0.99, *TLI* = 0.98, *SRMR* = 0.02, *RMSEA* = 0.05), indicating that the questionnaire had good structural validity.

Mental and Behavioral Problems of Parents During COVID-19

The parents' Mental and Behavioral Problems Questionnaire (PMBP) was a bespoke questionnaire, which was used to measure parents' psychological and behavioral problems in the face of the epidemic. The questionnaire included 11 questions, such as "I couldn't help to go to the hospital or repeatedly seek online consultations to confirm whether I have been infected with COVID-19" and "I couldn't control my browsing information related to the epidemic (e.g., see WeChat moments, Weibo, WeChat group, etc.)". Each question also used a 4-point Likert-type scoring method, ranging from 1 (inconsistent) to 4 (consistent). In this study, the internal consistency reliability of the questionnaire was 0.78. A confirmatory factor analysis of the questionnaire showed that the model fits well (χ^2/df = 4.88, *CFI* = 0.96, *TLI* = 0.95, *SRMR* = 0.03, *RMSEA* = 0.05), indicating that the questionnaire has good structural validity.

Parenting Stress Index—Short Form-15

The Parenting Stress Index—Short Form-15 (PSI-SF-15) was a self-report questionnaire composed of 15 questions. It was revised by Luo et al. (2019) according to the Parenting Stress Index, which was used to measure the level of parenting stress. Each question was scored by a 5-point Likert scoring method, ranging from 1 (very much disagree) to 5 (very much agree). There were three subscales: (1) parental distress (PD): the higher the score, the greater the perceived parenting stress; (2) parent–child dysfunctional interaction (PCDI): the higher the score, the worse the parent–child relationship; and (3) difficult children (DC): the higher the score of difficult children, the more difficult the parents think their children are to care for. The combined score of each subscale was the total score of the scale. The higher the total score, the greater the parenting stress (Lee et al., 2016). PSI-SF-15 was a reliable and effective tool for evaluating parental pressure in China (Luo et al., 2019). In this study, the Cronbach's α values of the three subscales of PD, PCDI, and DC were 0.84, 0.84, and 0.90, respectively, and the PSI-SF-15 was 0.92.

Multidimensional Scale of Perceived Social Support

The Multidimensional Scale of Perceived Social Support (MSPSS) was used to measure perceived social support from family, friends, and other important individuals (Zimet et al., 1988). There were 12 items in total, 4 items in each subscale, answered on a 7-point Likert scoring method, ranging from 1 (very low support) to 7 (very high support). The higher the total score of the 12 items, the better the level of social support felt by the individual. MSPSS showed good reliability and validity in the study of Chinese student samples (Zhang et al., 2016). In this study, the Cronbach's α values of the three subscales of family, friends, and other important members were 0.91, 0.91, and 0.87, respectively, and the total scale reliability was 0.95.

NEO Five-Factor Inventory

Costa and McCrae (1989) obtained a scale of NEO Five-Factor Inventory (NEO-FFI) including 60 items based on NEO-PI, which was used to measure five personality structures, such as neuroticism, conscientiousness, extraversion, agreeableness, and openness. Considering that neuroticism in personality had been proven to be a powerful predictor of anxiety in previous studies (Moore et al., 2014; Xin et al., 2014), in order to exclude the influence of neuroticism, the neuroticism subscale was used in this study. The scale included 12 items, each with five levels, from "strongly opposed" to "very supportive." In this study, the Cronbach's α value of the neuroticism subscale was 0.81.

State Anxiety Inventory

The State Anxiety Inventory (S-AI) in the State-Trait Anxiety Inventory (STAI) compiled by Spielberger and Gorsuch (1983) was used to evaluate the state anxiety of special needs children's parents under epidemic stress. S-AI was composed of 20 questions, which were graded 1–4: 1—none, 2—some, 3—moderate, and 4—very obvious. Studies conducted on Chinese samples confirm that S-AI had good reliability and validity (Cui et al., 2016). In this study, the Cronbach's α value of the S-AI was 0.90.

Statistical Analysis

IBM SPSS Statistics 25 and Mplus 8.3 were used for data statistical analysis. In this study, Mplus was mainly used for confirmatory factor analysis to determine whether the structural validity of the bespoke questionnaires is acceptable. And, SPSS was mainly used to do one-way analysis of variance (ANOVA), bivariate correlations, and multiple linear regression. First of all, descriptive analysis was carried out to explain the demographic characteristics of parents of special needs children and mental and behavioral problems of children and their parents. Secondly, a one-way ANOVA was carried out to compare the effects of gender, educational background, family monthly income, employment situation during the epidemic, and children's types of disabilities on parents' state anxiety. For the *post hoc* test, the Tukey test was used in the case of the homogeneous variance of each group, and the Games–Howell test was used in the case of heterogeneity of variance of each group. Finally, we used multiple linear regression to explore the influence of parenting stress, social support, and other variables on the state anxiety of parents. Considering the impact of additional factors, we controlled the parents' gender, age, family monthly income, educational background, and neuroticism. All tests were performed at a two-tailed level, and $p \leq 0.05$ was considered significant.

RESULTS

Content Summary

A total of 1,451 parents completed the questionnaire. The parents' gender, educational background, family monthly income, employment situation during the epidemic, types of children's disabilities, and children's grades are shown in **Table 1**. A total of 448 students (30.88%) were residential students, and 1,003 students (69.12%) were day students before the outbreak of COVID-19. Since the outbreak began, 1,304 (89.87%) parents and 1,420 (97.86%) students have been at home for more than 15 days. A total of 1,100 (75.81%) parents reported that their children were under their care, 308 (21.23%) reported that their children were under the care of their elders, and the rest reported that their children were under the care of others.

The Impact of Differences in Demographic Information on State Anxiety

One-way ANOVA was used to analyze the characteristics of state anxiety of parents during the epidemic. The data were analyzed by Shapiro–Wilk test, and the results showed that the data of each group did not conform to the normal distribution ($p < 0.001$). Combined with the Q–Q plots, the data distribution result can be considered as a little negative skew distribution (Field, 2009). When the sample size is large ($n > 50$), one-way ANOVA can be performed (Ghasemi and Zahediasl, 2012). After Levene's Test of Homogeneity of Variance, except for the educational background, the variance of data in each group was uniform ($p > 0.05$). For groups with different educational backgrounds, Welch's ANOVA was used to determine whether there were differences in anxiety levels, and Games–Howell *post hoc* test was used for multiple comparisons.

The specific results of the different tests are shown in **Table 1**. According to Richardson (2011), when Partial η^2 is 0.01–0.06, the effect is small. In the study, the above factors have less impact on parents' state anxiety. The results showed that there was no significant difference in state anxiety of parents across gender ($F = 2.86$, $p > 0.05$) and grades of children ($F = 1.11$, $p > 0.05$).

Parents with different educational backgrounds had significantly different state anxiety results. The results showed that parents with a college education or above had significantly lower state anxiety scores than those who only reached senior high school ($M_d = -2.49$, 95% CI: -4.03, -1.00) and under junior high school education ($M_d = -1.91$, 95% CI: -3.32, -0.54). There was no significant difference in the scores of state anxiety between the parents whose education level was at the junior high school level or below and the senior high school group ($p > 0.05$).

Parents with varying family incomes have significant differences in their state anxiety results. The results showed that the parents whose family income was less than 5,000 CNY had significantly higher state anxiety score than the group earning 5,000–15,000 CNY ($M_d = 1.44$, 95% CI: 0.21, 2.67) and the group earning more than 15,000 CNY ($M_d = 4.65$, 95% CI: 2.46, 6.82). The score of state anxiety of the parents whose family income was 5,000–15,000 yuan was significantly higher than that of the group whose family income was more than 15,000 yuan ($M_d = 3.20$, 95% CI: 0.93, 5.47).

And, there was a significant difference in parents' state anxiety when they had different working conditions during the COVID-19 epidemic. The results showed that parents who were unemployed during the epidemic had significantly higher state anxiety scores than parents who worked from home ($M_d = 2.91$, 95% CI: 1.25, 4.51) and parents who worked from the office ($M_d = 1.47$, 95% CI: 0.04, 2.87).

Finally, there were significant differences in the results of state anxiety among children with different types of disabilities. The results showed that the score of parents' state anxiety was significantly higher in children with autism than in children with visual impairment ($M_d = 2.95$, 95% CI: 0.44, 5.46). There was no significant difference in the scores of parents' state anxiety between the autistic children group and the intellectual and hearing-impaired children group ($p > 0.05$).

Influencing Factors of Parents' State Anxiety During the COVID-19 Epidemic

We examined the relationship between children's mental and behavioral problems, parents' mental and behavioral problems, perceived social support, parenting stress, neuroticism, and state anxiety during the COVID-19 epidemic. The average, standard deviation, range, and related analysis results of all measurements were shown in **Table 2**.

The study used state anxiety as the dependent variable, and the type of special needs children, mental and behavioral problems of children or parents during the epidemic, social support, and parenting stress were used as dependent variables to explore the influencing factors of parents' state anxiety. We included parents' gender, age, educational background, family monthly income, and neuroticism as control variables. The maximum variance inflation factor (VIF) was 3.78, indicating that there was no multicollinearity between independent variables. The final model

TABLE 1 | Statistical hypothesis testing for the influencing factors (N = 1,451).

Variables	*N* (%)	State anxiety		
		M* ± *SD	***F***	**Partial η^2**
Sex			2.86	0.00
Female	1,049 (72.29)	45.76 ± 9.45		
Male	402 (27.71)	44.83 ± 9.10		
Educational background			7.04***	0.01
Under junior high school	617 (42.52)	45.87 ± 8.48		
Senior high school	421 (29.01)	46.46 ± 9.06		
College degree and above	413 (28.46)	43.96 ± 10.67		
Family monthly income			14.00***	0.02
Under 5,000 CNY	843 (58.10)	46.35 ± 9.18		
5,000–15,000 CNY	495 (33.98)	44.91 ± 9.42		
15,000 CNY and above	113 (7.79)	41.71 ± 9.39		
Work situation during COVID-19			9.92***	0.01
Unemployed	914 (62.99)	46.26 ± 8.97		
Working from the office	313 (21.57)	44.80 ± 9.90		
Working from home	224 (15.44)	43.35 ± 9.78		
Type of disabilities			3.09*	0.01
Autism	453 (31.22)	46.16 ± 9.96		
Intellectual disability	700 (48.24)	45.40 ± 8.97		
Hearing impairment	183 (12.61)	45.64 ± 9.04		
Visual impairment	115 (7.93)	43.22 ± 9.48		
Child's grade			1.11	0.00
Preschool	97 (6.69)	46.57 ± 9.86		
Lower grade	555 (38.25)	45.65 ± 9.28		
High grade	438 (30.19)	45.62 ± 9.35		
Middle school	361 (24.88)	44.83 ± 9.36		

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

TABLE 2 | Descriptive statistics and inter-correlations among the variables.

Variables	*M* (*SD*) *Range*	1	2	3	4	5	6
1. CMBP	8.40 (2.98) 6–24	1					
2. PMBP	22.21 (5.39) 11–42	0.19**	1				
3. Social support	56.85 (12.95) 12–84	−0.11**	−0.09**	1			
4. Parenting stress	34.65 (12.01) 15–75	0.36**	0.35**	−0.13**	1		
5. Neuroticism	32.69 (7.03) 12–58	0.27**	0.29**	−0.32**	0.50**	1	
6. State anxiety	45.49 (9.36) 20–79	0.19**	0.36**	−0.34**	0.35**	0.48**	1

**$p < 0.01$.

was significant, $F = 60.21$, $p < 0.001$, and accounted for 33% of the total variance, $R^2 = 0.33$.

The results were shown in **Table 3**. The regression analysis results showed that among the independent variables included in the model, parents' mental and behavioral problems, perceived social support, and parental stress were statistically significant. During the epidemic, social support negatively predicted parents' state anxiety (B = -0.15, $p < 0.001$), whereas parenting stress (B = 0.07, p = 0.001) and parental mental and behavioral problems (B = 0.37, $p < 0.001$) positively predicted parents' state anxiety. That is, less social support combined with greater levels of parenting stress and parental mental and behavioral problems was significantly related to more parenting stress during the COVID-19 pandemic.

DISCUSSION

The main purpose of this study is to investigate the state anxiety of parents of special needs children during the COVID-19 epidemic, as well as the influence of parenting stress, social support, and other factors on the status anxiety of parents. We hope to provide a theoretical basis and support for the effective intervention of improving parents' mental health. The results confirmed the influence of factors, such as parenting stress, social support, and other factors, on state anxiety of parents under the COVID-19 epidemic.

The Effect of the Basic Situation of Parents on Their State Anxiety

It was found that parents with different educational backgrounds, family monthly incomes, and current working conditions had significant differences in state anxiety. *Post hoc* test results found that parents with a college education or above had the lowest level of anxiety compared with the other groups. This may be because parents with higher academic qualifications are more likely to learn and master the corresponding skills needed to deal with their anxiety in order to avoid the adverse effects of excessive anxiety on themselves.

At the same time, we also found that parents with a monthly family income above 15,000 CNY had the lowest level of anxiety. This is also understandable because parents who have lower monthly household incomes will have more worries and anxieties about themselves and their families' future economic situation. We also found that parents who worked at home during the epidemic had the lowest level of anxiety compared with the other groups. This may be because parents who still must go out to work during the epidemic are more worried about the safety and learning problems of the isolated children during the epidemic, making their anxiety level higher. However, those working at home can take care of their children so they are more likely to know more about their children's situation and be relatively reassured.

Sola-Carmona et al. (2016) showed similar results for parents' state anxiety of blind children: higher material well-being, job satisfaction, and family satisfaction were related to parents' lower anxiety level. Indeed, compared with the parents of typically developing children, the parents of special needs children make more effort to take care of their children and even sacrifice their job opportunities. When the family's socioeconomic level declines, parents' anxiety will further increase, which will harm their mental health. Our research results indicate that relevant government departments should increase support for vulnerable groups, such as families of special needs children. We can help the families of special needs children get through this extraordinary

TABLE 3 | Influencing factors of parents' state anxiety during COVID-19.

Predictor	Goodness of fit index			Unstandardized coefficients		β	t	95% CI for *B*	
	R	R^2	*F*	*B*	*SE*			Low	Up
Gender[b]	0.58	0.33	60.21***	−0.22	0.47	−0.01	−0.46	−1.14	0.7
Age[b]				0.02	0.04	0.01	0.65	−0.05	0.1
Education[b]				−0.17	0.19	−0.02	−0.93	−0.54	0.19
Family income[b]				−0.18	0.21	−0.02	−0.87	−0.59	0.23
Neuroticism[b]				0.41	0.04	0.31	11.70***	0.34	0.48
Visual impairment[c]									
Autism				0.42	0.83	0.02	0.51	−1.21	2.05
Hearing impairment				1.51	0.92	0.05	1.64	−0.3	3.32
Intellectual disability				0.87	0.78	0.05	1.11	−0.66	2.41
Social support				−0.15	0.02	−0.21	−8.99***	−0.18	−0.12
Parenting stress				0.07	0.02	0.09	3.27**	0.03	0.11
CMBP				0.09	0.08	0.03	1.13	−0.06	0.23
PMBP				0.37	0.04	0.21	8.94***	0.29	0.45

[a]*Dependent variable: state anxiety.*
[b]*Control variable: gender, age, education, family income, and neuroticism.*
[c]*This is a reference variable.*
****p < 0.001, **p < 0.01.*

period better by giving them financial subsidies and advocating home office work.

The Effect of Parents' Mental and Behavioral Problems on State Anxiety

The results showed that the mental and behavioral problems of parents of special needs children were the effective predictors of parents' state anxiety during the epidemic period, whereas the predictive effect of children's mental and behavioral problems was not significant. This highlights that we should focus on the mental health of parents during the outbreak. Facing the psychological problems caused by the epidemic, the National Health Commission of the People's Republic of China held an emergency psychological crisis intervention. Various mental health associations and organizations have established expert groups to prepare guidelines and public health education articles/videos for mental health professionals and the public, as well as online mental health service personnel. Apart from this, mental health professionals and expert teams are stationed in designated isolation hospitals to provide on-site services (Li et al., 2020). Therefore, our teachers and schools can make full use of the resources provided by the government and relevant organizations to help parents alleviate their psychological and behavioral problems to reduce their anxiety.

The Effect of Parenting Stress on State Anxiety During the Epidemic

Compared with the parents of typically developing children, more studies have confirmed that parents of special needs children have to bear more parenting stress, which is mainly due to the lack of professional support and the persistence of children's problems among other reasons (Dabrowska and Pisula, 2010; Hayes and Watson, 2013). Therefore, during the epidemic, when special needs children are not able to go to school normally, parents may have to bear more parenting stress. Our research results also show that during the epidemic, parenting stress is an effective predictor of parental anxiety. Faced with this epidemic, parents need to spend more time and energy to take care of their children than usual. Especially for special needs children, parents are more likely to feel more pressure than usual. Special needs children may not be able to adapt to online education, and there are few ways for parents to prevent viral infections during the epidemic. This suggests that our teachers should be more patient in communicating with parents when conducting online education for special needs children, giving parents advice on children's specific problems, and cooperating with parents to better carry out online education. The above measures will help parents alleviate parenting stress during the epidemic.

The Effect of Social Support on State Anxiety During the Epidemic

The results of a study on parents of deaf children confirmed that parents' perception of social support is an effective protective factor for their parenting stress (Åsberg et al., 2008). Therefore, helping parents improve their sense of social support also helps reduce their parenting stress. Previous studies have explored the relationship between anxiety levels and social support for parents of children with chronic kidney disease (Zengin et al., 2018) and parents of cancer children (Bayat et al., 2008). Our findings are consistent with their findings, confirming that social support is a protective factor for excessive anxiety. Support from family members, friends, and other people in the community helps to reduce the anxiety of parents.

In the face of the epidemic, the parents have limited power. All sectors of society need to help them find coping strategies together, to pass this difficult period more smoothly. Some studies provide suggestions for us to solve similar problems. A recent study confirmed the effect of reality therapy on perceived social support and state anxiety of parents of special needs children (Tumlu et al., 2017). The effect of such research deserves our attention. And, several studies have confirmed that mindfulness can make people more positively predict perceived social support (Kuhl and Boyraz, 2017; Sun et al., 2019). This may be because mindfulness enables individuals to focus on their current experience and realize the support they receive from social networks. Therefore, special schools could also carry out online psychological training specifically for parents to help them have a good level of mental health.

In conclusion, this study investigated the anxiety of parents of special needs children in China during the COVID-19 epidemic, as well as the influence of parenting stress, social support, and other factors on parents' anxiety. The families with special needs children are vulnerable groups, and they will bear more psychological burden for taking care of their children themselves for such a long quarantine time. Therefore, the whole society should pay more attention to the parents of special needs children to help them get through this difficult period better.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Ethics Review Committee (IRB) of Education School, Guangzhou University. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

JR, SQC, and YGN designed the study. JR, SQC, YGN, and SDC collected the data. XKL and JR analyzed the data. XKL, JR, and YGN wrote the manuscript. All authors read and approved the manuscript.

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Reduction of Physical Activity Levels During the COVID-19 Pandemic Might Negatively Disturb Sleep Pattern

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Background: The outbreak of novel coronavirus disease 2019 (COVID-19) has caused a global panic and public concern due to its mortality ratio and lack of treatments/vaccines. Reduced levels of physical activity have been reported during the outbreak, affecting the normal daily pattern.

Objective: To investigate (i) the relationship of physical activity level with sleep quality and (ii) the effects of reduction physical activity levels on sleep quality.

Methods: A Google form was used to address personal information, COVID-19 personal care, physical activity, and mental health of 1,907 adult volunteers. Binary logistic regression was used to verify the association of physical activity parameters and sleep quality.

Results: Insufficient physical activity levels were a risk factor to have disturbed sleep pattern [OR: 1.28, 95% CI (1.01–1.62)]; however, when the BMI was added to the analysis, there was no more statistical difference [OR: 1.23, 95% CI (0.96–1.57)]. On the other hand, we found that the reduction of physical activity levels was associated with negative changes in sleep quality [OR: 1.73, 95% CI (1.37–2.18)], regardless all the confounders [OR: 1.30, 95% CI (1.01–1.68)], unless when feeling of depression was added in Model 6 [OR: 1.28, 95% CI (0.99–1.66)].

Conclusion: Disruption in daily physical activity routine, rather than physical activity level, negatively influences sleep quality during the COVID-19 quarantine.

Keywords: sleep, COVID-19, physical activity, exercise, health

INTRODUCTION

The outbreak of novel coronavirus disease 2019 (COVID-19) began on December 2019, induced by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), causing a global panic and public concern because of its lethality (Rothan and Byrareddy, 2020). This novel virus rapidly spread worldwide and infected more than 37 million people with a ratio of death around

2.8% (Johns Hopkins University and Medicine, 2020), becoming on 11th March a pandemic, according to World Health Organization (WHO).

Since then, most of the countries advocated for a quarantine period ranging from social distancing to self-isolation at home in order to keep the virus from spreading. Due to neither treatment nor vaccine available[1], this approach is still the best option to avoid further virus spread. On the other hand, quarantine status was found to negatively affect behavior in general, including but not limited to physiological stress, sleep pattern, and physical activity practice (Brooks et al., 2020).

In this regard, FitBit® recently released a report about their 30 million users, in which they found a daily reduction in step counts up to 38% in European countries (e.g., Spain), while South and North American countries accounted for a reduction of 15% on average (Fitbit®, 2020). Several studies have shown the positive effects of physical activity on sleep quality, and it is considered one of the non-pharmacological interventions to improve sleep quality (Banno et al., 2018); however, the impact of reduced physical activity levels caused by the COVID-19 pandemic on sleep parameters still needs to be investigated. Furthermore, there is a close relationship between low levels of physical activity and sleep disorders, since the former negatively affects body composition, such as increase of body fat, which in turn is a well-known independent risk factor development of several sleep problems (Palm et al., 2015).

Therefore, the aim of this study is to investigate (i) the relationship of physical activity level with sleep quality and (ii) the effects of reduction physical activity levels on sleep quality. Here we hypothesize that quarantine might negatively affect sleep quality due the reduction of physical activity practice.

MATERIALS AND METHODS

Sample and Ethics

This survey research was conducted in Brazil between May 05th and 17th 2020. Participants were invited through social media to answer an online questionnaire, and the inclusion criteria were age higher than 18 years and to respond all questions of the survey. This study was approved by the Universidade Nove de Julho' Ethics Committee before data collection (CAAE #30890220.4.0000.5511). Participants did not identify themselves, and their answers were only included in the sample if they authorized it before the protocol started. All procedures follow the national legislation and the Declaration of Helsinki. The research design and characteristics of the sample have been previously described (Lofrano-Prado et al., 2020).

Procedures

After the ethics approval, a questionnaire (in Portuguese) in Google Forms was presented to participants with 70 questions divided into 7 domains: (a) personal information; (b) COVID-19 personal care; (c) physical activity; (d) eating behavior; (e) health risk habits; (f) mental health; and (g) overall health.

[1]clinicaltrials.gov

For the purpose of the present study, only some questions of some domains were selected: (a) personal information, (b) COVID-19 personal care, (c) physical activity, and (f) mental health. The instrument was developed for senior researchers with Ph.D. in different areas (Public Health, Science, Nutrition, Physiology, Human Movement Science, Neuroscience, and Behavior). In the following, we present the questions used in the present analysis.

Sleep quality: from this domain, changes in sleep quality were identified by the following: "Due to the COVID-19, are you feeling lower sleep quality?" (possible answers: "no," "a little," "sometimes," "very often," and "always"). Participants were classified as "decreased sleep quality" group if they answered "a little," "sometimes," "very often," and "always."

Personal information: from this domain, three self-reported information were collected: 1—sex (possible answers: "Woman or Man"); 2—date of birthday (DD/MM/YYYY); and 3—educational level ("elementary," "high school," "undergraduate," and "graduate"). In this domain, it was also questioned "What is your weight (in kilogram)?" and "What is your height (in centimeters)?" as open questions.

Social isolation: "How long have you experienced social isolation?" Participants who responded 15 or more days were classified as socially isolated.

Physical activity: participants were asked about the following: (a) How many times are you exercising a week? (possible answers: none to 7 days a week); (b) For how long are you exercising? (possible answers: "none"; "less than 30 min"; "between 30 and 60 min"; and "more than 60 min"); (c) For how long have you engaged in this physical activity? (possible answer: "less than 1 month"; "between 1 and 3 months"; "between 3 and 6 months"; "more than 6 months," and; "I am not exercising"); (d) What is the intensity of the physical activity? (possible answers: "low—i.e., to bathe, to shave, to drive, wash the dishes, and make the bed"; "medium/moderate—i.e., gardening, play volleyball, water aerobics, pedal, and brisk walking"; "high—i.e., climb stairs, swimming, jump rope, play soccer, running"; and "I am not exercising").

Based on these responses, time spent during each exercise session during the week was multiplied by the number of days spent exercising each week. Those that reached 150 min or more of moderate-vigorous physical activity (MVPA) were considered "physically active" whereas those that fell below this threshold were classified as "inactive." In this domain, it was also questioned "How much has the COVID-19 pandemic interfered with your daily physical activity habits?" (possible answers: "none," "a little," "a lot," and "I do not exercise"). Participants who answered "a little" was classified as not having impact on physical activity due to COVID-19 and those who answered a "lot" were classified as having an impact on physical activity due to COVID-19. These participants who answered "I do not exercise" were not considered in the analysis.

Mental health: Feeling of anxiety and depression were assessed by the questions "Due to the COVID-19, are you feeling anxious?" and "Due to the COVID-19, are you feeling depressed?" (possible answers for each question were "no," "a little," "sometimes," "very often," and "always"). The participants' responses were dichotomized into i) not having anxiety and/or depression ("no," "a little," and "sometimes") and having anxiety and/or depression ("very often" and "always").

Statistical Analysis

The sample characterization variables were presented as mean and standard deviation comparing between participants who did not feel any change in sleep quality with those who felt the impact of sleep quality in the quarantine by means of the Student's *t* test for independent samples. The association of sleep quality with the practice of physical activity during the pandemic and the impact of the pandemic on physical activity were achieved by binary logistic regression (Model 1: crude model; Model 2: Model 1 + adjusted by sex, age, and education level; Model 3: Model 2 + adjusted by BMI and Model 4: Model 3 adjusted by social isolation). Analyses were performed using the statistical software SPSS (version 13.0), and $p < 0.05$ was used as a statistically significant reference value. The polychoric correlation matrix was performed in the STATA statistical package.

RESULTS

The sample of the present study was composed of 1,874 adults with an average age of 38.30 (±13.09) years. The prevalence of decreased sleep quality during quarantine was 26.1%. In all, 514 participants (27.4%) were classified as physically active during quarantine (MVPA ≥ 150 min per week) and approximately 56.2% of participants reported that COVID-19 had an impact on physical activity. **Table 1** shows the comparison between normal and disturbed sleep quality groups. Disturbed sleep group was younger and less physically active during the week ($p < 0.05$).

In **Table 2** is shown the association of insufficient MVPA levels according to ACMS with sleep quality. We found that in the crude analysis (model 1) and adjusted by confounders (model 2), such as sex, age, and education practice, less than 150 min of MVPA has a detrimental effect upon sleep quality. Nonetheless, when the analyses were adjusted for BMI, social isolation, feeling of anxiety, and feeling of depression, the models did not reach statistical significance (model 3 to 6).

Table 3 shows the effects of reduction of physical activity levels upon sleep quality during the quarantine period. Without addition of confounders, it was found that decrease in physical activity practice increased up to 1.72 times the risk of sleep disturbances. This relationship dropped to 1.53 times when the confounders of sociodemographic variables, BMI, social isolation, and feeling of anxiety were added to the analysis. After the adjustment for feeling of depression, the association between reduction in physical activity level and impaired sleep quality lost statistical significance.

TABLE 1 | Characteristics of the sample dichotomized by sleep changes.

	Normal sleep quality	Disturbed sleep quality	*p*-value
Age (years)	39.72 (13.50)	34.29 (10.90)	**<0.001**
Weight (kg)	73.63 (16.45)	73.36 (16.77)	0.755
Height (cm)	168.78 (9.28)	168.01 (8.91)	0.114
BMI (kg)	25.65 (4.38)	25.83 (4.74)	0.463
MVPA (min/week)	90.77 (93.32)	76.25 (91.89)	**0.004**

BMI, body mass index; MVPA, moderate to vigorous physical activity. Bold values denote statistical significance at the p < 0.05 level.

TABLE 2 | Association of insufficient MVPA and changes in quality of sleep in adults during COVID-19.

	Impaired sleep quality during COVID-19		
	OR	95% CI	*p*-value
Insufficient MVPA			
Model 1	1.28	1.01–1.62	**0.044**
Model 2	1.29	1.01–1.65	**0.040**
Model 3	1.23	0.96–1.57	0.108
Model 4	1.21	0.94–1.56	0.133
Model 5	1.17	0.90–1.52	0.247
Model 6	1.16	0.88–1.51	0.289

MVPA, Moderate/Vigorous physical activity; Model 1, crude model; Model 2, model 1 + adjusted by sex, age, and education level; Model 3, model 2 + adjusted by BMI; Model 4, model 3 adjusted by social isolation; Model 5, model 4 adjusted by feeling of anxiety; Model 6, model 5 adjusted by feeling of depression. Bold values denote statistical significance at the p < 0.05 level.

TABLE 3 | Association of the impact of COVID-19 in the physical activity practice and changes in quality of sleep in adults.

	Impaired sleep quality during COVID-19		
	OR	95% CI	*p*-value
Reduction of PA by COVID-19			
Model 1	1.73	1.37–2.18	**<0.001**
Model 2	1.69	1.33–2.14	**<0.001**
Model 3	1.58	1.25–2.01	**<0.001**
Model 4	1.54	1.21–1.96	**<0.001**
Model 5	1.30	1.01–1.68	**0.043**
Model 6	1.28	0.99–1.66	**0.062**

PA, physical activity; Model 1, crude model; Model 2, model 1 + adjusted by sex, age, and education level; Model 3, model 2 + adjusted by BMI; Model 4, model 3 adjusted by social isolation; Model 5, model 4 adjusted by feeling of anxiety; Model 6, model 5 adjusted by feeling of depression. Bold values denote statistical significance at the p < 0.05 level.

DISCUSSION

In this study, we found that rather than physical activity level, the reduction of physical exercise practice during the COVID-19-induced quarantine increased the risk of sleep disturbance up to 1.5 times regardless of potential confounders.

The implications of COVID-19-induced confinement can be severe upon neuromuscular, cardiovascular, and metabolic health and sleep quality if physical activity levels decrease abruptly. For example, acute reduction in the physical activity levels lead to impaired insulin sensitivity and glucose handling, decreases in lean body mass and strength, and increases in visceral adiposity (Narici et al., 2020). Furthermore, adults who removed structured physical exercise for one week and, therefore, decreased their physical activity levels experienced an impairment in sleep quality (Edwards and Loprinzi, 2017). Long-term sleep disturbances have also been associated with impaired metabolic health (Gabriel and Zierath, 2019).

Here we found that the relationship of insufficient physical activity levels and sleep quality is affected by BMI. Obesity *per se* is a risk factor for sleep disorders. Weight gain across time is an independent risk factor for developing a range of sleep problems and daytime sleepiness (Palm et al., 2015). Otherwise, the reduction of physical activity levels during the COVID-19 outbreak increased 1.5 times the odds to decrease sleep quality regardless confounders, such as BMI, showing the importance to keep physical activity practice during this outbreak.

On the other hand, physical activity practice may improve metabolic health and sleep quality (Narici et al., 2020). In a recent meta-analysis, Banno et al. (2018) showed that the exercised group decreased up to 3 points in the Pittsburgh Sleep Quality Index, a questionnaire to address sleep quality, and 3.22 points in the Insomnia Severity Index when compared with the control group. In fact, a slight increase in daily physical levels is an effective strategy to improve sleep duration and decrease sleep latency (Hori et al., 2016).

The association between physical activity and impaired sleep quality due to COVID-19 is lacking when adjusted for depression feelings. The bidirectional association between sleep disorders and depression has been previously reported (Fang et al., 2019). Prevalence of depression is supposed to be 7 times higher during the COVID-19 outbreak than the previous global estimate (Bueno-Notivol et al., 2020). In this sense, it is possible that reduction in physical activity levels due to the COVID-19 outbreak has not been so strong as to override the association between depression and sleep quality in the subjects.

Sleep is a complex behavior that can be affected by a diversity of variables. Physical exercise has been described as a zeitgeber, a rhythmically external or environmental cue that acts in the regulation of the body's circadian rhythms (Gabriel and Zierath, 2019); therefore, we hypothesize that reduction of physical activity levels during the quarantine period might be affect the internal body clock and, therefore, impair sleep quality.

In order to maintain physical activity levels during the COVID-19-induced quarantine, home-based interventions might be a strategy. Several studies have shown that this kind of intervention is as effective as supervised ones to improve the body composition, metabolic profile, and physical fitness in a broad population (Emerenziani et al., 2018). Recently, the European CBT-I Academy published practical recommendations for improving sleep problems during the COVID-19 outbreak, in which they recommend physical exercise, especially in the daylight, as a tool to sleep better (Altena et al., 2020).

The effects of home-based exercise programs have been reported on sleep quality parameters in the literature. Cheville et al. (2013) conducted a randomized controlled trial to assess sleep quality in cancer patients who underwent a home-based exercise routine (strength and walking exercises) and found an improvement in sleep quality in the exercised group. Similarly, Tang et al. (2010) found that in cancer patients who performed home-based exercises the quality of sleep improved when compared to usual-care patients. Moreover, in patients with chronic kidney disease, Aoike et al. (2015) found that a home-based exercise program was able to decrease up to 3.3 points in the Pittsburgh Sleep Quality Index Questionnaire.

The limitations of this article should be mentioned: the use of an electronic-based questionnaire, which could represent a selection bias, and the use of a non-validated questionnaire, which could represent a non-exact method to estimate the outcomes. Some strengths should also be highlighted, such as the inclusion of other domains in the same questionnaire, the use of Likert scales, and the sample size.

In practical terms, since quarantine has disrupted normal daily physical activity events and impaired some people to keep doing gym and outside workout, home-based physical exercise is indeed recommended, preferably guided by a coach, in order to improve sleep quality.

Therefore, we showed that the disruption in daily physical activity routine rather than physical activity level negatively influences sleep quality. Therefore, public policies should be created in order to stimulate the practicing of physical exercise in a home-based approach.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/**Supplementary Material**.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Universidade Nove de Julho CAAE #30890220.4.0000.5511. Before the beginning of the protocol, all participants consented to their participation.

AUTHOR CONTRIBUTIONS

MC, RR-D, and GC: data collection. TD, DC, GC, WT, ML-P, and JB: study design. TD, DC, WT, GC, ML-P, and JB: data analysis. TD, DC, GC, JB, ML-P, and WT: manuscript draft. All authors contributed to the revision.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.586157/full#supplementary-material

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Stress, Emotional Intelligence and the Intention to Use Cannabis in Spanish Adolescents: Influence of COVID-19 Confinement

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The disease brought about by the SARS-CoV-2, COVID-19 coronavirus has had an unprecedented global impact. Confinement to control the outbreak may have mental health consequences for the most vulnerable in the population, including adolescents. This study aims to describe and analyze the relationships between the stress variables, Emotional Intelligence and the intention to use cannabis in healthy adolescents, before and after the end of the COVID-19 pandemic containment stage. A comparative correlational study was carried out with validated self-completed questionnaires through an online platform. The sample is made up of adolescents (n = 300) aged 13–17 from two different schools in Ponferrada (León, Spain). The analysis of correlation and differences between the groups indicate that confinement has had effects on the mental health of the adolescents, specifically on the emotional manifestations of stress. Furthermore, significant gender differences were found for stress values and Emotional Intelligence. However, no differences have been found for cannabis use intention.

Keywords: stress, emotional intelligence, cannabis, teenagers, adolescents, confinement, SARS-CoV-2, COVID-19

INTRODUCTION

In late 2019, a virus outbreak led to a previously unknown disease called COVID-19, which subsequently spread worldwide. There are at present more than 200 countries and more than two million people infected (Chinazzi et al., 2020). The most common symptoms of this disease include: fever, dry cough and tiredness. Some infected people have only minor symptoms. Most of them (about 80%) recover from the disease without needing hospital care. About 1 in 5 people who get COVID-19 eventually develop a severe condition and experience breathing difficulties. Older people and those with previous health conditions are more likely to suffer from serious conditions. However, anyone can get COVID-19 and become seriously ill (Organización Mundial de la salud, 2020). In Spain, the pandemic brought about by the COVID-19 virus, forced the government to declare a state of alarm (Royal Decree 463/2020, of March 14), for the management of the health crisis situation (Moncloa, 2020).

Since the activation of the health emergency measures, the outbreak of COVID-19 in Spain began to be controlled in May with the start of the de-escalation stages (see **Table 1**, which shows the chronology of stages implemented in Castile and Leon, the Autonomous Community to which the region in the study belongs). Population efforts and health resources have been key in this control. Confinement measures included the closure of educational centers in the middle of the academic year without reopening them before the end of the school year, which led to various academic and personal difficulties. In the case of adolescents, this situation has brought about changes in both their psychosocial aspect and academic performance, as well as negatively affecting their mental health as a result of the COVID-19 virus (Liang et al., 2020). The school closures due to the pandemic have affected students (UNESCO Education, 2020). From 15 March to 17 May there were 65 days of confinement for this healthy population. In this context, this research is focused on the well-being of the adolescent population, and to seeks not only to determine whether there is a change, but also to find out how these variables behave: stress, emotional intelligence (EI) and the intention to use substances, in particular cannabis.

Previous studies have shown that, despite public awareness, confinement causes stress levels that affect quality of life during epidemics (Yuan et al., 2020). Recent research with adolescents (Yang et al., 2020), in Wuhan, shows that there is widespread psychological stress in this population, despite positive behavioral compliance with personal hygiene practices. The literature indicates that effective coping strategies can protect individuals from mental health problems when dealing with emergency situations (Xu and He, 2012). On a general level, the literature to date indicates differences between the sexes in terms of stress levels. Adolescent girls generally have more stressful life events, academic, family, social or friendship, personal, and total stress than teenage boys. However, it is adolescent girls who present higher values of perceived EI (Veytia López et al., 2019). Not only the female gender, but also the student status and physical symptoms are associated with a greater psychological impact of the outbreak, and higher levels of stress, anxiety and depression (Wang et al., 2020). Therefore, students who engage in vigorous physical activity report better mental health and less perceived stress than those who do not (Vankim and Nelson, 2013). In Spain, during to the confinement resulting from the COVID-19 virus, a negative association of previous and current physical activity with stress scores was found in the general population (Planchuelo-Gómez et al., 2020). Furthermore, it is also adolescent girls who perceive and understand emotions better, as well as perceiving greater amounts of stress at a later age (Schoeps et al., 2019). In this sense, EI and perceived self-efficacy seem to play a determining role in stress levels and their satisfactory management in academic contexts, with benefits in both their emotional level (Mascia et al., 2020) and academic performance (Navarro-Mateu et al., 2020). Thus, emotional regulation and general well-being are improved by leading a healthy lifestyle (Lubans et al., 2016). The practice of physical activity has been found to improve personal well-being and disease prevention (Ahn et al., 2016). Students who have a better understanding of their emotions demonstrate higher levels of physical activity (González-Valero et al., 2019). The literature highlights the relationship between physical activity and the different dimensions of EI. In studies focusing on the university population, those young people who were physically active in their free time showed higher levels of EI (Gutiérrez and Araya-Vargas, 2014), and particularly of repair and attention (Acebes-Sánchez et al., 2019). Those college students who exercised regularly and continued their exercise habits during the COVID-19 outbreak correlated significantly with lower scores on the depression, anxiety and stress scale (Deng et al., 2020). However, the confinement brought about by COVID-19 virus reduced the outdoor activities of adolescents, and it has been seen how, although boys are more resistant to social isolation, girls experience a greater impact on their moods (Zhang et al., 2020).

The current situation affects children, adolescents and families so exceptionally. As educational centers were closed, social contacts became greatly limited, and leisure time activities were canceled (Fegert et al., 2020). Measures implemented in the field of physical distancing resulting from the COVID-19 virus have been associated with a decrease in physical activity and well-being, an increase in loneliness and Internet use among adolescents (Munasinghe et al., 2020). Among the mental health problems related to quarantine, we find depression, mood swings, anger, insomnia and emotional exhaustion (Brooks et al., 2020). However, most of the studies published to date focus on the general population, with less research into adolescents. In the face

TABLE 1 | De-opening phases in the Autonomous Community of Castilla y León (Spain) and permitted activities (Junta de Castilla y León, 2020a,b; Ministerio de Sanidad, 2020).

Stage	Start date	Allowed activities
Confinement	15/03/2020	Alarm stage: forbidden to travel between regions, teleworking for non-essential jobs. Purchase of basic necessities, assistance to health services and establishments allowed.
Stage 0	04/05/2020	Opening of retail trade with significant restrictions on capacity and rigorous hygiene measures. Special and very restricted hours for people of different age ranges to go out on the street.
Stage 1	17/05/2020	Reopening of premises with limited capacity and preferential opening hours for people over 65. Opening of street markets and terraces with limited capacity. Tourism in nature organized by companies, up to 10 people.
Stage 2	01/06/2020	On-site work in some sectors with 2 m safety distance. It is possible to circulate in groups of maximum 15 people. Different schedules for older people. Opening of retail trade, shopping centers and flea markets with less capacity.
Stage 3	15/06/2020	Larger capacity in bars and restaurants, meetings of max. 20 people. Travel within the province is permitted and time slots are eliminated according to the age of the population. Increased capacity in shops, museums, and sports activities.
New normality	21/06/2020	End of the State of Alarm.

of stressful events, high levels of acceptance and coping strategies, such as low self-blame, can help people to be better prepared to respond to stressful events and facilitate the use of active, problem-centered resolution (Finkelstein-Fox et al., 2019). Thus, adolescence is one of the highest risk stages for both the initiation of substance abuse and its continuance (del Carmen Pérez-Fuentes et al., 2018), during which cannabis use may appear as an escape mechanism from stress (Low et al., 2012).

Cannabis is the third most widespread drug among students aged 14–18 and the most prevalent illegal substance according to the most recent data from the ESTUDES survey (ESTUDES, 2018). Currently, in Spain, 3 out of 10 young people admit to having used cannabis, and the prevalence of those who have used it at some time in their lives is slightly higher in males (34.5%) than in females (31.5%) (ESTUDES, 2018). Cannabis users cope with stress less flexibly (Kruczek, 2017), and also show lower values of emotional repair (Sandín, 2003). The literature indicates how alcohol and tobacco use is related to EI, resilience and family functioning, the latter being both a protective and risk factor, depending on the circumstances (Molero Jurado et al., 2019). Similarly, while a higher level of emotional regulation capacity is related to a lower frequency of substance abuse, a higher level on the adaptability scale has been associated in a study by Kun et al. (2019) with more frequent substance abuse. Evidence from the literature reveals a negative association between cannabis use and adequate physical activity among adolescents in low- and middle-income countries. This study also shows how adolescents who have used cannabis in the past 30 days are less likely to achieve adequate levels of physical activity (Ashdown-Franks et al., 2019).

In order to provide evidence to promote mental health in adolescents, the aim of this study is to describe and analyze the relationships between the variables of stress, EI and intention to use cannabis in healthy adolescents, during and after the end of the confinement stage of the COVID-19 pandemic.

MATERIALS AND METHODS

Study Design

The design of the study is correlational comparative, following the modality of quantitative research without intervention, non-experimental. The technique used in the data collection was the questionnaire.

Study Sample

Two samples were obtained by convenience, non-probability, and sampling. In order to obtain homogeneous characteristics, they were chosen from adjacent neighborhoods with similar socio-demographic characteristics in the town of Ponferrada (León, Spain). All of the students were enrolled in the 2019/2020 academic year in two Obligatory Secondary Education (ESO) centers. As an inclusion criterion, all students from first to fourth grade were included, with ages ranging from 11 to 17 years old. A total of 216 students from centre 1 and 271 from centre 2 gave their consent to participate through the authorization of their parents or guardians. Finally, 300 adolescents participated in the study.

Variables and Measurement Instruments

Emotional Intelligence

The EI was assessed through the Trait Meta-Mood Scale (Salovey et al., 1995) in the validated Spanish language version (TMMS-24) (Fernández-Berrocal et al., 2004). It consists of 24 items divided into three dimensions of 8 items each: attention ($\alpha = 0.90$), clarity ($\alpha = 0.90$) and repair ($\alpha = 0.86$). Responses are scored using a five-point Likert-type scale (not at all, somewhat, fairly, very, and completely). The analysis of the scale is done taking into account the scores obtained in each of the three dimensions separately (Fernández-Berrocal et al., 2004).

Stress

Stress was measured using the Student Stress Inventory-Stress Manifestations (SSI-SM) (Fimian et al., 1989) validated in Spanish for adolescents (Espejo et al., 2011). This questionnaire consists of 22 items, with a five-point Likert-type scale (not at all, rarely, sometimes, often, and totally). These items are distributed in three factors: emotional ($\alpha = 0.79$), physiological ($\alpha = 0.62$) and behavioral ($\alpha = 0.66$).

Intention to Use Cannabis

The validated Cannabis Use: Intention Questionnaire-CUIQ was used for the youth population (Lloret et al., 2018). This questionnaire comprises 12 items and four subscales: attitude toward use ($\alpha = 0.81$), subjective norm ($\alpha = 0.70$), self-efficacy toward abstinence ($\alpha = 0.86$), and lastly, intention to use ($\alpha = 0.94$). Each one of the items is evaluated by means of a Likert type scale from 1 to 5 points.

Procedure

Data from this study were collected through an online questionnaire. The high schools that wished to participate in the collection of data were selected on the basis of their availability and access by students to the technological means from their homes. The data collection of the number 1 compulsory secondary school was carried out between February 7 and 27, 2020, before the declaration of the state of emergency and, therefore, before the confinement of the adolescents in their homes. In contrast, the data from Compulsory Secondary Education center number two were collected between 11 and 21 May, during the last days of confinement of the adolescents in their homes, at the beginning of the first phase of de-escalation programmed by the government of Spain for the town of Ponferrada.

The on-line questionnaire was carried out in different web programming languages, PHP and MySQL for the dynamic functionality of the same, joined to a front-end based on HTML5, CSS, JavaScript and jQuery, meeting different standards and measurements that facilitate the display of the same on different devices (responsive design). These questionnaires, as well as the database that stores the answers, are hosted on a server, ensuring the anonymization of the procedure from the outset. Moreover, the server in which these questionnaires were hosted has the secure hypertext transfer protocol (HTTPS), which guarantees the confidentiality of the data sent by the different respondents to the server.

Analysis

The statistical analyses were carried out using the Statistical Package for the Social Sciences software (SPSS v. 26.0). The quantitative variables were expressed with the mean and standard deviation (M $\pm$ ST). Qualitative variables were expressed as frequencies and percentages. To assess the relationship between stress, EI subscales and the intention to use cannabis, a correlation analysis was performed using Pearson's correlations. To determine the existence of significant differences between independent groups, the student t-test was performed. A value of $p < 0.05$ was considered statistically significant.

Ethical Considerations

The anonymity and confidentiality of the participants in the study was considered at all times. As minors, prior authorization was obtained from their parents or legal guardians to participate in the study, as well as the informed consent of the participants. The data obtained from the research will be treated in accordance with both the Constitional Law 3/2018, of December 5, on the Protection of Personal Data and the guarantee of digital rights and the General Regulation on Data Protection of the European Union EU 2016/679 (RGPD). In addition, permission was requested from each educational center and the competent body in the area of education in the region (Ministry of Education of the Junta de Castilla y León). The study was approved by the ethics committee (ETICA-ULE-035-2019) of the University of León (Spain), which guarantees compliance with ethical and legal issues.

RESULTS

Table 2 shows the demographic characteristics of the participants in the study from two centers both before and after confinement brought about by the COVID-19 pandemic. The age of the participants ranged from 13 to 17 (14.04 $\pm$ 1.043), of which 62% were female and 38% male. The sample before confinement comprised 202 students, and after confinement there were 98. The students were distributed among the 1st to 4th years of Obligatory Secondary Education (ESO) and the majority of the participants were in the 1st and 2nd years of ESO.

TABLE 2 | Characteristics of the participants.

		Center 1* 202 (67.3%)	Center 2** 98 (32.7%)	Total 300 (100%)
Gender *n* (%)	Female	113 (37.7%)	73 (24.3%)	186 (62%)
	Male	89 (29.7%)	25 (8.3%)	114 (38%)
Course *n* (%)	1º ESO***	55 (18.3%)	23 (7.7%)	78 (26%)
	2º ESO ***	52 (17.3%)	36 (12%)	88 (29.3%)
	3º ESO***	48 (16%)	18 (6%)	66 (22%)
	4º ESO***	47 (15.7%)	21 (7%)	68 (22.7%)
Age *n* (%)	13 years old	76 (25.3%)	41 (13.7%)	117 (39%)
	14 years old	63 (21%)	26 (8.7%)	89 (29.7%)
	15 years old	49 (16.3%)	15 (5%)	64 (21.3%)
	16 years old	12 (4%)	13 (4.3%)	25 (8.3%)
	17 years old	2 (0.7%)	3 (1%)	5 (1.7%)

**Center 1 Before confinement. **Center 2 after confinement. ***ESO, compulsory secondary education.*

The results of this study have shown significant correlations between most of the variables, the majority of which are of a weak and moderate nature both before and after confinement (see **Tables 3**, **4**). **Table 3** shows the correlations obtained before confinement resulting from the COVID-19 outbreak took place. There was a strong correlation in stress between the component of physiological and emotional manifestations (r = 0.778). In this context, there is a strong correlation between the physiological and emotional stress components (r = 0.778). In relation to the intention to use cannabis, the component of attitude toward its use is significantly correlated, although in a moderate way, with stress: emotional manifestations (r = 0.260), physiological (r = 0.300) and behavioral (r = 0.412). As regards EI, the correlation with the attitude toward consumption is given exclusively with the attention component (r = 0.238) therefore, we cannot affirm that clarity and reparation have an influence on the attitude toward consumption. In relation to the subjective norm of understanding the perceived pressure to carry out a certain behavior or not, statistically significant correlations of a mild to moderate level appear for all the dimensions of SSI-SM, and the attention and repair of the EI. Emotional clarity is not related to a greater or lesser subjective norm. Self-efficacy toward abstinence correlates with all of the components of stress and EI. Finally, intention to use is significantly correlated, in a mild/moderate way, with all three dimensions of stress and EI attention. **Table 4** shows the correlations obtained after the confinement of the second center. The results obtained are very similar to those of the first center; however, the following differences should be noted: There is no correlation between clarity and the emotional manifestations of stress, which may indicate that individuals are not able to understand them. On the other hand, correlations appear between clarity and the physiological and behavioral manifestations of stress, but at a significance level of 0.05, instead of.01 as in the first center. Repair also stands out, which does not correlate with any of the stress dimensions. Attitude toward consumption correlates significantly with behavioral manifestations of stress. Another difference we found with respect to those of the first center is that the attitude toward consumption does not correlate with any of the components of EI. And finally, in relation to the intention to consume it is exclusively correlated with the emotional manifestations of stress. Significant differences were found in the emotional, physiological and behavioral manifestations of stress depending on the sex of the adolescents. We see how women score higher on emotional and physiological manifestations than men, and men score higher on behavioral manifestations than women. In terms of gender differences for EI, it has been identifi ed that the attention component is significantly higher for women and, in contrast, men obtain better results in

TABLE 3 | Center 1 before confinement.

			SSI-SM			TMMS 24			CUIQ		
Questionnaire	**Dimensions**		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
SSI-SM	1. Emotional	r									
		Sig									
	2. Physiological	r	0.778**								
		Sig	0.000								
	3. Behavioral	r	0.661**	0.665**							
		Sig	0.000	0.000							
TMMS 24	4. Attention	r	0.503**	0.481**	0.362**						
		Sig	0.000	0.000	0.000						
	5. Clarity	r	0.208**	0.253**	0.222**	0.473**					
		Sig	0.003	0.000	0.002	0.000					
	6. Repair	r	0.225**	255**	0.195**	0.469**	0.724**				
		Sig	0.001	0.000	0.006	0.000	0.000				
CUIQ	7.Attitude toward consumption	r	0.260**	0.300**	0.412**	0.238**	0.051	0.107			
		Sig	0.000	0.000	0.000	0.001	0.472	0.130			
	8. Subjective standard	r	0.352**	0.335**	0.344**	0.209**	0.124	0.153*	0.474**		
		Sig	0.000	0.000	0.000	0.003	0.080	0.030	0.000		
	9. Self-efficacy toward abstinence	r	0.391**	0.410**	0.329**	0.426**	0.573**	0.624**	0.125	0.263**	
		Sig	0.000	0.000	0.000	0.000	0.000	0.000	0.076	0.000	
	10. Intention to use cannabis	r	0.395**	0.397**	0.418**	0.240**	0.056	0.081	0.563**	0.520**	0.169*
		Sig	0.000	0.000	0.000	0.001	0.429	0.252	0.000	0.000	0.016

*Correlations between stress, EI and intention to use in adolescents. **Pearson's correlation is significant at the.01 level (bilateral). *Pearson's correlation is significant at the.05 level (bilateral).*

TABLE 4 | Center 2 at the end of the confinement. Correlations between stress, EI and intention to use in adolescents.

			SSI-SM			TMMS 24			CUIQ		
Questionnaire	**Dimensions**		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
SSI-SM	1. Emotional	r									
		Sig									
	2. Physiological	r	0.738**								
		Sig	0.000								
	3. Behavioral	r	0.702**	0.535**							
		Sig	0.000	0.000							
TMMS 24	4. Attention	r	0.545**	0.530**	0.368**						
		Sig	0.000	0.000	0.000						
	5. Clarity	r	0.149	0.223*	0.246*	0.479**					
		Sig	0.144	0.0247	0.015	0.000					
	6. Repair	r	0.180	0.180	0.135	0.499**	0.671**				
		Sig	0.076	0.076	0.184	0.000	0.000				
CUIQ	7. Attitude toward consumption	r	0.304**	0.269**	0.221*	0.048	−0.047	0.153			
		Sig	0.002	0.008	0.028	0.641	0.646	0.134			
	8. Subjective standard	r	0.374**	0.280**	0.215*	0.198	−0.015	0.222*	0.516**		
		Sig	0.000	0.005	0.033	0.051	0.884	0.028	0.000		
	9. Self-efficacy toward abstinence	r	0.362**	0.332**	0.371**	0.528**	0.591**	0.573**	0.162	0.280**	
		Sig	0.000	0.001	0.000	0.000	0.000	0.000	0.111	0.000	
	10. Intention to use cannabis	r	0.253**	0.196	0.188	0.147	0.013	0.194	0.487**	0.462**	0.242*
		Sig	0.012	0.053	0.064	0.149	0.900	0.056	0.000	0.000	0.017

***Pearson's correlation is significant at the.01 level (bilateral). *Pearson's correlation is significant at the.05 level (bilateral).*

emotional clarity (see **Table 5**). Statistically significant differences were found for the emotional manifestations of stress, before and at the end of confinement, it being higher at the end (see **Table 6**). Results for the intention to use cannabis were above the 50th percentile both of the centers and for the male/female comparison.

DISCUSSION

The results of this study show how confinement seems to have had effects on the mental health of adolescents, specifically on stress. There is currently no research focusing on the effects that the confinement brought about by COVID-19 pandemic

TABLE 5 | Differences between males and females for the variables stress, emotional intelligence, and intention to use in adolescents.

Questionnaires	Dimensions	Men (M ± SD)	Women (M ± SD)	Total (M ± SD)	*t*	*p*
SSI-SM	Emotional	19.95 ± 8.63	23.58 ± 9.51	22.20 ± 9.34	−3.32	0.001
	Physiological	9.10 ± 3.98	10.25 ± 4.42	9.81 ± 4.29	−3.40	0.001
	Behavioral	9.61 ± 4.54	9.53 ± 3.95	9.56 ± 4.18	−2.28	0.023
TMMS 24	Attention	21.12 ± 8.55	24.32 ± 8.76	23.10 ± 8.80	−3.09	0.002
	Clarity	25.04 ± 9.19	22.77 ± 8.11	23.63 ± 8.59	2.23	0.027
	Repair	26.31 ± 9.10	24.67 ± 8.86	25.29 ± 8.97	1.54	0.126
CUIQ	Attitude toward consumption	1.00 ± 0.93	0.958 ± 0.851	0.9757 ± 0.88	0.44	0.664
	Subjective standard	0.94 ± 0.74	1.035 ± 0.702	0.98 ± 0.88	−1.12	0.664
	Self-efficacy toward abstinence	4.39 ± 1.44	4.392 ± 1.355	4.39 ± 0.39	0.003	0.998
	Intention to use cannabis	1.07 ± 0.71	1.265 ± 0.965	1.19 ± 0.88	−1.84	0.067

M, mean, SD, standard deviation.

TABLE 6 | Differences between ESO centers before and after confinement for the variables stress, emotional intelligence, and intention to use in adolescents.

Questionnaires	Dimensions	Center 1 before confinement (M ± SD)	Center 2 after confinement (M ± SD)	*t*	*p*
SSI-SM	Emotional	21.02 ± 8.88	24.63 ± 9.83	−3.196	0.002
	Physiological	24.63 ± 9.83	10.15 ± 4.54	−0.955	0.340
	Behavioral	9.38 ± 4.16	9.95 ± 4.21	−1.114	0.266
TMMS 24	Attention	22.72 ± 8.98	23.87 ± 8.43	−1.061	0.289
	Clarity	23.40 ± 8.65	24.13 ± 8.496	−0.701	0.484
	Repair	25.67 ± 9.28	24.52 ± 8.30	1.039	0.300
CUIQ	Attitude toward consumption	0.97 ± 0.94	0.98 ± 0.75	−0.102	0.918
	Subjective standard	0.96 ± 0.751	1.08 ± 0.641	−1.317	0.189
	Self-efficacy toward abstinence	4.29 ± 1.48	4.60 ± 1.15	−1.774	0.077
	Intention to use cannabis	1.20 ± 0.95	1.17 ± 0.715	0.351	0.726

ESO, compulsory secondary education, M, mean, SD, standard deviation.

may have on substance use in adolescents, and it remains to be seen whether these effects will be related in the long term to an increased probability of cannabis use.

In terms of EI, our results indicate that women score significantly higher than men in the attention dimension, and men score lowest in clarity. Research indicates how EI skills develop with age. In relation to gender differences, our results are consistent with those reported in previous studies in which women obtain higher EI scores than men (Billings et al., 2014), specifically in the attention dimension (Martínez-Marín and Martínez-Marín and Martínez, 2019; Veytia López et al., 2019; Vaquero-Diego et al., 2020), while men have higher scores for the clarity component. One of the key characteristics of emotionally intelligent people is that they are experts at regulating their emotions and maintaining the quality of their performance during periods of severe stress (Orak et al., 2016). In this sense, the outbreak brought about by COVID-19 pandemic and the subsequent confinement for epidemiological control is a stressful event for students, many of whom were preparing for their exams due to the end of the academic year. In relation to stress levels, our results show differences in terms of sex, women score higher in emotional and physiological manifestations, however, men score higher in behavioral manifestations. This is corroborated with results from previous studies, in which adolescents with lower levels of emotional regulation have more symptoms of stress, social stress and anxiety (Cejudo et al., 2018). However, it has been seen that the female sex, together with stressful life events can predict mental health problems, compared to those with better EI and cognitive skills (Nyarko et al., 2020). This is a factor to be considered and taken into account, as later in university life the regulation of emotions acts as a mediator in models of stress and life satisfaction (Saklofske et al., 2012). As regards the confinement situation, our results show how the COVID-19 pandemic seems to have had an effect on the health and well-being of adolescents, with significant differences at the end of the confinement in the emotional component of stress. There are a limited number of studies addressing these variables during confinement in the adolescent population. However, similarities have been found to that which was obtained in a study carried out at the Spanish University of Valladolid (Odriozola-González et al., 2020) focusing on the impact of the COVID-19 outbreak on the stress of students and teachers. In this study (Odriozola-González et al., 2020) 50.43% showed a moderate to severe impact due to both the outbreak and the confinement, with higher values of depression, anxiety and stress in students compared to university employees. On the other hand, in China a study (Wang et al., 2020) indicates that 53.8% of the population suffered a moderate to severe psychological impact from the COVID-19 crisis and 8.1% showed moderate to severe stress values. Furthermore, women, being students and having specific physical symptoms were associated with a greater psychological impact of the outbreak and higher levels of stress, anxiety and depression (Wang et al., 2020). In line with our results, Liang et al., 2020 (Liang et al., 2020) points out that in China, in population aged from 14 to 35, 40.4% of the population had a tendency to suffer psychological problems due to the outbreak associated with: having lower secondary education having post-traumatic stress symptoms and using negative coping measures, with women being more likely to show post-traumatic stress symptoms.

As regards the relationship between EI, stress and cannabis use, the findings of the study indicate that self-efficacy toward abstinence is highly correlated with EI in both situations. In line with this, the literature indicates that attitudes toward cannabis use, subjective norms, environmental restrictions and intention to use are positively correlated with each other and with weekly cannabis use (Jalilian et al., 2020). Thus, greater difficulty in stress management and empathy more often predict the use of substances such as alcohol, tobacco and cannabis (Kun et al., 2019). In contrast, characteristics indicating high levels of EI, such as higher self-esteem and problem-solving ability, were associated with a lower weekly cannabis use (Jalilian et al., 2020). Such statements are in line with the results obtained in this article, since we can see how those adolescents who, after confinement, pay such attention to their emotions, are not able to act clearly, or with adequate reparation, in other words, they are not able to regulate their emotions. Conversely, the intention to use cannabis is only correlated, in a significant way, with the emotional manifestations of stress. A study of American adolescents shows that susceptibility to tobacco use is not significantly associated with the initiation of cannabis use only, suggesting that the association between susceptibility to using tobacco and the initiation of cannabis use may be driven by the use of poly-substances in young cannabis users (Silveira et al., 2020). On the other hand, there is a significant number of adolescents who are unsure about the perceived benefits of using cannabis, and that use should be for medical purposes, as well as an association between a low perception of harm from use and a high perception of benefits and lifetime use of cannabis (Modeste and Hamilton, 2019). Understanding the cognitive-emotional and behavioral factors underlying the intent to use cannabis is therefore crucial to the effectiveness of countermeasures such as preventive interventions to avoid or reduce cannabis use (Jalilian et al., 2020). Moreover, the early use of substances, including cannabis, can be slowed down by not encouraging sedentary lifestyles among young people (Williams et al., 2019). In addition, the practice of physical activity (PA) in adolescents is related to their mood, where PA is significantly associated with the different moods of adolescents during the COVID-19 epidemic. It has been shown that the higher the level of PA, the better the mood (Zhang et al., 2020).

Limitations

Although the present paper makes a major contribution to the study of the effect of confinement on the mental health of adolescents and their intention to use cannabis, limitations must be taken into account. We found a convenience sample, only data from center one before confinement and data from center two after confinement were collected. Therefore, we cannot know exactly the situation of both centers during the two time periods considered in this study, for example, there may be factors that influence the results obtained, such as exams periods.

CONCLUSION

The exceptional situation experienced due to the COVID-19 pandemic has brought about a period of confinement with consequences for the emotional state of young people. Thus, at the end of the confinement, adolescents in the town of Ponferrada (León, Spain), are perceived to be more stressed (emotional manifestations) than those students before the confinement. In addition, the variables of stress and EI are related, although weakly, with intention of cannabis use. Gender differences between participants indicate that women present greater physiological and emotional manifestations of stress, as well as greater emotional attention. In contrast, men achieve greater emotional clarity. This highlights the need for increased health education which should be combined with emotional management counseling for healthy and vulnerable adolescents. These results can be applied to both drug prevention programs and substance abuse treatment interventions. Promoting adolescent mental health, through the management of emotional competencies such as EI attention, can influence the management of psychological stress affecting students. As shown in the literature, the practice of physical activity has beneficial effects on adolescent well-being, hence future research focusing on physical activity needs to be carried out to improve EI, stress, and prevent cannabis use.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the database of this article is part of a doctoral thesis that is in process of elaboration, therefore, it is not possible to publish it at present. Requests to access the datasets should be directed to MM-F, mmartf@unileon.es.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of the University of León ETHICS-ULE-035-2019. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

CL-P, IG-R, and MM-F: conceptualization. CL-P, MM-F, and IG-R: methodology. JB-A and IG-R: software. CL-P, MM-F, and EF-M: formal analysis. IG-R, MM-F, CL-P, JB-A, PM-S, and EF-M: investigation. JB-A, MM-F, and PM-S: resources. JB-A and CL-P: data curation. MM-F, CL-P, IG-R, EF-M, and JB-A: writing—original draft preparation. CL-P, MM-F, EF-M, JB-A, PM-S, and IG-R: writing—review and editing. CL-P and IG-R: supervision. All authors contributed to the article and approved the submitted version.

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Individuals' Self-Reactions Toward COVID-19 Pandemic in Relation to the Awareness of the Disease, and Psychological Hardiness in Saudi Arabia

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The coronavirus (COVID-19) outbreak around the world has caused public health concerns and changes in peoples' behaviors and psychological distress. The pandemic impacts on human behavior, emotions, and cognition, leading to diverse reactions in relation to awareness of the disease. However, there is little understanding around the psychological impacts of the pandemic and strategies to overcome this impact. This study aimed to examine individuals' reactions toward the COVID-19 pandemic in relation to their psychological hardiness, their degree of awareness toward the pandemic, and precautionary measures taken. Individuals living in Saudi Arabia were invited to complete an online questionnaire which included demographic items, psychological responses to the pandemic, awareness of COVID-19, and measures of psychological hardiness. A total of 1272 individuals were recruited into the study, with the majority being female (85%). Results indicated that the average psychological responses to the COVID-19 pandemic in the study sample were 75.85%. This indicates that the sample generally has a high level of positive psychological responses to the COVID-19 pandemic. The awareness of COVID-19 among Saudi was 91.50%. This indicates a high level of awareness among the study sample.

Keywords: COVID-19, public health, psychological hardiness, behavior, psychological impact

INTRODUCTION

The coronavirus (COVID-19) pandemic came as a shock to businesses, governments, and individuals. Just as it is threatening people's health, the pandemic is rapidly becoming a social and economic stressor, as people adopt new living methods to prevent the spread of the disease (Cao and Li, 2020). This pandemic has multiple influences on human behavior, emotions, and cognition, leading to diverse reactions in relation to awareness of the disease (Clay and Parker, 2020). Markedly, the COVID-19 pandemic elicits behavioral and psychological reactions that are likely to result in mental health issues amongst individuals depending on their level of awareness of the disease (Eurosurveillance Editorial Team, 2020; Lee and You, 2020; Lei et al., 2020).

Threats cause unpredictability among people, and they make decisions and choose behaviors that they perceive as useful in regaining a sense of control. Governments across the globe continue to issue facts and precautionary measures to reduce the spread of the pandemic at the individual, community, and international level. Citizens receive this information through media channels and public health channels, which are not evenly accessible. Consequently, people have different knowledge about the disease, its severity, and mortality. Variations in the information provided, lack of enough resources on the condition, and unfamiliarity with its varied outcomes reinforce the perception of its riskiness (Lee and You, 2020). Particularly, the unfamiliarity with the pandemic can heighten people's perception of its riskiness, which influences the development of behaviors such as hoarding. According to Gyulai (2020), a need to regain control when faced with uncertainties of contagion influences hoarding behaviors. As people seek to gain control, they revert to hoarding items that they perceive to be vital for their survival, including toilet paper, as was witnessed at the peak of the pandemic's outbreak. Lack of unfamiliarity with the epidemic results in heightened risk perception and risk-averse behavior.

Positive behavioral reactions stem from people's awareness and optimistic attitudes toward the pandemic. According to Zhong et al. (2020) people's adoption of safety behaviors, such as the use of preventive masks and hand sanitizers are primarily influenced by their attitudes, practices, and knowledge toward the virus. Socially related behaviors associated with disease awareness include avoiding crowded areas. However, these precautionary measures are reinforced at the state level through strict prevention and control measures such as banning public gatherings (Zhong et al., 2020). A study conducted among the Chinese population indicated that increased knowledge and awareness of the pandemic was associated with a high likelihood of positive attitudes, but potentially dangerous practices toward the epidemic (Zhong et al., 2020). These include closing schools and areas of work, which has contributed to a significant increase in unemployment. Other studies report similar behavioral reactions to the pandemic. For instance, those with little awareness of the illness pretended to be sick to avoid going to their academic or working institutions (Balkhi et al., 2020). Those who are aware of the potential of media channels to increase anxiety levels opted to avoid watching, listening, and reading current news (Balkhi et al., 2020). The positive behavior reactions could result from good knowledge and awareness of the high infectivity rate of the virus.

The COVID-19 pandemic has triggered fear and anxiety in people at some point since it began, regardless of their level of awareness (CDC, 2020). In normal circumstances, misinterpretation of perceived bodily changes and sensations results in health anxiety (Rajkumar, 2020). However, outbreaks of infectious diseases such as the COVID-19 trigger excessive health anxiety, especially when the information provided is exaggerated or inaccurate. Individual anxiety reactions manifest as maladaptive behaviors, such as avoidance of healthcare services, hoarding particular items, and repeated medical consultations, even with the slightest symptoms such as heat-induced headaches. The anxiety further induces mistrust of public authorities regarding the occurrence and preventive recommendations offered (Rajkumar, 2020). Uncertainty, misinformation, and unpredictability of the disease heighten anxiety levels among people, especially those at a high risk of contracting the infection. Zandifar and Badrfam (2020) state that the fear of death among patients is a common reaction related to disease pandemics such as COVID-19. Other likely reactions include the development of anger issues and feelings of loneliness, especially among those quarantined.

People's reactions to the breakout of COVID-19 have had a huge influence on their mental health, leading to the adoption of self-destructive behaviors among some. As governments continue to impose strict restrictions on movement, people's livelihoods and routines are disrupted, leading to increased levels of depression, loneliness, and the development of harmful alcohol and drug use, and self-harm.

"Psychological Hardiness" has a great importance in life, as it protects humans from the effects of various life pressures. It is defined as a personality trait with three interrelated dimensions. These dimensions include commitment, which is the tendency to regard life as interesting and meaningful; control, which is a belief that one can influence outcomes by taking action; and finally challenge, an explorative approach to living (Bartone, 2012). It makes the individual more resilient, optimistic and easy to deal with his stressful problems. Psychological hardiness works as a protection against physical illnesses and psychological disturbances. Kobasa (1979) highlights the fact that psychological hardiness and its components work as a psychological variable, alleviating the effect of stressful events on the individual's physical health. The most hardened people are exposed to stresses and do not get sick. Kobasa agreed with Folkman and Lazarus in that psychological characteristics such as psychological hardiness, for example, affect the individual's cognitive security to the stressful event itself and the threat comes to his security, mental health and self-esteem. It also affects the individual's assessment of confrontation methods, which include problems, escaping, avoiding, taking responsibility, seeking support.

On the protective role that personality hardiness plays in protecting an individual from the risk of disease, several studies have been conducted that have found that the trait of hardiness prevents the individual's level of tendency to deal effectively and logically with stressful situations (Holahan and Moos, 1987; Williams et al., 1992). The significance of the hardiness lies in protecting the individual from disease as it contains the trait of internal control (Kravitz et al., 1993) and the lack of a neurotic factor.

As the COVID-19 pandemic sweeps across the world, it is causing widespread concern, fear and stress, all of which are natural and normal reactions to the changing and uncertain situation that everyone finds themselves in. As Dr. Kluge, WHO regional director for Europe states: "The issue facing each and every one of us is how we manage and react to the stressful situation unfolding so rapidly in our lives and communities. Here we can draw on the remarkable powers of strength and cooperation that we also fortunately possess as humans. And that is what we must try to focus on to respond most effectively to this crisis as individuals, family and community members, friends and colleagues," (Wang et al., 2020).

Psychological hardiness is the most important characteristic of the personality that grows and develops. It also plays an important role in realizing, facing and resisting stressful events. It has an impact in evaluating the individual's psychological and social sources to confront pressure. It is a characteristic that may vary from one to another and, sometime at times, the stressful events play an important role in its development and advancement. Psychological hardiness contributes to the emotional, psychological and social maturity to prevent the impact of stressful events on mental and physical health of individuals. Thus, the following research questions are posed in the proposed study:

(1) What is the level of individuals' self-reaction toward COVID-19 pandemic, degree of the awareness of the disease and the psychological hardiness in Saudi Arabia
(2) Is there a relationship between individuals' self-reactions toward COVID-19 pandemic in relation to psychological hardiness, in Saudi Arabia?
(3) Is there a difference in individuals' self-reaction toward COVID-19 epidemic, hypochondria, due to the degree of awareness toward the disease in the Saudi society?
(4) Is there any significant differences in individual's self-reaction toward COVID-19 epidemic, and the degree of awareness toward the disease in relation to age, gender, marital status, educational level, job type, level of effect of the dieses in Saudi Arabia?

MATERIALS AND METHODS

Study Sample and Methods

An online survey Google form in Arabic was sent to the participants by different social media which they could fill out at their convenience. The first page contained a brief that informed participants about the study protocol, anonymity of data and the right to withdraw at any time during the study. Upon consent, the participants were guided through the questionnaire online. After completion, the participants were presented with a debrief. The questionnaire took up to 20 min to complete, which included the time reading through the briefing and debriefing.

The estimated population of Saudi Arabia (in 2019) is 34.4 million individuals, with 42.6% being female and nearly 47% are within the working age range of 25 and 54 years (Global media insight, 2020). Given that 26.12 million of the population is from the age of 14 and above and calculating a confidence level of 95% with a margin of error of 5% a sample size of 385 was needed. The final sample of the study consisted of (1,272) individuals, age ranged between 13 and 77 years with an average age of (36.85, SD = 12.61). The participants were from 13 regions in Saudi Arabia, distributed as following (1047 in Riyadh, 1 in Al Bahah, in from Al-Jawf, 17 in the northern border; 21 in Qassim, 8 in Medina, 26 in Tabuk, 1 in Jazan, 11 in Ha'il, 17 in Asir, 48 in Mecca, 6 in Najran, 67 in Al Sharqiya). The majority of the sample were female (1083 females by 85%; males = 189, 14.9%). Most of the sample were married (n = 771, 60.6%), university-educated (n = 809, 63.6%), and more than one third of the sample worked in the educational sector (n = 528, 41.5%).

Measures

Psychological Responses to COVID-19

The questionnaire measured individual's reaction to COVID-19 pandemic, including the cognitive, emotional, social, or behavioral reactions (**Supplementary Appendix 1**). The questionnaire was developed by the authors and items were created based on open-ended questions sent to a random sample (N 180) in Saudi Arabia. Questions addressed the effects of the pandemic on individuals, their knowledge, emotional, and social behaviors. Participants responses were analyzed, and a total of 68 items were constructed. The questionnaire was sent to six experts in the field of psychology for their feedback. Items were edited according to their suggestions and edits. The final version of questionnaire consisted of (48) items; 23 positive items and 25 negative items. The negative items (reversed) are: (1-2-3-4-5-13-14-15-16-17-18-19-20-21-24-33-41-42-44-45-44).

They are distributed in four constructs, as follows:

1. Cognitive Responses: The set of ideas and beliefs of an individual toward the COVID-19 pandemic; 12 items (1–12).
2. Emotional Responses: The combination of feelings and emotions that the individual feels toward the COVID-19 pandemic, and the number of items of this dimension; 12 items (13–24).
3. Social Responses: Social interactions with others are intended to be the period of the COVID-19 pandemic; 12 items (25–36).
4. Behavioral Responses: The various activities and actions of individuals are intended to be carried out by the COVID-19 period; 12 items (37–48).

The scales were based on a four item Likert scale (completely applicable, completely not applicable) and the scale is corrected by grades (1–4), and the grades are reversed for negative items. Validity was conducted on a random sample of (168) using a factor analysis for the questionnaire items. Results of exploratory analysis revealed that the items statistically significantly are under four factors. These four factors together accounted for 43.88% of the total variance, which is a large amount to reduce the variance explained by these factors.

Awareness of COVID-19 Scale

The scale was developed by the researchers based on the information available by the WHO with regard to COVID-19. The scale aimed to measure the extent to which individuals know COVID-19; the nature of the disease, ways of transmission, symptoms, and preventive action, it is consisted of 18 items based on five-point Likert scale (1 = low level of knowledge, 5 = high level of knowledge.).

The scale was sent to six experts in the field of psychology to review the items according to the guidelines presented by the WHO, and changes were made accordingly. The scale was sent to a random sample of (n = 168) to test the validity and reliability. The correlation coefficient and cronbach's alpha was calculated for the statements.

Psychological Hardiness Scale

This scale aims to measure individuals' psychological hardiness, the extent to which the individual perceives in his/her ability to use the available psychological and environmental resources to raise one's awareness, understanding and effectively face life pressures. The scale was developed by Mukhaimer (2002), consisted of 47 items (32 positive items; 15 negative items).

They are distributed under three constructs, as follows:

1. Commitment: A type of psychological contract that the individual commits to himself, his or her goals, values, and others around him, consisting of 16 items.
2. Control: Indicates how much an individual believes he can have control over the events he receives, and how much personal responsibility is to be assumed for what happens to them, and consists of 15 items.
3. Challenge: The belief that the change in aspects of life is more dramatic and necessary for growth than a challenge to it; this helps it to start and explore the environment and to learn the psychological and social resources that help the individual effectively cope with pressures, consisting of 16 items.

The scale is answered by response alternatives (always, sometimes never), the scale is corrected by scores (1–3) and the scores are reversed for the negative items, and the high scores on the scale reflects high psychological hardiness.

Mukhaimer (2002) tested the scale validity and reliability by calculating the reliability related to the ego strength scale and the reported Cronbach's Alpha = 75, and compared to Beck depression scale with Cronbach's Alpha = 0.61 This indicates that both reported Cronbach's' Alpha are statistically significant. The reliability of the psychological hardiness scale has been verified in the same ways as the reliability of the reaction feedback scale toward the COVID-19 pandemic.

Statistical Methods

Several statistical methods were applied to address the research questions. Psychological responses to the pandemic, individuals' level of awareness and their psychological trauma were calculated using percentages. The correlation coefficient of pearson correlation coefficient, to measure the relationship between psychological and psychological trauma as they are connected variables. The Mann–Whitney test for the two separate samples was conducted to examine the differences in psychological and psychological responses according to the different awareness of the disease. T-Tests were conducted for separate sample to examine the differences in psychological responses to the pandemic, based on dimorphological variables that compare two groups (gender, disease not infected). Demographical variables that compare more than two groups (social status, age, qualification, type of occupation) use one-way variation analysis.

RESULTS

Means and percentages are presented in **Table 1**. The average psychological responses to the COVID-19 pandemic in a sample of Saudi society were (M = 145.64) and the average was 75.85% of the maximum score for the scale (range 144 to 192). This indicates that the sample of research from Saudi society generally has a high level of positive psychological responses to the COVID-19 pandemic. The average degree of awareness of the disease in a sample of Saudi society was (82.35) and the average ratio was 91.50% of the maximum score of the scale, and the average was in the high range (66 to 90). This indicates that the sample of research from Saudi society generally has a high level of awareness of the disease.

The average psychological hardiness of a sample of Saudi society was (110.08) and the average ratio was 78.07% of the maximum grade of the scale, and the average is in the high range (from 109.67 to 141). This indicates that the sample of research from Saudi society generally has a high level of psychological hardiness. The highest average psychological hardiness dimension was (commitment), with an average of 39.69 out of 48, followed by second average after (challenge) with an average of (36.94 out of 48), third and final (control) with an average of (33.45 out of 45). These three averages are located at the high level of each of the three dimensions.

Relationship Between Psychological Responses to COVID-19 and Psychological Hardiness

There is a statistically significant positive correlation (at 0.01) between all dimensions (cognitive, emotional, social, and behavioral) and the overall degree of psychological responses toward the pandemic (**Table 2**). The higher the psychological responses toward the pandemic in terms of dimensions and overall grade, the higher the scores of the psychological response the higher the psychological hardness, and vice versa.

The grades of the sample of the disease awareness were high and only at the high and intermediate levels, depending on the degree of the levels of the variables in the search measures shown in **Table 3**. A statistically significant difference (at 0.01) between average grades of individuals with a high level of awareness of the disease in the psychological responses of individuals to the COVID-19 pandemic in favor of an average grade of high-awareness. Individuals with a high level of awareness of the disease have positive psychological responses to the COVID-19 pandemic, in statistical terms, then their mid-level counterparts.

The statistically significant difference (at 0.05) between average grades of individuals with high level of mental strength and high awareness of the disease in favor of average grades of high level of disease awareness. Individuals with a higher level of awareness of the disease have higher psychological hardness than their peers with a higher level of awareness of the moderate disease.

TABLE 1 | Average grade of the sample search on the measure of psychological responses to the COVID-19 pandemic and the average percentage (n = 1272).

Dimensions	Average percentage	Average	Performance levels on metrics					
			High		Medium		Low	
			Number	Ratio	Number	Ratio	Number	Ratio
Psychological responses to the COVID-19 pandemic	75.85%	145.64	722	56.76%	550	43.24%	–	–
Cognitive responses	82.83%	39.76	1239	97.40%	33	2.60%	–	–
Proactive responses	78.92%	37.88	1070	84.10%	202	15.90%	–	–
Social responses	76.38%	36.66	1089	85.60%	183	14.40%	–	–
Behavioral responses	65.29%	31.34	533	41.90%	736	57.90%	3	0.20%
Awareness of COVID-19 disease	91.50%	82.35	1235	97.09%	37	2.91%	–	–
Psychological hardiness	78.07%	110.08	676	53.14%	592	46.54%	4	0.31%
Commitment	82.69%	39.69	1208	95%	64	5%	–	–
Control	74.33%	33.45	1019	80.10%	249	19.60%	4	0.31%
Challenge	76.96%	36.94	1092	85.80%	180	14.20%	–	–

TABLE 2 | The correlation coefficient between the psychological responses of individuals to the COVID-19 pandemic and, and psychological hardiness, in a sample of Saudi society (n = 1272).

Variables	Cognitive	Eminency	Social	Behavioral	The overall degree of psychological responses to the COVID-19 pandemic
Commitment	0.21**	0.30**	0.34**	0.34**	0.45**
Control	0.15**	0.27**	0.19**	0.29**	0.35**
Challenge	0.18**	0.28**	0.27**	0.26**	0.37**
The overall degree of psychological trauma	0.22**	0.35**	0.33**	0.36**	0.48**

***Statistically Significant at (0.01) level.*

TABLE 3 | Mann–Whitney test examining differences in psychological responses to COVID-19 pandemic, and psychological hardiness, according to the degree of awareness of the disease.

	Levels	*N*	Mean rank	Sum of rank	*U* value	Significance level
Psychological responses of individuals to the COVID-19 pandemic	Medium	37	322.57	11935	5.28	0.01
	High	1235	645.91	797693		
Psychological hardiness	Medium	37	490.96	18165.5	2.45	0.05
	High	1235	640.86	791462.5		

Relationship Between Awareness of COVID-19 and Psychological Responses to the Pandemic

There was statistically little variability in the average male and female scores in the psychological responses to the COVID-19 pandemic (**Table 4**). However, there was a statistically significant difference in individuals' psychological responses to the COVID-19 pandemic when the type of disease infection was considered in a sample from the Saudi society (**Table 5**). There is a convergence between the average degrees of injured and uninjured in the psychological responses to the COVID-19 pandemic.

There was a statistically significant differences (at 0.01) in individuals' psychological responses to the COVID-19 pandemic between social statuses. The positive psychological responses of married, divorced, widowed, and widowed were higher than in those who were single. There was a statistically significant differences (at 0.01) in the psychological responses of individuals to the COVID-19 pandemic across the age groups. Individuals who were in the 50 years and older group were found to be higher in statistical terms in the psychological responses to the COVID-19 pandemic compared to all ages under 50. There was a statistically significant differences (at 0.01) in the psychological responses of individuals to the COVID-19 pandemic in terms of educational level. The higher-level education (higher than university) was found to be statistically higher in the psychological responses to the COVID-19 pandemic compared to the higher (university) level.

Staff in the education sector were also to be found to be higher in statistical terms in the psychological responses to the COVID-19 pandemic compared to employees in other sectors, non-employees and students.

DISCUSSION

The aim of this study was to examine the psychological impact of COVID-19 in Saudi Arabia. Awareness about COVID 19

TABLE 4 | *T*-test, one-way contrast analysis and the Mann–Whitney Tests examining differences in the psychological responses to the COVID-19 pandemic across demographic variables.

	N	Mean (SD)	Value (*t*)	Significance level
Gender				
Female	189	146.2 (12.18)	0.66	0.51
Male	1083	145.54 (12.56)		Change a function
Social status				
Single	404	141.9 (13.05)	27.84	0.01
Married	771	147.28 (11.65)		
Absolute or widows	97	148.15 (13.44)		
Age				
Less than 30	394	140.95 (12.96)	39.48	0.01
From 30 to less than 40	315	145.76 (11.33)		
From 40 to less than 50	320	147 (11.93)		
50+	243	151.28 (11.13)		
Educational level				
Minor and lower	179	146.42 (12.33)	7.61	0.01
University	809	144.66 (12.59)		
Higher than University	284	147.92 (12.08)		
Type of occupation				
Employed in the education sector	528	148.34 (12.13)	16.31	0.01
Health Officer	48	144.21 (13)		
Employed in other sectors	137	144.88 (11.9)		
Student	293	141.23 (13.09)		
Does not work	266	145.79 (11.37)		

TABLE 5 | Differences in the psychological responses to the COVID-19 pandemic type of disease.

Type of disease	*N*	Mean	Total grades	Value (*z*)	Significance level
Not injured	1242	635.52	789317.5	0.61	0.54
Injured or recovering	30	677.02	20310.5		Change a function

among Saudi was extremely high, which may be due to when the study was conducted. Due to the experience of the epidemic of MERS (Middle East respiratory syndrome related coronavirus) in 2015 in Saudi Arabia, the population were more aware of COVID-19 virus diseases. Zhong et al. (2020) indicated that the knowledge score of Chinese about the COVID-19 was similarly high to what our study found (90%). Although Saudi Arabia was largely unaffected by MERS, public knowledge of MERS at that time was high, 79.35% (Althobaity et al., 2017), which is less than the recorded knowledge of COVID-19 (86.5%) (Hoda, 2016). However, Bawazir et al. (2018) indicated that almost all participants heard about the (MERS) COVID-19 disease and causative agent however the overall knowledge was 66.0%. The reason of the difference between the results of the studies may be the time of data collection in relation to the spread of the disease.

A study done by Wolf et al. (2020) in the United States to investigate the knowledge of COVID 19 showed that participants who had heard of COVID-19 considered the disease to be a high threat. However, Clements (2020) reported that COVID-19 knowledge in the United States was approximately 80%, which was lower than the 91.5% reported in our study. Today most people in Saudi Arabia have easy access to the internet and information from different sources which could explain the high level of knowledge among people in Saudi Arabia.

Illness anxiety disorder (previously called hypochondriasis) is described as a person who worries that he\she may become seriously ill, or they may have serious disease. Gong et al. (2020) reported that hypochondriacal suspicion was 44.11%. Our results showed that the COVID-19 pandemic brought panic and hypochondria to the public, with just under half of the sample thinking they had the disease. Eichenberg and Schott (2019) reported that more than 40% of their Austrian participants showed at least some symptoms of hypochondria. Wolf et al. (2020) reported that 24.6% said that they were "very worried" about getting coronavirus. Huang and Zhao (2020) reported that anxiety about COVID-19 in China was 35.1%. AlNajjar et al. (2014) reported that 57.7% of Saudi Arabians recorded a moderate anxiety score about MERS, due to the higher mortality rates of MERS in comparison to COVID-19. In addition, the animal suspected of carrying the MERS virus was a camel, which is a common animal in Saudi Arabia.

In term of hardiness, we did find that hardiness levels in our sample was 78.07%. Brooks (2003) reported that higher levels of hardiness correlate with more positive outcomes in chronic illness patients. As hardiness increases, the positive outcome of the disease increases and in our study we did find that as awareness increased, hardiness increased. Costantini et al. (1997) reported that nurses working in Oncology or AIDS patient who have higher hardiness levels at the beginning of the course of treatment were associated with lower emotional exhaustion and higher personal achievement. One factor to be considered in hardiness was spiritual well-being. Carson and Green (1992) reported that there was a significant relationship between spiritual well-being and hardiness. People in Saudi Arabia have strong relationships to their religion which could be explained for the high levels of hardiness in our study during the COVID-19 pandemic.

We did find that 75.85% of our sample have a psychological impact due to the pandemic of COVID 19. The young have higher psychological impact however male and female have the same level of psychological impact. In contrast Varshney et al. reported that in India one third of respondents had significant psychological impact, younger age, female gender and comorbid physical illness have higher psychological impact. Wang et al. (2020) examined the psychological impact of COVID-19 and reported minimal psychological impact, mild psychological impact and moderate or severe psychological impact to be 24.5, 21.7, and 53.8% respectively.

Coronavirus is a serious disease and have shown that people are anxious about the disease. All governments have taken a major step to slow the spread of the virus. Mortality rates as of September 2020 in Saudi Arabia is less than 1% (Google search, 2020). However, the mortality rate of MERS at Saudi Arabia was reported at 37 and 22.9%. In the South Korea this was 21%. It is very clear that the MERS disease carries a higher mortality rate than COVID-19. It is very clear that psychological impact in the public is great. Further and more detailed studies to evaluate the best solution to combat devastating psychological impact is needed.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Princess Nourah Bint Abdulrahman University Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors who meet authorship criteria are listed each contribution. Furthermore, each author certifies that this material or similar material has not been and will not be submitted to or published in any other publication. AAA designed the analysis. NA and MA contributed to analysis. FSA, AAA, and RKA wrote the literature review. RKA performed the analysis. FSA collected the data.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.588293/full#supplementary-material

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Change in Physical Activity During the Coronavirus Disease 2019 Lockdown in Norway: The Buffering Effect of Resilience on Mental Health

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Imposition of lockdown restrictions during the coronavirus disease 2019 (COVID-19) pandemic was sudden and unprecedented and dramatically changed the life of many people, as they were confined to their homes with reduced movement and access to fitness training facilities. Studies have reported significant associations between physical inactivity, sedentary behavior, and common mental health problems. This study investigated relations between participants' reports of change in physical activity (PA; i.e., Reduced PA, Unchanged PA, or Increased PA) and levels of anxiety and depression symptoms during the COVID-19 pandemic lockdown in Norway in the time period from March 12, 2020 to June 15, 2020. The relations between age and gender and levels of anxiety and depression symptoms as well as how different levels of resilience influenced the relation between changes in PA and levels of anxiety and depression symptoms were also investigated. A cross-sectional survey design was used. Participants (N = 1,314; females = 31%) were members of an endurance sports organization aged between 18 and 81 years (M = 49 years; SD = 11.50 years). Participants completed the Resilience Scale for Adults and the Hospital Anxiety and Depression Scale and reported their changes in PA after lockdown restrictions were implemented on March 12, 2020. Regression analysis, independent samples t-test, and two-way multivariate analysis of variance were conducted. Reduced PA was associated with a higher risk of anxiety and depression symptoms. Younger participants in Reduced PA and Unchanged PA subgroups scored significantly higher on levels of anxiety symptoms and significantly higher on depression symptoms in Unchanged PA subgroup. Females in Unchanged PA and Increased PA subgroups scored significantly higher on levels of anxiety symptoms, whereas no gender differences were found for depression symptoms. The main and interaction effects of change in PA and resilience were significantly associated with depression symptoms. For anxiety symptoms, only the main effect of resilience, but not PA, and the interaction effect were significant. Results further showed that resilience was an important factor that influenced the levels of change in PA. High levels of resilience were associated with lower anxiety and depression symptoms in Reduced, Unchanged, and Increased PA subgroups during the COVID-19 lockdown. Promoting PA while boosting resilience factors such as confidence in own ability and drawing on the social support of even reduced social networks or connections while under lockdown can protect against common mental health problems.

Keywords: COVID-19, confinement, physical activity, anxiety and depression symptoms, gender, age, resilience

INTRODUCTION

The global outbreak of the novel coronavirus diseases [coronavirus disease 2019 (COVID-19)] caused by severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) has become a major global health issue around the world. Following the declaration by the WHO that COVID-19 is a global pandemic, many countries including Norway imposed measures to mitigate the effects of COVID-19 and contain community spread of this highly infectious viral disease. The imposition of COVID-19 lockdown measures was sudden and unprecedented and dramatically changed the life of people, even globally, as it forced a global lockdown. Social connections and relationships were undermined due to restrictions on outdoor movements, social gatherings, and social distancing protocols. Many people were confined to their homes with reduced movement and access to fitness training facilities. Normal daily activities including physical activity (PA) were disrupted or significantly reduced. Stress, anxiety, and depression symptoms were common psychological reactions to the measures that were implemented to mitigate and contain the spread of COVID-19 (Rajkumar, 2020).

Several studies have investigated COVID-19-related adverse mental health outcomes (e.g., Brooks et al., 2020; Pfefferbaum and North, 2020; Rajkumar, 2020; Rossi et al., 2020). The consensus across these studies is that the global outbreak of the COVID-19 is a major stress that has negative consequences on people's mental health (e.g., increases in post-traumatic stress symptoms, depression, anxiety, and insomnia). Rajkumar (2020) reported that evidence suggests anxiety and depression symptoms (16–28%) and self-reported stress (8%) are the commonest psychological reactions to the COVID-19 pandemic and may be associated with sleep problems. Additional evidence also suggests that the COVID-19 lockdown measures have caused significant changes in PA, which may explain the rise in mental health problems, including experiencing unpleasant emotions, sadness, anger, and frustrations (Lippi et al., 2020).

Regular participation in PA while under lockdown and confined to homes can be very challenging and almost impossible. Still, some amount of PA is recommended for preserving mental health. The WHO recommends that adults should engage in not less than 150 min per week of moderate-intensity aerobic PA, or not less than 75 min per week of vigorous-intensity aerobic PA, or an equivalent combination of moderate-and vigorous-intensity activity (WHO, 2020). Evidence from a meta-analysis of prospective cohort studies supports the preventive effect of PA on depression independent of age and geographic region (Schuch et al., 2018), and more recently, on anxiety, especially agoraphobia and post-traumatic disorder independent of demographic variables (Schuch et al., 2019). Previous studies have documented interesting results of PA. Among adults, PA has been found to be more effective for depression (Daley, 2008) and has potential benefits for reducing depression and anxiety among adolescents (Biddle and Asare, 2011). PA was found to be associated with a lower risk of mental health problems even in low doses (Teychenne et al., 2020), reducing depression by a medium effect [standardized mean difference (SMD) = −0.50; 95% CI: −0.93 to −0.06] and anxiety by a small effect (SMD = −0.38; 95% CI: −0.66 to −0.11) in nonclinical populations (Rebar et al., 2015). More recently, it has been found that while in lockdown due to COVID-19, light, moderate, and vigorous intensities of PA were associated with improved quality of life and decline in negative psychosocial effect of confinement (Slimani et al., 2020). Overall, mounting evidence suggests that not only does PA prevent and reduce anxiety and depression but also PA contributes to positive mental health and reduces the negative effects of COVID-19-related mental health problems (Schuch et al., 2018, 2019, 2020; Slimani et al., 2020; Teychenne et al., 2020).

Although it is well established that PA contributes to positive mental health (Rebar et al., 2015; Teychenne et al., 2020), the inability to participate in PA while under lockdown with restricted outdoor movements can negatively affect mental health. Despite significant changes to PA and the rise in COVID-19-related stress and mental health problems among some people due to the lockdown, other people with resilience factors or resources can overcome the odds for adaptive mental health (Wermelinger Ávila et al., 2017; Anyan, 2019). Resilience is the process and outcome of healthy adaptation despite significant stress (Fergus and Zimmerman, 2005). According to the resilience framework, despite the significant stress associated with COVID-19, not all people will show poor mental health (e.g., stress, depression, anxiety, and insomnia). On the contrary, some people will overcome the odds and preserve their mental health due to the availability of and access to resilience factors. Resilience has been found to be involved in the protection against anxiety and depression symptoms when exposed to major stress (Friborg et al., 2003; Anyan et al., 2017, 2019; Anyan, 2019) or when experiencing reduced or lack of social connections defined as loneliness (Anyan et al., 2020a). Protective factors involved in resilience represent intrapersonal and interpersonal resources that can modify the negative effects of stress and adversity on anxiety and depression symptoms (Anyan, 2019). Therefore, understanding how the COVID-19 pandemic has changed people's PA and how resilience is involved in the protection against common mental health problems such as anxiety and depression symptoms seems warranted.

The COVID-19 pandemic also presents an important opportunity for research regarding the relations between relevant background characteristics (e.g., age and gender) and levels of symptom of anxiety and depression; hence, understanding the relations between age and gender and the levels of anxiety and depression symptoms seems warranted. The global prevalence of anxiety disorders across 44 countries identified age and gender among factors that accounted for the greatest variance, with younger adults and women more likely to have anxiety disorders (Baxter et al., 2013). Another review of the prevalence of depression in community samples across 30 countries identified sex among the factors that accounted for the greatest variance (Lim et al., 2018). Higher score of depression among women has been documented by other studies (Nolen-Hoeksema, 1990; Wolk and Weissman, 1995; Bebbington, 1996; Sprock and Yoder, 1997). Results from the relations between relevant background characteristics and common mental health problems during the COVID-19 lockdown can contribute to the body of knowledge on COVID-19 for intervention science and practice.

The first objective of this study was to investigate the relation between participants' reports of change in PA (i.e., Reduced PA, Unchanged PA, or Increased PA) and anxiety and depression symptoms during the COVID-19 pandemic lockdown in Norway in the time period from March 12, 2020 to June 15, 2020. The second objective was to investigate the relations between age and gender and levels of anxiety and depression symptoms. Finally, this study investigated how different levels of resilience influenced the relation between change in PA and anxiety and depression symptoms.

Hypothesis i: It was expected that participants in the Reduced PA would be associated with a higher risk of anxiety and depression symptoms than participants in the Unchanged PA and Increased PA.
Hypothesis ii: It was expected that younger participants would score significantly higher on levels of anxiety and depression symptoms.
Hypothesis iii: Women were expected to score significantly higher on levels of anxiety and depression symptoms than men.
Hypothesis iv: It was expected that low resilience with reduced PA would be associated with higher levels of anxiety and depression symptoms.

MATERIALS AND METHODS

Participants

This study was approved by The Regional Committees for Medical and Health Research Ethics board and the Norwegian Centre for Research Data. Participants provided a written informed consent. Invitation to participate in the study was sent to all (N = 6,766, males = 75%) members of an endurance sports organization by e-mail. The survey was administered via an online survey platform. A total of 1,317 persons answered the survey, and a final sample (n = 1,314; males = 69%) was included for analyses. Three participants who reported gender as "other" were removed from the data prior to analyzing hypothesized differences between women and men in the levels of anxiety and depression symptoms. Participants were aged between 18 and 81 years (M = 49 years; SD = 11.50 years). Additional background information of participants can be found in **Table 1**. Five participants did not report their gender, two did not report their educational level, and three did not report their marital status. Eight participants did not report their income.

Instruments

Background Characteristics

For recording background characteristics, participants were asked to provide information about age, gender, marital status, level of education, history of mental disorder, and if they were working.

Self-Reported Change in Physical Activity

One questionnaire item asked the participants to indicate how the imposition of lockdown restrictions due to the COVID-19 pandemic has impacted their PA routine. Participants selected from three nominal responses, namely, Reduced, Unchanged, and Increased PA.

Resilience

Two subscales from the Resilience Scale for Adults (RSA; Hjemdal et al., 2001; Friborg et al., 2003) were included for assessing levels of resilience. The RSA is a 33-item self-report

TABLE 1 | Background characteristics of all participants (N = 1,314).

Variable	Reduced, n (%) 183 (14%)	Unchanged, n (%) 845 (64%)	Increased, n (%) 286 (22%)
Background characteristics			
Age (years)	47	50	46
Gender, n (%)			
Females	65 (36%)	247 (29%)	93 (33%)
Males	118 (64%)	594 (71%)	192 (67%)
Marital status, n (%)			
Married	135 (74%)	694 (82%)	229 (80%)
Unmarried	48 (26%)	151 (18%)	57 (20%)
Education, n (%)			
Primary school	2 (1%)	7 (1%)	2 (1%)
Secondary school	28 (15%)	134 (16%)	33 (11%)
<4 years university	55 (30%)	233 (27%)	70 (25%)
≥4 years university	98 (54%)	469 (56%)	181 (63%)
Working, n (%)			
Yes	162 (88%)	731 (86%)	269 (94%)
No	21 (12%)	114 (14%)	17 (6%)
Income (×1,000)			
<250	1 (0.5%)	6 (1%)	0 (0%)
250–450	6 (3%)	27 (4%)	9 (3%)
451–750	36 (20%)	147 (17%)	46 (16%)
751–100	38 (21.5%)	146 (17%)	45 (16%)
>1,000	99 (55%)	514 (61%)	186 (65%)
History of mental disorder			
Yes	29 (16%)	83 (10%)	31 (11%)
No	153 (84%)	760 (90%)	255 (89)
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
Resilience	4.78 (0.91)	5.03 (0.86)	5.11 (0.81)
HADS			
Anxiety	3.76 (3.47)	3.02 (2.93)	3.20 (2.88)
Depression	2.98 (2.93)	2.05 (2.29)	2.00 (2.06)

M, mean; SD, standard deviation; HADS, hospital anxiety and depression scale.

questionnaire rated on a 7-point semantic differential scale format. Higher scores indicate higher levels of resilience protective factors. Cronbach's alpha in this study was $\alpha = 0.83$.

Symptoms of Anxiety and Depression

The Hospital Anxiety and Depression Scale (HADS; Zigmond and Snaith, 1983) includes 14 items rated on a 7-point Likert scale. The HADS was used to assess how participants felt over a 2-week period prior to measurement. HADS includes seven items that measure anxiety symptoms (HADS-A; $\alpha = 0.81$) and seven items that measure depressive symptoms (HADS-D; $\alpha = 0.72$). HADS performs well in assessing symptom severity in clinical settings and in the general population (Bjelland et al., 2002).

Statistical Analyses

All analyses were conducted in IBM SPSS 25. Missing values for items were substituted with subscale mean scores. Similar approaches have been used elsewhere (Olstad et al., 2015; Anyan and Hjemdal, 2016, 2018). The first analyses computed the odds ratios (ORs) and 95% CI for the risk of anxiety or depressive symptoms per subgroup of PA using logistic regression (Hypothesis i). Simple linear regressions were conducted to investigate the effect of age on levels of anxiety and depression symptoms across all three different groups of change in PA (Hypothesis ii). Independent samples *t*-tests were used to investigate gender differences in the levels of anxiety and depression symptoms (Hypothesis iii). Finally, a two-way multivariate analysis of variance was used to investigate the main and interaction effects of resilience and change in PA on anxiety and depression symptoms (Hypothesis iv). Resilience scores were split at the median into low and high subgroups of resilience.

RESULTS

Table 1 displays background characteristics for Reduced PA, Unchanged PA, and Increased PA subgroups. Means and standard deviations of continuous measures and other relevant indicators are also displayed. The levels of anxiety and depression symptoms were generally low across all groups.

Physical Activity Effect on Symptoms of Anxiety and Depression

Using HADS cutoff score (≥ 8), anxiety and depression symptoms were evident in 118 (9%) and 57 (4%) of the participants, respectively. Compared with the Increased PA, the Reduced PA was associated with a higher risk of anxiety (OR 2.77, 95% CI 1.510–5.086, $p < 0.01$) and depressive symptoms (OR 4.18, 95% CI 1.692–10.316, $p < 0.01$), but not the Unchanged PA after adjusting for age and gender.

Age Effect on Symptoms of Anxiety and Depression Across Reduced, Unchanged, and Increased Physical Activity Subgroups

In the *Reduced PA* subgroup, regression of anxiety symptoms (standardized $\beta = -0.23$, $SE = 0.02$, $t = -3.17$, $p < 0.01$, $R^2 = 0.05$) on age was significant, indicating that younger participants scored significantly higher on levels of anxiety symptoms. In the *Unchanged PA* subgroup, regression of anxiety symptoms ($\beta = -0.20$, $SE = 0.01$, $t = -5.76$, $p < 0.001$, $R^2 = 0.04$) and depression symptoms ($\beta = -0.10$, $SE = 0.01$, $t = -2.84$, $p < 0.01$, $R^2 = 0.01$) on age were all significant, indicating that younger participants scored significantly higher on levels of anxiety and depression symptoms. Regression of anxiety and depression symptoms on age in the *Increased PA* subgroup was not significant.

Gender Differences in Symptoms of Anxiety and Depression Across Reduced, Unchanged, and Increased Physical Activity Groups

Females scored significantly higher than males on anxiety symptoms in both the *Unchanged PA* [(females: $M = 3.58$, $SD = 3.45$; males: $M = 2.79$, $SD = 2.65$), $t(372.31) = 3.193$, $p < 0.01$, mean difference (*MD*): 0.78 (95% CI: 1.264, 0.300)] and *Increased PA* [(females: $M = 4.04$, $SD = 3.38$; males: $M = 2.81$, $SD = 2.52$), $t(143.19) = 3.115$, $p < 0.01$, *MD*: 1.23 (95% CI: 2.011, 0.449)] subgroups. No significant gender differences in depression symptoms were found in all the groups and in anxiety symptoms for the *Reduced PA* subgroup.

Differences in Change in Physical Activity and Resilience on Symptoms of Anxiety and Depression

When predicting the levels of anxiety symptoms, significant main effects were found for resilience, $F(1, 1{,}307) = 129.32$, $p < 0.001$, partial $\eta^2 = 0.09$, but not self-reported change in PA, $F(2, 1{,}307) = 1.81$, $p = 0.165$. However, the interaction effect was significant $F(2, 1{,}307) = 4.56$, $p < 0.05$, partial $\eta^2 = 0.01$. Follow-up univariate tests indicated significant effects of resilience within each level combination of self-reported change in PA (all $p < 0.001$). Specifically, the levels of anxiety symptoms were higher when scoring low on resilience in the *Reduced PA* subgroup (*MD* = 3.06; 95% CI: 2.218, 3.897), *Unchanged PA* (*MD* = 2.07; 95% CI: 1.687, 2.447), and *Increased PA* (*MD* = 1.42; 95% CI: 0.768, 2.074). When predicting the levels of depression symptoms, significant main effects were found for resilience, $F(1, 1{,}307) = 128.983$, $p < 0.001$, partial $\eta^2 = 0.09$, and self-reported change in PA, $F(2, 1{,}307) = 6.99$, $p < 0.01$. The interaction effect was significant, $F(2, 1{,}307) = 6.11$, $p < 0.01$, partial $\eta^2 = 0.01$. Follow-up univariate tests indicated significant effects of resilience within each level combination of self-reported change in PA (all $p < 0.001$). Specifically, the levels of depression symptoms were higher when scoring low on resilience in the *Reduced PA* subgroup (MD = 2.52; 95% CI: 1.861, 3.176), *Unchanged PA* (MD = 1.57; 95% CI: 1.270, 1.865), and *Increased PA* (MD = 1.04; 95% CI: 0.524, 1.546; **Figure 1**).

DISCUSSION

This study investigated relations between participants' reports of change in PA (i.e., Reduced PA, Unchanged PA, or Increased

PA) and anxiety and depression symptoms during the COVID-19 pandemic lockdown in Norway. The relations between age and gender and levels of anxiety and depression symptoms as well as how different levels of resilience influenced the relation between change in PA and anxiety and depression symptoms were also investigated. Results from the descriptive statistics showed that participants in the Reduced PA subgroup reported the highest levels of anxiety and depression symptoms and the lowest on resilience. Conversely, participants in the Increased PA subgroup reported the lowest levels of depression symptoms and the highest on resilience. In support of the first hypothesis, Reduced PA (but not Unchanged PA) was associated with higher odds of caseness anxiety and depression symptoms than Increased PA. This finding is not surprising, as recent evidence continues to show that PA is associated with a lower risk of mental health problems (Teychenne et al., 2020) and reduction in levels of anxiety and depression (Daley, 2008; Biddle and Asare, 2011). In the wake of the COVID-19 lockdown, other studies have reported that the lack of PA during COVID-19 lockdown could be associated with experiencing unpleasant emotions, sadness, anger, and frustrations (Lippi et al., 2020), which may explain why the Reduced PA was associated with a higher risk of caseness anxiety and depression symptoms. It is, therefore, interesting that the present findings show that, despite the lockdown, participants who were in the Increased PA subgroup reported the lowest scores on anxiety and depression symptoms and the highest score on resilience. Thus, PA could contribute to preserve mental health and reduce the negative effects of anxiety and depression while boosting levels of resilience during the lockdown.

The second hypothesis sought to determine the relation between age and the levels of anxiety and depression symptoms. It was expected that younger participants would report significantly higher levels of anxiety and depression symptoms. Different results were found between the three groups of change in PA. Specifically, in the Unchanged PA subgroup, younger participants scored significantly higher on both anxiety and depression symptoms, while in the Reduced PA subgroup, younger participants scored significantly higher on only anxiety symptoms. This finding partly corresponds to results from an Australian study that found higher scores in one or more psychological distress states among the youngest age group (18–45 years) during the COVID-19 lockdown (Stanton et al., 2020). There is little consensus in the literature describing what happens to the risk of anxiety and depression as people get older, and the empirical evidence is largely variable. Older reviews of epidemiological data indicated that there was no consistent pattern across studies for the age differences in anxiety and depression (Jorm, 2000). Furthermore, Jorm (2000) reported that age biases in the assessment of anxiety and depression and the masking effect of other risk factors account for the observed common trend whereby an initial rise in the symptoms across age was followed by a drop in symptoms (Jorm, 2000).

The main conclusion in a later meta-analytic review was that older adults were about 20% less likely to be diagnosed with anxiety compared with younger adults (Baxter et al., 2013), suggesting that old age reduces the risk of anxiety and depression. Supporting Baxter's conclusion and consistent with findings in this study, evidence from previous empirical studies have found significant negative associations between age and anxiety and depression symptoms among a sample of adults in the general population (Anyan et al., 2017). However, other studies found no associations among a university sample (Anyan et al., 2020b), adults in a community dwelling (Strawbridge et al., 2002), and adults undergoing chemotherapy (Weiss Wiesel et al., 2015). Overall, our cautious interpretation of the findings is that higher age may reduce the risk of anxiety and depression independent of change in PA, although the stability of this finding across different developmental stages cannot be defended. As such, this finding should be further investigated across different developmental periods in a life span perspective using longitudinal studies.

Hypothesis iii sought to determine the relations between gender and the levels of anxiety and depression symptoms. Women were expected to report higher levels of anxiety and depression than men. Meta-analytic reviews have found that women report significantly higher than men on anxiety (Baxter et al., 2013) and depressive symptoms (Nolen-Hoeksema, 1990; Wolk and Weissman, 1995; Bebbington, 1996; Sprock and Yoder, 1997; Lim et al., 2018), which was the basis for our second hypothesis.

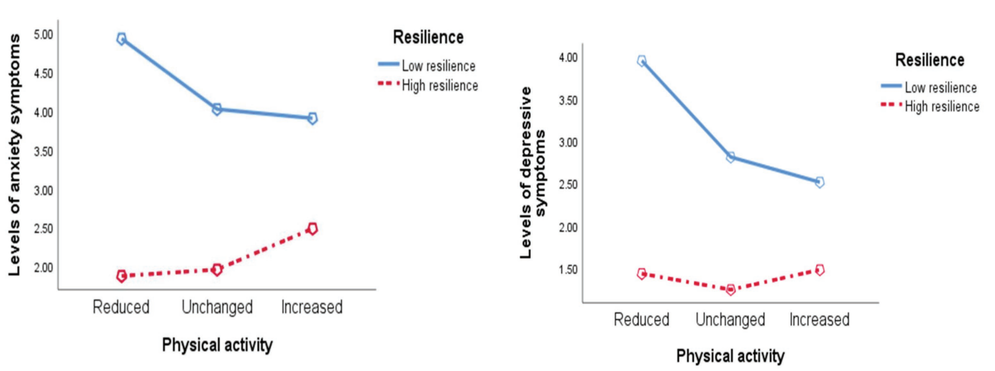

FIGURE 1 | The relations between physical activity and resilience on anxiety and depression symptoms.

Various explanations have sought to clarify the consistently high scores of anxiety and depression among women, attributable to risk factors including genetic, hormonal, psychological, and psychosocial variables (Kuehner, 2003). A recent study also found women to have significantly higher scores than men in one or more psychological distress states during the COVID-19 lockdown (Stanton et al., 2020). The findings in this study corroborate the differences in levels of anxiety, but not depressive symptoms. Women scored significantly higher on anxiety symptoms in the Unchanged PA and Increased PA groups, but not in the Reduced PA group. Contrary to our hypothesis, women did not have elevated depression scores compared to men in any of the PA groups. However, in some aspects, particularly for the Reduced PA, the results are in line with a large Norwegian population study that did not find gender differences for the association between cardiorespiratory fitness, a physiological measure highly influenced by PA level, and depression and anxiety (Shigdel et al., 2019). The same study indicated a positive effect of cardiorespiratory fitness on depression, but not for anxiety. This finding is supported by a meta-analysis that showed that PA has a stronger antidepressive effect than for anxiety (Rebar et al., 2015). Possible explanations for the findings in the present study could be that depressed women did not participate in the online survey (only 31% of the sample were women, whereas 69% were men), and that highly physically active women reduced the risk for depression, but levels of anxiety were less influenced by PA. Another important characteristic of the present study is the generally high sociodemographic status of the participants. The majority of respondents had a high level of education, high income, and were married, all of which may protect against mental illness. It must be noted though that other studies show an association between PA and anxiety (Brunes et al., 2015; Schuch et al., 2019), and the failure to establish such a relationship in the present study warrants further research.

The fourth hypothesis sought to determine how different levels of resilience influenced the relation between change in PA and anxiety and depression symptoms. Restrictions during the COVID-19 pandemic caused significant stress with mental health problems (Brooks et al., 2020; Pfefferbaum and North, 2020; Rajkumar, 2020; Rossi et al., 2020), and as such, resilience could be an important factor that may contribute to help people preserve mental health despite the stress accompanying COVID-19 and the lockdown measures. At the general level, findings in this study showed that the levels of anxiety and depressive symptoms were higher when scoring low on resilience in the Reduced PA than in the Unchanged PA and Increased PA, respectively. Alternatively, the levels of both anxiety and depressive symptoms were higher among low resilience participants who reduced their PA due to COVID-19 lockdown than among participants who increased their PA. This result brings into relief the benefits of PA and resilience during a pandemic. Recent evidence shows that while in lockdown due to COVID-19, participation in PA was associated with improved quality of life and decline in negative psychosocial effect due to confinement (Slimani et al., 2020).

Resilience-based interventions have delivered promising results for adaptive mental health, thus becoming an auspicious initiative for mental health intervention and practice (Anyan et al., 2018; Anyan, 2019). When facing pandemics with major restrictions and lockdowns, people could benefit from participation in PA and could even benefit more in combination with improving access to protective resources involved in resilience. For example, promoting PA while boosting resilience factors, such as confidence in own ability and drawing on the social support of even the reduced social networks or connections while under lockdown, may protect against stress and common mental health problems due to the outbreak of a sickness such as COVID-19. The findings in this study deepen the body of knowledge related to the consequences of PA and adaptive psychosocial and behavioral factors that can contribute to various intervention responses to COVID-19. Overall, findings in this study also contribute to the growing body of primary research and identifying the nature of relations between PA, resilience factors, and common mental health problems, especially during pandemics.

The findings should be interpreted in the light of some limitations. The three groups of change in PA were highly disproportional in their sample sizes, with only 14% of the total sample belonging to the Reduced PA subgroup while 64% belonged to the Unchanged PA and 22% in the Increased PA, which may relatively affect the power to detect effects in the analyses. The use of self-report survey questionnaires without further clinical observations only indicates the levels of symptoms without implications for clinical diagnosis. As such, generalizing results to clinical samples may be problematic. As the study sample consisted of members from a fitness association, it is not surprising that they reported a generally high weekly PA level. In addition, the fact that the average education level was very high, the findings may not be representative of the general population. The fitness association had a majority of male members (69% in total), which is reflected in the overrepresentation of male respondents in the survey, and this limits the generalizability of the results to women. Self-report survey questionnaires are also vulnerable to social desirability, which could be a potential problem for a study that relied on self-reported retrospective behaviors and thoughts. The use of cross-sectional samples precludes answering questions about protective mechanisms or processes involved in resilience, as longitudinal studies are better suited for answering questions about processes and mechanisms (Anyan and Hjemdal, 2016).

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the ethics requirement is to keep the data under lock and key. Requests to access the datasets should be directed to frederick.anyan@ntnu.no.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Regional Committees for Medical and Health Research Ethics board and the Norwegian Centre for Research Data.

The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FA contributed to the conceptualization of study, statistical analyses and interpretation of results and drafted and made substantive edits and revisions to the manuscript. OH provided feedback and contributed to revising the manuscript through either direct edits or feedback. LE and AH contributed to the conceptualization of study design and made substantive edits and revisions to the manuscript. All authors contributed to the article and approved the submitted version.

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REVIEW
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Social and Psychophysiological Consequences of the COVID-19 Pandemic: An Extensive Literature Review

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The Coronavirus Disease 2019 (COVID-19) pandemic, now a global health crisis, has surprised health authorities around the world. Recent studies suggest that the measures taken to curb the spread of the COVID-19 outbreak have generated issues throughout the population. Thus, it is necessary to establish and identify the possible risk factors related to the psychosocial and psychophysiological strain during the COVID-19 outbreak. The present extensive literature review assesses the social, psychological, and physiological consequences of COVID-19, reviewing the impact of quarantine measures, isolation, vast human loss, social and financial consequences in the family's economies, and its impact on the psychological health of the population. We also discussed the effect of psychophysiological factors, considering the impact of physical inactivity and modifications in nutritional habits, at psychological and physiological levels. The present review includes an actualized to date bibliography, articles for which were methodologically analyzed to verify they met the standards of quality and scientific accuracy. Authors understand the pandemic as a multifactorial event for which only a profound and extensive analysis would lead to better compression and efficient intervention in the near future.

Keywords: COVID-19, pandemic, stress, anxiety, depression, nutrition, gut, physical activity

INTRODUCTION

Since the emergence of severe acute respiratory syndrome (SARS)-Cov-2 in the city of Wuhan, (Hubei, China) in December 2019, governments around the world have taken unprecedented actions to respond and contain the virus (Vital Surveillances, 2020). Countries are implementing different community, economic, and public health control measures to flatten the epidemic curve and avoid the overload and possible collapse of their health systems. The quick response by governments is strictly necessary since epidemiologists predict 7.0 billion infections and 40 million deaths globally for the year 2020 if no interventions are done (Walker et al., 2020). To date (22th June of 2020), the ongoing SARS-Cov-2 pandemic has resulted in 9,053,536 active infected cases, with a total of 4,482,312 recovered patients and 470,844 deaths (WHO Coronavirus Disease (COVID-19) Dashboard, 2020). These large and rapid increases in the confirmed cases and deaths are causing medical personnel and the general population to experience psychological health problems, including anxiety, depression, and stress (Kang et al., 2020). Studies suggest that frontline nurses present lower vicarious traumatization scores than non-frontline nurses and the general public, possibly due to their reduced accessibility to formal psychological support, less first-hand medical information on the outbreak, or less intensive training on personal protective equipment and infection control. However, a survey of 500 health care workers showed that 14.5% screened positive for anxiety, 8.9% for depression, 6.6% for stress, and 7.7% for clinical posttraumatic stress disorder (PTSD; Tan et al., 2020).

In order to attenuate the reproduction/infection cases, suppression measures are being taken worldwide to bring the *R* number below 1 with the use of non-pharmaceutical interventions. These measures must be taken till a vaccine is available, which according to recent data is likely at least 12–18 months away (James et al., 2020). These types of actions focus on the restriction of free movement and assembly, quarantining people with absolute diligence. According to the World Health Organization (WHO), these suppression strategies will allow the scientific community and governments to have time until a vaccine or an effective treatment becomes widely available. However, quarantine is an unpleasant experience for those who undergo it. Separation from loved ones, the loss of freedom, and uncertainty over disease status creates dramatic effects. Although the majority of people are not expected to suffer mental disorders in the actual pandemic, a significant percentage of the population will still experience intense emotional adjustment reactions (Li et al., 2020). The impact of prolonged confinement, in addition to the death of relatives and increased social adversity, may lead to psychological adverse effects, increasing the risk of emotional disturbance, depression, low mood, irritability, insomnia, and post-traumatic stress symptoms (Duan et al., 2020). Authors relate how loss of appetite, mood swings, delusions, fear, sleep disorders, and suicidal/domestic-violence cases have become quite common during lockdowns with helpline numbers being overload with people seeking help (Ammar et al., 2020b). Since authors have stated the high risk of psychosocial strain during the current home confinement period and have provided a clear remit for the urgent implementation of a technology-based intervention to foster an Active and Healthy Confinement Lifestyle (AHCL; Ammar et al., 2020a,b), an accurate understanding of behavioral changes accompanying the Coronavirus Disease 2019 (COVID-19) lockdowns is a necessary step. Quarantine and confinement measures have been taken with the main objective of alleviating the medical systems, which were in danger of collapse, but the remedy cannot be worse than the disease. However, psychological care services can be highly affected, collapsing as a consequence of the measures for health prevention. Regardless of whether mobility restriction measures are being progressively lifted in most countries, we must be prepared for a rebound in the disease, or a new wave in the appearance of the virus, which clearly indicates the need to produce guidance for the public.

Thus, the aim of the present review was to examine the present literature and provide a comprehensive narrative explanation of the psychophysiological and social effects of the COVID-19 pandemic. Since a second wave of the virus is likely to appear, it is essential to know the consequences of COVID-19 on the human psyche and physiology.

PSYCHOSOCIAL AND PSYCHOLOGICAL STRESSORS IN THE PANDEMIC

Numerous studies, mostly using questionnaires, have been developed to identify how confinement has impacted the health of the world population, aiming at identifying possible relationships between psychosocial, psychological, and behavioral changes during the confinement period and obtaining scientific data that could help to characterize the psychosocial aspects of the COVID-19 crisis (Ammar et al., 2020a,b). In general, authors describe how the COVID-19 pandemic has impacted the mental health of citizens worldwide; isolation measures, fear, uncertainty, and economic turmoil, lack of social connectedness and trust in other people and institutions, and jobs and incomes being at risk are taking a huge toll in terms of anxiety and worry, leading to "psychological distress" (Zhang J.J. et al., 2020). The United Nations (UN) has warned of the necessity for a policy briefing, calling for substantial investment in support services (Howard, 2020). Depression and anxiety cost the global economy more than one trillion dollars per year, and this was before the COVID-19 pandemic, and globally the ratio of mental health professionals per citizen is 1 to 10,000 (Chisholm et al., 2016). Although anxiety and depression affects over 264 million citizens worldwide, only 2% of the healthcare budget on average goes on mental health services (Sobocki et al., 2006).

Due to the novelty of the virus, there is little evidence available on how this new global political, economic, and health scenario may impair the psychological health of subjects. Researchers have suggested that new psychiatric symptoms in people without mental illness would increase, and that people with pre-existing mental illness would aggravate their symptomatology (Ho et al., 2020). Independently of the exposure to the virus, the experience of depression and anxiety and fear of falling sick or dying may potentially trigger mental breakdowns (Hall et al., 2008). Previous research has revealed a large spectrum of psychological impacts that outbreaks could inflict on people. Increasing psychiatric morbidities vary from depression, anxiety, panic attacks, somatic symptoms, and PTSD symptoms, to delirium, psychosis, and even suicidality (Yang et al., 2020). However, effects may vary according to the psychological trigger.

Imminent Psychological Effects, the Fear, and the Normalization Process

The health alert state declared by the WHO due to the COVID-19 pandemic merited this the greatest challenge faced by societies since the Influenza virus. Countries like the United States, France, the United Kingdom, Spain, or Brazil were forced to adopt policies without precedents to prevent the spread of the virus (Thakur and Jain, 2020). These actions were mostly taken only when fear was already evident in society and involved the restrictions of free movement, closure of airports and shops, and the total confinement of the population (Xiao et al., 2020a). Thus, within the space of 1 day, citizens went from experiencing a generalized feeling of uncertainty and lack of information to being notified of their confinement in their homes to avoid infection and the collapse of the health systems. Countries found themselves unable to cope with the increasing number of daily cases and to administer correct treatments due to the lack of technical and human resources (Liu et al., 2020). Fear was evident in society, from fear of contagion, fear of how the virus was transmitted, fear of the future, of losing jobs, to fear for loved one's health (Shanafelt et al., 2020).

Therefore, citizens are experiencing an extremely stressful and novel living situation, one which is impacting each subject in different ways and undoubtedly leading to psychological consequences in the medium and long term (Holmes et al., 2020). Confinement is an anomalous situation that forces people to modify their normal life habits and daily routine (Girdhar et al., 2020). Suddenly, normal activity comes to a halt; even in cases where it is possible to continue with work, the person modifies their natural way of acting: they no longer wake up every day to the rhythm of the alarm clock, do not get dressed and clean, do not leave the house to go to work, do not take public or private transport to get to their work location, do not interact for at least 8 h a day with their colleagues, and they do not organize the rest of the day to attend to other family and social obligations (Venkatesh and Edirappuli, 2020).

During confinement, the person is forced to suddenly stop their life, and although in the first days a brief relief is felt due to this stop, like that produced during the vacation period, the person quickly begins to present symptoms associated with anxiety produced by social isolation, lack of mental hygiene habits, and repeated exposure to negative news and information. Thus, feelings of sadness, apathy, fear, uncertainty, frustration, lack of impulse control, anxiety, alterations of the circadian cycles, insomnia, hypervigilance, or difficulties in concentrating may appear (Kumar and Nayar, 2020). In this line, it is important to consider that people with mental pathologies existing before the pandemic should be extremely cautious about the fulfillment of some rules that prevent a worsening of the symptoms associated with their diagnosis (Tsamakis et al., 2020). While for people without previous pathologies, it should be equally important to be aware to apply different prevention actions to maintain a balanced mental health during the complex and unusual situation of social isolation in the pandemic (Ahmed et al., 2020).

Consequently, it would be indispensable for people to create a series of habits that protect their mind from these associated negative factors (Pancani et al., 2020). Amongst these, previous authors highlighted the need to control exposure to the news, and to limit choices to the most reliable sources. People are encouraged to try to normalize the day-to-day by creating healthy routines, maintaining as far as possible those that we had previously internalized, such as exercising at a certain time each day. Daily rituals should be established if possible; when the subject can maintain his/her work activity, it was recommended to maintain a more or less established schedule, trying to separate personal life from work. When a person cannot maintain such activity, a reasonable part of the day should be dedicated to actively seeking employment, then the feeling of having been productive can increase. Personal care rituals should also be practiced as we would do daily (Lippi et al., 2020).

In short, in a state as exceptional as the one society is experiencing now, we must act in the most rational way possible to try to prevent not only the worsening of the pandemic but also the exacerbation of mental disorders.

From Social Beings to Total Isolation: The Imposed Quarantine

The current situation produces a new social feeling not previously experienced by society, wherein there may be certain level of distrust toward other individuals in terms of disease spread and toward the government and healthcare services in terms of their capability to contain the outbreak (Ho et al., 2020). In previous pandemics, such as the SARS, confinement resulted in symptoms of PTSD and depression in Canadians (28.9% and 31.2% of the population, respectively; Lesser and Nienhuis, 2020). Specifically, hospital staff who quarantined for 9 days developed acute stress disorder, reporting exhaustion, detachment from others, anxiety when dealing with febrile patients, irritability, insomnia, poor concentration, indecisiveness, deteriorating work performance, and reluctance to work or consideration of resignation (Bai et al., 2004). In this line, parents and children who were in quarantine presented with four times higher stress scores than ones who were not in quarantine (Sprang and Silman, 2013).

In the case of the COVID-19 epidemic in China, researchers found a prevalence of 45.3% for moderate and severe depressive symptoms, of which 84.7% spent between 20–24 h a day confined at home (Wang et al., 2020). Recent research suggests that there is an emotional impairment caused by extreme fear and uncertainty (Shigemura et al., 2020). Furthermore, and given the uncontrolled fear and distorted risk perception, symptomatology of insomnia, anger, extreme fear of the disease, fear to leave the house, increased use of drugs and tobacco, and social isolation were reported (Wang et al., 2020). Authors found that home confinement due to COVID-19 evoked a negative effect on mental well-being and emotional state and these psychosocial rates were associated with unhealthy lifestyle behaviors, with a greater proportion of individuals experiencing physical and social inactivity, poor quality sleep, unhealthy eating habits, and unemployment (Ammar et al., 2020b). An analysis of the Chinese social media Weibo found that negative emotions, such as outrage, depression, and anxiety, significantly increased after the declaration of the COVID-19 pandemic, leading to a decrease in life satisfaction (Li et al., 2020). This information is in line with further studies in the Chinese population, where nearly 20% reported moderate to severe depressive symptoms, and almost 30% reported symptoms of moderate to severe anxiety, with over 85% of the participants spending around 20 h confined at home a day (Wang et al., 2020). In this line, previous studies suggested that larger hours of isolation and quarantine are associated with a larger prevalence of PTSD and depressive symptoms, establishing a direct correlation with time (Hawryluck et al., 2004).

However, once again, the experience of anxiety symptoms and psychological disorders may be modulated through several triggers, which can aggravate the quarantine situation, its perception, and somatization (Brooks et al., 2020). One of the most important elements is the duration of the quarantine since authors relate a directly proportionate relationship with psychological disorders, showing greater post-traumatic stress symptoms, avoidance behaviors, and anger during longer periods (Reynolds et al., 2008). In addition, the creation of a vicious circle of routine can lead to frustration and boredom, as well as the loss of a routine and the high sense of isolation from the rest of the world by the imposed law (Wilken et al., 2017). A lack of information is a further aggravator of symptoms, with surveys exposing how participants cited poor information from health authorities as a powerful stressor, making the uncertainty of the context greater, thereby increasing fear (Di Giovanni et al., 2004; Cava et al., 2005; Caleo et al., 2018).

Undoubtedly, quarantine and isolation are perceived as a negative and stressful stimulus, leading to psychological discomfort. Interestingly, the psychological scar of quarantine can be found months and even years after the quarantine happened, suggesting acute and chronic effects (Jeong et al., 2016; Liu et al., 2020). Thus, along with the quarantine measures imposed by governments, psychological assistance, planning, and measures must be implemented, not only during the quarantine period but also in the subsequent de-escalation.

Experiencing COVID-19 Symptomatology

Experiencing sickness may trigger shame, social stigma, and even the feeling of guilt. A large survey of 730 COVID-19 positive patients from China showed a 96.2% prevalence of post-traumatic stress symptoms associated with the COVID-19, of which 49.8% considered psycho-educational services helpful (Bo et al., 2020). When compared to previous outbreaks like the 2003 SARS, the prevalence of PTSD in SARS survivors was 9.79% in their early recovery phase (Fang et al., 2004) and 25.6% at 30-month post-SARS (Mak et al., 2020). In the actual pandemic, the authors concluded that patients who experienced COVID-19 infection have a 29.2% increased prevalence of depression. Also, trends for an increased prevalence of depression comorbid with anxiety were identified in patients who experienced COVID-19 infection (21.1%) and the general population (22.4%; Zhang J. et al., 2020).

Among COVID-19 patients, there are certain groups which are likely more exposed to and suffer greater psychological impact from than the quarantined population, such as health workers. Authors reported in this collective a 14.5% prevalence of anxiety, 8.9% of depression, 6.6% of stress, and 7.7% of PTSD (Tan et al., 2020). Cross-sectional studies of self-rated questionnaires in medical staff treating COVID-19 patients showed how greater levels of anxiety scores positively correlate with stress and negatively with sleep quality, social support, and self-efficiency (Xiao et al., 2020b). Interestingly, traumatization related to COVID-19 was higher among non-front-line than front-line nurses, while traumatization was lower among the general public and higher for front-line nurses but not non-front-line nurses (Li et al., 2020). Finally, the presence of any COVID-19 symptoms and the self-perceived poor health state were largely associated with higher rates of anxiety, depression, and the possible need for psychological assistance (Rajkumar, 2020).

Vast Human Loss

Since the tendency of deaths continues to rise, knowledge of the idiosyncratic nature of loss and grieving its essential. The grieving process is a completely normal and expected reaction which reflects a unique convergence of responses, from affective, behavioral, physical, and cognitive ones. Psychologists pointed out that the death of a loved one should not be categorized as a mental illness but, rather, as a process of recovery from an imbalance, a return to homeostasis. However, due to the actual situation and the inability to attend the last hours of life and to provide a decent burial, this has led to the impossibility of gaining closure, leading to an ambiguous loss, thus stimulating feelings of resentment (Shear et al., 2020).

Also, patients, family members, and loved ones under the COVID-19 symptomatology may experience the possibility of anticipatory grief. For health care workers, the discontinuation of palliative care or disconnection from mechanical ventilation systems is perceived as emotionally onerous and psychologically difficult, but little time is allowed for mourning due to the intense situation. For families, they know that they will miss the final moments in case of death, will be unable to say goodbye, and know that their loved ones are suffering without being able to assist them. Therefore, as a result of prolonged and disabling grief, a large number of the population is at risk of prolonged grief disorder (PGD) in this pandemic, which will compromise mental wellbeing (Zhai and Du, 2020).

Specific strategies to help grievers to adapt to loss in these highly challenging times are essential. A general approach could be following the model of William Worden, which states that acceptance of the loss is the first step in healing (Worden et al., 2020). The appearance of mental and psychological blocks may be usual as a consequence of the shock due to the sudden disappearance with the impossibility of a goodbye. Two possible scenarios may be established, negation or indifference, which will indicate an unprepared duel. In these situations physical actions, spiritual connections, and rituals may be helpful for the patient to gradually accept the irreversibility of the situation and the human loss. In this line, a home-based ritual, letters to the deceased, or reorganizations associated with objects are strategies that are easily achievable at home and may be of substantial helpful. Secondly, it is necessary to work on emotions and pain since the situation will lead to a collapse or the manifestation of depressive symptoms. Subsequently, an adaptation phase is reached, and the person accepts an environment in which the deceased is absent. If the previous phrases are correctly processed, the person should be able to emotionally relocate the deceased, beginning to resume their normal way of life while still remembering their loved one.

Financial Collapse, the Fall Dawn of Personal Economies

Coronavirus Disease 2019 has led to a global economic recession (Fernandes, 2020), rating the Economic Cooperation and Development (OECD) losses between 2.3 and 4.4% of gross national product worldwide (Organisation for Economic Co-operation and Development, 2014). This is a direct consequence of the reduction in jobs, as well as a marked loss in productivity (Melnychuk, 2012), with labor markets playing a fundamental role in mental health results (Gili et al., 2013).

Worldwide, confinement policies have forced large corporations, financial markets, and small businesses to stop suddenly. The reality after this situation is having a catastrophic effect on economies and resulting in a vast loss of employment (Pfefferbaum and North, 2020; Piguillem and Shi, 2020). One of the largest world economies, the United States of America, suggests a loss of employment in the second quarter similar to that experienced during the great recession, with a 30% drop in Gross Domestic Product (GDP; Kennedy, 2020). For European Union countries such as Spain, one of the most affected by the pandemic, the amount of unemployed people registered a 14.5% increase during the first three weeks of the alarm state decreed by the government, making it the country in Europe with the second highest number of unemployed people (Woolhandler and Himmelstein, 2020).

Indeed, work activity is among the most important factors for the development of the individual, since it not only consolidates a way of obtaining economic income but is also an essential factor for personal and societal development (Monitor, 2020). The individual who exercises stable work activity will be able to develop both individually and collectively, and develop emotional ties with other individuals, generating relations of equality, respect, and collaboration that will form part of their personality and that will directly impact their self-image and self-concept (Fernandes, 2020). Therefore, employment is of great value for the person and is not only a functional fact; it has psychological and social implications since the individual can establish future projections and planning of work level and personal identity (Fleming et al., 2019). Some authors related that the effects on people when they lose their jobs are going to be just as devastating in social and health terms as the spread of the health pandemic (Douglas et al., 2020).

Currently, there is extensive scientific literature that links unemployment and the mental health of workers, establishing a strong inverse relationship (Paul and Moser, 2009). Feelings of depression, anxiety, psychological distress, and decreased life satisfaction are direct indicators of psychological illnesses and psychiatric morbidity (Boyle et al., 2020). When unemployment is prolonged, other symptoms may appear, such as hopelessness about the future, not being able to understand one's own feelings, a decrease in self-esteem, and chronic stress, which may lead to a feeling of listlessness and negative helplessness (Pfefferbaum and North, 2020). The immediate changes in social stage, loss of self-concept and identity, decrease in social contacts, financial deprivation, and uncertainty about the future have been the main mechanisms that explain the appearance of psychological pathologies (Extremera and Rey, 2016). However, it must be considered that the possible psychophysiological impact of job loss would depend on family circumstances, for example by increasing financial stress (Draghi, 2014), generating economic instability in the family unit (Maitoza, 2019), influencing marital conflicts, and increasing the possibility of divorce (González-Val and Marcén, 2018). There is a clear tendency to consume alcohol and different drugs such as benzodiazepines, cannabis, or other addictive substances in an attempt to prevent these negative emotions from appearing. Addiction becomes a refuge in the face of a lack of stability and to try to silence the most emotional and negative parts of the loss of employment (Nurmela et al., 2018). It is important to note that longitudinal studies have shown that although life satisfaction is moderately stable over time, individuals strongly reacted to unemployment and did not completely return to their previous satisfaction and happiness levels, even after becoming employees (Lucas et al., 2004). In addition, according to Ammar et al. (2020b), the negative psycho-emotional effect of COVID-19 was also shown to be accompanied by a negative effect of unemployment compared to before the confinement period.

On a physiological level, unemployment could elicit alterations in sleep cycles, chronic fatigue, exhaustion, and physical strain that could occur, facilitating continued muscular pain (Antillón et al., 2014). All of these symptoms would be present due to the excess in cortisol production, which regulates these physiological responses to stress and is associated with a wide range of diseases and alterations in areas of the hippocampus. Memory loss and difficulties in the correct functioning of higher executive functions, such as attention and information processing, among others, may also be experienced (Musana et al., 2019). From a long term perspective, unemployment has been associated with increased cardiovascular diseases (Johansson et al., 2020), chronic inflammation (Sumner et al., 2020), abusive consumption of antidepressants, tobacco, and alcohol (Kaiser et al., 2017), decreased immune function (Sumner and Gallagher, 2017), and an 11% increase in all-cause mortality (Browning and Heinesen, 2012). In this line, the need for a specific approach to unemployed individuals that takes into account their vulnerability should be considered.

PHYSIOLOGICAL STRESSORS IN THE PANDEMIC

Severe acute respiratory syndrome-CoV-2 has shown a high virulence that has caused a rapid increase in infected and deceased patients. Currently, without a developed vaccine and population herd immunity, it is an individual's immune system that must face this virus (Clemente-Suárez et al., 2020). In this regard, different behavioral factors have a direct effect on the immune system and the organic state of the subject, also affecting their mental state (Anderson, 2020). Nutritional habits, physical activity, and even the individual's microbiota are be factors that could play an important role in the fight against COVID-19.

Physical Inactivity in the Pandemic

Social isolation measures imposed by governments across the world caused an abrupt decline in physical activity, as recreation facilities, athletic centers, gyms, public parks, playgrounds, and schools were forced to close. As it may take some time for communities to return to normal daily life, the longitudinal effects of physical inactivity are still not noticeable. Still, several studies conducted through online surveys measured the effects of social isolation on physical activity in various populations, given the fact that prolonged inactivity can lead to various health issues and potential remedies (Lippi et al., 2020).

There are recent studies that showed the impact of confinement on the physical activity habits of citizens. One of the first ones found insufficient physical activity in 60% of Chinese citizens during the early days of the pandemic (Qin et al., 2020). They also showed a negative effect of social isolation on physical activity during various intensities, from vigorous exercise to walking, while daily sitting time presented an increase from 5 to 8 h daily (Ammar et al., 2020a).

In Australia, biomedical students of both sexes were found to have reduced physical levels by 30%, compared to the pre-pandemic years (2018 and 2019), despite the participants' report for sufficient activity levels (Gallo et al., 2020). Meanwhile, the% of United Kingdom citizens of both sexes (20 years old) reported equal levels of physical activity intensity during the lockdown period, compared to the pre- pandemic period. These findings were more obvious for males, while other factors, such as living alone or the existence of a garden in the house, also influenced the results (Rogers et al., 2020). In adult Canadians, 22.4% of the participants that were self-reported as "active" became less active, while 40.3% became more active. For those reported as "inactive," 40.5% became less active and 33% became more active (Lesser and Nienhuis, 2020). In the Spanish population (age range 18- to 64-years-old) a decrease in vigorous physical activity and walking time (16.8% and 58.2%, respectively), with a simultaneous increase of sedentary time (23.8%), were reported. Males reduced the time for vigorous physical activity to a greater degree compared to females (21% vs. 9%, respectively). Finally, young participants (18- to 24-years-old) and students had the highest decrease in moderate activities and walking time (Castañeda-Babarro et al., 2020). Finally, using a microsimulation model, childhood obesity under four different scenarios related to school closure in the United States was analyzed, reporting an increase in the obesity rate of 2.4% during the ominous scenario (school closure until December 2020) with a modestly higher impact in specific populations (i.e., boys, non-Hispanic black children, and Hispanics; An, 2020; Chen et al., 2020; Hammami et al., 2020; Ricci et al., 2020).

It is obvious that the quantification of the impact and extent of COVID-19 on physical inactivity is largely dependent on the lockdown duration and the transition phase to "normal life" strategies imposed by different governments. Given the importance of staying physically active, useful home-based activities are already available through different studies (Chen et al., 2020; Hammami et al., 2020; Ricci et al., 2020) and the American College of Sports Medicine, 2020 (3/2020). In addition, authors developed a proposal of physical performance tests adapted as home workout options during the COVID-19 pandemic, with simple home-based exercises, considering individual limitations. According to these authors, individuals might monitor their performance daily and employ useful home-based exercise strategies to counterbalance the negative impact of the sedentary lifestyle during confinement. Therefore, they recommend the practice of physical exercise (easy, useful, and suitable) to be performed in a small physical space, such as at home without special devices (da Cunha de Sá-Caputo et al., 2020). Moreover, specific populations, such as cardiac patients, are also encouraged to participate in home-based activity programs, under online supervision, aiming to minimize premature mortality (Peçanha et al., 2020).

Being a disease primarily affecting the respiratory system (Yuki et al., 2020), greater attention has been given to moderate aerobic exercise as a proposed strategy to improve lung function, decrease hospitalization (Mohamed and Alawna, 2020), enhance the immune system (Zbinden-Foncea et al., 2020), prevent respiratory infections (Olivo et al., 2014) and, consequently, prevent new COVID-19 incidences (Dixit, 2020). Complementary, the role of low- to medium-intensity resistance training to prevent neuromuscular degeneration is highlighted (Narici et al., 2020).

Nutrition in the Pandemic

The relationship between nutritional status and the prevention and treatment of COVID-19 means that several dietary-nutritional aspects can be worked on. In this sense, although there is no specific diet that can prevent COVID-19, a balanced diet and adequate hydration favors presenting a stronger immune system and having a lower risk of chronic and infectious diseases (Naja and Hamadeh, 2020). Therefore, it is recommended to eat a variety of fresh and unprocessed foods every day to obtain the vitamins, minerals, dietary fiber, proteins, and antioxidants that the body needs in order to prevent any infectious disease, including COVID-19 (Jayawardena et al., 2020). In addition, the consumption of sugar, fat, and salt that promote comorbidities (obesity, cardiovascular diseases, and diabetes, among others) that have been associated with having COVID-19 should be reduced (Zhou et al., 2020). Along with these dietetic recommendations, supplementation with 10,000 IU/day of vitamin D for a few weeks (≈4 weeks) and subsequent maintenance of 5,000 IU/day could be suggested due to the direct relationship that has been shown between low concentrations of 25-hydroxyvitamin D [25 (OH) D] and serious complications of COVID-19 (Grant et al., 2020). This may be because vitamin D is important in regulating the physical barrier, natural cellular immunity, and adaptive immunity (Rondanelli et al., 2018). However, although supplementation with probiotics has shown a direct relationship with the immune system and could prevent all types of infections (Kanauchi et al., 2018), the blind use of conventional probiotics for the treatment of COVID-19 is not recommended until understanding of SARS-CoV-2 pathogenesis and its effect on the intestinal microbiota is gained

(Mak et al., 2020). These same recommendations could be applied to people who have emerged from a confined situation and in which physical inactivity together with an excess of energy has caused them to have a higher risk of suffering metabolic disorders (Martinez-Ferran et al., 2020).

Concerning the best nutritional strategy in the treatment of people infected with COVID-19, this will depend on the state of health of the patient. For those patients who are not in a critical situation, diets containing at least 25–30 kcal/day with foods of different textures and consistencies that are easily digestible (yogurt, custard, fruit mousse, fruit slices, and soft cheese, etc.) should be recommended (Caccialanza et al., 2020). This type of diet in addition to ensuring adequate energy content will ensure an optimal content of vitamins and minerals, as well as protein (Zhang and Liu, 2020). However, for those patients who have intake problems due to COVID-19 (Beltrán-Corbellini et al., 2020), supplementation with 20 g/day of whey protein may be considered together with a supplement that includes vitamins and minerals that cover daily recommendations (Caccialanza et al., 2020). Whey protein supplementation is based on its anabolic, antioxidant, and immunomodulatory (Cross and Gill, 2000) properties and its potential antiviral activity (Ng et al., 2015), combined with a high digestibility (Ha and Zemel, 2003). In addition, vitamin D supplementation [50,000 IU/week if 25 (OH) D $<$ 20 ng/ml; 25,000 IU/week if 25 (OH) D $\geq$ 20 to $<$ 30 ng/ml] would be justified (Caccialanza et al., 2020) in order to reduce levels of inflammation and immune activation, and increase immunity against pathogens (Grant et al., 2020).

On the other hand, although enteral nutrition in the ICU has been shown to be feasible and safe (Pan et al., 2020), its implementation in patients with COVID-19 could be difficult due to frequent gastrointestinal symptoms in these patients (vomiting and diarrhea; Saez de la Fuente et al., 2016). Furthermore, hypoxemia requires delayed enteral nutrition (Singer et al., 2019). However, in patients with acute respiratory distress syndrome/acute lung injury, enteral diets containing eicosatetraenoic acid, gamma-linolenic acid, and antioxidant agents may offer a clinical benefit in oxygenation and ventilation days (Singer et al., 2019).

Finally, in situations of quarantine and/or confinement, an appeal must be made to nutritional moderation since the decrease in physical activity is large. An excess of energy in a situation of physical inactivity can increase metabolic disorders that increase the risk of multiple chronic diseases (Winn et al., 2019). Consequently, the recommendation during a period of confinement is to eat a balanced and healthy diet with a restricted calorie intake, avoiding an over-intake. In this line, using the SDBQ-L, a short, crisis-driven questionnaire recently developed to assess eating behaviors before and during the blocking period, Ammar et al., 2020a, reported that food consumption and meal patterns (the type of food, eating out of control, snacks between meals, number of main meals) were more harmful to health during confinement, with only excessive alcohol consumption decreasing significantly. In their study, in responses to the diet behavior questionnaire before and during home confinement, they found that consuming unhealthy food, eating out of control, the number of snacks between meals or late-night snacking, and the numbers of main meals were significantly higher during home confinement. Thus, the diet should be based on low glycemic carbohydrates (vegetables, legumes, or fruits), foods rich in healthy fats (olive oil, salmon, or nuts), and foods rich in protein with low-fat content (skim dairy, poultry, or rabbit; Martinez-Ferran et al., 2020). In addition, vitamin D supplementation would also be justified due to the low sun exposure that is usually received during confinement (Nair and Maseeh, 2012). These nutritional guidelines reduced the possibility of suffering from chronic diseases and increased the chance having a strong immune system that ensures a return to optimal normality and being prepared to face a relapse of COVID-19 or any other disease.

Gut Microbiome Alterations Due to COVID-19 and Its Brain Nexus

The gut microbiome has been defined as the second human brain, due to its bidirectional signaling between the gastrointestinal tract and the brain, being vital for homeostasis maintenance and involved in the production of brain transmitters such as serotonin, dopamine, GABA, norepinephrine, or acetylcholine (Ridaura and Belkaid, 2015).

Current scientific evidence shows that the gut microbiota plays an important role in the development of mental disorders such as depression, anxiety, Alzheimer's, Parkinson's, obsessive-compulsive disorder, eating disorders, autism spectrum disorders, multiple sclerosis, and epilepsy (Kelly et al., 2015). In this line, stress has proven to influence the composition and function of gut microbiota (Foster et al., 2017). The high co-morbidity between stress-related psychological symptoms, such as anxiety, with gastrointestinal disorders, including irritable bowel disorder, and inflammatory bowel disorder (Cámara et al., 2009), is strong evidence of this axis (Cryan and O'mahony, 2011). Animal studies on germ-free mice reported altered anxiety-related behavior, supporting the link between microbiota and stress (De Palma et al., 2014), as well as increased hypothalamic-pituitary-adrenal axis (HPA) activity (Luczynski et al., 2016).

Recent studies suggest how psychological stress may also increase the production of hypothalamic and amygdala corticotropin-releasing hormone (CRH), which has been related as a precursor of the HPA axis, thus leading to cortisol production (Vanuytsel et al., 2014). Since CRH has an impact on the production of inflammatory cytokines and tumor necrosis factor-alpha (TNF-α), it is likely to underpin the association of stress and stress-associated medical conditions with the novel SARS-CoV-2, therefore increasing the severity of and fatalities associated with the COVID-19 pandemic. Thus, by such effects on the immune system and the reactions it may trigger, the gut microbiome may modulate the pathophysiology of SARS-CoV-2 (Anderson, 2020). In addition, most of the medical conditions that have been pointed as causing an increased risk of fatality from SARS-CoV-2 are associated with alterations either on gut permeability and dysbiosis, such as obesity, diabetes, cardiovascular disorders, and lung and respiratory airways inflammation (Anderson and Maes, 2020).

In this line, the increased level of pro-inflammatory cytokines presents a direct effect on the downregulation of hormones such as serotonin and melatonin, which are necessary for the maintenance of circadian rhythms (Markus et al., 2018). This situation suggests that stress will make the population more susceptible to the viral infection by an affection of the second brain, the gut microbiome (Ridaura and Belkaid, 2015). COVID-19 is pulmonary, a fact that highlights the importance of gut, since previous authors already found a "gut-lung axis" (Keely et al., 2012), suggesting how respiratory infections are associated with a change in the composition of the gut microbiota (Groves et al., 2020). This exposes a bidirectional relation, in which microbial metabolites and certain endotoxins may impact the lung through blood and when inflammation may happen on the lung, reciprocally affecting the gut microbiota (Dumas et al., 2018). This in turn raises an interesting possibility that novel SARS-Cov2 might also have an impact on the gut microbiota.

PHYSIOLOGICAL SEQUELAE OF THE COVID-19

Coronavirus Disease 2019 infection in humans can lead to mild symptoms, with a recovery time of 1 to 2 weeks, to more severe cases which may result in death (Adhikari et al., 2020). That being said, the magnitude of symptoms is related to the health status before infection. As such, elderly men and people with underlying cardiovascular and respiratory diseases and cancer (Tan and Aboulhosn, 2020; Wu and McGoogan, 2020), obese individuals (Petrakis et al., 2020), and those with diabetes mellitus (Muniyappa and Gubbi, 2020) are more susceptible to infection. Nevertheless, the relative importance of these health conditions is yet unknown. Infants, children, and young adults (20- to 54-years-old) are also likely to be infected (Bialek et al., 2020; Lu et al., 2020). While cases of cardiomyopathy have been reported in pregnant women (Juusela et al., 2020), this population group is not considered a high-risk group; however, more studies are required (Fang et al., 2020).

The most common symptoms include fever, dry cough, dyspnea, arthralgia, and myalgia (Zhang J.J. et al., 2020). Recently two more symptoms, loss of taste and loss of smell, were identified as markers of mild to moderate infection (Lechien et al., 2020). Less common symptoms include headache, hemoptysis, rhinorrhea, and gastrointestinal symptoms such as abdominal pain, diarrhea, and nausea (Di Gennaro et al., 2020). In more severe cases, lymphopenia is acknowledged (Tan et al., 2020; **Figure 2**). Moreover, arrhythmias and acute kidney injury have been reported in COVID-19 patients (Fanelli et al., 2020; Guo et al., 2020), as well as the production of blood clots, ultimately causing a pulmonary embolism and thrombosis (Wise, 2020). Finally, regarding older individuals, the potential link and implications of gut microbiota (Dhar and Mohanty, 2020), as well as cachexia and sarcopenia (Morley et al., 2020), in severe cases during the recovery phase are discussed.

The chronic physiological sequelae of this pandemic will not be fully understood for some time. Since no viable vaccine is currently available and coronavirus cases are growing exponentially, continued worldwide research is needed in this challenging period to analyze the potential COVID-19-associated health issues and provide detailed and specific guidance.

PSYCHOLOGICAL SEQUELAE OF THE COVID-19

A large amount of fear, despair, and death has been spread worldwide. The unknown consequences, symptoms, and condition of the virus, the lack of a vaccine, and the collapse of the economic system which is leading to a worldwide recession, is causing mass fear since we are facing the most serious pandemic of the last 100 years (Thakur and Jain, 2020). The dramatic and exponential increase in infections, which could only be countered by drastic decisions such as confinement and quarantine of the entire population, has forced a radical change in citizen's lifestyles, which has had psychological impacts on many people (Galea et al., 2020).

Although it is not yet known exactly what the psychological impact of these drastic measures will be, it is possible to infer some psychological consequences (**Figure 1**). Firstly, it is important to consider the psychological and emotional state of vulnerable people who, prior to the emergence of the pandemic, had already been diagnosed with some mental pathology (Pfefferbaum and North, 2020). In these cases, it is possible that confinement, social isolation, and the impossibility of continuing with their life routine and habits, may lead subjects with depressive symptoms or other mental disorders to suffer panic attacks due to the sudden stop of activity and the extraordinary situation (Torales et al., 2020). In this line, support is highly necessary, either professional or familiar, through offering therapy or ensuring that they do not worsen over time and that there are not decompensations at a psychopathological level that may lead these patients to address anxiety through disruptive autolytic behaviors (Alradhawi et al., 2020).

Secondly, adolescents are another high-risk group. There is an increase in rates of depression, panic disorder, agoraphobia, and substance use disorders, as well as a decrease in separation anxiety disorder and attention-deficit hyperactivity disorder in the transition from childhood to adolescence (Costello et al., 2011). Major depression and psychological disorders increased with the rise in ownership of smartphones and the consumption of digital media and social networks (Twenge et al., 2019), factors which increased during the pandemic. The confinement made social connections difficult, connections which form the basis for the self-affirmation of adolescents' personality (Lebel et al., 2020), and the isolation could negatively affect adolescent's relationships, especially when they did not previously have a good relationship with their relatives (Rosen et al., 2020). In these cases, when the adolescent is in the situation of not being able to correctly face the demands of such an exceptional situation, aggressive behaviors may be found, which may become a risk for people around them and also for themselves. In this sense, different organizations call for attention to the fact that, during the months of confinement, the percentage of

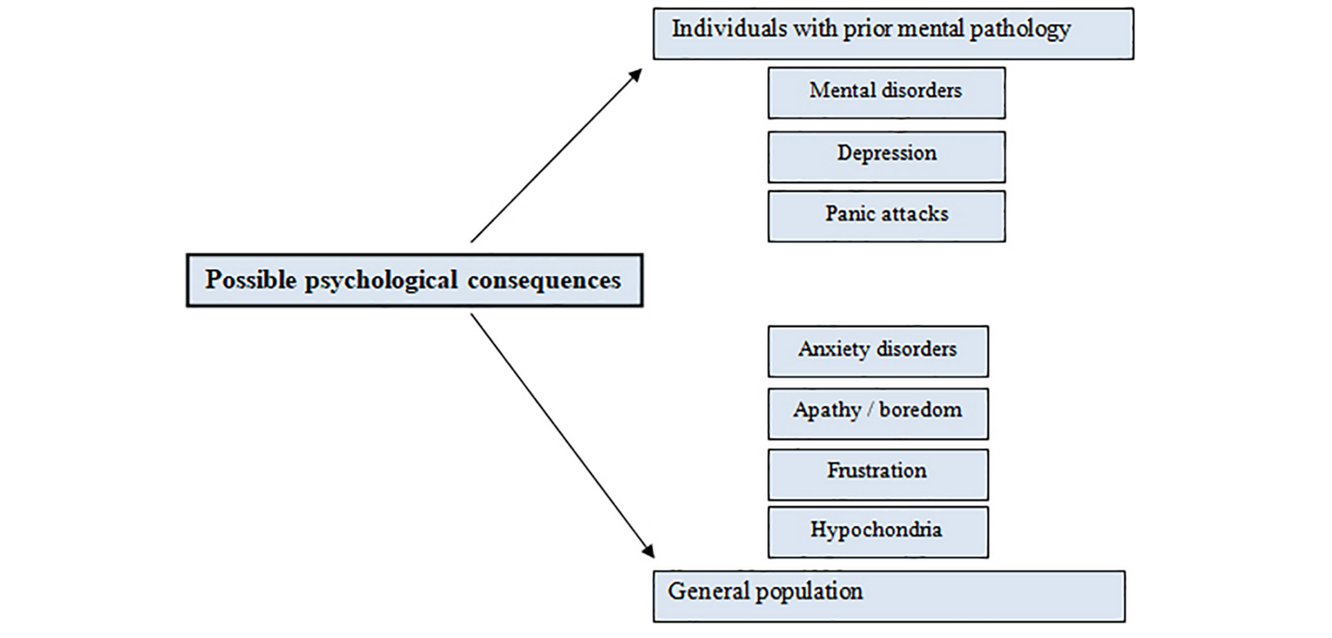

FIGURE 1 | Common and less common physiological symptoms related to the COVID-19 pandemic.

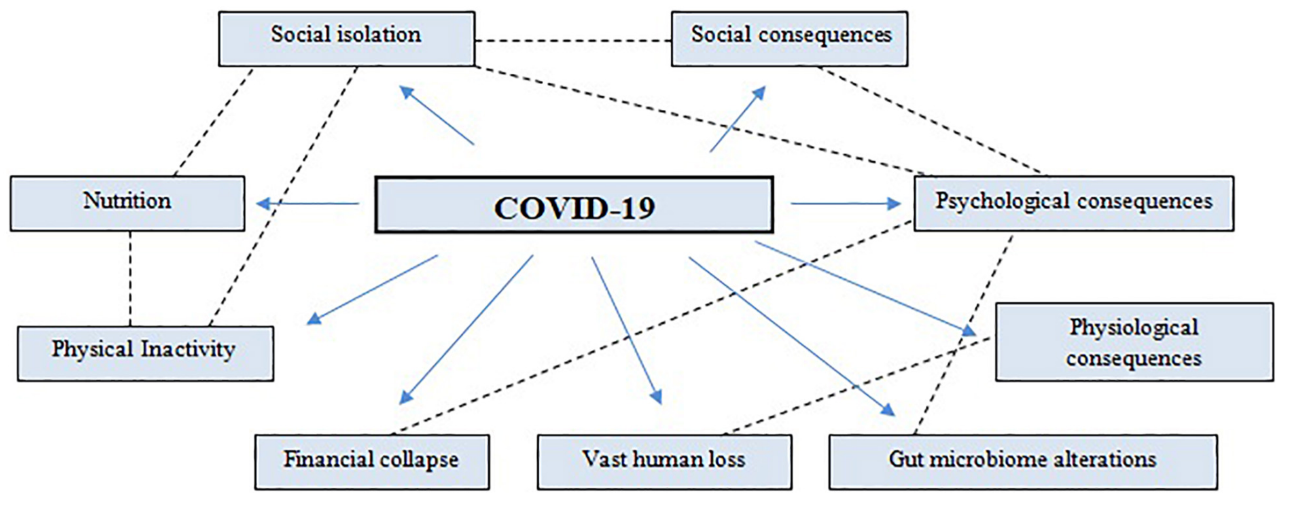

FIGURE 2 | Possible psychological consequences related to the COVID-19 pandemic.

suicide attempts by this group has increased from 1.9% to 8.3% (Assari and Habibzadeh, 2020).

As for the general population, many who previously had not suffered any kind of pathological symptomatology before the pandemic will find themselves developing symptoms. It was estimated that a high percentage of the general population could present psychological sequelae such as anxiety disorders, apathy, boredom, loneliness, and frustration due to the confinement, hypochondria due to fear of contagion, insomnia or sleep disorders, difficulties in the proper functioning of concentration, memory or attention, and may even present symptoms associated with post-traumatic stress disorder (Jia et al., 2020; **Figure 2**). These consequences will silently appear, as individuals return to the so-called "new normality," then, researchers will start talking again about a new pandemic, the psychological scar of COVID-19 in our society.

A correct understanding of pleasure and pain, happiness, and virtue gained from Stoic philosophical thought could be applied to the current pandemic and sociological context and be used to cope with the situation.

Today's society skids, since it has been seduced by the wrong lines of thought (hedonism), instead of following a stoic path. The current western man has let hedonism win the ideological and consequently today we pursue pleasure, forgetting about the

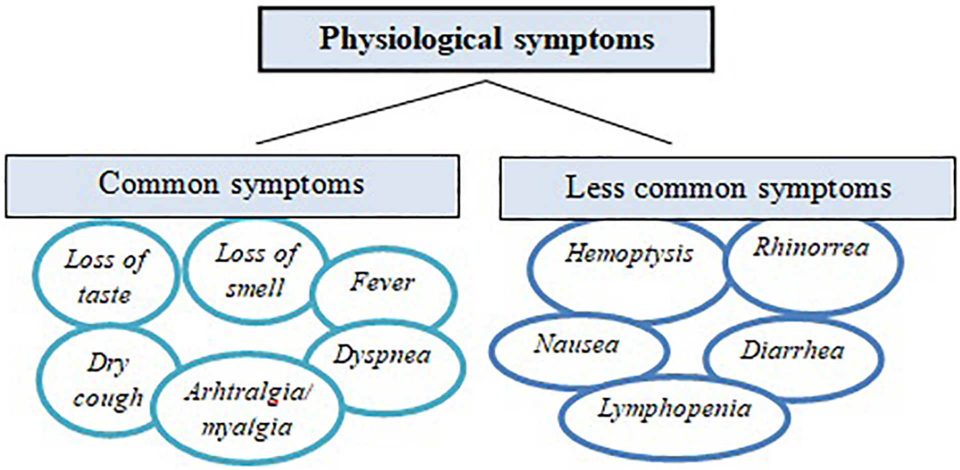

FIGURE 3 | Social and psychophysiological consequences of the COVID-19 pandemic.

consequences that it has. We have undoubtedly created a world that seeks stimulation for stimulation and pleasure for pleasure. Consequently, when all of this is taken from us and a pandemic strikes, our lives are emptier than ever, since no one prepared us for misfortune.

We despair the lack of instant, free, superficial, and fleeting pleasure that defines today's hedonistic society. All this, because we chose to follow a philosophical line of thought which does not prepare us for difficult times since, from a very young age, we have been taught that the immediate satisfaction of the drives is the right way to go. We only paid attention to Hedoné and not to Areté.

Stoicism teaches us that situations which we are not capable of controlling should not matter to us, since only we are the owners of our thoughts and emotions. The objective must be marked to those elements which we can change. In this sense, the pandemic is irrelevant; it is how we face it that really matters.

Seneca pursued poverty voluntarily in order to appreciate wealth when it was available to him, so in this order. . .Allow yourself to enjoy confinement to appreciate freedom, that freedom that we take for granted. Let us not be afraid of the loneliness that we now live, since it will make us value future company. Do not fear the inaction that the pandemic brought us because it will show us that the work that we once believed to be a torment was not really one. Enjoy missing family and friends, as this will have taught us how much we love them. Appreciate how cinemas, shops, theaters, and bars are closed so that in this way we will understand what place all this occupied in our lives, in order to establish future priorities. Let's avoid suffering from inefficiencies since when these comforts are missing some other day, everything will matter and affect us much less. See the obstacles as opportunities. Being locked up offers limitless opportunities for study, to pick up old friendships, to discover new skills, or simply to spend time in solitude in the guise of what you can offer yourself.

Thus, confinement does not have a positive or negative charge, since the only thing that matters for the Stoic is the reaction to events. A stoic does not judge facts or events, but sees how confinement occurs and accepts it as it is, tries to use all their resources to change things if necessary, never becoming that fly that hits the glass, over and over again. There are millions of factors that affect the possibility of our wishes being fulfilled, but a stoic will always have the certainty of controlling that part of things that only depends on him. Let us never hope that the world is as we wish it to be, if not as it really is, in this way we will have a peaceful life, that with ourselves, is enough, since the only way of getting out of the mud, is leaving by our own foot.

CONCLUSION

Depression, anxiety, panic attacks, somatic symptoms, and PTSD symptoms, delirium, psychosis, and even suicidality may be experienced according to the psychological and psychosocial stressors/triggers. The fear and normalization process of the new reality creates an extremely stressful and novel context for the population. Confinement and restriction measures translates to a sudden stop of citizens' normal life. thus the person quickly begins to present symptoms associated with an anxiety state produced by social isolation, lack of mental hygiene habits, and repeated exposure to negative news and information. Feelings of sadness, apathy, fear, uncertainty, frustration, lack of impulse control, anxiety, alterations of circadian cycles, insomnia, hypervigilance, or difficulties in concentrating may appear. These symptoms would be aggravated if the person presents mental pathologies previous to the pandemic. The experience of COVID symptomatology may trigger shame, social stigma, and even the feeling of guilt. Moreover, the presence of some symptoms, such as headaches, migraines, or irritating cough, can be mistaken by the subject as COVID symptoms, despite not having the virus; this and the impossibility of performing individual PCR or rapid tests to know if he is infected or not, adds to an even greater state of uncertainty, exponentially increasing psychological distress. Another potential trigger is the grieving process, which is a completely normal and expected reaction which reflects a unique convergence of responses, from affective, behavioral, physical, and cognitive ones. However, unexpected and sudden deaths and the inability to attend the last hours of life and to provide a decent burial, lead to the impossibility of gaining closure to the emotional link, leading to an ambiguous loss, thus stimulating feelings of resentment. Since the world economy is entering into recession, the reality after this situation is showing a catastrophic effect on economies and a vast loss of employment, strongly affecting the mental health of workers, which may translate into depression, anxiety, psychological distress, and a decreased life satisfaction. The social isolation measures imposed by governments across the world caused an abrupt decline in physical activity, as recreation facilities, athletic centers, gyms, public parks, playgrounds, and schools were forced to close. However, physical activity is more than encouraged, since it has been proven to enhance the immune system, prevent respiratory infections, and consequently, prevent new COVID-19 incidences. An excess of energy in a situation of physical inactivity can increase metabolic disorders that in turn increases the risk of multiple chronic diseases; thus appropriate nutrition is essential and it is recommended to have a balanced and healthy diet with a restricted calorie intake, avoiding an over-intake. Finally, gut microbiome may be a potential key factor (**Figure 3**), since the gut microbiota plays an important role in the development of mental disorders such as depression and anxiety (strongly present as a consequence of the pandemic) and the bidirectional relation, in where microbial metabolites and certain endotoxins may impact the lung through blood and when inflammation may happen on the lung, reciprocally affects the gut microbiota, raises an interesting focus point.

AUTHOR CONTRIBUTIONS

VC-S and JT-A: conceptualization. JM-A: methodology. AD: writing—original draft preparation all, writing—review and editing, all. VC-S and JT-A: supervision. All authors contributed to the article and approved the submitted version.

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COVID-19-Related Restrictions and Quarantine COVID-19: Effects on Cardiovascular and Yo-Yo Test Performance in Professional Soccer Players

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The present study aimed to verify the quarantine's effects during a serious viral outbreak on the cardiovascular and performance associated with the Yo-Yo test in a sample of professional soccer players. 20 high-level soccer players ($n = 20$; age: 26 ± 4 years-old; weight: 76.85 ± 6.7 kg; height: 179 ± 6 cm) participated in this study. The intermittent Yo-Yo test was performed pre- and post- COVID-19 quarantine in a random order. During each test, the soccer players' running performance outcomes were monitored using a portable 5-Hz GPS with a 100 Hz accelerometer and a paired t-test was conducted at a p-value of ≤ 0.05. The main results demonstrated significant differences between pre- versus post-COVID-19 quarantine in the following variables: relative distance (161.7 ± 5.9 > 141.1 ± 33.8 m/min), maximal speed (18.7 ± 0.9 > 18.2 ± 0.6 km/h), acceleration (60 ± 20 frequency > 52 ± 16 frequency), deceleration (34 ± 13 frequency > 27 ± 6 frequency), sprints > 19 km/h [0.8 (0.2;3)% >0.5 (0;0.5)%], and in high intensity running distance [16.48 (2.68;41.64)m > 0.827 (0.164;3.0)m]. We concluded that COVID-19-related restrictions and quarantine COVID-19 demonstrated adverse effects on professional soccer players' Yo-Yo tests performance.

Keywords: athletic performance, behavior analysis, coronavirus, exercise program, physical conditioning

INTRODUCTION

"Coronavirus disease 2019" (COVID-19) is a new, rapidly emerging zoonotic infectious disease (World Health Organization [WHO], 2020). The first case was reported from the city of Wuhan (Hubei Province, Mainland China) on 31 December 2019. On 30 January 2020, the World Health Organization (WHO) declared the outbreak as a public health emergency of international concern, and, on 11 March 2020, as a global pandemic (World Health Organization [WHO], 2020). COVID-19 is caused by a novel coronavirus, named "Severe Acute Respiratory Syndrome Coronavirus type 2" (SARS-CoV-2), which is transmitted via droplets during close unprotected contact with an infector and fomites (World Health Organization [WHO], 2020). Currently, no effective pharmacological interventions or vaccines are available to treat or prevent COVID-19. For this reason, behavioral, non-pharmacological public health measures such as isolation, physical distancing, quarantine, and even lockdown of entire communities and territories are the only effective ways to respond to the outbreak (World Health Organization [WHO], 2020).

Besides its social, psychological, and economic impact, COVID-19 has affected sports activities too, with major competitions and events being canceled/postponed (Fuentes-García et al., 2020; Guerrero-Calderón, 2020). Also, professional soccer has been affected (Guerrero-Calderón, 2020). Every year, soccer clubs invest significant amounts of money in professional players, with soccer being one of the most popular and competitive Olympic sports worldwide. Therefore, this sport was one of the first to return to training and competition practices, even during quarantine, but the cardio-respiratory condition of the players after this isolation period has not been investigated yet.

Cardiovascular fitness is one of the most important aspects of physical fitness in soccer (Castagna et al., 2017; Slimani and Nikolaidis, 2019). During professional competitions, athletes dispute between two and five games per month, with each game lasting for ∼90 min, a time span, that, in case of a tie, can be extended (Castagna et al., 2010; Costa et al., 2019). Moreover, athletes have training sessions twice a day during the competitive season and take part in national and international championships (Slimani et al., 2018b). This hard and demanding training schedule and tournaments involve great developed physical, mental, and physiological factors (Slimani et al., 2018a; Degens et al., 2019). A well-developed aerobic fitness is essential for soccer players to maintain repetitive high-intensity actions within a soccer match, to accelerate the recovery process, and to maintain their physical condition at an optimum level during the entire season (Orntoft et al., 2016; Michailidis et al., 2020).

Currently, the Yo-Yo intermittent test is the most adequate test for aerobic fitness assessment, with different versions and levels for soccer athletes (Castagna et al., 2020b). The reason for its acceptance is associated with its logical validity (i.e., comprising intermittent high-intensity protocols) (Gimenez et al., 2019), with practical application for testing a large number of players at the same moment with practically no related costs (Povoas et al., 2016; Castagna et al., 2019, 2020b; Papanikolaou et al., 2019). As such, the Yo-Yo intermittent tests are the most explored field tests for aerobic fitness valuation, and are crucial for evaluating soccer athletes (Oberacker et al., 2012; Beato et al., 2019; Castillo et al., 2019).

It is well documented that Yo-Yo intermittent test performance was affected by many factors, such as the detraining period and the expertise level of players (Joo, 2016). However, literature reports contrasting findings regarding this aspect. Short-term (1 and 2 weeks) detraining appears not to have any significant effects on Yo-Yo intermittent test in professional soccer players (Joo, 2016; Rodríguez-Marroyo et al., 2018). In contrast, other studies found that the short-term detraining period (2 weeks) decreased performance in the Yo-Yo test (Thomassen et al., 2010; Christensen et al., 2011; Joo, 2018). This contradiction may be due to the expertise level of players (Joo, 2018).

In the scholarly literature, there is a dearth of data concerning the effects of physical distancing in athletes after COVID-19 related quarantine and restrictions: for the above-mentioned practical reasons, field-testing represents an interesting approach for exploring such effects. Indeed, no published paper has addressed so far the external responsiveness (i.e., sensitivity) of the Yo-Yo intermittent tests in tracking professional players' VO_2max development after a period of physical distancing, quarantine, and potential detraining (i.e., pre-to-post-COVID-19 physical distancing and related restrictions; Castillo et al., 2019; Povoas et al., 2020). Therefore, the aim of the present study was to verify the effects of the quarantine during a serious viral outbreak on the cardiovascular and performance associated with Yo-Yo test in a sample of professional soccer players.

MATERIALS AND METHODS

Participants

From an initial list of 82 state professional soccer players of different line positions (30% Midfielders, 12% Defenders, 20% Wingers, and 38% Strikers), the final sample was randomly composed by 20 professional soccer players assessed in two different moments, pre- COVID-19 quarantine (n = 20; age: 26 ± 4 years-old; weight: 75.9 ± 6.9 kg; height: 179 ± 6 cm, and Body Fat: 13.8 ± 2.9%) and post- COVID-19 quarantine (n = 20; age: 26 ± 4 years-old; weight: 76.85 ± 6.7 kg; height: 179 ± 6 cm, and; Body Fat: 14.6 ± 3.75%). These athletes were from professional soccer teams (Brazil League Serie A) and competed in national and international representative championships once (∼90 min) per week and had been regularly training 2 h of technical and tactical aspects 4–7 times a week, 1 h of physical preparation 2–3 times a week, before the quarantine. During the quarantine of 40 days, they conducted three times a week for 30 min per session of aerobic training between ∼65 and∼75% of maximal heart rate. More specifically, they performed:

- 10 min of warm-up workout and cool-down;
- 15 min of mini-band workouts: 3× the 60 s each exercise in the continuous circuit training: jumping jacks, jumping squat tap, alternating forward lunges, burpees, fast lateral walks;
- 15 min of functional exercises: 8 min dynamic mobility workout – 30 s skipping with and 30 s without shoulder rotation, 30 s skipping with high knees, 30 s running with butt kicks, 30 s side to side with and 30 s without arm movement, 30 s running opening the gate and 30 s closing the gate, 240 s running with leg stretch and swing variations

1:10 s, 2 min of suicide drills and 5 min coordination with the ball;
- 15 min exercise bike workout.

Pacing frequency during workouts and functional exercises were controlled per athletes, using their heart rate. In addition to the heart rate, athletes were familiarized with the Borg's RPE-scale (6–20; Borg, 1985) and instructed not to exceed efforts ∼14 (McArdle et al., 2014).

Athletes were periodically monitored by direct and indirect cardiovascular tests. Inclusion criteria were the following: being aged over 18 years, without cognitive alterations, without surgeries or injuries, and with more than 3 years in the professional soccer level, and presenting COVID-19 symptoms. Asymptomatic cases or discharged ones were considered eligible. Exclusion criteria were the following: being unable to carry out the Yo-Yo test or suffering from limitations during the study, mainly for health reasons, duly certified by doctors. Besides this, the participants were instructed not to intake alcohol or drugs for at least 24 h before the measures and were maintaining regular diets.

Before proceeding with data collection, all participants attended a briefing meeting and signed a written, informed consent document to understand the testing parameters and the risks and benefits of the study. In addition, a letter of consent was sent and duly signed by all the participants' soccer clubs. This study was submitted to and approved by the Local Committee of Ethics in Research, following the National Health Council's rules of resolution and according to the World Medical Association (WMA) Declaration of Helsinki.

Procedures and Measures

The Yo-Yo intermittent test was performed in a random order. All tests were realized at the same time of day, avoiding circadian effects on test performance (Castagna et al., 2020b). A doctor was monitoring the Yo-Yo test. A standardized warm-up was done before the test, consisting of 10 min of 20 m back and forth running at an intensity subjectively set by the participants (2–3 of the Börg CR10 scale) and with changes of direction of 180° to mimic the evaluation protocols, preceding each Yo-Yo intermittent test (Castagna et al., 2020b). Participants were asked to progressively increase the intensity toward the end of the warm-up, nonetheless without reaching maximal speed. A 2-min passive recovery preceded each test (Castagna et al., 2020b). On the day before testing, participants refrained from performing vigorous physical activity (Castagna et al., 2020b).

The Yo-Yo Intermittent Endurance Test Level 1 (initial speed: 10 km final speed: 19 km) was designed to evaluate the ability to perform intense exercise repeatedly during a prolonged intermittent exercise (Krustrup et al., 2015). In the test, each participant performed a series of 20-m shuttle runs at a pace set by an audio metronome from a calibrated CD player (Sony CFD-V7), with a standard resting interval between shuttles (5 s; Bradley et al., 2014). The time allowed for the shuttles was progressively decreased, while the speed was increased (Lago-Penas et al., 2014). The test was terminated when the subjects failed twice to reach the starting line, or the participant felt unable to complete another shuttle at the dictated speed (Castagna et al., 2020b). The VO_2 max (ml/kg/min) was assessed as indicated in Povoas et al. (2020) study.

During each test, the soccer players' running performances were monitored using a portable 5-Hz GPS unit (Catapult, Melbourne, Australia) with a 100-Hz accelerometer. The GPS device was positioned via an elasticized shoulder harness to sit between the scapulae of the bowler at the base of the cervical spine (Petersen et al., 2009). The GPS unit was then activated and the GPS satellite lock was established for at least 15 min before the player taking the field as per the manufacturer's recommendations (Petersen et al., 2009). After each session, the recorded information was downloaded using Catapult Sprint software (Catapult Innovations, Melbourne, Australia) for analysis, as used by preceding protocols (Beenham et al., 2017). The mean number of satellites and the horizontal dilution of position were recorded during data collection (Abbott et al., 2018). Horizontal dilution of precision (HDOP) designates accuracy of GPS in a horizontal plane (Catapult Sports), and optimal satellite availability (HDOP = 0.0) is where one satellite is directly overhead with a minimum of four spaced equally around the horizon. During Yo-Yo test, HDOP ranged from 0.8–1.6, which is considered a good signal (Catapult Sports). External loads of GPS parameters followed a standardized protocol (Abbott et al., 2018) and are described in **Table 1**.

Statistical Analysis

The Kolmogorov-Smirnov test (K-S) was used to determine the normal distribution of data. The null hypothesis was rejected for sprints > 19 km/h (%; p = 0.011) and in the high intensity running distance (p = 0.008). For parametric data, descriptive analysis was performed and computed as mean (X) and standard deviation (±SD). In contrast, non-parametric data

TABLE 1 | Description of external loads parameters.

External loads	Description
Total distance (m)	Distance traveled during all the test
Relative ditance (m/min)	Distance traveled during all the test per min
Sprints > 19 km/h (%)	% distance traveled running > 19 km/h
Total of sprints (freq.)	Number of sprints > 19 km/h
High intensity runningdistance (m)	Distance traveled during the test > 19 km/h
Max speed (km/h)	Maximum speed during the test
Number of Acceleration (freq.)	Number of accelerations > 2 mss
Number of decelerations (freq)	Number of decelerations > 2 mss
Change direction to the right	Number of change direction to the right
Change of direction to the left	Number of change direction to the left
Explosive efforts (freq)	Sum of accelerations and deceleration
Maximum Heart Rate (bpm)	Maximum heart beats per minute
Walking or jogging distance	Distance traveled during the test with 0 > 11 km/h
Moderate speed running distance	Distance traveled during the test with 11 > 15.5 km/h
Fast speed running distance	Distance traveled during the test with 15.5 > 19 km/h
Total time (min)	Total time in the test

TABLE 2 | Descriptive analysis of yo-yo test analysis in two moments, pre versus post quarantine.

Variables	Mom.	Mean	SD	95% C.I. of the Diff.		*t*	*p*-value
				Lower	Upper		
Total distance (m)	Pre	1570.51	409.93	−275.78	90.45	−1.068	0.301
	Post	1477.84	367.43				
Relative distance (m/min)	Pre	**161.74**	**5.90**	**−37.46**	**−3.79**	**−2.585**	**0.019**
	Post	**141.11**	**33.79**				
Total of sprints (freq.)	Pre	0.28	0.96	−0.75	0.20	−1.230	0.236
	Post	0.00	0.00				
Max speed (km/h)	Pre	**18.72**	**0.93**	**−0.99**	**−0.09**	**−2.538**	**0.021**
	Post	**18.18**	**0.61**				
Acceleration (freq.)	Pre	**59.94**	**19.89**	**−15.02**	**−0.87**	**−2.368**	**0.030**
	Post	**52.00**	**15.86**				
Decelerations (freq.)	Pre	**33.67**	**12.62**	**−13.41**	**0.07**	**−2.086**	**0.05**
	Post	**27.00**	**6.13**				
Change to the right	Pre	18.67	10.30	−7.38	3.05	−0.877	0.393
	Post	16.50	9.40				
Change to the left	Pre	20.67	15.35	−6.69	1.47	−1.351	0.194
	Post	18.06	14.55				
Explosive Efforts (freq.)	Pre	9.00	8.72	−5.42	2.42	−0.808	0.430
	Post	7.50	6.04				
Walking/jogging (m)	Pre	226.36	57.49	−3.93	60.12	1.851	0.082
	Post	254.45	56.87				
Moderate running speed (m)	Pre	471.28	117.93	−109.58	11.32	−1.715	0.105
	Post	422.15	89.49				
Fast speed running (m)	Pre	871.83	256.15	−173.01	35.86	−1.385	0.184
	Post	803.26	242.80				
Total time (min)	Pre	9.65	2.38	−0.48	3.05	1.542	0.142
	Post	10.94	2.92				
Variables	Mom.	Median	Q1;Q3	Effect size		*w*	*p*-value
sprints > 19 km/h(%)	Pre	0.83	0.16;3.0	0.3922		660.50	0.006
	Post	0.52	0.0;0.5				
High intensity running distance (m)	Pre	16.48	2.68;41.24	0.3849		656.50	0.008
	Post	0.94	0.0;7.1				

Bold values represents significant differences between pre- and post-quarantine values, p > 0.05.

were described as median (1st quartile – Q1; 3rd quartile – Q3). A paired *t*-test (parametric data) and the Wilcoxon test (non-parametric data) were conducted to compare two moments (pre-versus post-COVID-19 quarantine). The significance level was set at $p < 0.05$ for all analyses. Subsequently, the effect size measure for non-parametric analysis was calculated, defined as $ES = Z/\sqrt{N}$, where ES represents the effect size, Z is derived from the z-score of the Wilcoxon (W) test and N is the total number of observations. This analysis considers ES-values as small effect size ($r = 0.10$), medium effect size ($r = 0.30$), or large effect size ($r = 0.50$). Data were analyzed using the "Statistical Package for the Social Sciences" (SPSS v. 22.0 program, SPSS, Inc., Chicago, IL, United States).

RESULTS

Table 2 shows the findings of the descriptive analysis of pre-versus post-COVID-19 quarantine.

Statistical analysis indicated a significant reduction of ~12.5% in relative distance, 13.3% in acceleration and 19.8% in deceleration during quarantine, with an impact on the maximal speed performed ($p \leq 0.05$ for all comparisons). The Wilcoxon test demonstrated significant differences in sprints > 19 km/h and in the high-intensity running distance with a medium effect size.

DISCUSSION

The present study aimed to verify the effects of the COVID-19 induced quarantine on the cardiovascular and performance associated with Yo-Yo test in professional soccer players. Our results indicated a significant main effect on the relative distance, maximal speed, acceleration, and deceleration. To the best of the authors' knowledge, this is the first article that observed COVID-19-related restrictions and quarantine COVID-19 induced effects on cardiovascular and Yo-Yo test performance in professional soccer players. In the present investigation, maximal speed, sprints > 19 km/h, high-intensity running distance, acceleration and deceleration in Yo-Yo test had a significant effect between pre- and post-COVID-19 quarantine. Quarantine and self-isolation were two public health measures that could prevent, or at least minimize, the impact of infectious disease outbreaks in professional soccer teams. However, some professional players still got sick. In addition to this problem, our results could have been influenced by changes in lifestyles and nutritional habits. Despite this, the reduction of physical activity did not contribute to weight gain during the quarantine.

Previous reports indicated that straight line sprinting is categorized as acceleration, deceleration and maximal running speed (Haugen et al., 2014). Yo-Yo test has a higher ecological validity and reliability (Castagna et al., 2019; Francini et al., 2019), since soccer matches performance analyses have shown that >90% of all sprints in games are shorter than 20 m, acceleration and deceleration capabilities are essential for soccer athletes (Modric et al., 2019). Still, the importance of peak velocity increases during the game when sprints start from a jogging or non-stationary condition (Datson et al., 2014; Palucci Vieira et al., 2019; Slimani and Nikolaidis, 2019), with the Yo-Yo intermittent test being useful to evaluate the physical fitness condition of soccer players in terms of levels (Redkva et al., 2018; Povoas et al., 2020; Castagna et al., 2020b), gender (Emmonds et al., 2019; Castagna et al., 2020a), and age classes (Ehlert et al., 2019; Francini et al., 2019).

Concerning our sample, even with a normalized and controlled oxygen saturation between 96 and 98% during the COVID-19 quarantine, the players showed a significant pre- versus post-variation in the results. Our outcomes indicated a significant impact during determinant situations (maximal speed, sprints > 19 km/h, high-intensity running distance, acceleration and deceleration). Moreover, an adaptive planning process to return to the optimum levels occurred. Coaches, analysts, and physiologists played a substantial role in athletes' physical capacities, using their expertise to evaluate the athlete and providing insight into how effective a post-COVID-19 training system could be improved to increase the athlete's performance. If the training system was not optimal, then the performance enhancement team reevaluated and modified the design. All athletes received daily medical attention during this initial evaluation and training, as well as psychological support for any emotional problems.

Match analyses indicated that outfield soccer players cover 9 to 12 km during the game, ∼10% of this amount is higher than 19 km/h (Rampinini et al., 2010; Rogers et al., 2019). The present decrease in the relative distance, maximal speed, acceleration, and deceleration of soccer athletes could be associated with the lack of sprint training, and reduction of the total training load during the COVID-19 quarantine. Therefore, present results indicated that quarantine without specific or general stimulus had a negative effect on determinant high-intensity actions. Practical applications of these results suggest realizing sprint intervention on soccer players without COVID-19 contagious to maintain short sprint abilities. Previous reports indicated that short training with distances < 30 m improves specific maximal speed during the games (Randers et al., 2010; Nyberg et al., 2016; Hostrup et al., 2019).

Present results agree with previous reports about VO_2max values of soccer athletes, ranging between 48 and 62 ml/kg/min for soccer players (Slimani et al., 2019). The typical competitive soccer season has from 8 to 9 months, with a mean of two matches a week and a high aerobic intensity demand estimated at ∼80% of VO_2max by the game (Slimani et al., 2019). No effects were observed in VO_2max of Yo-Yo test comparing between pre- and post-COVID-19 quarantine in the present study (**Figure 1**). The low level of VO_2max value can explain this before the quarantine period. Coaches and conditioning specialists should include/recommend a specific training program targeting

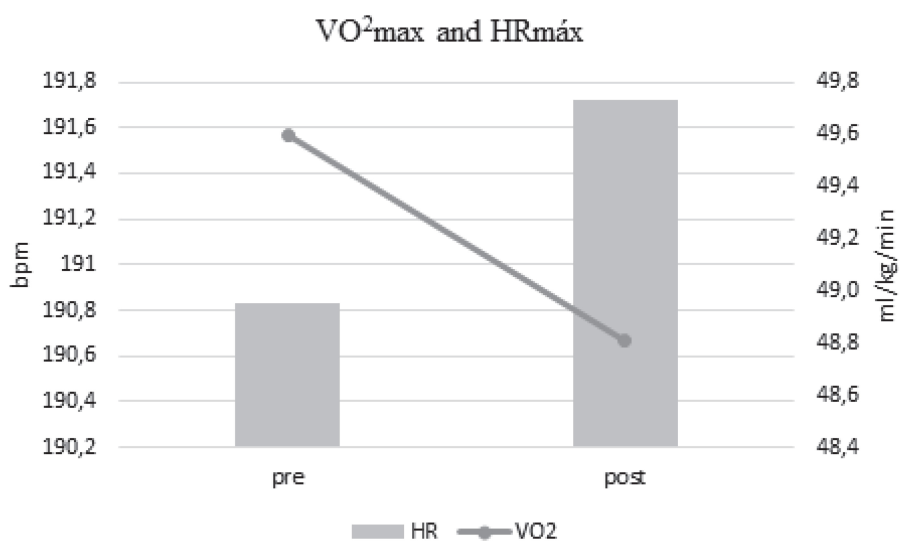

FIGURE 1 | VO_2 max and HRmax pre- and post-quarantine.

VO_2max performance during the COVID-19 quarantine, off-season and competitive season to improve the cardiovascular condition in soccer players. In addition, our results highlight the focus on sprinting training progression and periodization/timing, as the sprint is the most frequent mechanism related to hamstring injuries, as ~20% of all injuries in soccer are hamstring damages (Duhig et al., 2016).

Concerning Yo-Yo test test-retest reliability, investigation indicated intra-class correlation coefficients (ICCs) for test–retest reliability ranging from 0.78 to 0.98, with ~60% of all ICCs0 > 0.90, while ~95% of ICCs were 0 > 0.80 (Krustrup et al., 2003; Castagna et al., 2012; Deprez et al., 2014; Povoas et al., 2016; Ehlert et al., 2019). Moreover, the present study controlled for several factors, including those which may affect Yo-Yo test performance, as caffeine ingestion (Ranchordas et al., 2018), participants maintained their usual nutritional habits during all the moments of the collected data (Chtourou et al., 2011), restricting any caffeine intake. Past research indicated that time of day could affect the exercise performance; our measures were standardized between 4 and 6 P.M. (Rampinini et al., 2010; Buchheit and Rabbani, 2014) and all athletes slept between 8 and 10 h in the night before the testing sessions (Fernandes et al., 2015; Fowler et al., 2015).

Although the results of VO_2max did not demonstrate significant effects of COVID-19 quarantine, coaches and athletes without coronavirus should focus on speed and explosive strength during this moment. In a periodized approach to training whereby training phases with specific adaptive responses have to be appropriately sequenced, following guidelines recommendations, at least 200–400 min of aerobic exercise/week (Fallon, 2020; Jimenez-Pavon et al., 2020) and two times of resistance training/week resistance training performed during COVID-19 quarantine seems to be appropriate (Fallon, 2020; Jimenez-Pavon et al., 2020) – for soccer athletes, our results indicated a distinct focus on specific muscular strength, agility, and power of specific motor skills.

CONCLUSION

Our findings demonstrated that COVID-19 related restrictions and quarantine had adverse effects on increasing, decreasing, or maintaining sprints of professional soccer players during the Yo-Yo test. In contrast, aerobic training at 65–75% of maximal heart rate maintained the aerobic capacity during the quarantine and could be a protective health intensity. A multi-component soccer-training program could be considered as the most adequate for professional athletes, including aerobic, resistance, balance, coordination, and specific power motor abilities with short running actions, accelerations, and decelerations.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by before proceeding with data collection, all participants attended a briefing meeting and signed a written, informed consent document to ensure the understanding of the testing parameters and the risks and benefits associated with the study. In addition, a letter of consent was sent and duly signed by all the soccer clubs of the participants. This study was submitted to and approved by the Local Committee of Ethics in Research, following the rules of resolution of the National Health Council and according with the World Medical Association (WMA) Declaration of Helsinki. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LA, MT, MSa, and BM conceived and conducted the experiment, wrote the manuscript, analyzed data, and wrote the manuscript. EA-M, DS, MSl, HZ, BM, and CB revised the manuscript. All authors contributed to the article and approved the submitted version.

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Effect of Coronavirus Disease 2019 (COVID-19) on Elite Spanish Student-Athletes' Perception of the Dual Career

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The aim of the present research was to assess elite student-athletes' perception of the dual career during the lockdown caused by the coronavirus disease 2019 (COVID-19) pandemic, compared with a group of elite student-athletes who could develop their dual career under normal conditions. A total of 150 elite athletes who were also undergraduate or postgraduate students self-completed the "Perceptions of dual career student-athletes (ESTPORT)" questionnaire. From them, 78 did it during the mandatory lockdown period due to the state of emergency caused by COVID-19 (COVID-19 group) and 72 completed it in the previous year to Rio 2016 Olympic Games (control group). The COVID-19 group was found to spend a significantly higher number of hours per week studying, while no significant differences were observed between groups in any training time variable. Student-athletes of the COVID-19 group showed better perception of whether their sport career could help them cope with their academic career and better general perception of remote learning and the use of tasks and videoconferencing as learning support tools. A lower percentage of athletes of the COVID-19 group than of the control group wished to continue with their sport career once they finished their studies. To conclude, student-athletes of the COVID-19 group show adaptations with regard to the organization of their studies and the importance they give to them and to the services provided by dual-career programs, compared with student-athletes from an ordinary pre-Olympic year. In general, student-athletes' perception of the dual career is very positive.

Keywords: academic career, Coronavirus (COVID-19), dual career, sport career, sport tutor, student-athlete, university

INTRODUCTION

Spain has been one of the most affected countries by the pandemic (according to the WHO, on March 14, 2020, there were 4,231 cases and had been 120 deaths, and by the end of the lockdown, on May 3, 216,582 cases and 25,100 deaths) (World Health Organization, 2020). The state of emergency declared in Spain on March 14, 2020, due to the health crisis derived from the coronavirus disease 2019 (COVID-19) pandemic entailed home lockdown, which was mandatory except to perform activities considered essential (Agencia Estatal Boletín Oficial del Estado, 2020b). This fact had a big impact on the daily life (changes in daily routines and cancelation of important

Abbreviations: COVID-19, coronavirus disease 2019; OG, Olympic Games.

activities) and psychological factors (increased anxiety, stress, and depression, among others) of the Spanish population (Rodríguez-Rey et al., 2020).

From that moment, face-to-face lessons were suspended in Spanish universities, and teaching and evaluation have been adapted to remote or online mode, provided it was feasible (Odriozola-González et al., 2020). In this exceptional scenario, the Spanish university system, with the effort of the whole university community and the institutions, provided a responsible, prompt, and agile response in order to guarantee the continuation of the academic activities by adapting to remote methods (Torrecillas, 2020). The different bodies with competence in high education in Spain in this unique situation agreed on the following academic criteria: (1) students should not miss the academic year due to this crisis, or would not be overcharged due to the measures adopted related to teaching; (2) administration, universities, and agencies would join forces in order to ensure the academic quality of the training received by students during the academic year 2019–2020; and (3) universities would autonomously manage and develop their official degrees, and the competent authorities (self-governed regions, with collaboration of the Ministry of Universities) would supervise the process in order to guarantee the system's quality standards (Conferencia General de Poliìtica Universitaria, 2020).

This situation has affected the normal development of the dual career. The concept of dual career refers to the combination of an athletic career with education and/or occupation (Geraniosova and Ronkainen, 2015). Educational models that promote the dual career are based on the human right to education and guarantee that elite athletes can train and compete and at the same time develop their academic career (Sánchez-Pato et al., 2017). For an athlete, pursuing education while competing in high-performance sport can be a challenging task. The increasing demands on athletic performance in elite sports place high pressure on athletes, who may feel forced to choose between maximizing their athletic potential or obtaining a satisfying education for a post-athletic career (Lavallee and Wylleman, 2000). As stated by Geraniosova and Ronkainen (2015), this situation may lead to premature discontinuation of the athletic career due to prioritization of education (Amara et al., 2004) or, by contrast, to lower investment in education due to exclusive focus on achieving athletic success (Aries et al., 2004).

It is essential to keep a holistic and systematic approach that can appropriately adapt to the essence of education as an organic, complex, circular, dynamic, and open process, promoting the participation of all agents in order to trigger improvements in the education, sport, professional, and personal systems (Isidori, 2016). The student-athlete is the leading role in this scenario where sport is the main life axis and an athletic identity based on success determines a personality that represents the values and is the source of affective and interpersonal relationships (Lally and Kerr, 2005). This identity must be preserved and, at the same time, developed in such a manner that the athlete accepts, with responsibility, the student role that will allow them to broaden their personal knowledge and to work on their own future through the acquisition of specific skills (Migliorati et al., 2016).

Some universities facilitate this process through the creation of a key role to ensure dual-career efficiency: the sport tutor. From this perspective, it seems necessary to offer a personalized tutorship model using a clear pedagogic approach in which sport must be always connected to comprehensive education. Thus, there must be a very close relationship between sport and continuous learning, based on mutual acknowledgment (Isidori, 2016). In this regard, the sport tutor plays the role of an academic guide, encouraging the achievement of good academic results, and of a mediator among student-athletes, the university, and the sport organizations. Furthermore, they plan the training and studying schedules and monitor and support the academic career through e-learning and other online support tools, especially during competition periods when the student-athlete cannot attend university (Isidori, 2016).

Elite student-athletes, who work on their sport and academic careers at the same time, have needed to adapt both their training and studies due to the lockdown caused by COVID-19. Under normal conditions, student-athletes make an effort to perform both activities simultaneously, organizing and optimizing their time with the help of their tutor. In an extraordinary situation like the one arising during the COVID-19 pandemic, student-athletes stopped attending their training centers and needed to adapt to home training with very limited resources and facilities (Toresdahl and Asif, 2020). All sport events and on-site training were postponed or canceled, leading to economic loss (Jiménez-Gutiérrez et al., 2020). In line with this, the report created by the Association for Spanish Sport (Asociación del Deporte Español, ADESP) together with Active Spain Federation (Fundación España Activa) and the High Council for Sport (CSD) has yielded very relevant results as regards the impact that the health crisis has had on the Spanish sport system. The estimated loss for 2020 is 4.6 billion Euro, meaning 38.5% of the revenue expected by the participating organizations in 2020. According to this report, COVID-19 has also caused a decrease of 31% in athletes' income. The unemployment rate within the sector has raised by the same percentage (Jiménez-Gutiérrez et al., 2020). Besides this uncertainty, on March 24, 2020, the International Olympic Committee announced that Tokyo Olympic Games (OG) would be postponed 1 year, until summer 2021, because of the pandemic (International Olympic Committe, 2020). This unprecedented decision left elite athletes in a standby situation as regards the training plan followed during the previous 4 years. These athletes resumed training individually, after a 7-week lockdown, on Monday, May 4 (beginning of lockdown ease in stages), when basic training was allowed again as well for professional leagues and high-level athletes (Agencia Estatal Boletín Oficial del Estado, 2020a).

Nevertheless, the lockdown gave them the opportunity to focus on other tasks, such us continuing with their studies online, since Spanish universities switched to this more accessible and flexible modality (Odriozola-González et al., 2020), which are key features in the success of the dual career (Sánchez-Pato et al., 2017).

Studies on the impact of COVID-19 on sport have started to emerge in different fields, especially in those related to the negative effects on elite athletes' performance and physical fitness after the pandemic (Baggish et al., 2020; Dores and Cardim, 2020), athletes' psychological aspects (Sarto et al., 2020), financial and structural aspects of sport organizations (Drewes et al., 2020), or the consequences of the cancelation or postponement of sport events such as the Tokyo 2020 OG (Gallego et al., 2020). Nevertheless, beyond sport itself, there is a lack of research on the effects of COVID-19 on complementary elements of elite athletes' life like, for example, their student role. Up to date, no study has been found to address this topic. Therefore, the aim of the present research was to assess elite student-athletes' perception of the dual career during the lockdown caused by the COVID-19 pandemic, compared with a group of elite student-athletes who could develop their dual career under normal conditions, both in pre-Olympic years.

MATERIALS AND METHODS

Design and Participants

A descriptive, cross-sectional study design with non-probability-based sampling was used. The sample was selected based on convenience. It comprised 150 elite Spanish student-athletes (50% male and 50% female), of mean age 25.29 years (SD = 4.67). All of them competed or were preparing to compete at the OG that would be held the following year. They had all previously participated in international competitions. Participants belonged to two different groups that remained academically active during the academic years 2015–2016 (control group; n = 72), previous to Rio 2016 OG, and 2019–2020 (COVID-19 group; n = 78), previous to Tokyo 2020 OG, within the dual-career university program (**Table 1**). The inclusion criteria were as follows: (a) to be enrolled on any university degree or master's studies within a dual-career university program; (b) to be considered a high-level athlete according to the Spanish High for Sport and to be included in the list published in the national official bulletin (Boletín Oficial del Estado, BOE); (c) to have participated in international competitions; and (d) to have participated in the previous OG or to be eligible to participate in the upcoming OG. The sample consisted of undergraduate (n = 120; 80.00%) or postgraduate (n = 30; 20.00%) students and, at the same time, elite athletes of individual (n = 97; 64.66%) or team sports (n = 35.33%) who were in different stages of their sport career:

TABLE 1 | Descriptive statistics of student-athletes in normal pre-Olympic year (control group) and student-athletes in COVID-19 pre-Olympic year (COVID-19 group).

		Control group	COVID-19 group	Differences between groups
Age (years)		25.40 ± 4.37	25.18 ± 4.97	t = 0.29; p = 0.77; d = 0.05; 95% CI = −1.30 to 1.74
Sex (n,%)	Male	38 (52.8%)	37 (47.4%)	χ^2 = 0.44; p = 0.51
	Female	34 (47.2%)	41 (52.6%)	
Type of sport	Individual	50 (69.4%)	47 (60.3%)	χ^2 = 1.38; p = 0.24
	Team	22 (30.6%)	31 (39.7%)	
Self-consideration of spor performance level	Amateur	40 (55.6%)	36 (46.2%)	χ^2 = 1.44; p = 0.49
	Semiprofessional	29 (40.3%)	39 (50.0%)	
	Professional	3 (4.2%)	3 (3.8%)	
Self-consideration of stage in sport career	Beginning of high-level competition	15 (20.8%)	28 (35.9%)	χ^2 = 5.29; p = 0.07
	Top performance in high-level competition	44 (61.1%)	34 (43.6%)	
	End of high-level competition	13 (18.1%)	16 (20.5%)	
Ongoing studies	Degree	56 (77.8%)	64 (82.1%)	χ^2 = 0.43; p = 0.51
	Master's degree	16 (22.2%)	14 (17.9%)	
Employed	Yes	25 (34.7%)	30 (38.5%)	χ^2 = 0.22; p = 0.63
	No	47 (65.3%)	48 (61.5%)	
Study completion pace (years/level)		1.88 ± 0.89	1.87 ± 1.14	t = 0.02; p = 0.98; d = 0.01; 95% CI = −0.33 to 0.33
Self-perception	Athlete-student	18 (25.0%)	17 (21.8%)	χ^2 = 0.21; p = 0.64
	Student-athlete	54 (75.0%)	61 (78.2%)	
Priority	Studies	28 (38.9%)	41 (52.6%)	χ^2 = 2.82; p = 0.09
	Athletic career	44 (61.1%)	37 (47.4%)	
Hours per week spent on studying		9.87 ± 8.59	12.93 ± 8.60	t = −2.15; p = 0.03; d = 0.36; 95% CI = −1.58 to 3.32
Training sessions per week	Between 1 and 5	13 (18.1%)	19 (24.4%)	χ^2 = 1.51; p = 0.47
	Between 6 and 10	38 (52.8%)	42 (53.8%)	
	More than 10	21 (29.2%)	17 (21.8%)	
Training hours per week	Fewer than 5	0 (0.0%)	1 (1.3%)	χ^2 = 3.78; p = 0.44
	Between 5 and 10	7 (9.7%)	15 (19.2%)	
	Between 11 and 15	18 (25.0%)	17 (21.8%)	
	Between 16 and 20	20 (27.8%)	20 (25.6%)	
	More than 20	27 (37.5%)	25 (32.1%)	

beginning (n = 43; 28.66%), top (n = 78; 52.00%), or end (n = 29; 19.33%).

Sample Size

The calculations to establish the sample size were performed using RStudio 3.15.0 software. Significance level was set at $a = 0.01$. The standard deviation (SD) was determined based on a previous study (Sánchez-Pato et al., 2016). With an estimated error (d) of 0.33, a valid sample size for a 99% confidence interval (CI) was found to be 72 for each group.

Data Collection

The perceptions of university student-athletes as regards their dual career were analyzed using a simple version of the questionnaire "Perceptions of dual career student-athletes (ESTPORT)" (Sánchez-Pato et al., 2016; Gavala-González et al., 2019). The instrument was composed of 84 items, with various question types (Likert scale, multiple choice, short answer). Most questionnaire items used a Likert-type scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). This assessment tool was divided into two categories: (a) sociodemographic and context variables (14 items) and (b) dual-career aspects (70 items). The items about dual career comprised three subscales: "academic career" (38 items), "sport career" (15 items), and "sport tutor" (11 items). In addition, it included some questions about the dual career (six items). The results revealed high internal consistency of the questionnaire, since Cronbach's alpha coefficients were higher than 0.70 in the three dimensions: academic career (alpha = 0.81), sport career (alpha = 0.73), and sport tutor (alpha = 0.93), which are above the lower limit accepted as reliable (Corbetta, 2007; Sánchez-Pato et al., 2016).

Procedure

The study obtained the approval from the ethics committee of the authors' university (code: 19/6/2015). The student-athletes were contacted through the university sport services and the Spanish Olympic Committee. Participants were contacted *via* email to participate in the study. The student-athletes were informed about the aims and procedure of the study through an informed consent form. The student-athletes completed the questionnaire anonymously and individually at home, without being under academic or competition pressure, without the presence of their coach or professors. After signing the informed consent, they could start completing the questionnaire. The participants did not receive any additional explanation about the purpose of the questionnaire apart from that contained in the questionnaire itself. The questionnaire was accessed online using Google Forms®. The participants completed it during 20–30 min. The COVID-19 group self-completed the questionnaire during the week before the lockdown ease started (seventh week of lockdown, between April 27 and May 01, 2020), when individual outdoor training was allowed again.

Statistical Analysis

The scale internal consistency values were acceptable (Streiner, 2003). After assessing variable normality through the Kolmogorov–Smirnov test, homogeneity through Levene's test, and sphericity through the Mauchly test, a descriptive analysis was conducted for the quantitative (means and standard deviations) and qualitative variables (counts and percentages). The differences between the two groups (COVID-19 and control groups) in the continuous variables were determined using unpaired t-tests. The effect size was calculated, defined as low (r = 0.10), moderate (r = 0.30), high (r = 0.50), or very high (r = 0.70) (Cohen, 1988). Chi-square analyses were used to analyze differences between groups in the categorical variables. Cramer's V was used for *post hoc* comparison of 2×2 tables and the contingency coefficient was used for $2 \times n$ tables, obtaining the value of the statistic and the p-value. The maximum expected value was 0.707; $r < 0.3$ indicated low association, r between 0.3 and 0.5 indicated moderate association, and $r > 0.5$ meant high association. The statistical analysis was performed using the statistical package SPSS 21.0 for Windows. An error of $p \leq 0.05$ was established.

RESULTS

Table 1 contains the results of the descriptive variables for both groups. No statistically significant differences were found between groups ($p > 0.05$). The COVID-19 group was found to spend a significantly higher number of hours per week studying, with a moderate effect ($p = 0.03$), while no significant differences were observed between groups in the number of training sessions or training hours per week ($p > 0.05$).

Table 2 shows the athletes' perceptions and opinions about the dual career. The COVID-19 group showed better perception of whether their sport career could help them cope with their academic career ($p = 0.03$) and better general perception of remote learning ($p < 0.001$). No significant differences were detected in the perception of interference of studies with athletic performance or vice versa, or in the perception of the sport career–academic career balance ($p > 0.05$). All participants perceived certain interferences between both spheres and admitted that it was not easy to achieve good balance.

However, the majority of athletes from both groups did not perceive barriers that could hinder their success in the dual career. In general, they showed positive perception of the flexible curriculum, sport monitoring of the dual career by the university, the role of the sport tutor, and the services provided by the sport tutor, with no differences between groups in any of these variables ($p > 0.05$).

With regard to the use of learning support tools, the COVID-19 group considered the tools tasks ($p = 0.001$) and videoconferencing ($p < 0.001$) to be more important than the control group. Both groups showed positive perception of the use of the virtual campus as a learning support tool, while they did not consider the use of fora, chat, Facebook, or Twitter relevant, with no significant differences in the use of these tools ($p > 0.05$).

Table 3 shows the athletes' expectations after finishing their university studies. A lower percentage of athletes of the COVID-19 group than of the control group wished to continue with their sport career once they finished their studies ($p = 0.01$). By

TABLE 2 | Comparison of the perception of the dual career, according to the variables studied, between student-athletes in normal pre-Olympic year (control group) and student-athletes in COVID-19 pre-Olympic year (COVID-19 group).

		Control group	COVID-19 group	Differences between groups
Interference of studies with athletic performance	Yes	33 (45.8%)	40 (51.3%)	$\chi^2 = 0.44$; $p = 0.50$
	No	39 (54.2%)	38 (48.7%)	
Interference of athletic performance with studies	Yes	49 (68.1%)	57 (73.1%)	$\chi^2 = 0.45$; $p = 0.50$
	No	23 (31.9%)	21 (26.9%)	
My sport career helps cope with my studies	Strongly agree	11 (15.3%)	15 (19.2%)	$\chi^2 = 10.78$; $p = 0.03$
	Agree	15 (20.8%)	28 (35.9%)	
	Neither agree nor disagree	28 (38.9%)	21 (26.9%)	
	Disagree	7 (9.7%)	11 (14.1%)	
	Strongly disagree	11 (15.3%)	3 (3.8%)	
Balance between my sport career and academic career	Very easy	0 (0.0%)	2 (2.6%)	$\chi^2 = 4.93$; $p = 0.29$
	Easy	14 (19.4%)	18 (23.1%)	
	Neither easy nor difficult	22 (30.6%)	26 (33.3%)	
	Difficult	25 (34.7%)	27 (34.6%)	
	Very difficult	11 (15.3%)	5 (6.4%)	
I encounter barriers to achieve good balance between my sport career and academic career	Strongly agree	2 (2.8%)	0 (0.0%)	$\chi^2 = 4.10$; $p = 0.39$
	Agree	8 (11.1%)	5 (6.4%)	
	Neither agree nor disagree	25 (34.7%)	27 (34.6%)	
	Disagree	30 (41.7%)	34 (43.6%)	
	Strongly disagree	7 (9.7%)	12 (15.4%)	
Perception of sport monitoring services as part of the university dual career	Very high	14 (19.4%)	19 (24.4%)	$\chi^2 = 4.79$; $p = 0.31$
	High	17 (23.6%)	28 (35.9%)	
	Neutral	24 (33.3%)	17 (21.8%)	
	Somewhat high	10 (13.9%)	9 (11.5%)	
	Not high at all	7 (9.7%)	5 (6.4%)	
Perception of flexible curriculum	Very high	23 (31.9%)	34 (43.6%)	$\chi^2 = 7.40$; $p = 0.12$
	High	18 (25.0%)	21 (26.9%)	
	Neutral	20 (27.8%)	20 (25.6%)	
	Somewhat high	8 (11.1%)	3 (3.8%)	
		3 (4.2%)	0 (0.0%)	
Perception of remote learning	Very high	29 (40.3%)	26 (33.3%)	$\chi^2 = 20.16$; $p < 0.001$
	High	14 (19.4%)	38 (48.7%)	
	Neutral	11 (15.3%)	14 (17.99%)	
	Somewhat high	10 (13.9%)	3 (3.8%)	
	Not high at all	5 (6.9%)	0 (0.0%)	
Perception of the sport tutor services as part of the university dual career	Very high	30 (41.7%)	30 (38.5%)	$\chi^2 = 5.62$; $p = 0.23$
	High	13 (18.1%)	22 (28.2%)	
	Neutral	10 (13.9%)	15 (19.2%)	
	Somewhat high	8 (11.1%)	6 (7.7%)	
	Not high at all	11 (15.3%)	5 (6.4%)	
Perception of the need for sport tutor services as part of the university dual career	Strongly disagree	8 (11.8%)	15 (20.5%)	$\chi^2 = 4.43$; $p = 0.35$
	Disagree	2 (2.9%)	5 (6.8%)	
	Neither disagree nor agree	13 (19.1%)	13 (17.8%)	
	Agree	26 (38.2%)	19 (26.0%)	
	Strongly agree	19 (27.9%)	21 (28.8%)	
Use of the virtual campus as learning tool	Always	43 (60.6%)	56 (71.8%)	$\chi^2 = 6.45$; $p = 0.17$
	Almost always	11 (15.5%)	13 (16.7%)	
	Sometimes	10 (14.1%)	8 (10.3%)	
	Almost never	2 (2.8%)	0 (0.0%)	
	Never	5 (7.0%)	1 (1.3%)	

(Continued)

TABLE 2 | Continued

		Control group	COVID-19 group	Differences between groups
Use of online fora as learning tool	Always	6 (8.3%)	10 (13.0%)	$\chi^2 = 6.54$; $p = 0.16$
	Almost always	9 (12.5%)	8 (10.4%)	
	Sometimes	6 (8.3%)	16 (20.8%)	
	Almost never	11 (15.3%)	7 (9.1%)	
	Never	40 (55.6%)	36 (46.8%)	
Use of online tasks as learning tool	Always	23 (31.9%)	40 (52.6%)	$\chi^2 = 19.46$; $p = 0.001$
	Almost always	16 (22.2%)	18 (23.7%)	
	Sometimes	12 (16.7%)	15 (19.7%)	
	Almost never	5 (6.9%)	2 (2.6%)	
	Never	16 (22.2%)	1 (1.3%)	
Use of online chat as learning tool	Always	4 (5.6%)	4 (5.3%)	$\chi^2 = 3.41$; $p = 0.49$
	Almost always	4 (5.6%)	6 (7.9%)	
	Sometimes	4 (5.6%)	9 (11.8%)	
	Almost never	10 (13.9%)	14 (18.4%)	
	Never	50 (69.4%)	43 (56.6%)	
Use of videoconferencing as learning tool	Always	1 (1.4%)	19 (25.0%)	$\chi^2 = 50.21$; $p < 0.001$
	Almost always	1 (1.4%)	10 (13.2%)	
	Sometimes	9 (12.5%)	18 (23.7%)	
	Almost never	5 (6.9%)	12 (15.8%)	
	Never	56 (77.8%)	14 (22.4%)	
Use of Facebook as learning tool	Always	2 (2.9%)	6 (7.8%)	$\chi^2 = 5.41$; $p = 0.25$
	Almost always	2 (2.9%)	3 (3.9%)	
	Sometimes	5 (7.4%)	11 (14.3%)	
	Almost never	5 (7.4%)	9 (11.7%)	
	Never	54 (79.4%)	48 (62.3%)	
Use of Twitter as learning tool	Always	6 (8.5%)	11 (14.3%)	$\chi^2 = 2.39$; $p = 0.66$
	Almost always	3 (4.2%)	6 (7.8%)	
	Sometimes	8 (11.3%)	8 (10.4%)	
	Almost never	9 (12.7%)	10 (13.0%)	
	Never	45 (63.4%)	42 (54.5%)	

contrast, there were no significant differences in the rest of the items related to their expectations after completing their studies ($p > 0.05$).

DISCUSSION

The aim of the present research was to assess elite student-athletes' perception of the dual career during the lockdown caused by the COVID-19 pandemic, compared with a group of elite student-athletes who could develop their dual career under normal conditions, both in pre-Olympic years. It was noteworthy that the student-athletes from the COVID-19 group spent a higher number of hours studying than those from the control group, composed of elite athletes in a normal pre-Olympic year. There was no difference in the number of training sessions or training hours per week between groups, maybe because during the lockdown period caused by COVID-19, the training sessions were performed at home with the aim to keep a physical conditioning routine (Andreato et al., 2020). Previous studies have pointed out that the major barrier Olympic athletes encounter to complete a university degree is time management, since they need to spend over 40 h a week on duties derived from studies and sport (Subijana et al., 2015). This barrier becomes even greater if athletes compete at the international level (Fuchs et al., 2016), like in the present study. One factor that affects the balance between the time spent on training and studying is directly related to the distance from the student-athlete's home to the training venue or university (Condello et al., 2019). The lockdown has allowed for increased time availability, since these transfers were not needed anymore. This has allowed student-athletes to increase studying hours, without negatively affecting the number of training hours. From the above, it can be hypothesized that, under normal circumstances, switching to online university studies might increase success in the dual career and this is a key aspect to consider when planning dual-career programs in the future. It would allow athletes to better manage their agenda and to reduce their transfer time, thus solving one of the major and most stressful issues for them, which is lesson attendance, especially during competition periods (Gavala-González et al., 2019).

Nonetheless, the significant increase in studying hours has not led to student-athletes' identity reconfiguration, since they

TABLE 3 | Comparison of expectations between student-athletes in normal pre-Olympic year (control group) and student-athletes in COVID-19 pre-Olympic year (COVID-19 group).

		Control group	COVID-19 group	Differences between groups
To continue with further studies	Yes	36 (50.0%)	38 (48.7%)	$\chi^2 = 0.02$; $p = 0.87$
	No	36 (50.0%)	40 (51.3%)	
To work in the area of university studies	Yes	56 (77.8%)	61 (78.2%)	$\chi^2 = 0.00$; $p = 0.95$
	No	16 (22.2%)	17 (21.8%)	
To work in a different area from university studies	Yes	3 (4.2%)	1 (1.3%)	$\chi^2 = 1.20$; $p = 0.273$
	No	69 (95.8%)	77 (98.7%)	
To continue with sport career	Yes	52 (72.2%)	40 (51.3%)	$\chi^2 = 6.92$; $p = 0.01$
	No	20 (27.8%)	38 (48.7%)	
To continue being involved in sport	Yes	61 (84.7%)	66 (84.6%)	$\chi^2 = 0.00$; $p = 0.99$
	No	11 (15.3%)	12 (15.4%)	
To live on my savings	Yes	1 (1.4%)	3 (3.8%)	$\chi^2 = 0.87$; $p = 0.35$
	No	71 (98.6%)	75 (96.2%)	

still perceive themselves more as athletes than as students. This result is in keeping with previous studies (Sánchez-Pato et al., 2017; Gavala-González et al., 2019). This could be due to the fact that the study sample was fully composed of international-level elite athletes, which could reinforce their identity as athletes (Lupo et al., 2015).

Another relevant finding was the increase in the perceived benefits of the sport career on the academic career for COVID-19 athletes, compared with a group of Olympic athletes in a normal pre-Olympic year. It is important to highlight that the majority of them obtained university scholarships, thanks to their status of elite athletes. According to previous studies, these athletes are aware of this fact, which could partially compensate the reduced time spent with family and friends, due to the high demands in order to perform well in both sport and academic fields (Gavala-González et al., 2019). The change observed in this item in the COVID-19 group could be due to the fact that elite athletes have become aware during the lockdown that university studies are a means and not a barrier to develop their life projects, and as a consequence, a greater adherence and perceived importance from athletes of dual-career programs may be expected after the COVID-19 pandemic. In this regard, a student-athlete's priorities are highly determined by the circumstances of their ecosystem (Aquilina, 2009). In contrast to the normative concept of enrolling at university because of social pressure, student-athletes of the COVID-19 group self-realized the importance of holding a university degree for their future after retirement from sport (Jordana et al., 2017; Gavala-González et al., 2019) and that this is a possibility they can only access thanks to their status of elite student-athletes (Debois et al., 2015). In fact, previous studies have stated that motivated athletes are able to combine their academic and sport careers in an optimal manner (Lupo et al., 2015), both dimensions being equally relevant within their identity (O'Neill et al., 2013). Nevertheless, motivations may differ depending on the support structures available to athletes during their dual career (Kerstajn et al., 2018), making further research needed on this topic.

Another noteworthy result was that student-athletes did not consider it easy to achieve balance between their sport and academic careers, in keeping with previous studies (Kristiansen, 2017). Furthermore, there were different opinions about whether the academic career interferes with sport performance. It was much more obvious for student-athletes that sport performance interfered with their academic performance. Both groups presented the same trend in these variables despite the fact that the COVID-19 group dedicated longer time to their academic development. A possible explanation to this would be related to the influence of external factors on student-athletes' dual career (Guidotti et al., 2015; Kerstajn et al., 2018). Previous studies have revealed that the coach's role acquires key relevance during student-athletes' adulthood, being the external factor with the greatest influence on their decision-making and priority setting (Wylleman and Lavallee, 2004). Actually, coaches are usually reluctant to their athletes spending time on studies, in spite of the official rhetoric (Ronkainen et al., 2018). The absence of the coach during the lockdown may have modified their capacity of influencing these factors. Based on this, interventions with coaches would be needed so that they become a positive influence on elite student-athletes' dual career. This is an important topic to be considered in future research.

COVID-19 has had a huge impact on lifestyle worldwide, and student-athletes have not been an exception. Nevertheless, in general, athletes of the COVID-19 group did not encounter any additional barriers that could hinder success in their dual career, apart from the traditional ones (Subijana et al., 2015). This could be because these athletes were already enrolled on a long-term dual-career program, whose development is guaranteed by the university and the Spanish Olympic Committee. This program has kept running with the required adaptations (Conferencia General de Poliìtica Universitaria, 2020), i.e., face-to-face lessons were suspended and teaching and evaluation was adapted to remote or online mode (Odriozola-González et al., 2020). Furthermore, as the Spanish government decided that universities would autonomously manage their official degrees and master's programs (Conferencia General de Poliìtica Universitaria, 2020), the university where the participants came from decided to teach the 100% of hours of the face-to-face degrees and master's virtually, while the online studies continue in the same way, with the sole adaptation to the evaluation to online mode (Universidad Catoìlica San Antonio, 2020). This suggests that the existence of formal support structures is an irreplaceable aspect in the dual career, especially in exceptional situations, and they are expected to be a more successful strategy than the laissez-faire/non-formal models applied in other contexts (Aquilina and Henry, 2019). In fact, student-athletes showed positive perception of some of the characteristics that are inherent to a formal dual-career program, such as the flexible curriculum, sport monitoring of the dual career by the university, the role of the sport tutor, and the services provided by the sport tutor (Isidori, 2016; Sánchez-Pato et al., 2017). Previous studies have already detected that the lack of these features hinders success in the dual career (Fuchs et al., 2016; Gavala-González et al., 2019). According to these findings, it should be proposed that future dual-career programs be based on formal structures and established protocols that help to successfully develop the two areas that converge in the dual career.

The results of the present study revealed improved perception of online learning by the COVID-19 group. Previous studies had already reported that student-athletes prefer online education to the traditional methodology (Tsiatsos et al., 2018), maybe because it allows them more flexibility in their time management, which is the major barrier encountered during the dual career (Subijana et al., 2015). Another aspect that could have influenced this perception is the evolution that online learning resources have experienced in the last few years (Wieman and Gilbert, 2014; Camus et al., 2016). This probably led to a better perception of the learning tools most commonly used by students in online learning (Sánchez-Pato et al., 2017). Based upon these data, the importance of connecting dual-career programs with innovation in education and keeping them up to date must be emphasized in the future.

In accordance with this, student-athletes from the COVID-19 group considered videoconferencing and online tasks to be more important learning resources than the control group, while there were no differences as regards other tools like fora, chat, Facebook, or Twitter. Previous studies have already suggested that students enrolled on online learning programs may better appreciate those tools that are directly related to achievement goal orientation, like the former ones (Dumford and Miller, 2018). Another possible explanation is that during the lockdown caused by COVID-19, the use of the necessary tools in order to turn face-to-face learning into online learning has increased at university (Chaka, 2020), making students who have a positive perception of these resources to use them more. In this line, online tasks were the virtual campus tool that allowed students to submit essays, reports, and similar projects. Through this tool, lecturers can evaluate the assignments and give feedback. During the COVID-19 pandemic, it has been the official way to submit all the works (Universidad Catoìlica San Antonio, 2020), which may explain that students have used it more times as a learning tool. Meanwhile, videoconferencing was the tool provided by the university that allowed students to attend 100% of the theoretical and practical lessons during the lockdown. While students from online modalities used it before the COVID-19 pandemic, students from face-to-face learning had never used it (Universidad Catoìlica San Antonio, 2020), which can explain differences between groups. On the other hand, fora is a tool that aims to create a space of discussion between lecturers and students on a specific topic. This tool was not used in face-to-face studies, while it is optional in virtual ones (Universidad Catoìlica San Antonio, 2020), which can explain why the majority of both groups have never used it. Chats helped students to establish contact between them (Universidad Catoìlica San Antonio, 2020); however, according to the present findings, its use was marginal. This could be a consequence of the students' preference for the use of smartphones for communication in university environments (Gasaymeh, 2017). In line with the latter, there is not much use of Twitter and Facebook in the current high education context, although previous studies have reported that a pedagogical use of this kind of tools can increase the students' motivation, learning climate, and academic achievement (Calderón et al., 2019). Further dual-career programs may include this kind of tools in learnings in order to analyze differences in student-athletes' perception.

This has been the first general emergency experience in the lives of the student-athletes of the COVID-19 group, possibly causing alterations to their emotional status and affecting their decision-making (Shigemura et al., 2020). Consequently, a change of trend has been observed as regards professional expectations after completing their studies, compared with the group of student-athletes in a normal pre-Olympic year. Thus, a lower percentage of COVID-19 athletes intended to continue with their athletic career after completing their studies. This could be due to a change in the student-athletes' life project. Under normal circumstances, they would have relied more on sport as their main professional activity, but now, in a scenario full of uncertainty, they see their income decrease (Jiménez-Gutiérrez et al., 2020) and, consequently, go for their university career as an instrumental means for life. Nonetheless, the definition of an athlete's professional path and vocation needs a complex multifactor process (Álvarez-Pérez and López-Aguilar, 2017), which may explain the lack of differences in the rest of the variables regarding professional aspects. This is an important issue for future research.

One interesting finding is that 46.2–55.6% of student-athletes of the current study considered that they were amateur, while 40.3–50.0% considered that they are semiprofessional, although they were high-level athletes, with participations in international competitions, and they had participated in the previous OG or they were eligible to participate in the upcoming OG. The Spanish Sport Law (Jefatura del Estado, 1990) established that only the first and second divisions of the Spanish soccer league and the first division of the Spanish basketball and handball leagues are professional leagues. As a consequence, clubs involve in these competitions act as companies and their players are considered as workers at all levels (salaries, legal rights and duties, etc.) (Martínez-Lemos, 2015). On the contrary, Spanish athletes have difficulty to devote themselves professionally to sport out of these modalities, which is one of the main perceived barriers in order to achieve success in dual career (Subijana et al., 2015). In this line, a high percentage of the student-athletes of the current study were doing some kind of remunerated work in addition to being athletes and students (34.7–38.5%), supporting that athletes' autoperception is influenced by the fact of being able to live autonomously from sport (North and Lavallee, 2004; Subijana et al., 2015). However, more studies are needed on the relationship between salary and athletes' self-perception as professional athletes.

Concerning the study limitations, although the questionnaire was found to be a valid and reliable assessment instrument (Sánchez-Pato et al., 2016), it could be interesting to complete the findings in conjunction with other quantitative and quality methods (Kader, 1994). Another limitation was that the current study did not analyze the differences in the student-athletes' perception of the dual career with a longitudinal design, but with a transversal design involving student-athletes in both pre-Olympic years, one during the lockdown caused by the COVID-19 pandemic and another one under normal conditions. Future studies need to analyze if the changes in the Spanish student-athletes' perception of the dual career as a consequence of the COVID-19 still remain once the pandemic ends and they can return to their normal lives.

CONCLUSION

Student-athletes of the COVID 19-group show adaptations with regard to the organization of their studies and the importance they give to them and to the services provided by dual-career programs, compared with student-athletes from an ordinary pre-Olympic year. In general, student-athletes' perception of the dual career is very positive. Consequently, student-athletes' perception allows for reconsideration of the implementation of the dual career under the current circumstances and, especially, in the post-pandemic situation.

DATA AVAILABILITY STATEMENT

The datasets generated and analyzed for this study can be found in **Supplementary Material** and at INVESOCIAL database (Fundación Católica de San Antonio, address: Avda. de los Jerónimos de Guadalupe 30107, Murcia, email: investigación@ucam.edu).

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee. Catholic University of Murcia, Murcia, Spain. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LA-C, AL-A, and AS-P conceptualized the study. LA-C, RV-C, JG-R, LM, AL-A, and AS-P designed the study. RV-C and LM carried out the statistical analysis. LA-C, JG-R, AL-A, and AS-P recruited the participants. JG-R and LM collected the data. RV-C organized the database. LA-C, RV-C, JG-R, LM, AL-A, and AS-P wrote the first manuscript draft and the final manuscript draft, conducted the English proofreading, and reviewed and edited the final version of the manuscript. All authors contributed to the manuscript revision and approved the final version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.620042/full#supplementary-material

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Anxiety and Leisure-Domain Physical Activity Frequency, Duration, and Intensity During Covid-19 Pandemic

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This study investigated relationships between state anxiety and leisure-domain physical activity levels during Covid-19 pandemic. We used frequency, duration, and intensity as key variables of physical activity. Trait anxiety, state anxiety before pandemic, age, gender, and education level were also included in the analysis. Our general hypothesis was that participants who declared doing more physical activity levels would exhibit lower levels of anxiety during the Covid-19 pandemic. A convenient sample of 571 volunteer adults (mean age 39 ± 14 years) was drawn mainly from São Paulo State (89.2% of the sample), the epicenter of Covid-19 pandemic in Brazil. To obtain the participants' levels of anxiety (trait, state before pandemic, and state during pandemic) we used a validated short-version of the *State and Trait Anxiety Inventory*. Levels of physical activity were measured via questions from VIGITEL, a validated questionnaire about the individual's habits on risk factors. Answers were given regarding the first week of March 2020 (before pandemic) and at the very moment the participant was filling in the electronic form (June 2020). Data analyses were conducted through descriptive and inferential techniques, with the use of non-parametric tests and linear regression models. Overall, participants' responses indicate that anxiety levels were higher during the pandemic compared to the period that preceded the pandemic, and that frequent and long physical activity in the leisure-domain reduced anxiety, regardless its intensity. The regression models revealed an inverse relationship between physical activity and anxiety (the more physical activity, the less anxiety) and independent of gender, age, education level, trait anxiety, and physical activity before pandemic.

Keywords: exercise, sport, anxious, personality, coronavirus, individuality

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INTRODUCTION

High levels of anxiety have been regarded as a factor that provokes feelings of personal vulnerability because it negatively affects well-being and everyday functioning (Asmundson et al., 2010). In addition, increased anxiety might threaten the individual's health by increasing risk perception (Köteles and Simor, 2014) and leading to depression (World Health Organization, 2019). Anxiety is a negative emotion to situations perceived as dangerous or stressful characterized by subjective feelings of nervousness, worry, and unease that is related to the activation of the autonomic system, e.g., heart rate, perspiration, breathing (Spielberger and Reheiser, 2009). Taken as a state, a regulatory factor of anxiety is control perception, the degree to which individuals believe having resources and capacity to face an imposed challenge (Cheng et al., 2009). For example, individuals with high levels of anxiety tend to respond to perceived threatening situations with reactions that are disproportionate to the objective danger when compared to those with low levels (Spielberger and Reheiser, 2009).

Although high anxiety is often associated with negative performance on cognitive tasks (Eysenck et al., 2007), it has not always provoked negative effects as indicated by Jones (1995), who makes a distinction between debilitating and facilitating dimensions of the anxiety response. Joneś model of anxiety is centered on the degree of control the individual is able to exert over the self and the environment. Those who have self-perception to be capable of being in control and to achieving the goals tend to fathom anxiety symptoms as facilitative, whereas the ones who regard themselves as unable to control themselves and thus have diminished expectations about goal achievement are prone to construe as debilitative the anxiety effects. According to Jones' model, the individual might interpret the stressor in the environment as either a challenge or a threat, influencing differentially physical activity and anxiety levels. The perception of the stressor according to individual differences leads to either a positive or a negative perception of control under which the individual is optimistic or pessimist, respectively. If optimistic, individuals are able to deal with the stressor and to reach their goals. If pessimistic, they are not capable of handling the stressor and reaching the goals. Sport studies have showed that the athletes who interpret stressors as a challenge are more inclined to exhibit superior performance (Weinberg and Gould, 2017).

The Covid-19 pandemic is a current global health problem that has been plaguing the world population. To minimize the health damages of the disease, most countries' governments adopted measures of social distancing and home isolation. These measures are thought to decrease contagion rates of coronavirus (Bedford et al., 2020), at the expense of impacts on mental health of individuals, for instance raising the incidence of symptoms of anxiety and depression (Brooks et al., 2020). Fear is another mental health symptom that has been associated to Covid-19 (Ornell et al., 2020). These restraining factors are potential factors that give rise to the possibility of being contaminated and being constrained at home. This unknown and detained environment condition characterizes uncertainty, which is regarded as a stressor for individuals (Weinberg and Gould, 2017). The stress response to the risk of contamination and confinement situation might give rise to distinct levels of anxiety and lead to various misbehaviors (Muniyappa and Gubbi, 2020; Pfefferbaum and North, 2020; Qiu et al., 2020; Rajkumar, 2020; Torales et al., 2020), including the ones related to physical activity (McGrath, 1970). Physical activity is thought to be a positive mediator of anxiety and, in some cases, even an individual who exhibits high anxiety can sustain high levels of physical activity, for instance, by activating compensatory mechanisms (Eysenck et al., 2007). We adopted leisure-domain physical activity definition from the 2020 WHO guidelines on physical activity (Bull et al., 2020): *physical activity performed by an individual that is not required as an essential activity of daily living and is performed at the discretion of the individual.*

It is widely known that physical active is an effective "remedy" for reducing anxiety levels. Physiological studies have developed some hypotheses to explain the beneficial effects of physical activity on anxiety: it produces protective effects on neurogenesis (Moylan et al., 2013), potentially reduces hyperactivity of the sympathetic nervous system affecting abnormalities in the fear conditioning processing (Asmundson et al., 2013), and tends to activate anti-inflammatory mechanisms to diminish oxidative stress (Viana and Andrade, 2012). Research syntheses (Jayakody et al., 2014; Gordon et al., 2017; Stubbs et al., 2017) and cross-sectional studies (Vancini et al., 2017) have indicated physical activity as a positive mediator for anxiety in patients and practitioners. During the Covid-19 pandemic, behavioral studies have advocated for physical activity as a positive aspect when coping with anxiety. Creese et al. (2020) compared prior (from 2015 to 2019) longitudinal mental health data of individuals with data collected from the same individuals during the Covid-19 pandemic. The findings demonstrated that loneliness and diminished physical activity levels were associated to a poor mental health during the pandemic. These studies indicate that physical activity might be closely linked to mental health, especially anxiety. As the Covid-19 pandemic is likely to increase anxiety, it is important to thoroughly scrutinize levels of physical activity and relate them to levels of anxiety during the health problem we are facing in 2020. As far as we know, the association of anxiety with frequency and duration of physical activity during the Covid-19 pandemic was not tackled by any study.

Thus, the purpose of the present study was to examine relationships between state anxiety and leisure-domain physical activity levels during Covid-19 pandemic. We used frequency, duration, and intensity as key variables of physical activity. Trait anxiety, state anxiety before pandemic, age, gender, and education level were also included in the analysis. We set a general hypothesis: participants who report performing more physical activity exhibit lower levels of anxiety during the Covid-19 pandemic. The imposing restrictions that the pandemic encompasses could alter the way individuals perceive control (Jones, 1995), with effects on their levels of anxiety and physical activity. If interpreted as a challenge, individuals feel able to control the possibility to be infected by coronavirus so that we hypothesize that they will keep or increase physical activity levels. Conversely, as long as individuals are not capable of assuming effective control over being contaminated by coronavirus, we believe they will reduce the levels of physical activity. Given that personal and environmental mediating factors may have significant effects on the evaluation by individuals about stress factors (Jones, 1995), we also examined relevant variables in the pandemic scenario, such as age, gender, and education level.

MATERIALS AND METHODS

Participants

This was a cross-sectional study with a convenient sample of 571 adult volunteers, 200 male and 371 female, mean age of

39 ± 14 years, was selected mainly from São Paulo State (89.2% of the participants), the epicenter of Covid-19 pandemic in Brazil. The state of São Paulo (Brazil), whose estimated population in 2020 is 46 million people, had 200, half million, and 1 million Covid-19 cases in 18th March, 15th June, and 16th August, respectively. By 21st November 2020, there have been in the state more than 1.2 million cases and more than 41.000 deaths caused by Covid-19[1].

The presence of comorbidity(ies) was stated by 21.7% of the sample (no participant was excluded due to this criterion) and 69.9% had completed tertiary education. We excluded 19 participants who had not yet completed 18 years of age and one participant who did not fill out the anxiety and physical activity questions.

All participants read and signed an electronic consent form prior taking part in the study, which was approved by the University's Ethics Committee under the protocol CAAE 33639720.0.0000.5390.

Instruments and Procedure

Due to time restraints reasons, to measure anxiety we used a validated short version of the *State and Trait Anxiety Inventory-Y* (Spielberger et al., 1983), a traditional self-report instrument extensively used in research and clinical settings across different cultures. The Brazilian short-version is the *STAI-S-6*, whose psychometric properties were reported as appropriate for the six questions of each anxiety scale – State Anxiety: Cronbach α coefficient was 0.75 and full-length and short-form STAI-S-6 version correlation was 0.90; Trait Anxiety: Cronbach α coefficient was 0.73 and full-length and short-form STAI-S-6 version correlation was 0.89 (Fioravanti-Bastos et al., 2011). To respond to the state scale participants are required to describe how they feel at "this very moment" about the following items: I am worried; I am tense; I feel nervous; I feel calm; I am relaxed; I feel at ease. Participants describe how they "generally" feel about the trait scale "I feel secure; I worry too much over something that really doesn't matter; I feel nervous and restless; I get in a state of tension or turmoil as I think over my recent concerns and interests; I am calm, cool and collected; I make decisions easily." The answers are given along a four-point Likert intensity scale: 1 = not at all, 2 = somewhat, 3 = moderately, 4 = very much. The score of each answer adds up to the final score of anxiety.

In order to obtain leisure-domain physical activity data, we used the 2019 version of the Surveillance System of Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL), an official (Ministry of Health – Brazil) self-report instrument based on non-face-to-face interviews available online at https://portalarquivos.saude.gov.br/images/pdf/2020/April/27/vigitel-brasil-2019-vigilancia-fatores-risco.pdf. VIGITEL was validated by Monteiro et al. (2008). Its leisure-domain physical activity section has five questions about the practice of physical exercise or sport in the last 3 months (yes/no), the main type of activity (one choice among multiple options), whether the practice is done once at least once a week (yes/no), the weekly frequency of the activity (one choice among multiple options), and the daily duration of the practice (one choice among multiple options). Participants' responses were organized according to the following variables (yes/no): physical activity practice, 40 min or more, three or more times per week, three or more times per week during at least 40 min. The intensity of physical activity was obtained according to the type(s) of activity(ies) self-declared by the participant; we labeled the categories "moderate" and "vigorous or vigorous + moderate" as specified by the compendium of physical activities (Ainsworth et al., 2011). Moreira et al. (2017) reported reliability (k) of 0.7 for active individuals in leisure time and 0.64 for inactive individuals and regarding validity, there were no significant differences for leisure-domain physical activity in the VIGITEL frequencies (32.8%) when compared to those of the World Health Organization (2015)'s Global Physical Activity Questionnaire – GPAQ (30.8%), $p = 0.538$. We chose VIGITEL because it holds simple and short questions with objective and direct answers and involves no cost.

In the first week of June 2020 we invited in private approximately 800 individuals (response rate of 71.4%) to answer the questionnaires via social media (Facebook, Instagram, and Whatsapp) and email. The outbreak of the pandemic in the State of São Paulo, when social restrictions came into effect, began in the third week of March 2020. To give answers about behaviors before the pandemic, the participants were instructed to recall behaviors from the first week of March 2020. The responses about the period during the pandemic were given at the very moment the participants were filling in the electronic form, that is, during June 2020. We collected the answers via electronic devices through a Google electronic form designed exactly as the original questionnaires. The missing data were reported at the end of the tables.

Data Analysis

Data were organized in Microsoft Excel sheets. Analyzes were threefold. Firstly, we ran a descriptive analysis that reported absolute and relative (percentage) frequencies of participants on each variable of interest. Then, due to non-normal distributions measured by Kolmogorov–Smirnov tests, to compare different levels of physical activity frequency, duration, and intensity on levels of state anxiety during Covid-19 pandemic we used non-parametric techniques (separate Kruskal–Wallis and Mann–Whitney tests). The Wilcoxon test was employed to compare anxiety levels before and during pandemic. Lastly, four linear regression models were conducted to establish the influence of leisure-domain physical activity during the pandemic in state anxiety during the pandemic. Although homoscedasticity Durbin–Watson tests pointed out violations of this assumption for some models, we ran the analyzes with the original data because regression analyzes are robust for any distribution of data in large samples (Lumley et al., 2002). We initially ran unadjusted models and then adjusted models by gender, age range, education level, and anxiety range. Analyzes were conducted in IBM SPSS Statistics 24.0 version and Stata version 16.1 StataCorp LCC. The alpha level was set at 5% for all analyzes.

[1] https://www.seade.gov.br/coronavirus

RESULTS

Descriptive and Inferential Analysis

Descriptive values of absolute and relative frequencies are shown in **Table 1**. The sample is particularly adult, female, highly educated, and from the State of São Paulo, Brazil.

With reference to anxiety data, the Wilcoxon test for paired samples (before x during pandemic) indicated a significant effect ($Z = -9.51$; $p < 0.0001$), with higher values during the Covid-19 pandemic. We also ran comparisons of state anxiety levels during Covid-19 pandemic. The Kruskal–Wallis analysis showed a significant effect for age [χ^2 (3) = 44.41; $p < 0.0001$], with higher values for the younger age ranges. The Mann-Whitney analysis indicated a significant effect for gender, with women exhibiting higher anxiety compared to men (U = 29,410; $p < 0.0001$).

TABLE 1 | Frequencies of social demographics, anxiety, and physical activity variables.

Variable	Categories	*n*	%
Gender	Male	200	35
	Female	371	65
Age (range)	18–29	172	30.1
	30–39	112	19.6
	40–49	159	27.8
	50–76	128	22.5
Education level	Incomplete tertiary –	172	30.1
	Complete tertiary +	399	69.9
Physical activity practice before pandemic			
Once a week*	Yes	475	94.4
	No	27	5.6
3 times or more/week$^{\infty}$	Yes	367	75.5
	No	119	24.5
40 min or more/day$^{\#}$	Yes	424	86.9
	No	64	13.1
3 times or more/week and 40 min or more/day$^{\times}$	Yes	328	65.3
	No	174	34.7
Physical activity practice during pandemic			
Once a week**	Yes	382	86.1
	No	58	13.9
3 times or more/week$^{\wedge}$	Yes	267	67.9
	No	126	32.1
40 min or more/day^{circ}	Yes	259	65.6
	No	136	34.4
3 times or more/week and 40 min or more/day$^{\sim}$	Yes	185	47.2
	No	207	52.8

*Missing responses: *69, $^{\infty}$85, $^{\#}$83, $^{\times}$69, **131, $\wedge$78, °176, $^{\sim}$179.*

The test detected significant effect for education level, with the ones who completed tertiary education self-reporting lower anxiety compared to those who did not finished higher education (U = 27,001.5; $p < 0.0001$). There were no differences between those who declared having comorbidity and the ones with no reported comorbidity (U = 25,767.5; p = 0.404). The descriptive and p-values for these variables are presented in **Table 2**.

Regarding leisure-domain physical activity during Covid-19 pandemic (**Table 3**), Mann-Whitney tests revealed no differences in the level of anxiety between those who practiced *versus* the ones who did not practice physical activity (U = 9919; p = 0.198). However, the tests pointed out significant low levels of anxiety for participants who practiced physical activity for (1) 40 min or more per session compared to those who practiced less than 40 min per session (U = 14607.5; p = 0.005), (2) three or more days per week compared to the ones who practiced less than 3 days per week (U = 12760.5; $p < 0.0001$), and (3) at least 40 min per session on three or more days of the week in comparison to those who practiced less than this and also those who did not practice at all (U = 14616.5; $p < 0.0001$). No differences were detected between those who engaged in moderate physical activity compared to the ones who took vigorous or vigorous and moderate physical activity (U = 18714; p = 0.119).

Linear Regression Models

We carried out four linear regression models (**Table 4**) to establish the influence of leisure-domain physical activity (practice, frequency, duration, frequency, and intensity of physical activity as predictors) on state anxiety during the pandemic (dependent variable) controlled by physical activity and state anxiety before pandemic, trait anxiety, gender, age, and education level. Homoscedasticity was checked through the test of Durbin–Watson in all models. Violations of this assumption were detected for the unadjusted models that combined duration and frequency of physical activity and for all adjusted models. As regression analyzes are valid for any distribution of data in large samples (Lumley et al., 2002), we ran the analyzes with the original data.

The first and the last regression models were not significant for physical activity practice (once a week) during pandemic and for intensity of physical activity as predictors of state anxiety during Covid-19 pandemic. The remaining regression models indicate that state anxiety during Covid-19 pandemic can be predicted by duration (40 min or more per day), frequency (three or more days per week) and the combination of physical activity duration and frequency (40 min or more a day, three times a week). The analysis demonstrated an inverse relationship between physical activity and anxiety (the more physical activity, the less anxiety), independent of gender, age, education level, trait anxiety, and physical activity before pandemic.

DISCUSSION

Our aim in the present study was to examine relationships between state anxiety and leisure-domain physical activity levels during Covid-19 pandemic. We used frequency, duration, and

TABLE 2 | Descriptive statistics of anxiety and statistical differences of state anxiety during Covid-19 pandemic (total sample and stratified by age, gender, and education level).

	Trait anxiety (Mean ± SD)	State anxiety before pandemic (Mean ± SD)	State anxiety during pandemic (Mean ± SD)	*p*
Total sample	13.78 ± 3.66	13.30 ± 3.81	15.33 ± 4.16	<0.0001*
Age				<0.0001#
18–29	15.45 ± 3.92	13.64 ± 3.84	16.74 ± 3.9	
30–39	13.57 ± 3.22	13.53 ± 4.14	15.76 ± 4.1	
40–49	13 ± 3.17	12.87 ± 3.71	14.8 ± 4.11	
50–76	12.19 ± 3.14	13.18 ± 3.58	13.73 ± 3.98	
Gender				<0.0001#
Male	12.8 ± 3.36	12.5 ± 3.5	14.35 ± 3.93	
Female	14.13 ± 3.69	13.73 ± 3.9	15.87 ± 4.2	
Education level				<0.0001#
Incomplete tertiary –	15.13 ± 3.94	13.91 ± 3.68	16.39 ± 4.21	
Complete tertiary +	13.04 ± 3.3	13.04 ± 3.84	14.88 ± 4.1	

**p-values of the comparison state anxiety before pandemic x state anxiety during pandemic; # p-values of comparisons during pandemic.*

TABLE 3 | Descriptive statistics and statistical differences of anxiety according to leisure-domain physical activity during Covid-19 pandemic.

	Trait anxiety (Mean ± SD)	State anxiety before pandemic (Mean ± SD)	State anxiety during pandemic (Mean ± SD)	*p*
Practice once a week				=0.198
Yes	13.59 ± 3.59	13.37 ± 3.87	15.11 ± 4	
No	13.48 ± 3.67	12.69 ± 3.47	15.93 ± 4.54	
40 min per day				=0.005*
Yes	13.39 ± 3.63	13.30 ± 3.76	14.77 ± 4.03	
No	13.82 ± 3.52	13.38 ± 3.93	15.82 ± 3.9	
3 days/week				<0.001*
Yes	13.34 ± 3.63	13.37 ± 3.97	14.57 ± 3.94	
No	14.02 ± 3.49	13.25 ± 3.55	16.33 ± 3.88	
40 min/day on 3 days or +				<0.001*
Yes	13.64 ± 3.52	13.23 ± 3.83	15.87 ± 4.09	
No	13.44 ± 3.73	13.33 ± 3.8	14.3 ± 3.9	
Intensity				=0.119
Moderate	13.62 ± 3.70	13.11 ± 3.93	15.48 ± 4.19	
Vigorous/vigorous + moderate	13.61 ± 3.52	13.48 ± 3.73	14.85 ± 3.85	

**Significant effect: $p < 0.05$ (all comparisons were performed only among the participants who practiced physical activity during the Covid-19 pandemic).*

intensity as key variables of physical activity and conveniently selected a Brazilian sample, mainly from the State São Paulo, because this region was the epicenter of the pandemic in the country. Overall, our findings were in line with our general expectation that individuals who declare performing more physical activity show lower levels of anxiety. Practice of physical activity *per se* showed no significant statistical association, but there was a significant effect in the comparison of the group that practiced physical activity for 40 min or more with the group that practiced less than 40 min. The results were stronger for the group that practiced physical activity for at least 40 min on 3 days or more of the week as compared to the group that practiced less than this or those who did not practice physical activity. Even more impressive were the results of the group that practiced physical activity for at least 40 min on five or more days of the week as compared to the group that practiced less than three times a week for 40 min. Surprisingly, those who practiced moderate physical activities did not differ in terms of anxiety levels from the ones who practiced vigorous or vigorous/vigorous + moderate physical activities. These findings appear to give evidence that not "any" or "general" physical activity was capable of lessening anxiety. Thus, frequency and duration of physical activity seems to play a pivotal role in reducing anxiety levels during Covid-19 pandemic.

As identified by the participants' self-reports, specifications for physical activity regarding frequency and duration were crucial to reduce anxiety during Covid-19 pandemic. In fact, other studies and institutions advocate frequent and lengthy physical activity. World Health Organization (Bull et al., 2020) recommended at least 150 min per week of moderate to vigorous physical activity, and during the Covid-19 pandemic, WHO recommended that people maintain their physical activity levels. In addition, the study carried out by Moore et al. (2012) with many dataset of cohort showed a dose-response between

TABLE 4 | Linear regression results examining the association between state anxiety and leisure-domain physical activity among participants during Covid-19 pandemic.

Main effect	Leisure-domain physical activity	Model	State anxiety scores			
			β scores	CI 95% (scores)	*p*-value	R^2
F (1,438) = 2.06	Practice (once a week)	Unadjusted	−0.82	−1.95; 0.3	0.152	0.005
F (11,402) = 17.65		Adjusted	−0.93	−2; 0.14	0.087	0.33
F (1,393) = 6.12	Duration (at least 40 min per session)	Unadjusted	−1.04	−1.87; −0.21	0.014	0.02
F (11,364) = 15.68		Adjusted*	−1.04	−1.81; −0.27	0.008	0.32
F (1,391) = 17.22	Frequency (at least 3 times per week)	Unadjusted	−1.76	−2.59; −0.93	0.0001	0.04
F (11,362) = 16.64		Adjusted∧	−1.57	−2.32; −0.81	0.0001	0.34
F (1,440) = 16.34	Duration and Frequency (at least 3 times/week for 40 min/day)	Unadjusted	−1.57	−2.33; −0.81	0.0001	0.04
F (11,404) = 20.11		Adjusted#	−1.78	−2.49; −1.07	0.0001	0.35
F (1,405) = 2.43	Intensity (moderate/vigorous)	Unadjusted	−0.63	−1.42; 0.16	0.12	0.006
F (11,375) = 15.99		Adjusted	−0.7	−1.43; 0.03	0.06	0.32

*Main contributors: *gender, state anxiety before pandemic and trait anxiety; ∧ state anxiety before pandemic and trait anxiety; #physical activity practice, gender, state anxiety before pandemic and trait anxiety.*

leisure-domain physical activity and mortality. The participants who do not perform frequent and lengthy physical activity during the pandemic tend to exhibit higher levels of anxiety, thus provoking negative feelings that affect well-being and everyday functioning (Asmundson et al., 2010) as well as increasing risk perception (Köteles and Simor, 2014). These higher levels of anxiety may lead to personal vulnerability and depression (World Health Organization, 2019; Muniyappa and Gubbi, 2020; Pfefferbaum and North, 2020; Qiu et al., 2020; Rajkumar, 2020; Torales et al., 2020). Absent or little exercise might degrade even more the perception of the pandemic danger by the individual, who may not feel capable of facing the challenges imposed by the pandemic (Cheng et al., 2009), even producing disproportionate reactions, e.g., elevated heart rate, sweat, and breathing (Spielberger and Reheiser, 2009). Built upon the degree of control the individual is able to exert over the self and the environment, Jones (1995) model might be a credible explanation for the findings of the current study. His model differentiates anxiety into a debilitating and a facilitating dimension. Self-perceptions to be in control and to achieve the goals tend to fathom anxiety symptoms as facilitative, and this might be the case for the participants who practice more physical activity as compared to the ones who practice less or no physical activity, these latter probably regard themselves as having little control during the pandemic, hence exhibiting debilitative anxiety effects.

Research syntheses have provided support for physical activity as a key component in dealing with anxiety. When compared with regular treatments (antidepressants and/or psychological techniques), physical activity, regardless of type and intensity, had an important role in diminishing patients' anxiety symptoms, though not as effective as the administration of antidepressants (Jayakody et al., 2014). Further, Stubbs et al. (2017) pointed out that aerobic and moderate-to-high intense exercise decreased anxiety symptoms more than control conditions in individuals who have currently been diagnosed with anxiety and stress-related disorders. Moreover, Gordon et al. (2017) revealed that resistance exercise training reduced anxiety symptoms, especially on healthy participants compared to the ones with physical or mental illnesses and that effect sizes did not vary according to duration, frequency, and intensity of exercise or gender, age, and strength improvement. Thus, physical activity seems to be a contributing anxiolytic to treat anxious patients and appear to be a crucial factor to allay anxiety of healthy individuals.

In addition, cross-sectional studies give considerable evidence that physical activity can reduce anxiety levels. Vancini et al. (2017) addressed in obese and overweight participants the effects of an aerobic physical activity program (walking) versus a mixed program (Pilates method) on levels of depression, trait and state anxiety, and quality of life. The programs were held for 8 weeks, 3 days a week, with session durations of 60 min. Both programs exerted marked effects on quality of life, depression, and trait-anxiety, but the aerobic program surprisingly increased state-anxiety. These latter findings are not in line with prior research on the positive role of aerobic physical activity in anxiety (Gordon et al., 2017). In addition, Creese et al. (2020) investigated the relationship between anxiety and physical activity during the Covid-19 pandemic and demonstrated isolation and low levels of physical activity were related to poor mental states when compared to the pre-pandemic period. Taken together, these findings tend to support physical activity as a distinctive feature to overcome anxiety.

Our cross-sectional study has some limitations that should be pointed out. The participants of our convenience sample filled out the questionnaires on their own via the electronic form so that they had to recollect behaviors, what might pose a recall bias problem. As in other anxiety scales, STAI only measures the intensity of symptoms that represent the presence of anxiety, not the interpretation of symptoms as positive or negative about behaviors or performance. We did not measure the perception of control related to stressors in the environment; therefore, even though we feel it is useful to explain the findings, the reasoning employed to discuss this concept should be taken as speculative. Additionally, the education level of more than 2/3 of the sample is high (complete tertiary), thereby, it is noteworthy to highlight that highly educated people tend to show high levels of physical activity as compared with the general population. In spite of these limitations, we believe the present study makes a valuable contribution to the field with the indication that regular (at least three times a week for 40 min a day) leisure-domain physical activity can be an ally against anxiety during the Covid-19 pandemic.

CONCLUSION

Self-declared reports on leisure-domain physical activity and anxiety give evidence that during the Covid-19 pandemic that the practice *per se* (once a week) of physical activity is not sufficient to reduce anxiety levels. It is important that individuals take frequent and lengthy physical activity to diminish levels of anxiety. In particular, moderate and/or vigorous physical activity performed regularly at least 3 days a week for 40 min per session seems to exert anxiolytic effects during Covid-19 pandemic.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee for Research with Human Beings, School of Arts, Sciences and Humanities, University of São Paulo. Written informed consent to participate in this study was provided by the participants'.

AUTHOR CONTRIBUTIONS

CM: conception, data organization, and writing. KM: data collection, data organization, and writing. ML: data organization, formatting, and writing. AF: data analysis and writing. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.603770/full#supplementary-material

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Motivation and Commitment to Sports Practice During the Lockdown Caused by Covid-19

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In Spain, the state of alarm declared on March 14, 2020 caused changes in the population in relation to the habits of physical activity and sports practice. This study analyzed what motivational variables predicted the self-efficacy and commitment to sports practice, as well as the differences according to gender, during lockdown and the progressive de-escalation caused by COVID-19, using the theory of self-determination as a theoretical framework. The study sample was conformed of 179 subjects (90 men and 89 women) between 18 and 65 years of age (M = 28.64; SD = 10.28). The Behavioral Regulation in Sport Questionnaire (BRSQ), the Psychological Need Satisfaction in Exercise Scale (PNSE), the Physical Activity Self-Efficacy scale, and the Sport Commitment scale were applied. The most relevant results have showed significant differences in favor of the male gender in terms of levels of controlled motivation and amotivation, as well as higher levels of self-efficacy and basic psychological need of autonomy. Furthermore, the regression analysis has revealed that self-efficacy and current commitment to sports practice were explained by a variance of 57 and 64%, respectively, due to autonomous motivation and the basic psychological need of competence. Therefore, the basic psychological need of competence should be fostered in order to increase the levels of self-determined motivation, self-efficacy, and commitment to sports practice of the population.

Keywords: motivation, commitment, sports, COVID-19, self-determination theory

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INTRODUCTION

Due to the global pandemic declared by the World Health Organization (WHO) (2020) caused by the Covid-19 virus, many changes have taken place affecting work, personal, and psychological factors, and as a result, the way people live. In Spain, on March 14, 2020, a state of alarm was decreed, which meant a period of confinement at home. In general terms (depending on the Autonomous Community), this confinement has lasted approximately 3 months. This has meant changing the daily routine, overnight, both in the way of working, which in most cases has shifted to teleworking, and in how we live our daily lives, influencing healthy lifestyles such as eating, drug consumption, rest habits and, particularly, the practice of physical activity.

The many benefits of regular physical activity for adults are well known. The World Health Organization (WHO) (2019) recommends at least 150 min of moderate activity or 70 min of vigorous activity per week for this practice to provide health benefits. Some of the most important benefits at the physical level are the improvement of body composition, image, metabolic level, and cardio respiratory capacity, helping to prevent diseases such as morbidity, sarcopenia, hypertension, and even cancer (among others; González-Carcelén et al., 2018; Jodra et al., 2019). It also produces a positive psychological effect by reducing the rate of illness due to anxiety and depression (Chan et al., 2019).

The confinement produced by Covid-19 has had a major negative psychological impact on most people (Cheval et al., 2020; Li et al., 2020). This impact has also affected people who were physically active before the confinement and have reduced their possibilities of carrying out their usual sports practice, sometimes adapting such practice at home, and in the worst case, abandoning the practice until the de-escalation began (Ammar et al., 2020; Tison et al., 2020; Woods et al., 2020), with the consequent damage to the individual's immune system (Granados and Cuéllar, 2018).

Motivation toward sports practice is a fundamental factor for continuity and adherence (Batista et al., 2020). One of the theories that help explain motivational processes is the self-determination theory (SDT; Deci and Ryan, 1980, 1985, 1991, 2012; Ryan and Deci, 2020). The SDT determines that motivation lies within a continuum in which three levels are distinguished (Vansteenkiste et al., 2006, 2010): autonomous motivation, which includes, from most to least: self-determined intrinsic motivation, integrated regulation, and identified regulation (performing an activity for one's own pleasure that involves practicing it); controlled motivation, which includes introjected and external regulation (these are determined by external rewards or recognition), and amotivation (least self-determined, lack of intention to practice; Deci and Ryan, 2000).

Deci and Ryan (2000) establish that this theory is based on the fact that human behavior is motivated by three basic psychological needs (BPN), which are autonomy, reflecting the desire to have the ability to choose activities, and the origin of the behavior itself (Deci, 1975; Deci and Ryan, 1985); competence, which implies a desire to produce desired results in practice (Deci, 1975; Deci and Ryan, 1985); and relationship with others, which refers to the effort to relate to and care for others, as well as to feel that others have a good relationship with you (Ryan and Deci, 2000; Deci and Ryan, 2002).

The more these BPNs are satisfied, the more self-determined the person will be toward physical activity (Hope et al., 2019). In addition, this self-determined motivation can also trigger other positive psychological aspects, such as higher levels of self-efficacy (Duchatelet and Donche, 2019) and increased commitment to sports practice (Murillo et al., 2018).

A person's perception of self-efficacy refers to the perceived ability to overcome their fears, trust their possibilities, and face adverse situations in a positive and decisive way, decisively influencing how they think, feel, and act (Bandura, 1990; Diego-García and Zubiaur-González, 2019), while the commitment to sports practice (current and future commitment) represents the desire, the need, and the decision to continue practicing sports (Scanlan et al., 2003). This develops as we grow, relating to the perseverance and perception that one possesses in relation to one' s capacity within the sport performed (Hernández and Capella, 2014).

A high perception of self-efficacy is important during situations of confinement and even currently, with progressive de-escalation, in relation to the continuity or not of sports practice, since, although several studies have demonstrated that the perception of self-efficacy is not a predictor of the practice of physical activity, it is an important factor (Alert et al., 2019; Tang et al., 2019).

In addition to the perception of self-efficacy, it is important to be committed to the sports practice, since the commitment that the person acquires, provided that it is by their own will, will lead them to maintain practice for a longer period of time (Podlog et al., 2015). Motivation is a key concept for the achievement of these two psychological aspects that are essential for the continuity of practice (Murillo et al., 2018; Duchatelet and Donche, 2019); however, how can motivation be maintained during a situation of confinement?

Recent studies of Covid-19 and its influence on the practice of physical activity (Hall et al., 2020; Hammami et al., 2020) have determined that many social agents (official agencies, fitness centers, personal trainers, etc.) have implemented mechanisms to facilitate the practice of physical activity from home, through written guidelines and/or online videos, for example, the recommendations of the American College of Sports Medicine (2020). However, many people have also decreased or altogether ceased their physical activity during confinement (Maugeri et al., 2020) due to a number of factors such as type of housing, means, and lack of motivation. Thus, it is necessary to understand how these psychological variables have been affected in people who practice physical activity during confinement caused by Covid-19, and how these variables are related, in order to be able to establish strategies aimed at continuity of practice.

Therefore, the aims of this study were: (a) to determine the levels of motivation, satisfaction of basic psychological needs, perception of self-efficacy, and commitment to sport of people practicing physical activity, during confinement and progressive de-escalation; (b) to determine whether there were differences between men and women in relation to these variables, to establish personalized strategies according to gender, in case these were necessary; and (c) to determine which motivational variables (levels of self-determined motivation and BPN) predict the perception of self-efficacy and commitment toward sports practice, in order to propose strategies to increase the levels of these variables and, therefore, to extend the continuity of sports practice affected by the confinement.

MATERIALS AND METHODS

The study received the approval of the Research Ethics Committee of the Rey Juan Carlos University (Madrid, Spain) following the guidelines of the Helsinki Declaration. All participants were treated in agreement with the ethical guidelines of the American Psychological Association in relation to participant consent, parent/guardian consent, confidentiality, and anonymity. Moreover, informed written consent was obtained from the participants and their parents/guardians.

Research Design

An empirical, quantitative study was performed, using a descriptive population-based study based on surveys (Montero and León, 2007).

Participants

The study sample was comprised of 179 Spanish subjects (90 men and 89 women) between the ages of 18 and 65 years old (M = 28.64; SD = 10.28), who practiced regular physical activity. The selection criteria were that they performed physical activity at least three times a week and 150 min of moderate/vigorous physical activity, before lockdown. Thirty-one percent were studying, 49% were working, 16% were studying and working, and 4% were retired. Sixty-three percent admitted to having lost physical form during confinement compared to 37% who did not lose form. The exclusion criteria were not answering most of the questions and unusual response patterns, although no participants were excluded. Intentional sampling was used for sample selection (Montero and León, 2007).

Instruments

Below, the variables used in the study are listed, together with the measurement tools used:

Motivation level: The Behavioral Regulation in Sport Questionnaire (BRSQ) by Lonsdale et al. (2008) was used and validated into Spanish by Moreno-Murcia et al. (2011). This scale is composed of 36 items, which are divided into eight factors, and introduced with the phrase "I participate in this sport…": intrinsic motivation toward knowledge (e.g., "Because I like to learn how to use new techniques"), intrinsic motivation toward execution (e.g., "Because I enjoy trying to achieve long-term goals"), intrinsic motivation toward stimulation (e.g., "Because I like to learn how to use new techniques" and "Because of the positive feelings I feel while practicing this sport"), integrated regulation (e.g., "Because it allows me to live according to my values"), identified (e.g., "Because it teaches me discipline"), introjected (e.g., "Because I would feel I had failed if I abandoned it"), external (e.g., "Because if I do not do it others would be unhappy with me"), and amotivation (e.g., "However, I wonder why I strive for this"). For this study, after the factor analysis was performed, the grouping was formed according to: autonomous motivation (intrinsic motivation toward knowledge, toward execution, toward stimulation, integrated regulation, and identified regulation), controlled motivation (introjected regulation and external regulation), and amotivation (Vansteenkiste et al., 2006, 2010).

Satisfaction of basic psychological needs: The Psychological Need Satisfaction in Exercise Scale (PNSE) was used, by Wilson et al. (2006), and validated into Spanish by Moreno-Murcia et al. (2011). This scale is composed of 18 items, which are divided into three factors and introduced with the phrase "In my training…." These factors are autonomy, composed of six items (e.g., "I think I can choose the exercises in which I participate"), competence, composed of six items (e.g., "I feel capable of completing the most challenging exercises"), and relatedness, composed of six items (e.g., "I think I get along well with my partners when we do exercises together").

Self-efficacy: The Self-efficacy Scale of Bandura (2006) was used. This scale consists of 18 items that correspond to a single factor, self-efficacy (e.g., "When I do not feel physically well while training"). The questionnaire begins with the phrase "I am able to regularly sustain the training routine…."

Commitment to sports practice: The Sports Commitment Grade Scale of Orlick (2004) was used and validated into Spanish by Belando et al. (2012). This scale is composed of 11 items, which are divided into two factors with the opening phrase "In my trainings…": current commitment, composed of seven items [e.g., "I have made the determination not to quit even if obstacles appear (defeats, injuries, suspensions, etc.)"], and future commitment, composed of four items (e.g., "I put 100% of my concentration and effort into the trainings, whether or not they go well").

In all of the questionnaires, answers were provided for all of the items based on a Likert Scale of 5 points, ranging from 1, which means complete disagreement, to 5, completely agree. To facilitate the reliability of the responses by the participants, the response range of the Bandura Self-Efficacy Scale was adapted to the rest of the scales.

Procedure

First of all, a document was created to link the four questionnaires. Following the study by Astorgano-Diez et al. (2017), the age of the participants, sex, and work situation were also collected. The Google Form platform was used, so that the questionnaire could be accessed online. The questionnaire was available on the online platform for 2 months (from May to June of 2020). The questionnaire was disseminated through different channels (WhatsApp, Facebook, Twitter, and email). The duration of the application of the questionnaire was approximately 15 min.

Data Analysis

After performing the Kolmogorov-Smirnov normality and variance homogeneity test by means of the Levene test, it should be noted that the results obtained from both tests show a normal distribution of the data, and therefore, parametric statistics were applied.

A descriptive analysis was carried out of all the measured variables. For the tests of univariate normality, the indicators of skewness and kurtosis of variables were initially used. Curran et al. (1996) establish the limits of asymmetry and kurtosis in absolute values. Values of up to 2 for skewness and 7 for kurtosis are considered normal; values between 2 and 3 for skewness and between 7 and 21 for kurtosis are considered moderately normal; and values above 7 in skewness and 21 in kurtosis are considered non-normal. For the analysis of reliability, two indices were used, Cronbach's Alpha (α; equal to or greater than 0.70; Nunnally, 1978) and the Omega Coefficient (ω; McDonald, 1999), which also serves to check the internal consistency of the variables used in the research and, which, according to some authors (Revelle and Zinbarg, 2009), have shown evidence of greater accuracy. This means that in McDonald's Omega Coefficient, the established range is between 0 and 1, with the highest values giving us the most reliable measurements (Revelle and Zinbarg, 2009). With the Omega Coefficient by McDonald, the calculations were made with the "psych" 1.4.2.3 (Mullan et al., 1997) of R 3.0.3 (R Core-Team, 2014). However, according to Campo-Arias and Oviedo (2008), to consider an acceptable reliability value *via* the Omega Coefficient, this should be greater than 0.70.

A gender-based ANOVA analysis was performed, and the effect size was calculated using the following formula: Cohen's $d = M_1 - M_2/SD$, where $SD = \sqrt{[\sum\ (X - M^2)/N]}$, where X is the raw score, M is the mean, and N is the number of cases. Following Cohen's (1988) considerations, the effect size is considered small when the value is below 0.20, medium when it is between 0.20 and 0.50, and large when it is above 0.80. Subsequently, a stepwise regression analysis was performed.

For the analysis of the data obtained, the SPSS 23.0 statistical program was used.

RESULTS

Descriptive and Reliability Analysis

The mean and SD of the measured variables were determined. The measures of skewness and kurtosis verify the univariate normality. The reliability index by means of the Cronbach's Alpha Index and McDonald's Omega Coefficient (see **Table 1**). All factors presented an adequate reliability index both for Cronbach's Alpha (>0.70; Nunnally, 1978) and the Omega Coefficient (>0.70; Campo-Arias and Oviedo, 2008). The highest mean value was obtained for the variable autonomous motivation to practice physical activity, whereas the lowest value was obtained for the variable amotivation to practice physical activity.

Differential Analysis

The most relevant results revealed significant differences in favor of the male gender in terms of levels of controlled motivation and amotivation, as well as higher levels of self-efficacy and the basic psychological need for competence. In relation to effect size, following Cohen's (1988) considerations, the effect size is considered small when the value is below 0.20, medium when it is between 0.20 and 0.50, and large when it is above 0.80 (see **Table 2**).

Linear Stepwise Regression

In order to predict the perception of self-efficacy and the current and future commitment to sport practice of the sample subjects, these variables were considered as dependent variables in their respective analyses, whereas the following were considered predictive or independent motivational variables of the tad: autonomous motivation, controlled motivation, amotivation, autonomy BPN, competence BPN, and relatedness BPN.

Linear regression analysis (successive steps) revealed that self-efficacy and current commitment to sport practice were explained by a variance of 54 and 56% for autonomous motivation and 57 and 64% for the basic psychological need for competence, respectively (see **Table 3**). However, future commitment to sport was not explained by any variable.

DISCUSSION

The aims of this study were: (a) to determine the levels of motivation, satisfaction of BPN, perception of self-efficacy, and commitment to sport practice of people who practice physical activity, during confinement and progressive de-escalation; (b) to determine if there were differences between men and women in relation to these variables; and (c) to find which motivational variables predict the perception of self-efficacy and commitment to sport practice.

Given the importance of maintaining an active style during periods of confinement, it is crucial to know some of the psychological variables that determine these processes in order to improve the quality of life of the subjects. We will now discuss the data found according to the previously formulated objectives.

In relation to the first aim, the participants of the study showed high levels of autonomous motivation toward the sports practice, which seems logical since the selected sample practiced physical activity on a regular basis. Studies such as those by Belando (2013) and Leyton-Román et al. (2020) showed that those who are more intrinsically motivated to practice physical activity are more likely to remain physically active. This is linked to the fact that the majority of participants showed high levels of satisfaction with their BPNs, slightly higher in the case of competence BPNs. According to Ryan and Deci (2020), satisfaction of the three BPNs is fundamental to achieving high levels of self-determined motivation, which makes us reflect on the importance of being able to perform the exercises and activities correctly and effectively, being able to choose which types of exercises one wants to do, and having a good relationship with others when practicing sports. In relation to self-efficacy and sports commitment, both showed high means. As mentioned, autonomous motivation greatly affects the achievement of these two variables (Murillo et al., 2018; Duchatelet and Donche, 2019), which suggests that those who practiced physical activity prior to confinement already showed high levels of autonomous motivation, self-efficacy, and current commitment to the practice of physical activity. Consequently, most continued practicing physical activity during the confinement period.

The third aim described the differences between genders in the variables studied. The most relevant results reveal significant differences in favor of men, in the levels of controlled motivation and amotivation, as well as in the BPN of autonomy and in the perception of self-efficacy. A study by López-Bueno et al. (2020) in a Spanish population determined that overall, the practice of physical activity decreased during confinement, and men decreased their activity the most. Controlled motivation

TABLE 1 | Descriptive and reliability analysis.

Variables	Range	M^1	SD^2	Skewness	Kurtosis	α^3	ω^4
BRSQ							
Autonomous motivation	1–5	4.09	0.84	−0.92	0.42	0.96	0.97
Controlled motivation	1–5	1.99	0.84	1.01	1.03	0.85	0.88
Amotivation	1–5	1.60	0.88	1.76	3.03	0.84	0.84
BPNES							
BPN autonomy	1–5	3.73	0.94	−0.51	−0.44	0.86	0.86
BPN competence	1–5	3.96	0.93	−0.92	0.57	0.94	0.91
BPN relatedness	1–5	3.45	0.93	−0.54	−0.19	0.82	0.87
Self-efficacy							
Self-efficacy	1–5	3.44	0.76	−0.17	−0.28	0.93	0.71
Sports commitment							
Current commitment	1–5	3.68	0.78	−0.56	−0.27	0.82	0.86
Future commitment	1–5	3.20	0.87	0.08	−0.78	0.71	0.82

[1]M, media.
[2]SD, standard deviation.
[3]α, Cronbach's Alpha.
[4]ω, Omega Coefficient.

TABLE 2 | ANOVA analysis by gender.

Variables	Female	Male	p^1	Root mean square	F	Effect size
Autonomous motivation	3.98 ± 0.93	4.19 ± 0.73	0.09	1.98	2.79	0.25
Controlled motivation	1.84 ± 0.77	2.13 ± 0.89	0.02	3.81	5.42	0.34
Amotivation	1.46 ± 0.81	1.74 ± 0.94	0.03	3.60	4.65	0.31
BPN autonomy	3.57 ± 1.00	3.90 ± 0.86	0.02	4.72	5.39	0.35
BPN competence	3.87 ± 1.04	4.05 ± 0.79	0.18	1.52	1.76	0.19
BPN relatedness	3.36 ± 0.96	3.54 ± 0.90	0.21	1.40	1.60	0.19
Self-efficacy	3.31 ± 0.76	3.57 ± 0.75	0.02	3.03	5.24	0.34
Current commitment	3.61 ± 0.83	3.76 ± 0.72	0.20	0.99	1.62	0.19
Future commitment	3.12 ± 0.86	3.28 ± 0.88	0.22	1.14	1.49	0.18

[1]p = significance ($p < 0.05$; $p < 0.01$).

TABLE 3 | Coefficients of the analysis of linear regression by successive steps.

Variables	β	R^2	t	p
Self-efficacy				
Autonomous motivation	0.56	0.54	7.37	0.00[1]
BPN competence	0.23	0.57	3.07	0.00
Current commitment				
Autonomous motivation	0.42	0.56	6.09	0.00
BPN competence	0.43	0.64	6.34	0.00

[1]$p < 0.001$.

and amotivation are the least self-determined forms of motivation that tend to trigger the abandonment of physical activity practice. However, men were those who obtained greater levels of satisfaction of the BPN of autonomy, which, according to studies such as those of Pérez-González et al. (2019), is related to greater levels of more self-determined motivation, with no such results found in the present study. The same occurred with the perception of self-efficacy, which was greater in men than in women, in line with the study by Chen et al. (2019) conducted in a sample of high school students, who found that the perception of self-efficacy was related to physical activity, and that these relationships were stronger in boys than in girls. Also, the power of this relationship in terms of gender was found to vary according to the age of the individuals, and, therefore, no conclusive relationships can be drawn. It is necessary to continue investigating these variables with different age groups and in situations of confinement (Chen et al., 2019).

In relation to the fourth aim, our findings revealed that self-motivation and competency BPN significantly predicted both the perception of self-efficacy and current commitment to sports practice. Many studies have established a close relationship between the BPN of competence and autonomous motivation both in the field of sports and physical activity (Prieto and Huertas-Delgado, 2019), in the field of Physical Education (Cuevas et al., 2018), and in the practice of physical activity in adults and seniors (Leyton et al., 2017). Thus, in line with the results of this study, people who are intrinsically more motivated to practice sports are those who have a greater perception of self-efficacy, as found in the studies by Neace et al. (2020) in a group of yoga practitioners, and

Knight (2020) in young athletes. This prediction also occurs between more self-determined motivation and commitment to sports practice, as in the model of structural equations proposed by Pulido et al. (2018) among young soccer players.

The positive consequences related to the satisfaction of the competence BPNs originates greater levels of self-determination and consequently adaptive patterns for the sports practice. Therefore, it is necessary for public organizations and agents dedicated to sports training to use strategies aimed at improving this future commitment to practice. To this end, and according to the results obtained, the strategies to be used should focus on the satisfaction of the BPNs, with special attention to the competence BPN, since the satisfaction of the latter will improve the most self-determined motivation, and with this, the continuity and commitment to the practice. These strategies should aim to offer different exercises with the same objective so that the person can choose the exercise according to their preference or level of difficulty, set realistic and individualized activities and objectives so that the person feels capable of performing them and/or does not feel bored if they are too easy, and provide positive feedback, as well as encourage group activities and positive relatedness among participants.

It is very important to pay attention to these strategies so that, within this current situation of uncertainty, people do not stop practicing physical activity, in an effort to maintain healthy lifestyles (Dwyer et al., 2020). Identifying the level of motivation of individuals and determining the influence of the context associated with their behaviors and choices can improve interventions aimed at changing the perception of self-efficacy and commitment to sports practice, as suggested by the results of studies using SDT in relation to health (Silva et al., 2015).

Although the study presents interesting and useful results to understand how sport professionals should guide the practice of physical exercise, some limitations were found, such as the sample size. Therefore, it is necessary to carry out similar studies with larger samples, which can draw more accurate and extrapolated conclusions. It would also be interesting to replicate the study in different countries to determine differences between countries and to verify whether these psychological variables act in a similar way. It would also be very interesting to carry out a pre- and post-confinement measurement to see if the results have changed according to the situation.

It would be necessary to propose physical activity programs that last over time, paying special attention to the use of strategies aimed at improving the satisfaction of the competence BPN, and, therefore, increasing the forms of more self-determined motivation toward sports practice, to ensure that people increase their perception of self-efficacy, dealing more effectively with situations of risk and uncertainty, such as the present, and to maintain and/or increase the commitment to sports practice. In conclusion, the satisfaction of the BPN of competence and the autonomous motivation significantly predict the perception of self-efficacy and the current commitment to the practice of physical activity.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Comité Ético de la Universidad Rey Juan Carlos de Madrid. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

ML-R and RJ-C: conceptualization, software, validation, investigation, and resources. ML-R, RV, and RJ-C: methodology, formal analysis, and data curation. ML-R: writing – original draft preparation, writing – review and editing, and visualization. RJ-C: supervision and project administration. All authors contributed to the article and approved the submitted version.

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Who Is Listening? Spokesperson Effect on Communicating Social and Physical Distancing Measures During the COVID-19 Pandemic

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Effective communication during a pandemic, such as the current COVID-19 crisis, can save lives. At the present time, social and physical distancing measures are the lead strategy in combating the spread of COVID-19. In this study, a survey was administered to 705 adults from Switzerland about their support and practice of social distancing measures to examine if their responses depended on (1) whether these measures were supported by a government official or an internationally recognized celebrity as a spokesperson, (2) whether this spokesperson was liked, and (3) the respondent's age. We also considered several attitudinal and demographic variables that may influence the degree to which people support and comply with social distancing measures. We found that the government official was more effective in eliciting responses supportive of social distancing, particularly as manifested in the stated current compliance with social distancing measures. The effect was substantially stronger among older respondents, although these respondents expressed a lower risk perception. Although there was a general trend for greater endorsement of the social distancing measures among participants who liked the spokesperson, this was non-significant. In addition, respondents' greater support and compliance was positively associated with (1) higher concern for the current situation, (2) higher concern for the well-being of others, and (3) greater belief that others were practicing social distancing, and negatively with (4) greater self-reported mobility. Current compliance correlated negatively with (5) household size. Since different parts of the population appear to have different perceptions of risk and crisis, our preliminary results suggest that different spokespersons may be needed for different segments of the population, and particularly for younger and older populations. The development of evidence-based knowledge is required to further identify who would be the most effective spokesperson, and in particular to groups with low risk perception and low compliance.

Keywords: COVID-19, pandemic (COVID-19), public health messaging, spokesperson, effective communication, celebrity

INTRODUCTION

In an effort to avert the spread of the coronavirus disease 19 (COVID-19), a commonly given instruction is to practice social and physical distancing, generally defined as deliberately keeping a distance of at least 2 m (6 feet) from other people. To enforce this measure, people are advised, instructed, or even mandated to cancel sports events, cruises, festivals, and other gatherings; cancel or postpone conferences and large meetings; work from home instead of at the office; close schools, universities, and daycare centers; and visit loved ones through the use of electronic devices instead of in person (Gostin et al., 2020; JHU, 2020; Maragakis, 2020). This survey-based study aims to contribute to the development of evidence-based knowledge to improve our communication efforts in responding to unprecedented health crises such as the current COVID-19 crisis. Specifically, the current study sought to investigate the influence of the messenger (spokesperson) on inducing support for, and compliance with social distancing measures.

In times of pandemics, public health messaging with the affected population in a coordinated, effective, and credible way is considered a key factor in controlling the spread of the disease. Beyond the content of the message, the person who communicates the message–the spokesperson–is one of the most important factors that could determine the effectiveness of the message, particularly during times of heightened uncertainty as during emerging infectious diseases (Vaughan and Tinker, 2009; Lyu et al., 2013). During the current COVID-19 crisis, in addition to designating government official spokespersons, governments have also resorted to enlisting celebrities to bring heightened awareness about the pandemic (Swiss Federal Office of Public Health, 2020), and more recently to persuade people to take the coronavirus vaccine (Campbell, 2020). Enlisting celebrities may seem a reasonable strategy, given evidence suggesting that celebrities who are viewed favorably consistently have positive effects on people's opinions, attitudes, and behaviors (Jackson and Darrow, 2005; Jackson, 2018), perhaps through a pseudo-personal, one-way rapport (Basil, 1996). However, little is known about the effect of celebrity spokespersons in times of crises. In a rare study that investigated the effect of a government official compared to a celebrity spokesperson during *hypothetical* crises (humanitarian and security), support for intervention or increased interest in the crisis were lower when the cue came from the celebrity rather than the government official (Frizzell, 2011). The extent to which this effect manifests in *real* crises is greatly understudied (Belt, 2011).

In addition, studies investigating responses during the early stages of prior pandemics have identified a number of important demographic, attitudinal, and psychological factors that could influence compliance (DiGiovanni et al., 2004; Bish and Michie, 2010; Reddy and Gupta, 2020). With respect to demographic factors, evidence from previous and the current COVID-19 pandemic suggest that age is a key factor, with young adults are likely to be least compliant (Bish and Michie, 2010; Barari et al., 2020; Everett et al., 2020; Pfattheicher et al., 2020; YouGov, 2020). For example, preliminary findings from Italy suggest that, while public messaging is generally being adhered to, this is true to a lesser degree among young adults (Barari et al., 2020). Similarly, while 76% of United States adults (at least 18 years old) reported that they were practicing social distancing, this was reported only in 67% of young adults between 18 and 34 years of age (YouGov, 2020). Moreover, it has been reported that older people felt more responsible for preventing the spread of the disease and expressed stronger intentions to practice social distancing measures such as avoiding gatherings and staying in self-isolation (Everett et al., 2020). Similarly, attitudinal factors (e.g., perceived health status, attitudes toward public health, and government officials) have been shown to influence the degree to which people support, and comply with, social distancing measures (Bish and Michie, 2010; Barari et al., 2020; Everett et al., 2020; Pfattheicher et al., 2020; YouGov, 2020). For example, greater trust in authorities has been associated with adopting protective behaviors (Bish and Michie, 2010). Psychological factors such as risk perception and concern for others have also been shown to affect compliance (Bish and Michie, 2010; Pfattheicher et al., 2020; Wise et al., 2020). For example, concern for others (empathy) has been associated with the motivation to adhere to physical distancing and to wearing face masks (Pfattheicher et al., 2020), and the willingness to restrict one's own mobility to "flatten the curve" was particularly high when the motivation was to protect vulnerable others (Betsch, 2020). The protection motivation theory (PMT) (Maddux and Rogers, 1983) suggests that these factors are guided by threat appraisal processes–which assess the severity and seriousness of the situation/health information and coping appraisal processes–which assess the cost-benefit ratio of the response to the situation/health information (see also Schimmenti et al., 2020).

However, research on compliance with public health messaging during health crises has primarily focused on how these factors might relate to the content of the message, and considerably less so to the messenger (Nyhan et al., 2014; Bavel et al., 2020). This is particularly important given research showing that the message content alone may have no or even counterproductive effect on compliance with recommendations regarding diseases of great risk to public health (Nyhan et al., 2014; Nyhan and Reifler, 2015). The current study was thus conducted with three main goals in mind. Our first main goal was to assess, among adults in Switzerland, (1) whether self-reported support for, and current and future compliance with, social distancing measures depended on the spokesperson stated to have supported these measures (Swiss President Simonetta Sommaruga or celebrity actor Tom Hanks), and (2) whether these differences depended on the respondent's sentiment toward the spokesperson, that is, on the extent to which the spokesperson is liked. We predicted that respondents would express more favorable responses to social distancing measures when the spokesperson is a liked celebrity.

Our second main goal was to examine whether support for, and compliance with social distancing measures is age-dependent. We predicted that, while the younger respondents would express lesser support and practice of social distancing measures, the celebrity would have a greater effect on them than the government official. In addition, our third goal was to examine the potential association of several attitudinal and demographic factors with engagement in social distancing (see section "Materials and Methods" for details) (Bish and Michie, 2010; Barari et al., 2020; Everett et al., 2020; Pfattheicher et al., 2020; YouGov, 2020), and whether the effects of spokesperson and age can be observed when adjusting for these factors.

MATERIALS AND METHODS

Participants

Two online surveys (see **Supplementary Appendix**) were randomly assigned to 705 respondents (see **Table 1** demographic details, see section "Preliminary Analysis"). In one survey, social distancing was supported by Simonetta Sommaruga (sitting President of the Swiss Confederation), and in the other survey, social distancing was supported by Tom Hanks (a celebrity actor). The two surveys were identical in all other respects. Respondents were recruited via a targeted ad campaign to users of Facebook and via a university online research platform. The Facebook ad consisted of rendered image of the virus, the sentence "Help us understand how the COVID-19 is affecting people's lives in a 3-min survey," and a link that redirected the respondent to one of two survey forms. The university online platform sent emails to registered university students, which randomly contained a link to one of the survey forms. Responses were digitally captured and downloaded for data processing at the end of the study period (see section "The Study in Context"). The study was conducted in compliance with the EPFL Human Research Ethics Committee guidelines.

Study Material

The survey (see **Supplementary Appendix**) elicited, on a 7-point Likert scale, responses that gauged the extent to which respondents (1) supported social distancing (*To what degree do you support social distancing as a valid measure in the current situation?*), (2) currently practiced social distancing (*To what degree are you currently practicing social distancing?*), and (3) intended to practice social distancing in the future (*To what degree do you see yourself practicing social distancing in the weeks to come?*). These three questions constitute the main outcome measures of the study. They were posed after an informative text block describing social distancing measures and a statement that these measures had been publicly supported by a randomly sampled one of the two spokespersons. The statement was accompanied by a portrait picture of the spokesperson. The two spokespersons were selected to, respectively, represent a source of official government instructions on social distancing (Simonetta Sommaruga) and an unofficial endorsement by an unaffiliated celebrity (Tom Hanks). To avoid spreading misinformation, we ensured that both speakers had actually previously issued public support of social distancing. Simonetta Sommaruga was chosen as the highest-ranking Swiss government official to have issued such support, while Tom Hanks was selected as a celebrity spokesperson who is well-liked, well-known across age groups and to an international audience (McDonald, 2013), and made headlines for his public endorsement of social distancing prior to the study and his coronavirus infection. The wording of the social distancing message was adapted from the definition by Johns Hopkins Medicine (JHU, 2020).

Participants were also asked whether they liked, disliked, were neutral toward, or did not know the spokesperson. In addition, the following demographic and attitudinal variables were collected: age, gender (male, female, other), employment status (employed and unemployed), years of education, household size, settlement size (village, small town, town, city, and metropolitan area), general health (on a 5-point Likert scale from very good to very bad), and perceived fraction of population infected by coronavirus (in 10% increments on a 100% scale). In addition, we asked the respondents to indicate on a 7-point Likert scale their level of concern about COVID-19, concern for the well-being of others, perception of others' practice of social distancing, religiosity, liberty of movement (henceforth, mobility), satisfaction with the government's efforts to combat COVID-19, and perception of the government's concern for public health versus the economy.

The Study in Context

The survey was administered during the period of March 22–27, 2020, 6 days after the Swiss Federal Council had categorized the situation as *extraordinary* under the terms of the Epidemics Act (FOPH, 2020). From February 25, when the first case was confirmed in Switzerland (Thelocal.ch, 2020), a number of social distancing measures were progressively introduced by the Federal Council, which among other measures, included closing non-essential businesses on March 16 (6 days before the start of the survey), and limiting gatherings to a maximum of five persons on March 20 (2 days before the start of the survey) (FOPH, 2020). In addition, by the start of the survey, there were 7,474 confirmed cases, and 98 COVID-19 related deaths in Switzerland (see **Figure 1** for total cumulative cases and deaths during the study period).

Statistical Analyses

First, we computed Spearman's correlation between the study variables. For the main analyses, we performed a series of multivariable regressions to examine the effect of the spokesperson on the responses to the three attitudinal questions about social distancing: (1) support, (2) current practice, and (3) future practice. Analyses were conducted while controlling for all demographic and attitudinal measures listed above. Analyses were performed in the entire sample and as a function of age group (see **Supplementary Figure 1** and clustering details in the **Supplementary Material**). In addition, Kruskal–Wallis H-tests were used to compare young to old participants on all study measures. For gender differences, two respondents who indicated "Other" as their gender were excluded. For the regression analyses, 11 participants were excluded due to the small number of respondents in the following response categories: "Other" gender = 2, "no schooling" = 1, and living in a metropolitan area = 8.

To account for multiple testing, we applied false-discovery rate (FDR) correction (q-value = 0.05) (Benjamini and Hochberg, 1995). Effect sizes are reported in terms of Cohen's d (mean difference divided by pooled standard deviation, reported

TABLE 1 | Demographic details of the overall and subsamples.

Sample variable	Overall sample (*N* = 705)	Facebook users (*N* = 447)	University students (*N* = 258)
Age (mean ± σ)	34.35 ± 16.46	42.02 ± 16.04	21.05 ± 3.94
Gender (%)			
Male	155 (22%)	111 (24.8%)	44 (17.1%)
Female	548 (77.7%)	335 (74.9%)	213 (82.6%)
Other	2 (0.3%)	1 (0.2%)	1 (0.4%)
Employment (%)			
Employed	364 (51.6%)	292 (65.3%)	72 (27.9%)
Unemployed	341 (48.4%)	155 (34.7%)	186 (72.1%)
Education (%)			
No schooling	1 (0.1%)	1 (0.2%)	0 (0.0%)
1–6 years	22 (3.1%)	21 (4.7%)	1 (0.4%)
7–13 years	116 (16.5%)	116 (26.0%)	0 (0.0%)
14–16 years	328 (46.5%)	152 (34.0%)	176 (68.2%)
17–18 years	149 (21.1%)	81 (18.1%)	68 (26.4%)
Over 18 years	89 (12.6%)	76 (17.0%)	13 (5.0%)
Household size (mean ± σ)	3.08 ± 1.38	2.74 ± 1.32	3.68 ± 1.28
Settlement size (%)			
Village	223 (31.6%)	154 (34.5%)	69 (26.7%)
Small Town	221 (31.3%)	126 (28.2%)	95 (36.8%)
Town	148 (21.0%)	90 (20.1%)	58 (22.5%)
City	105 (14.9%)	71 (15.9%)	34 (13.2%)
Metropolitan	8 (1.1%)	6 (1.3%)	2 (0.8%)

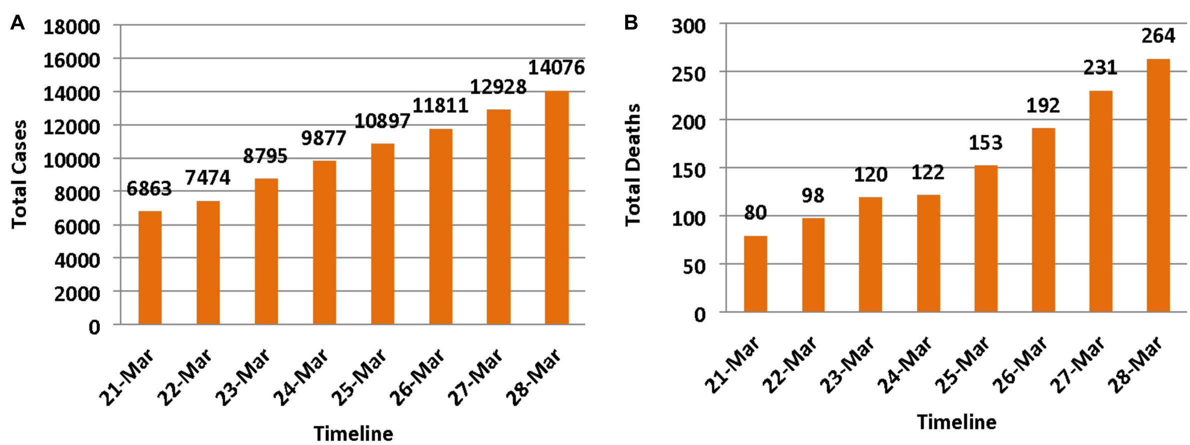

FIGURE 1 | Total cumulative number of confirmed COVID-19 cases and deaths in Switzerland during the study period, 22–27 March, 2020 (Worldmeter, 2020). **(A)** The number of people who were infected with virus SARS-CoV-2, and **(B)** the number of COVID-19 related deaths. Numbers are likely to be much higher, particularly when, as of March 6, targeted testing strategy was the official policy in Switzerland (derbund.ch, 2020).

in absolute values), partial eta-squared ($\eta_p{}^2$), and Cramer's V as appropriate.

RESULTS

Preliminary Analysis

Demographics and details of the respondents are summarized in **Table 1**. About 98.3% of all respondents stated that they were aware of the social distancing measures at the time of the study. There were no statistically significant differences between employed and unemployed respondents on any of the three social distancing measures (all $H < 0.89$, $p > 0.345$), or between female and male respondents on current ($H = 1.59$, $p = 0.207$) or future practice ($H = 0.97$, $p = 0.324$). However, female respondents reported greater support for social distancing measures ($H = 5.47$, $p = 0.019$, $d = 0.16$). Spearman's correlations (see **Figure 2**) revealed a significant positive associations between all three attitudinal measures of social distancing (support, current, and future practice) and the respondents' age, concern for the current situation, concern for others, others' practice of social distancing, as well as a significant negative association with movement

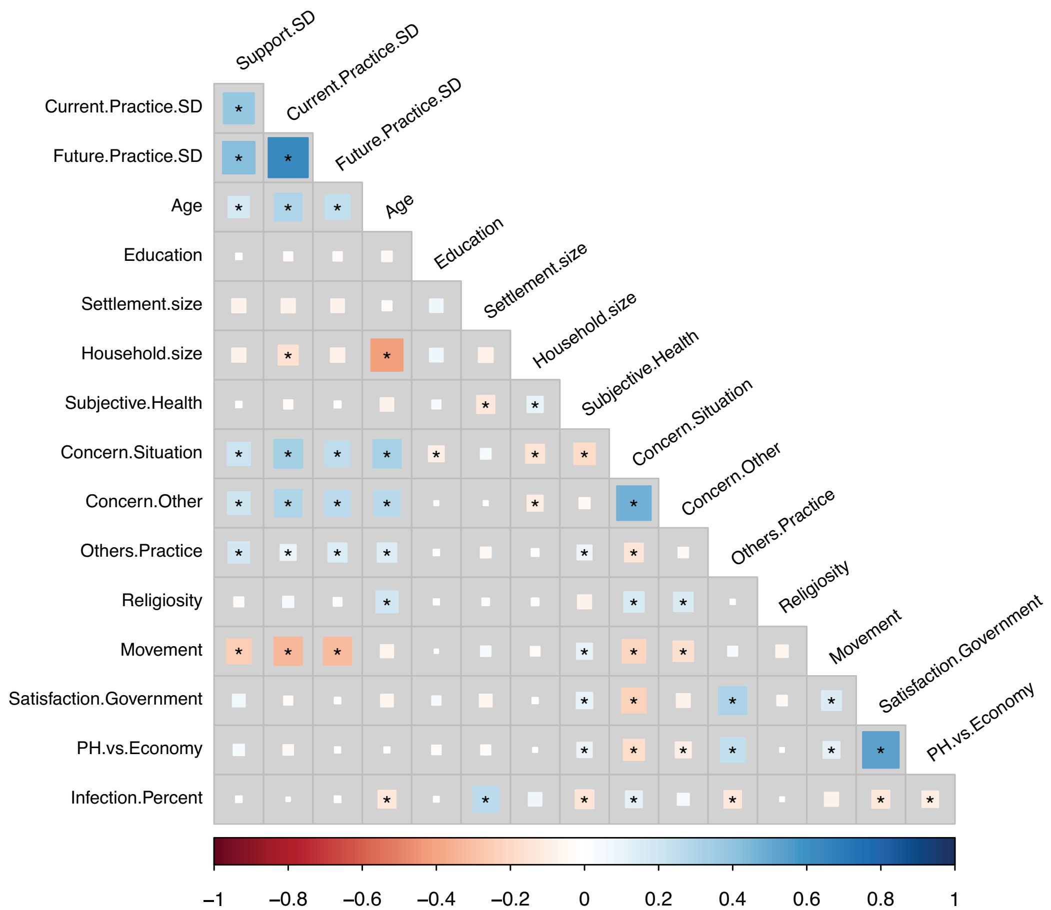

FIGURE 2 | Spearman's correlation matrix between the study variables. Square color and size, respectively, indicate direction and size of the correlation coefficients. Asterisks indicate significant correlation coefficients after false-discovery rate (FDR) correction for multiple testing. Figure was constructed with the R package *ggcorrplot*. SD, social distancing; PH, public health.

(mobility). Furthermore, household size was significantly and negatively associated with the respondents' degree of current practice of social distancing.

Moreover, given the bimodal structure of the age distribution of our sample (**Supplementary Figure 1** and clustering details in the **Supplementary Material**), we compared differences between the younger (17–36 years of age) and older (37–80 years of age) groups on all the social distancing and attitudinal measures of the study. As can be seen in **Figure 3**, the scores reported by the older group were significantly higher for all questions, except for the perception of the spread of COVID-19 and the state of their general health, where the younger group reported higher scores. There was no difference between the age groups in movement (mobility), satisfaction with the government and the government's prioritization of public health over the economy (see **Supplementary Table 1** for details).

Spokesperson Effect

Accounting for all demographic and attitudinal variables, the multivariable regressions revealed that the government official had a small but significant effect on the reporting of current practice of social distancing measures [$F(1,688) = 5.07$, $p = 0.025$, Cohen's $d = 0.17$]. We did not observe a statistically significant spokesperson effect for the respondents' support or future practice of social distancing (see **Figure 4**).

Supplementary Tables 2–4 summarize the regression coefficients of the association of the demographic and attitudinal variables with each of the three social distancing outcome measures. For the support of social distancing (see **Supplementary Table 2**), parameter estimates revealed significant positive associations with the concern for others, concern for the situation, and others' practice of social distancing, and significant negative associations with settlement size, religiosity, and mobility.

For current practice of social distancing (see **Supplementary Table 3**), parameter estimates revealed significant positive associations with age, concern for others, concern for the situation, others' practice of social distancing, and with satisfaction from the government effort. Significant negative associations were observed for city size, mobility, and employment, where the employed reported lesser practice of social distancing measures than the unemployed.

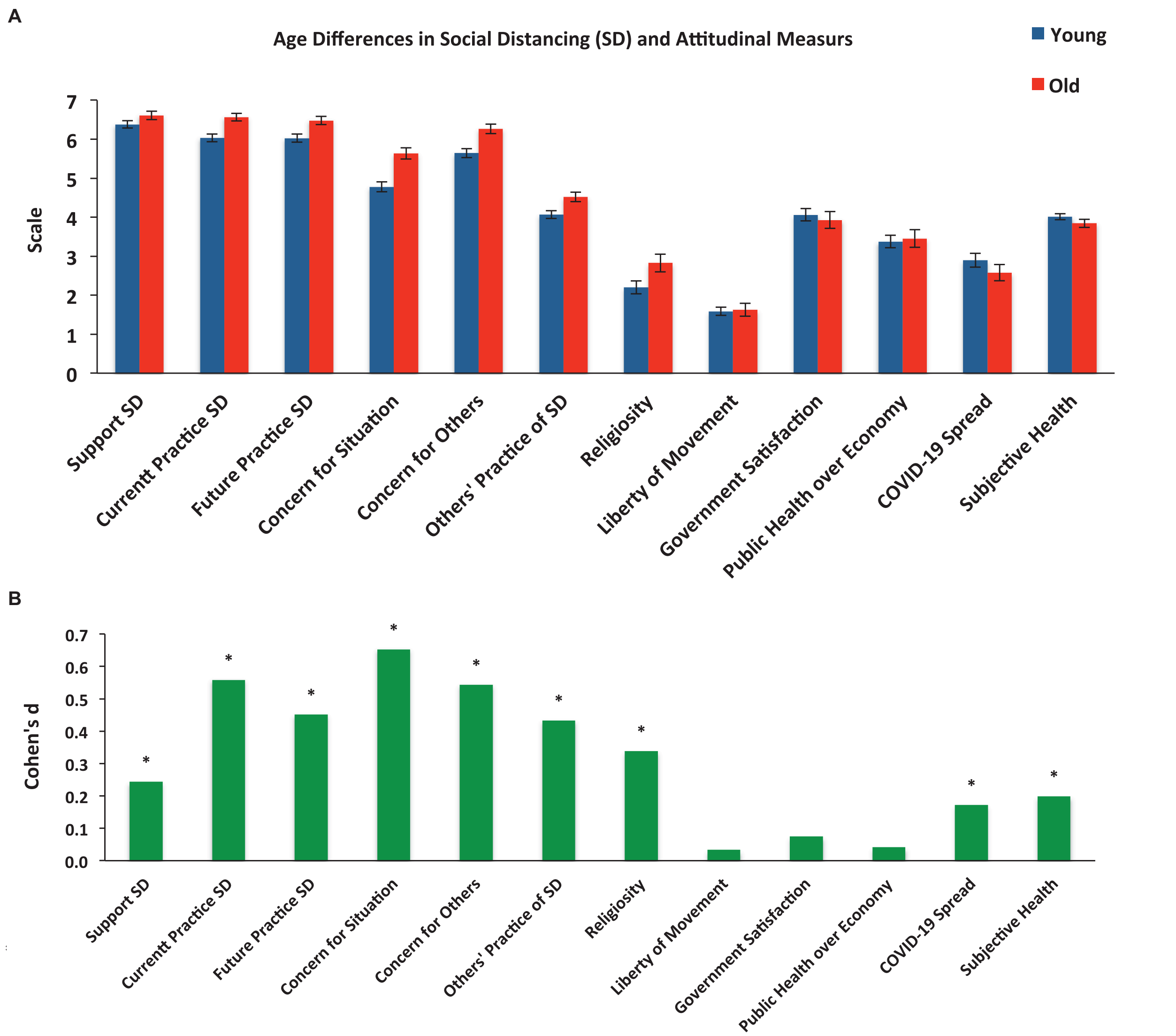

FIGURE 3 | Differences in the social distancing and attitudinal measures between the younger and older groups. **(A)** Displays the means and 95% CI. **(B)** Displays Cohen's *d* effect sizes (in absolute values). Asterisks denote false discovery rate-corrected significant effects (*q*-value = 0.05). SD, social distancing.

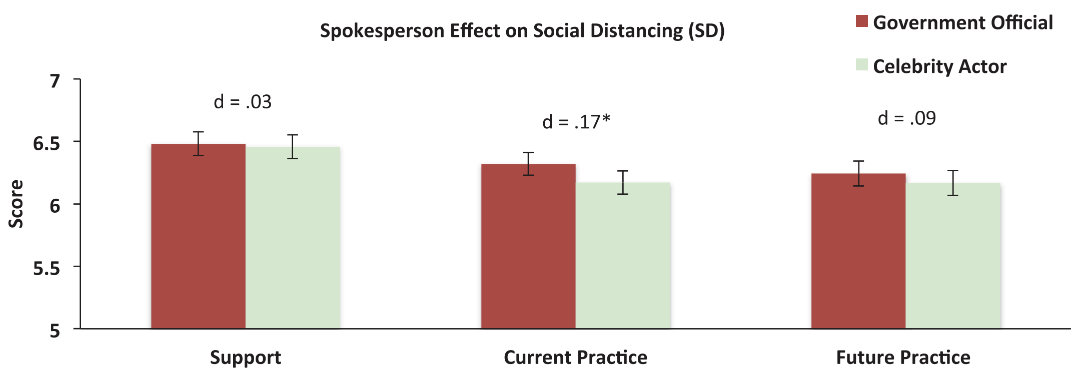

FIGURE 4 | Spokesperson effect on the respondents' support, current practice, and future practice of social distancing. Error bars represent 95% CIs; *d* = Cohen's *d* effect size, *$p < 0.05$.

TABLE 2 | Cross-tabulation of spokesperson likeability.

Spokesperson	Like	Neutral	Dislike	Don't know
Government official (%)	87 (25%)	151 (44%)	11 (3%)	97 (28%)
Celebrity actor (%)	149 (43%)	150 (43%)	2 (1%)	47 (14%)

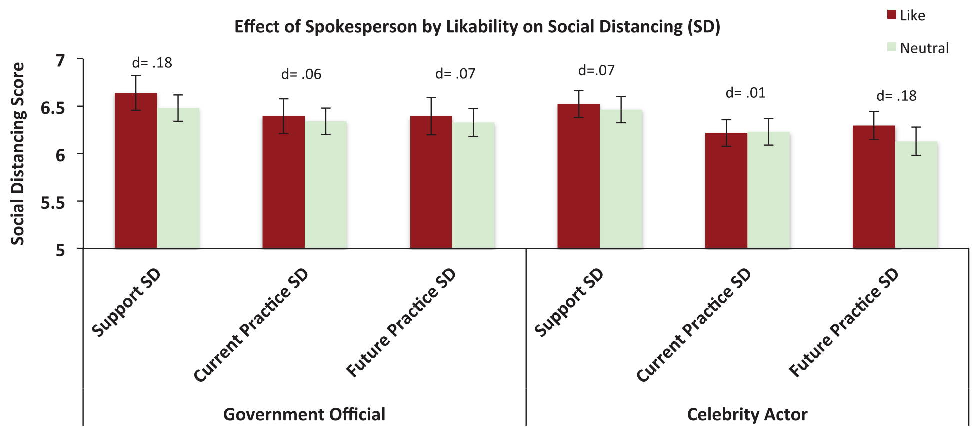

FIGURE 5 | Effect of spokesperson likeability on the respondents' support, current practice, and future practice of social distancing. Error bars represent 95% CIs; *d* = Cohen's *d* effect size (in absolute values).

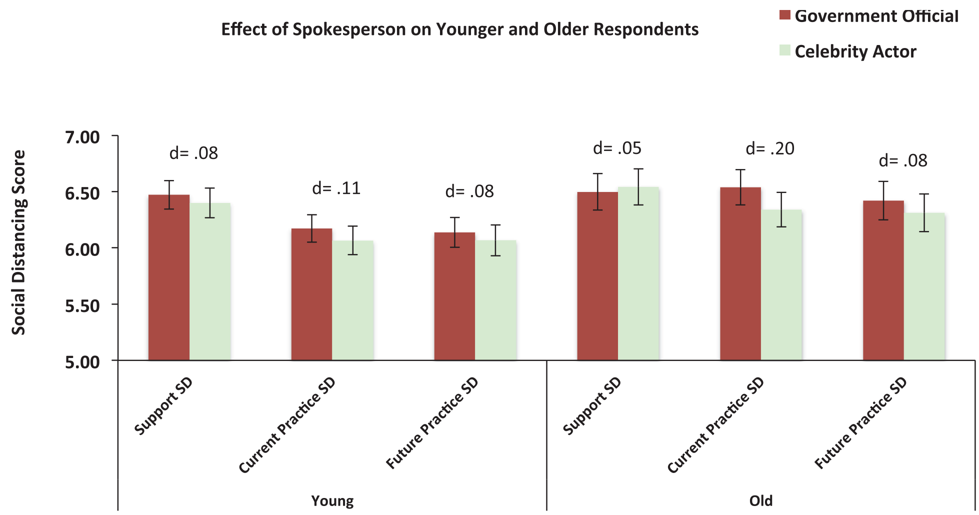

FIGURE 6 | Spokesperson effect on the respondents' support, current practice, and future practice of social distancing in the younger and older respondents. Error bars represent 95% CIs; *d* = Cohen's *d effect size* (in absolute values).

For future practice of social distancing (see **Supplementary Table 4**), parameter estimates revealed significant positive associations with age, concern for others, concern for the situation, and others' practice of social distancing, and a significant negative association with mobility.

Effect of Spokesperson Likeability

Respondents indicated if they liked, disliked, were neutral toward, or did not know the spokesperson. Chi-squared analysis revealed significant differences in the distribution of the responses across the two spokespersons (χ^2 = 39.88, df = 3, p < 0.001, Cramer's V = 0.24; see **Table 2**).

As can be seen from **Table 1**, overall only 1.87% of the respondents expressed dislike toward the spokespersons. Given this small number, the effect of the spokesperson's likeability was only analyzed with respect to "like" versus "neutral." Accordingly, we performed a series of multivariable regression analyses in which we also included the "Likability" factor and the "Likeability × Spokesperson" interaction term. Respondents who liked the spokesperson tended to report higher levels of support and practice of the social distancing measures, although these effects were not statistically significant (see **Figure 5**). Models details and parameter estimates are provided in the **Supplementary Tables 5–7**.

Spokesperson Effect in Younger Versus Older Adults

We performed a series of multivariable regression analyses in which we also included the "Age Group" factor and the "Age Group × Spokesperson" interaction term (see **Supplementary Tables 8–10** for model details). The results revealed a significant Age Group effect for both current and future practice of social distancing, where the older group reported greater current practice of social distancing [$F(1,676) = 16.16$, $p < 0.001$, Cohen's $d = 0.31$] and greater intention to practice social distancing in the future [$F(1,676) = 9.22$, $p = 0.002$, Cohen's $d = 0.23$]. In addition, there was a significant spokesperson effect on current practice of social distancing, where the government official had a greater effect than the celebrity actor [$F(1,676) = 4.84$, $p = 0.028$, Cohen's $d = 0.17$]. While the interaction of Age Group × Spokesperson was non-significant for current practice of social distancing, this effect, as can be seen in **Figure 6**, was larger in the older (Cohen's $d = 0.20$) than the younger group (Cohen's $d = 0.11$).

Sensitivity Analysis

Since our sample was not representative of the Swiss general population, we performed Weighted Least Squares Regressions, wherein we weighted the study's sample by the Swiss population demographic figures of 2019 for gender, age, and years of education (FSO, 2019). The weighting of these sample stratification variables was performed using the sequential weighting method, which allowed us to obtain unbiased estimates from the biased sample (Alkaya et al., 2017). First, we examined the effect of spokesperson and age on the social distancing measures, while also controlling for the study's demographic and attitudinal factors. The regression model for current practice of social distancing measures showed that the weighted mean for the government official was higher than the celebrity actor, albeit at a non-significant level [$F(1,676) = 3.15$, $p = 0.076$, Cohen's $d = 0.14$], and significantly lower among younger adults [$F(1,676) = 21.69$, $p < 0.001$, Cohen's $d = 0.36$]. The regression model for future practice of social distancing measures showed that the weighted mean was significantly lower among younger adults [$F(1,676) = 10.31$, $p = 0.001$, Cohen's $d = 0.25$], and similar for the government official and the celebrity actor ($p = 0.784$). There was no significant effect for either age ($p = 0.322$) or spokesperson ($p = 0.675$) on support for social distancing measures. In further analyses, taking into account the effect of likeability (Like vs. Neutral), the weighted means of the respondents' current practice of social distancing measures was significantly higher for the government official [$F(1,519) = 4.97$, $p = 0.026$, Cohen's $d = 0.19$] and lower among younger adults [$F(1,519) = 4.97$, $p = 0.001$, Cohen's $d = 0.29$]; the effect of likeability was non-significant ($p = 0.134$) (see **Supplementary Table 11** for model details). The effects of the spokesperson, age, and likeability on the respondents' weighted means of support and future practice of social distancing measures were non-significant ($ps > 0.073$). These results largely consolidate our previous estimates obtained from the biased sample.

DISCUSSION

We discuss our results under three main headings: (1) the influence of spokesperson on compliance with social distancing measures; (2) respondents' stance and attitudes toward social distancing measures; and (3) the association of demographic variables with compliance with social distancing measures.

Spokesperson Influence

Social and physical distancing measures are paramount in preventing the spread of COVID-19 (Wilder-Smith and Freedman, 2020). Information about these measures has been communicated by various official and non-official sources. In an effort to provide evidence-base knowledge about who would be most effective in communicating recommended preventive health behavior, we tested if respondents were more likely to heed information conveyed by a government official or by a celebrity actor. Contrary to our prediction—namely, that the celebrity actor would be more effective than the government official due to a closer (perceived) relationship to the respondents (Basil, 1996)—the government official was in fact more effective, particularly with respect to the reported current compliance with social distancing measures (**Figure 4**). This effect was robust after adjusting for the effects of all demographic and attitudinal factors included in the study (**Supplementary Table 3**), and was largely confirmed in a sensitivity analysis in which we weighted our biased sample by the Swiss population demographic figures of 2019 for gender, age, and years of education (FSO, 2019). These results are consistent with previous studies showing that (1) a government official garners greater support and interest than a celebrity entertainer for *hypothetical* crises (Frizzell, 2011). During times of crises, people tend to rally around their leaders in the hope for assurance. Indeed, it has been well-documented that government leaders tend to elicit higher approval and trust ratings during times of crises (Gaines, 2002; Gregg, 2003). Furthermore, although there was a general trend for greater endorsement of the social distancing measures among those who liked the spokesperson, this was non-significant (**Figure 5**). This suggests that the likeability of a government leader may largely be insubstantial in the development of strategies for improving the adoption of measures for social distancing, since it is a factor that cannot be easily adjusted—exchanging an (elected) government official is typically not an option.

Stance and Attitudinal Variables Toward Social Distancing Measures

Concerning the relationship between risk perception, and attitudinal variables with the stance toward social distancing measures, we highlight key results. First, respondents who indicated greater support, and current and future practice of social distancing measures also expressed (1) higher concern for the current situation, (2) higher concern for the well-being of others, (3) higher belief that others are practicing social distancing, and (4) lower perceived mobility (see **Figure 2** and **Supplementary Tables 2–4**). The association between social distancing and the concern for others is consistent with the results of a German survey, which showed that this association was particularly strong when the motivation was to protect the vulnerable (Betsch, 2020). This association can be interpreted from a pro-sociality point of view. While compliance can be seen as a response to protect oneself, it may also be motivated by the desire to protect others. In this regard, recent research has demonstrated that inducing empathy for people most vulnerable to the coronavirus promotes the motivation to adhere to these measures (Pfattheicher et al., 2020), which is consistent, the authors point out, with research suggesting that the motivation to adhere to social distancing measures includes concerns for both self and others (Wise et al., 2020). In addition, the association of perceived mobility with social distancing has also been recognized as an important variable in the development of messages and policies that are most effective. Specifically, it has been suggested that examining the impact of social distancing messaging on population mobility patterns, will help officials understand what kinds of messaging are most effective (Buckee et al., 2020). Collectively, these results can be interpreted in terms of the PMT (Maddux and Rogers, 1983), which, as stated in the introduction, attempts to explain the effects of threatening health information on attitude and behavior change in terms of threat appraisal and coping appraisal processes. In the context of our results, concern for the situation, others' practice of social distancing, and mobility can be construed as part of the threat appraisal process, while concern for others can be construed as part of the coping appraisal process, which can manifest by empathizing and helping the vulnerable (Betsch, 2020).

In addition, when taking demographic and other attitudinal measures into account, we found that individuals who reported greater importance for religion in their daily life also expressed less support for the social distancing measures (**Supplementary Tables 2**, **5**). This result is contrary to the findings by Everett et al. (2020) who found a positive association between religiosity and adherence to social distancing measures among American respondents. It is possible that the negative association we observe is reflective of the notion that more religious people have a preference for persistence and consistency over flexibility and change (Zmigrod et al., 2019). Finally, respondent's general health, perception of spread of the disease, satisfaction with the government's efforts to combat COVID-19, and perception of the government's concern for public health versus the economy were of little importance in predicting engagement in social distancing.

Demographic Variables

As discussed above (see section "Spokesperson Influence"), we found evidence suggesting that the government official was more effective than the celebrity spokesperson in communicating recommended preventive health behavior. It appears that this effect is stronger among older respondents (**Figure 6**). Intriguingly, however, we observed that support and reported compliance was higher among older versus younger respondents, despite older respondents having lower risk perception as indicated by their own assessment of the spread of COVID-19 (**Figure 3**). This result is consistent with the findings of COVID-19 research showing that younger respondents exhibit attenuated support of, and compliance with social distancing measures (Barari et al., 2020; Everett et al., 2020), and that older people have lower risk perception (Betsch, 2020). Importantly, our finding consolidate previous conclusions drawn from previous pandemics, such as the 2009 H1NA pandemic (Bish and Michie, 2010), suggesting that being older was associated with a better chance of adopting behaviors that could contribute to controlling the spread of pandemic disease.

In addition, we found that support and current practice of social distancing were inversely related with settlement size (**Supplementary Tables 2**, **3**). This dovetails with the findings of a recent study showing that the spread of COVID-19 in the United States increases with city size (Stier et al., 2020), and suggests that different communication strategies for social distancing in rural versus urban settings (Vaughan and Tinker, 2009) may be needed, not least because both settings are clearly governed by markedly different socioeconomic interactions (Stier et al., 2020). We also found evidence suggesting that household size is inversely associated with compliance with social distancing measures (see **Figure 2** and **Supplementary Tables 9**, **11**), and that current practice of social distancing was significantly lower among the employed (see **Supplementary Tables 3**, **11**). Finally, respondent's level of education and gender status were of little importance in predicting engagement in social distancing.

Strengths and Limitations

The study's results contribute to the development of evidence-based knowledge regarding the influence of the spokesperson on the effectiveness of public health messaging during times of emerging infectious diseases; the results were obtained while controlling for a number of relevant demographic, attitudinal and psychological factors, and which were largely confirmed in a sensitivity analysis adjusting for the representativeness of the study sample in terms of the Swiss population demographic figures for gender, age, and education (FSO, 2019). However, given the complexity of the issue and the experimental design, this study has a number of limitations that we discuss in the following.

Time Frame

The data were necessarily collected within a short period of time, due to the highly dynamic nature of COVID-19 and the continuous introduction of new social and physical distancing measures. These conditions may have affected respondents differently depending on the time at which they completed the survey. Furthermore, this time frame is not representative for the entire duration of the pandemic, and a survey of longitudinal effects could be useful in determining long-term adoption and acceptance of measures. However, obtaining data during this timeframe of the COVID-19 pandemic may be particularly informative about the effectiveness of the spokesperson during the early stages of emerging infectious diseases, which could greatly affect how individuals interpret health risk communications throughout the course of the pandemic.

Experimental Biases

As with all online surveys, our analyses are based on self-reported measures that might be susceptible to confirmation bias. Furthermore, our main outcome measures suffered from ceiling effects (but note that we nonetheless observed significant effects) that should be addressed in future experiments.

Spokespersons

We only compared two spokespersons in this study, a government official and an international celebrity who had been infected and outspoken about the pandemic prior to the survey. In the context of COVID-19, future research should consider a more diverse set of parameters for the selection of spokespersons, for example by including a scientist spokesperson or a citizen spokesperson, to better gauge the effectiveness of celebrity and government officials in communicating preventive health recommendations, particularly in the early stages of the pandemic when many of the facts may be uncertain. For celebrity spokespersons, it would also be pertinent to consider celebrities from different domains (e.g., the music or film industry, athletes, or even celebrities in science and education). Finally, the effect of the spokespersons' gender, ethnicity, and nationality on the reported adherence to distancing measures should be considered.

Political and Cultural Differences

For our study, we focused on Switzerland. However, one may reasonably expect differences in actual or reported behavior of people from different cultural background or political systems, e.g., in countries where free speech is not guaranteed and respondents may have to fear repercussions for perceived disobedience to authority.

Likeability

Our ability to gauge the effect of likeability was limited to a "like" versus "neutral" attitude toward the spokesperson. Perhaps a continuous measure would provide more testing power, and a larger sample size and more diverse selection of spokespersons might provide results for the response to "disliked" spokespersons.

Sample and Representativeness

Our sample size is relatively small and thus our ability to detect additional significant effects might be hampered by lack of power. In addition, our sample was not representative of the Swiss general population. It consisted of university students and Facebook users, who were highly educated (80% with $\geq$14 years of education), younger adults (60% between 18 and 34 years of age), and mostly females (78%). However, the sensitivity analysis suggests that the effect of age may be generalizable to the general Swiss population and that the spokesperson effect may be worthy of further investigation in subsequent, more highly powered studies of representative samples.

Self-Reported Versus Actual Behavior

Since our data solely consisted of self-reports, the extent to which observed effects reflect actual, rather than merely reported social distancing behavior is unknown. We emphasize, however, that our findings are nonetheless consistent with previous research on actual COVID-19 related behavior (Buckee et al., 2020), and that self-reported social distancing measures seem to reflect real-world behavior (Gollwitzer et al., 2020).

CONCLUSION

Even with the availability of a vaccine and improved medical treatment, strict social and physical distancing measures are necessary and perhaps our best strategy in combating the spread of COVID-19, which may need to be sustained as late as 2022 (Kissler et al., 2020). However, ensuring that these measures are enforceable for an extended period of time will be challenging. The limitations of our study notwithstanding, and consistent with lessons drawn from past pandemics (Vaughan and Tinker, 2009; Bish and Michie, 2010; Lyu et al., 2013), we can offer a number of recommendations that may help face these challenges. Our findings suggest that having an effective spokesperson might further increase adherence to these measures. Importantly, however, since different parts of the population appear to have different perceptions of risk and crisis, our findings also suggest that different spokespersons may be needed for different segments of the population and particularly for younger versus older populations. Evidence-based knowledge is thus required to further identify who would be the most effective spokesperson, in particular to groups with low risk perception and low compliance. While the effect sizes of our study are small, in the context of the COVID-19 pandemic, a modest effect can translate into saving the lives of thousands. Furthermore, the applicability of our findings is not limited to the COVID-19 pandemic, since they stand to be useful in the context of other respiratory infections, for which similar social distancing measures have been proposed (Glass et al., 2006; Bish and Michie, 2010; Qualls et al., 2017). Collectively, these findings may provide practical insight for the development of strategies to help mitigate this as well as future impending crises, and suggest that while previous research on the communication efficacy of public health messaging during pandemics reflect thoughtful, evidence-based strategies, they could be strengthened by having more emphasis on the messenger and not just the message.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the EPFL Human Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AA-A, AS, and RW contributed to the conceptualization of the study, design, and the administration of the survey. AA-A performed the analysis and drafted the manuscript. AS and RW provided statistical suggestion on the data analysis and contributed to the writing of the manuscript. All authors reviewed and approved the final version of the manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.564434/full#supplementary-material

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Athletes' Psychological Adaptation to Confinement Due to COVID-19: A Longitudinal Study

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Studies of individuals under conditions of confinement or severe social and physical restrictions have consistently shown deleterious mental health effects but also high levels of adaptability when dealing with such conditions. Considering the role of physical activity and sport in psychological adaptation, this paper describes a longitudinal study to explore to what extent the imposed restrictions due to the outbreak of SARS-CoV-2 may have affected athletes' mental health outcomes and how far the process of adaptation to confinement conditions is differentially affected depending on whether the sports activity was practiced individually or in a group, and outdoors, indoors, or both. Two hundred and seventy-four athletes were assessed over 7 weeks using the GHQ-28 and an *ad hoc* survey exploring the practice of physical activity. A mixed-model fixed effects ANCOVA was used to analyze the effects of time, place, and company in which the sport was practiced, with an index of the amount of physical activity expended as a covariate. Results show a significant effect of time in three out of four of the GHQ-28 subscales, in all cases showing a consistent adaptation to conditions over time. Results also show that playing sport indoors, outdoors, or both, and practicing alone vs. with others differentially affect the somatic symptoms exhibited during confinement: Athletes who practiced sport with others showed higher levels of somatic symptoms at the beginning of the set of data but a quicker rate of adaptation. Differences arising from practicing sport alone or with others were more pronounced in the case of indoor sports, which could be related to the fact that physical activity that can be practiced during confinement is more similar to that practiced indoors alone. Implications relating to what sport psychologists and other health professionals may offer to athletes in stressful situations are discussed.

Keywords: COVID-19, confinement, psychological adaptation, sport, physical activity, mental health

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INTRODUCTION

Studies of individuals under conditions of confinement or severe social and physical restrictions have consistently shown deleterious mental health effects. This is the case of prisoners placed in solitary confinement. For instance, Chadick et al. (2018), using a pre-post design comparing a group of general population with people who had been up to 4 years in solitary confinement, found higher levels of depression, anxiety, post-traumatic stress, and somatic complaints in the latter. Valentine et al. (2019) reported a statistically significant association between length of segregation and mental illness outcomes; the longer the greater. Reiter et al. (2020), in a very recent study, found an extremely high rate of serious mental illness and self-harm of inmates in solitary confinement compared to the rest of the prison population. These results have also been confirmed in people facing other situations, which exposed them to medium or long periods of confinement and isolation, such as members of polar expeditions (Palinkas and Suedfeld, 2008) or astronauts on space missions (Suedfeld, 2005).

These isolated and confined scenarios are considered extreme and unusual environments due to their exotic, abnormal, and/or stressful nature, beyond the range of individuals' optimal survival and/or implying conditions far removed from ordinary living conditions, generally involving high levels of stress (Suedfeld, 1987).

The outbreak of the Severe Acute Respiratory Syndrome Coronavirus Type 2 (SARS-CoV-2), responsible for COVID-19 at the end of 2019, and its rapid expansion worldwide leading to the declaration of pandemic by the World Health Organization, brought governments of many countries to order a lockdown, which included the banning of social gatherings, the closing of schools and colleges, restrictions on traveling, and the imposition of stay-at-home orders on people not directly involved in essential activities. All of these can be considered an extreme and unusual environment, according to Suedfeld (1987). In fact, the studies already carried out on the impact and disruption this situation is producing worldwide have highlighted its stressful nature. For instance, in one of the first studies carried out, Wang et al. (2020) reported an increase in depressive and anxiety symptoms and stress levels in a sample of Chinese people from different cities in China during the initial stages of confinement, and Zhang et al. (2020) found individuals reporting several mental and physical health issues; the larger the restrictions to their ordinary life, the worse their mental and physical health conditions, just one-month after the commencement of confinement in that country. The same occurred in other countries, as Ammar et al. (2020b) reported in an extensive study including 1,047 participants from a wide range of countries, mainly from Asia, Africa, and Europe. These authors found an expected decrease in social participation but also a substantial reduction in life satisfaction. Moreover, authors also detected an increase in the reporting of depressive symptoms and in the need for social support.

Human beings, as social animals, need sociality (Hawkley and Capitanio, 2015), and confinement, if not challenging to survival, was definitely producing a substantial change in communities' ordinary way of living, seriously affecting their physical contact with other people and condemning many to a strict social isolation, not to mention the stress produced by uncertainty regarding one's own and others' health, jobs, and future way of living. In all cases, these situations are associated to an overlap between living and working environments, a non-desired separation from family and friends, a restriction on daily life activities including leisure activities, and forcing either physical closeness with cohabitants or full isolation for a period of time (Nicolas et al., 2019).

The crisis produced by the pandemic and confinement measures have also affected the practice of sport and physical activity (Ammar et al., 2020a; López-Bueno et al., 2020; Stanton et al., 2020), with competitions canceled and practicing physical activity out of doors banned or severely restricted at the height of the confinement. Precisely this reduction in physical activity, together with the cutback in social interactions, has been related to the increase in major sleep and psychological disorders (Chtourou et al., 2020; Lesser and Nienhuis, 2020; Stanton et al., 2020).

Psychological Adaptation to Stressful Conditions

Despite the large amount of evidence regarding the adverse consequences of isolation and confinement, several authors have also called for a more salutogenic outlook when focusing on the psychological effects of facing such extreme and unusual environments (Suedfeld and Steel, 2000). One particularly important aspect is the adaptability human beings show when dealing with isolated, confined, and/or extreme conditions. Adaptability has been defined as "the capacity to make appropriate responses to changed or changing situations; the ability to modify or adjust one's behavior in meeting different circumstances" (VandenBos, 2007). Likewise, many studies have used mental health as an outcome of adaptability [see Bartone et al. (2018), review on individual differences in adaptability to such conditions].

The idea of adaptation is not new in the field of psychology. According to Brickman and Campbell (1971), people usually tend to adapt to either strongly positive or strongly negative life events and are prone to return back to the baseline levels of subjective well-being. This idea has been tested through different pieces of research. For instance, Lucas et al. (2003), in a 15-year longitudinal study, surveyed over 24,000 16+-year-old German households assessing the effects of marital transitions on life satisfaction. Their findings showed that people tended toward stable levels of well-being and usually returned to their baseline level within a period of time after the event. However, they also appreciated individual differences among participants. As an example, those who reacted strongly to the events showed a slower return to baseline (Lucas et al., 2003).

Relationships Between Physical Activity, Mental Health, and Psychological Adaptation

Physical activity has beneficial effects across a very broad range of physical health outcomes, including cardiovascular health, metabolic functioning, musculoskeletal balance, functional capacity, and general health (Haskell et al., 2007; García-Hermoso et al., 2020). It has also shown protective effects over diseases such as colon cancer, stroke, or diabetes (Shiroma and Lee, 2010; Loaiza-Betancur et al., 2020; Loh et al., 2020) and is directly related to preventing obesity and the insidious effects of sedentarism (Kim et al., 2020), the "silent enemy" (Bauman, 2004).

However, the positive effects of physical activity are not just limited to physical outcomes: acute and chronic exercise have been shown to increase several cognitive-related outcomes, such as executive functioning and academic performance (Chang et al., 2012; de Greeff et al., 2018). Furthermore, there is a well-documented relationship between physical activity and mood, both increasing positive affect and reducing negative affect (Chan et al., 2019). Regularly practicing physical activity is associated with higher levels of health-related quality of life (Penedo and Dahn, 2005) and treatments based on promoting exercise have also been shown to be effective in reducing stress (Schnohr et al., 2005), anxiety, and depression (Steptoe, 2006; Perry et al., 2020). These results have also been confirmed during the pandemic, the individuals reporting worse mood being either those who had reduced the frequency of their regular physical activity or those who had remained inactive if they did not exercise pre-pandemic (Brand et al., 2020). Moreover, there is also a relationship between exercise, well-being, and health (Grant et al., 2009). Additionally, there exists a closed-loop linking physical activity, well-being, and health (Steptoe, 2006, 2010).

Likewise, physical activity contributes to increasing adaptation to extreme and unusual conditions. For instance, Niebuhr et al. (2013), in a large study of more than 15,000 United States army recruits, found that physical conditioning predicted better adaptation of recruits during their first 6-month service period. In the same vein, Schneider et al. (2013) found endurance exercising to increase adaptability in a group of six participants confined in the MARS500 capsule. Authors also highlighted not just exercise *per se* but the general immersive experience of practicing the activity (rhythmicity, refocusing, etc.) as the key factor contributing to adaptability.

The crisis produced by the pandemic and confinement has also affected the practice of sport and physical activity (Ammar et al., 2020a; López-Bueno et al., 2020; Stanton et al., 2020), with competitions canceled and practicing physical activity out of doors banned or severely restricted at the height of the confinement. Precisely this reduction in physical activity together with the cutback in social interactions have been related to the increase in major sleep and psychological disorders (Chtourou et al., 2020; Lesser and Nienhuis, 2020; Stanton et al., 2020). Additional stressors to athletes are career disruption, uncertainty regarding major competitions and qualifying tournaments, and limitations to accessing training facilities (di Fronso et al., 2020; Schinke et al., 2020).

Physical activity in children, adolescents, and young adults is achieved mainly through practicing sports and is related to energy liberation, friendship, and enjoyment. Therefore, the restrictions imposed due to the lockdown to check the spread of COVID-19 have severely affected the exercise to which athletes and sportspeople were accustomed. Nevertheless, confinement conditions do not equally affect all kinds of sports and/or physical activity. The imposed lockdown might have had a more severe impact on sports and physical activity carried out outdoors and with other people (e.g., soccer) and less severe on indoor activities that are usually practiced alone (e.g., calisthenics).

This study longitudinally explores the process of psychological adaptation to the confinement conditions. As mentioned, the psychological adaptation process can be expressed in terms of the extent to which the restrictions may affect athletes' mental health outcomes. The study is also focused on ascertaining how far these mental health outcomes are differentially affected according to the type of sport (individual or group) and the place (outdoors, indoors, or both) where it was practiced. As Brickman and Campbell (1971) suggested, it is expected that athletes will show a progressive reduction in mental health disorder outcomes over time, thus characterizing a process of psychological adaptation to the conditions imposed by the pandemic. However, even though the study is exploratory in nature, the adaptation process to confinement is also expected to be affected differently depending on the impact of restrictive measures on the sport activity: greater restrictions to the ordinary performance of the sport activity give rise to more limited contact with mates, worse mental health outcomes, and slower psychological adaptation to the situation.

MATERIALS AND METHODS

Participants

The sample comprises 274 participants (52.2% female) with ages between 18 and 73 years ($M = 35.8$, $SD = 14.1$). Inclusion criteria to participate in the study were as follows: (1) being 18+ years old, (2) being residents of Spain, and (3) practicing physical activity or sport a minimum of 1 h a day at least 3 days a week. Using a snowball sampling approach, participants were recruited through social networks (WhatsApp, Instagram, Twitter, and Facebook) where they were invited to participate in the study and to disseminate the link to acquaintances who may be interested in participating as well.

Instruments

Spanish Version of the Goldberg and Hillier (1979) General Health Questionnaire-28 (GHQ-28) (Lobo et al., 1986)

This is a symptom screening instrument for differentiating psychiatric from non-psychiatric patients, also used in epidemiological studies to identify somatic, anxiety, social dysfunction, and depression symptoms, which make up the seven-item each, four-factor questionnaire. Participants are asked about "how their health has been in general over the past week" and items are answered on a four-level Likert-type scale from "Better than usual" to "Much worse than usual." According to the Spanish adaptation, which uses what has been called the classic scoring method (see Campbell et al., 2003), they are scored as 0 or 1 based on the symptom being compatible or not with psychopathology. The scores for each factor ranged from 0 to 7; the higher the score, the more psychopathological symptoms shown. Examples of items are as follows: Have you recently. . . Been feeling perfectly well and in good health? (Somatic symptoms), . . .Lost much sleep over worry? (Anxiety and insomnia), . . .Been managing to keep yourself busy and occupied? (Social dysfunction), . . .Been thinking of yourself as a worthless person? (Severe depression).

The psychometric characteristics of the scale have been demonstrated adequate in the original adaptation and in other studies (Lobo et al., 1986; Godoy-Izquierdo et al., 2002). We assessed reliability in our sample *via* Cronbach's alpha, at each week of measurement. Depression showed low consistency at some measurement moments, with values ranging from 0.366 to 0.714. However, we found adequate reliability values for the other three subscales, ranging from 0.691 to 0.802 for Somatic Symptoms, 0.810 to 0.847 for Anxiety, and 0.779 to 0.835 for Social Dysfunction.

Sports Activity and Sociodemographic Survey

In the first wave, an *ad hoc* survey was designed to collect information about participants' age and gender as well as how many days a week they practiced sport, for how long each day (1 h, between 1 and 2 h, between 2 and 3 h, and more than 3 h), perceived intensity (light, moderate, and strong), whether the activity was individual or with others (individual sport, team sport, physical activity practiced alone, physical activity practiced with others, and more than one option), and what kind of activity. The following waves collected information about physical activity practiced during confinement (yes or no, how many days, for how long each day, degree of intensity, and kind of activity) and about the conditions and changes in confinement in the participants' area of residence.

Index of Quantity of Sports Practice

An Index of Quality of Sports Practice (ioQ) was computed based on subjects' reports on how many days a week they usually practiced sports or physical exercise before confinement, and the duration of each session. The IoQ was obtained by combining (i.e., multiplying) these two variables, with scores potentially ranging from 1 to 28. In our sample, this index ranged from 3 to 24 (M = 8.7, SD = 4.8).

Procedure

The study was carried out over 7 weeks extending from the beginning of April to May 2020, concurring with the establishment of tighter measures by the Spanish government on the whole country, their easing, and subsequent return to a "new normality."[1] Participants were asked to fill in the questionnaires online once a week on the Qualtrics platform. Athletes recruited using social networks who completed the first wave, including their e-mail address, received an e-mail with a link to the next series each Sunday morning at 8:00 am and were invited to access Qualtrics and answer the questions up until Monday at 11:59 pm. Participants who did not answer during Sunday received a reminder on Monday.

In order to protect the anonymity of participants' responses, they were asked on accessing the survey for the first time to create a code including their initials and the last numbers of their ID, which was used to associate their responses to the survey in the different waves.

Data Analysis

We calculated the descriptive statistics mean for the sample characteristics (gender, age, weekly frequency, intensity, duration, place, and company of exercise; see Participants). Polynomial F contrasts were carried out to test the linear

TABLE 1 | Sportive activities reported by the participants.

Sportive activity	Responses	% of responses	% of cases
Gym, fitness, dumbbells, TRX, crossfit, HIIT, GAP, and calisthenics	77	19.00%	28.10%
Jogging and trail running	46	11.30%	16.80%
Soccer, football, and futsal	40	9.90%	14.60%
Yoga, pilates, body balance, and bowspring	37	9.10%	13.50%
Swimming	35	8.60%	12.80%
Aerobic, zumba, body pump, and body combat	27	6.70%	9.90%
Biking	20	4.90%	7.30%
Tennis, paddle, and badminton	19	4.70%	6.90%
Trekking, walking, and hiking	17	4.20%	6.20%
Basketball	13	3.20%	4.70%
Athletics and triathlon	12	3.00%	4.40%
Dancing	11	2.70%	4.00%
Martial arts: karate, judo, taekwondo, boxing, and wrestling	10	2.50%	3.60%
Rugby	7	1.70%	2.60%
Lifeguard training	6	1.50%	2.20%
Water polo	5	1.20%	1.80%
Indoor cycling	4	1.00%	1.50%
Weightlifting, powerlifting, and power building	4	1.00%	1.50%
Climbing	2	0.50%	0.70%
Rehabilitation	2	0.50%	0.70%
Rowing, canoeing, and kayaking	2	0.50%	0.70%
Equestrianism	1	0.20%	0.40%
Fencing	1	0.20%	0.40%
Gymnastics	1	0.20%	0.40%
Ping-pong	1	0.20%	0.40%
Skating or skateboarding	1	0.20%	0.40%
Skiing	1	0.20%	0.40%
Surfing	1	0.20%	0.40%
Training for physical fitness test	1	0.20%	0.40%
Volleyball	1	0.20%	0.40%
Not specified	1	0.20%	0.40%
Total	406	100.00%	148.20%

N = 274 The total number of responses is greater than N, as each participant could report more than one activity.

[1]Confinement in Spain started on 15 March. On 30 March, when the study began collecting data, confinement measures were tightened, and remained till 11 May, when de-escalation commenced and ended on 21 June.

relationship between weekly frequency and intensity or duration of the exercise.

For each factor in the GHQ (Somatic Symptoms, Anxiety, Social Dysfunction, and Depression), we used a mixed-model fixed effects ANCOVA to analyze the effects of time (7 weeks), place (indoors, outdoors, or both), and company (alone, with others), and their potential interactions, on GHQ scores, using the IoQ of sport practice, age, and gender as covariates (control variables). The Bonferroni correction was applied to pairwise *post hoc* tests. The mixed random effects procedure can include cases with incomplete data, effectively handling missing values (Pardo and Ruiz, 2012, p. 92; Quené and van den Bergh, 2004). We selected compound symmetry as the covariance matrix structure, assuming that (1) all the time point measures have the same variance, and (2) there is symmetry (i.e., the same covariance between each pair of time point measures). Significance level was set at α = .050. All statistical analyses were performed using SPSS 25.

RESULTS

The participants reported taking exercise between 3 and 7 days per week (M = 4.4, SD = 1.1), mildly (2.9% of participants), moderately (56.9%), or vigorously (40.1%); a higher frequency per week was associated with vigorous exercise, $F(1, 271) = 47.92$, $p < 0.001$, and $\eta^2 = 0.147$. As for duration, participants exercised from 30 min to 1 h (29.9%), from 1 to 2 h (54.0%), from 2 to 3 h (12.8%), and more than 3 h (3.3%); a higher frequency per week was associated with higher duration, $F(2, 270) = 41.87$, $p < 0.001$, and $\eta^2 = 0.133$. Thus, participants who exercised more often tended to do so more vigorously and in longer sessions.

We classified the sports activities reported by the subjects regarding (a) where they performed them: indoors (137 participants, 50.0%), outdoors (70 participants, 25.5%), or both indoors and outdoors (67 participants, 24.5%); and (b) the company: alone (154 participants, 56.2%) or with others (120 participants, 43.8%). **Table 1** summarizes the activities reported.

Somatic Symptoms

Table 2 shows the estimated means and standard errors for the GHQ Somatic Symptoms values along measurements.

The mixed model yielded the following results: As per the controlled variables, IoQ had a significant effect, $F(1, 240.8) = 6.36$, $p = 0.012$; age did not, $F(1, 235.3) = 2.17$, $p = 0.142$; and gender was also significant, $F(1, 242.9) = 10.84$, $p = 0.001$.

Regarding fixed effects, whereas place and company did not show a significant effect on Somatic Symptoms in the GHQ, $F_{Place}(2, 246.1) = 1.81$, $p = 0.165$; $F_{Company}(1, 243.4) = 1.72$, $p = 0.191$; time did, $F_{Week}(6, 1187.7) = 16.51$, $p < 0.001$.

When the participants practiced both indoor and outdoor sports activities, there were no significant mean differences along time in any level of company, nor between company levels in any given week (all ps > 0.050).

The two-way interactions were non-significant, $F_{Place \times Company}(2, 244.8) = 0.54$, $p = 0.582$; $F_{Place \times Week}(12, 1{,}188.1) = 1.06$, $p = 0.396$; $F_{Company \times Week}(6, 1{,}188.3) = 0.80$, $p = 0.567$. However, we found a three-way interaction Place × Company × Week, $F_{Place \times Company \times Week}(12, 1{,}188.2) = 1.86$, $p = 0.035$. Based on *post hoc* analyses, and as can be seen in **Figure 1**, this three-way interaction shows that individuals were progressively adapting to the conditions through time, the later the better. However, adaptation was not the same depending on where (indoors, outdoors, or both) and with whom (with others or alone) the sport was practiced. Athletes who practiced sport with others, either indoors or outdoors (but not both indoors and outdoors), showed higher levels of somatic symptoms at the beginning of the set of data. Conversely, they showed a sharp negative slope, which is related to a quicker rate of adaptation. Differences arising from practicing sport alone or with others were more pronounced in the case of indoor sports, which could be related to the fact that physical activity that can be practiced during confinement is more similar to that practiced indoors alone (e.g., weightlifting at a gym) but more distant from sports played indoors with others (e.g., futsal).

Anxiety

We found no effect of place and company on anxiety scores, $F_{Place}(2, 256.4) = 1.03$, $p = 0.358$; $F_{Company}(1, 253.6) = 0.86$, $p = 0.353$, but we found a main effect of time, $F_{Week}(6, 1{,}189.4) = 19.27$, $p < 0.001$, and *post hoc* analyses showed a significant reduction in anxiety symptoms through time. We did not find interaction effects, either, $F_{Place \times Company}(2, 255.3) = 0.41$, $p = 0.960$; $F_{Place \times Week}(12, 1{,}189.9) = 0.65$, $p = 0.792$; $F_{Company \times Week}(6, 1{,}190.0) = 0.73$, $p = 0.626$; $F_{Place \times Company \times Week}(12, 1{,}189.9) = 0.57$, $p = 0.871$, from which we infer that this reduction appears regardless of place and company in which sport is conducted. The covariate IoQ had a significant effect on anxiety, $F(1, 249.8) = 6.60$, $p = 0.011$, as well as on gender, $F(1, 253.1) = 11.06$, $p = 0.001$, but not on age, $F(1, 246.1) = 1.35$, $p = 0.247$. **Table 3** shows the estimated descriptive statistics, by place, company, and time.

Social Dysfunction

We did not find main effects on social dysfunction for place or company, $F_{Place}(2, 261.9) = 0.60$, $p = 0.550$; $F_{Company}(1, 259.1) = 0.34$, $p = 0.560$. However, there was a significant effect of time, $F_{Week}(6, 1190.2) = 18.31$, $p < 0.001$; *post hoc* analyses show a decrease of mean social dysfunction scores along time, with a slight non-significant upturn at week 7. We did not find any interaction effects, $F_{Place \times Company}(2, 260.9) = 0.17$, $p = 0.842$; $F_{Place \times Week}(12, 1{,}190.7) = 1.17$, $p = 0.299$; $F_{Company \times Week}(6, 1{,}190.7) = 1.34$, $p = 0.235$; $F_{Place \times Company \times Week}(12, 1{,}190.7) = 0.88$, $p = 0.564$. The covariate IoQ showed no significant effect on social dysfunction, $F(1, 254.8) = 3.43$, $p = 0.065$; nor did gender, $F(1, 258.6) = 2.28$, $p = 0.133$; however, age did, $F(1, 252.1) = 7.62$, $p = 0.006$. **Table 4** shows the estimated descriptive statistics as a function of the factors.

Depression

We did not find any fixed effect or main effects on depression scores, $F_{Place}(2, 239.4) = 0.38$, $p = 0.685$; $F_{Company}(1,$

TABLE 2 | GHQ somatic symptoms.

		Week						
		1	2	3	4	5	6	7
Place	Company	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*
Indoor	Alone	0.78 (0.09)	0.57 (0.09)	0.50 (0.09)	0.39 (0.10)	0.37 (0.10)	0.44 (0.10)	0.41 (0.10)
	With others	1.08 (0.11)	0.79 (0.12)	0.97 (0.12)	0.64 (0.13)	0.54 (0.14)	0.43 (0.13)	0.61 (0.14)
Outdoor	Alone	0.69 (0.13)	0.39 (0.14)	0.50 (0.14)	0.39 (0.15)	0.32 (0.15)	0.19 (0.15)	0.54 (0.15)
	With others	1.05 (0.14)	0.79 (0.15)	0.63 (0.15)	0.59 (0.16)	0.39 (0.16)	0.28 (0.17)	0.11 (0.17)
Both	Alone	0.69 (0.14)	0.52 (0.15)	0.35 (0.15)	0.30 (0.15)	0.32 (0.15)	0.33 (0.16)	0.32 (0.16)
	With others	0.66 (0.14)	0.41 (0.15)	0.38 (0.15)	0.22 (0.15)	0.25 (0.15)	0.34 (0.16)	0.68 (0.16)

Estimated Means and Standard Errors Along Time, by Company and Place of Sportive Practice.

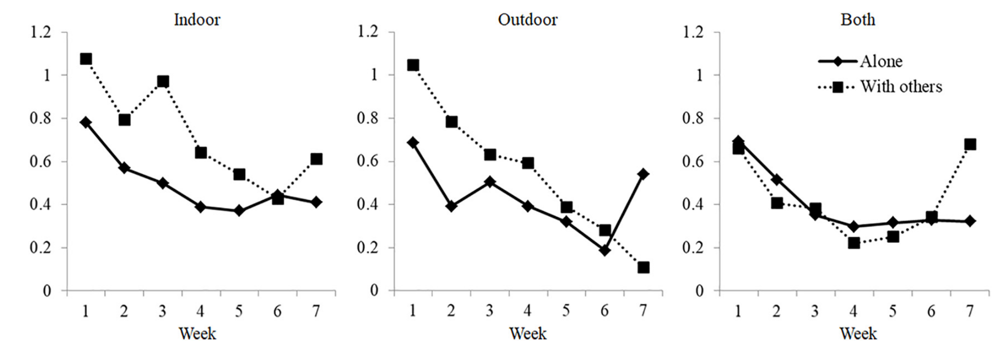

FIGURE 1 | Estimated means of the GHQ somatic symptoms scores along time, by place and company of sports practice.

TABLE 3 | GHQ anxiety.

		Week						
		1	2	3	4	5	6	7
Place	Company	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*
Indoor	Alone	1.07 (0.11)	0.81 (0.11)	0.77 (0.11)	0.60 (0.12)	0.59 (0.12)	0.56 (0.12)	0.67 (0.12)
	With others	1.20 (0.14)	1.06 (0.15)	0.91 (0.15)	0.64 (0.16)	0.68 (0.16)	0.52 (0.16)	0.73 (0.17)
Outdoor	Alone	0.87 (0.16)	0.68 (0.17)	0.65 (0.17)	0.65 (0.18)	0.53 (0.18)	0.46 (0.18)	0.58 (0.18)
	With others	1.20 (0.17)	0.91 (0.18)	0.95 (0.18)	0.63 (0.19)	0.64 (0.20)	0.68 (0.20)	0.60 (0.20)
Both	Alone	1.09 (0.17)	0.63 (0.18)	0.64 (0.18)	0.57 (0.18)	0.57 (0.18)	0.33 (0.19)	0.19 (0.19)
	With others	0.99 (0.17)	0.81 (0.18)	0.74 (0.18)	0.67 (0.18)	0.34 (0.19)	0.27 (0.19)	0.48 (0.20)

Estimated means and standard errors along time, by company and place of sportive practice.

236.9) = 3.35, p = 0.069; F_{Week}(6, 1,168.9) = 1.38, p = 0.221; or interaction effects, $F_{Place \times Company}$(2, 238.4) = 0.38, p = 0.684; $F_{Place \times Week}$(12, 1,169.4) = 0.71, p = 0.745; $F_{Company \times Week}$(6, 1,169.5) = 0.96, p = 0.883; $F_{Place \times Company \times Week}$(12, 1,169.4) = 1.05, p = 0.404. The covariate IoQ had a significant effect on depression, F(1, 33.0) = 14.45, $p < 0.001$; unlike age, F(1, 229.9) = 0.46, p = 0.500; or gender, F(1, 236.3) = 3.03, p = 0.083. **Table 5** shows the estimated descriptive statistics.

Discussion

The current study analyzes the psychological adaptation process shown by athletes and people accustomed to the regular practice of physical activity during COVID-19 confinement in terms of their mental health outcomes. According to our results, participants show higher levels of mental health distress at the beginning of the set, when confinement was imposed, which is in tune with the findings of some other studies (di Fronso et al., 2020), but also an adaptation through time, significantly reducing the scores over a period of 7 weeks. These results are in agreement with scholars who have praised human beings' capacity for resilience (Masten, 2001) and highlight the tendency people usually show to adapt to either strongly positive or strongly negative life events and return to their baseline levels of subjective well-being (Brickman and Campbell, 1971; Clark and Georgellis, 2013).

Authors have also emphasized the wide range of individual differences shown by people in their adaptation to stressful situations (Lucas et al., 2003). Sport plays a key role in promoting mental health and well-being (Penedo and Dahn, 2005; Steptoe, 2006, 2010; Chan et al., 2019) and has been successfully used for reducing stress, anxiety, and depression (Schnohr et al., 2005; Steptoe, 2006; Perry et al., 2020). Therefore, the current study has also analyzed to what extent the characteristics of the sport/physical activity practiced (i.e., place and company) might influence individuals' adaptation to confinement.

According to our results, engaging in sport indoors, outdoors, or both, and practicing alone vs. with others, differentially affects mental health outcomes shown during confinement, particularly in one of the subscales of the GHQ scores (somatic symptoms). People accustomed to practicing outdoor sports with others presented higher levels of somatic symptoms at the beginning of confinement compared to those used to practicing sport alone and indoors, though they also presented a sharper decrease in negative mental health outcomes. This can be related to the fact that confinement restrictions are at odds with practicing indoor sports with others, such as futsal, but not with practicing calisthenics, for instance. These results, however, do not fit with di Fronso et al.'s (2020) results, who did not find significant differences between individual and group sports. Nevertheless, our results show differences in the psychological adaptation shown by athletes that could be longitudinally analyzed. Moreover, di Fronso et al. studied perceived stress and psychobiological states, which are essentially related to emotional responses to a situational condition.

Likewise, it should be noted that all these results have been obtained by partialling out the effects of the amount of physical activity (IoQ) participants engaged in before lockdown, which are seen to have a significant effect in all the subscales. This means that the amount of physical activity is related to mental health outcomes, in tune with previous literature (Schnohr et al., 2005; Steptoe, 2006; Chan et al., 2019; Perry et al., 2020).

The current study is not without some strengths and limitations. Among its strengths, the study adopts a longitudinal approach to address the adaptability shown by athletes and sportsmen and women engaging in regular physical activity in an extreme and unusual environment such as the period of lockdown imposed due to the pandemic. Although adaptation is a dynamic process, most pieces of research on the topic have analyzed the process from a cross-sectional approach (Frederick and Loewenstein, 1999; Lucas et al., 2003). Similarly, studies on the factors potentially underlying the differences among individuals during this adaptation process have usually been centered on personality and other inner traits, regardless of the role played by other possible influences (Lucas et al., 2003). As for the role of exercise in well-being (Grant et al., 2009), this study focuses on the type of physical activity and sport and with whom it is practiced, making it more or less liable to being affected by lockdown conditions and, therefore, promoting more or less rapid adjustments to these conditions.

TABLE 4 | GHQ social dysfunction.

		Week						
		1	2	3	4	5	6	7
Place	**Company**	***M (SE)***	***M (SE)***	***M (SE)***	***M (SE)***	***M (SE)***	***M (SE)***	***M (SE)***
Indoor	Alone	0.83 (0.11)	0.81 (0.11)	0.73 (0.11)	0.58 (0.11)	0.62 (0.11)	0.61 (0.12)	0.62 (0.12)
	With others	1.08 (0.13)	1.07 (0.14)	1.02 (0.14)	0.89 (0.15)	0.63 (0.16)	0.55 (0.15)	0.94 (0.16)
Outdoor	Alone	0.85 (0.15)	0.72 (0.16)	0.52 (0.17)	0.52 (0.17)	0.39 (0.17)	0.39 (0.17)	0.41 (0.18)
	With others	1.24 (0.16)	0.88 (0.18)	0.67 (0.18)	0.75 (0.19)	0.45 (0.19)	0.38 (0.19)	0.36 (0.19)
Both	Alone	1.01 (0.17)	0.82 (0.17)	0.62 (0.17)	0.68 (0.17)	0.71 (0.18)	0.37 (0.18)	0.52 (0.18)
	With others	1.04 (0.16)	1.02 (0.18)	0.76 (0.17)	0.61 (0.18)	0.40 (0.18)	0.59 (0.18)	0.64 (0.19)

Estimated means and standard errors along time, by company and place of sportive practice.

TABLE 5 | GHQ depression.

		Week						
		1	2	3	4	5	6	7
Place	**Company**	***M (SE)***	***M (SE)***	***M (SE)***	***M (SE)***	***M (SE)***	***M (SE)***	***M (SE)***
Indoor	Alone	0.09 (0.03)	0.08 (0.03)	0.11 (0.03)	0.08 (0.04)	0.08 (0.04)	0.07 (0.04)	0.10 (0.04)
	With others	0.09 (0.04)	0.16 (0.04)	0.11 (0.04)	0.08 (0.05)	0.12 (0.05)	0.09 (0.05)	0.09 (0.05)
Outdoor	Alone	0.04 (0.05)	0.05 (0.05)	0.02 (0.05)	0.03 (0.05)	0.02 (0.05)	0.02 (0.05)	0.02 (0.06)
	With others	0.18 (0.05)	0.14 (0.05)	0.11 (0.06)	0.07 (0.06)	0.08 (0.06)	0.05 (0.06)	0.05 (0.06)
Both	Alone	0.06 (0.05)	0.05 (0.05)	0.07 (0.05)	0.03 (0.05)	0.04 (0.06)	0.01 (0.06)	0.01 (0.06)
	With others	0.10 (0.05)	0.11 (0.06)	0.12 (0.05)	0.16 (0.06)	0.00 (0.06)	0.12 (0.06)	0.13 (0.06)

Estimated means and standard errors along time, by company and place of sportive practice.

Among its limitations, we did not find any main or interaction effects on the Depression subscale. However, the GHQ Depression subscale shows a low internal consistency, which could mean that we are missing some interesting effect due to this low reliability.

Furthermore, the study does not assess any personality dimensions or other factors such as social support, which have been shown to influence the adaptation process (Cocking, 2017; Bartone et al., 2018). Moreover, mental health outcomes have been used as a measure of adaptation. Such outcomes are present in many studies observing people's psychological adaptation. However, attending to the fact that the GHQ is usually applied to mental health screening, it may have failed to detect other subtle manifestations of lack of adaptation. GHQ is a widely used instrument due to its psychometric properties and because it is an easy-to-administer scale, which might not prevent participants, particularly in a follow-up study, from giving up due to boredom and demand. In any case, a number of participants abandoned the study and this may have biased the original sample.

It should also be mentioned that the categorization of sports as indoor/outdoor and individual/group has been based on the information reported by participants. Even though there are sports that are played either indoors or outdoors in natural surroundings, others can be practiced both as indoor and outdoor games (e.g., basketball). In the same vein, there are individual sports that are practiced in groups (e.g., cycling). Our classification is based on the information reported by participants who stated whether they usually practiced sport indoors/outdoors or on an individual/group basis.

Finally, it may have been of interest to keep the series ongoing. However, the return to the "new normality" and the reduction in the number of participants fulfilling the last waves suggested the cancellation of data collection.

The study has implications relating to what sport psychologist practitioners and other health professionals may offer to athletes in stressful situations such as this. For instance, it has shown that athletes, in general, tend toward a psychological adaptation to the stressful conditions they have to face, but there are important individual and group differences. This means that intervention programs can be designed to improve such psychological adaptation. Health professionals may focus not only on mitigating the deleterious effects of canceling or restricting sports activities, but also on dimensions such as time management, personal growth, health habits, and general coping strategies to life events (Andreato et al., 2020; Batey and Parry, 2020; di Fronso et al., 2020; Jukic et al., 2020). Moreover, promoting social links with coaches and peers that may explain the scarcity of other significantly different studies found on comparing individual vs. team sports (di Fronso et al., 2020) might also be a way of reducing psychological impact and promoting adaptation to stressful conditions such those imposed by the pandemic (Bertollo et al., 2020).

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Subcomité de Ética. Facultad de Psicología. Universidad Autónoma de Madrid. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

VR designed the study, supervised the data analysis, and wrote the first draft. IS-I carried out the data analysis and contributed to the final manuscript. MB recruited athletes and proceeded with the different survey waves. GM contributed to the design of the study, supervised the data collection, and revised the final version. All authors contributed to the article and approved the submitted version.

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The Psychological Impacts of COVID-19 Home Confinement and Physical Activity: A Structural Equation Model Analysis

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Background: COVID-19 break out has created panic and fear in society. A strict kind of lockdown was imposed in Wuhan, Hubei province of China. During home confinement due to lockdown, people face multidimensional issues. The present study explored the psychological impacts of COVID-19 home confinement during the lockdown period and Wuhan's residents' attitude toward physical activity.

Methods: A cross-sectional online survey was conducted to collect the primary data according to the study objectives. The population was Wuhan residents (+ 18 years) who were in home confinement. A total of 2280 participant's reply to the online questionnaire survey and collected data after quantifying the data, about 2200 (96.49%); about (49.8%) female, about (49.4%) male, others about (0.2%), and about (0.6%) were not disclosed their gender participants responses were used for analysis. The collected data were analyzed through appropriate statistical techniques.

Results: According to results, H1 is supported with $\beta = -40.793$, $t = 57.835$, $p = 0.000$, which claimed a negative association between COVID-19 lockdown policy and behavior and attitude. Results for H2 reveals that the COVID-19 lockdown policy have negative influence on emotional control with $\beta = -0.769$, $t = 46.766$, $p = 0.000$ and it is supported. H3 documented a significant positive relationship between COVID-19 lockdown policy and lockdown period psychological impact, which means lockdown policy, is the main reason to increase the lockdown psychological impact. Further, COVID-19 lockdown policy have negative influence on physical activity (H4) and self-belief (H5) with $\beta = -0.657$, $t = 32.766$, $p = 0.000$ and $\beta = -0.620$, $t = -6.766$, $p = 0.000$ respectively. H6 stated that there is a positive impact of behavior and attitude toward physical activity. The results for H6, behavior, and attitude affecting the physical activity with $\beta = 0.401$, $t = 10$, $p = 0.000$, which is supported.

Conclusion: COVID-19 home confinement created various psychological impacts, negatively affecting the emotional state due to depression and anxiety. Physical activity is the best strategy to manage human nature's psychological issues, and people's attitudes were positive toward physical activity during home confinement. However, the lockdown policy also affects physical activity participation negatively, and a sedentary lifestyle prevailed during home confinement.

Keywords: COVID-19, psychological impact, lockdown, physical activity, China

INTRODUCTION

A novel beta coronavirus (COVID-19) emerged in Wuhan, Hubei province of China, which caused a worldwide public health emergency. It was declared a pandemic by the World Health Organization (WHO) due to its severity, which caused panic and anxiety (Pradhan et al., 2020). According to the WHO, the COVID-19 has spread across the world, and currently, 213 countries are facing different measures imposed by their governments to contain the COVID-19. On January 23, 2020, the Chinese Government, in the face of such a severe epidemic, implemented a variety of steps to prevent and control viral transmissions, such as the lock-out of entire cities, travel warning regulation, and home medical observations (Anna, 2020). Limitations on travel and outdoor leisure will eventually disrupt Chinese people's daily routine and lifestyle. People would also be less physically active, more sedentary, and more depressed, which could pose substantial risks to safety and wellbeing (Chen et al., 2020).

The lockdown policy implementation across China created many socio-psychological issues for the Chinese people in every life segment. During the lockdown period, people were remained confine at home to contain the pathogen. Home confinement has a long-lasting negative psychological impact on mental health and wellbeing. Chinese people faced anger, boredom, and loneliness during home confinement, increasing psychological issues such as depression, stress, and anxiety (Duan and Zhu, 2020). Different kinds of outbreaks, such as MERS, Ebola, and swine flu, caused multiple psychological impacts (Rubin et al., 2010; Al Najjar et al., 2016). Furthermore, Wang and Zhao (2020) reported higher anxiety among graduate students during the COVID-19 outbreak, which further created psychological impacts on their academic life. Limitations on travel and outdoor leisure will eventually disrupt Chinese people's daily routine and lifestyle. People would also be less physically active, more sedentary, and more depressed, which could pose substantial risks to safety and wellbeing (Chen et al., 2020). Quarantine brought multiple psychological impacts on people's lives, such as fear of infection, financial loss, boredom, and frustration (Brooks et al., 2020).

Home confinement has negative socio-psychological impacts on mental and physical health. Long term isolation creates negative emotions, impaired cognition, and stress (Hawkley and Capitanio, 2015). In the context of the COVID-19 pandemic negative impacts, a study conducted in Spain reported that adverse psychological effects have occurred on Spanish people, and women and young people suffered most (Rodríguez-Rey et al., 2020). Sleep quality is also negatively impacted by COVID-19. A study conducted by Xiao et al. (2020) reported a negative relationship between quality of sleep and psychological impacts. The WHO has recommended various protective measures to stop the transmission of COVID-19, and physical activity while staying at home is also one of the protective measures. Social isolation is essential as the global response to the pandemic of COVID-19 continues. In everyday tasks, the physical distance from others is conserved. The criteria for participation in physical activity have drastically changed. COVID-19 should have had a huge social impact as opposed to years of public safety lobbying. Many individuals rediscover the pleasure and happiness of exercise activities (Tison et al., 2020).

Previous studies regarding different outbreaks reported that the psychological impact of confinement differs from immediate effects such as impulsivity, frustration, uncertainty, dissatisfaction, isolation, depression, anxiety, denial, insomnia, the desperation to extremes of consequences, like suicide, fear of contracting, and transmitting the infection to family members (Robertsons et al., 2004). Compared with their sedentary peers, physically active people are less at risk for certain disorders, including cardiovascular diseases (Murtagh et al., 2010), metabolic disorders (Hamilton et al., 2014), and depressive symptoms. It is generally accepted that insufficient physical activity is a significant risk factor for cardiovascular diseases, elevated blood pressure, asthma, and breast and colon cancer. Physical inactivity is the leading cause of mortality across the world. The extended homestay can lead to increased sedentary behavior, such as spending too much time sitting down, reclining, lying down for screening habits, and often reducing physical activity. There is a clear health argument for continued physical activity in the home to remain healthy and preserve immune system function in the current precarious climate. Even though the virus pandemic is an immediate public health concern as soon as possible, there are few recommendations for public health as to what people should or can do to preserve their regular practice or physical activity habits. It is possible that an unintended negative effect can occur when remaining at home since efforts to prevent the transmission of the virus from human to human may lead to a reduction in physical activity (Owen et al., 2010; Chen et al., 2020). With the COVID-19 outbreak, some researchers have shown a good health case for maintaining physical activity at home to retain a healthy immune system function (Martin et al., 2009).

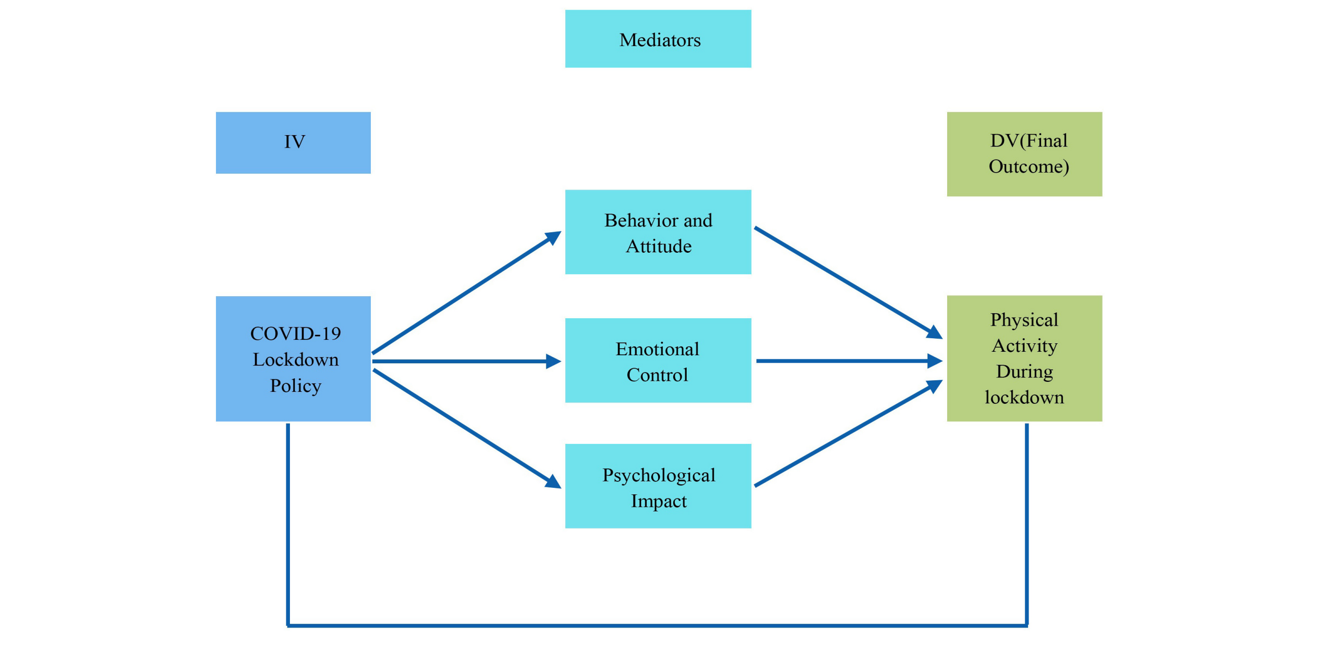

FIGURE 1 | The relationship between different variables of the study.

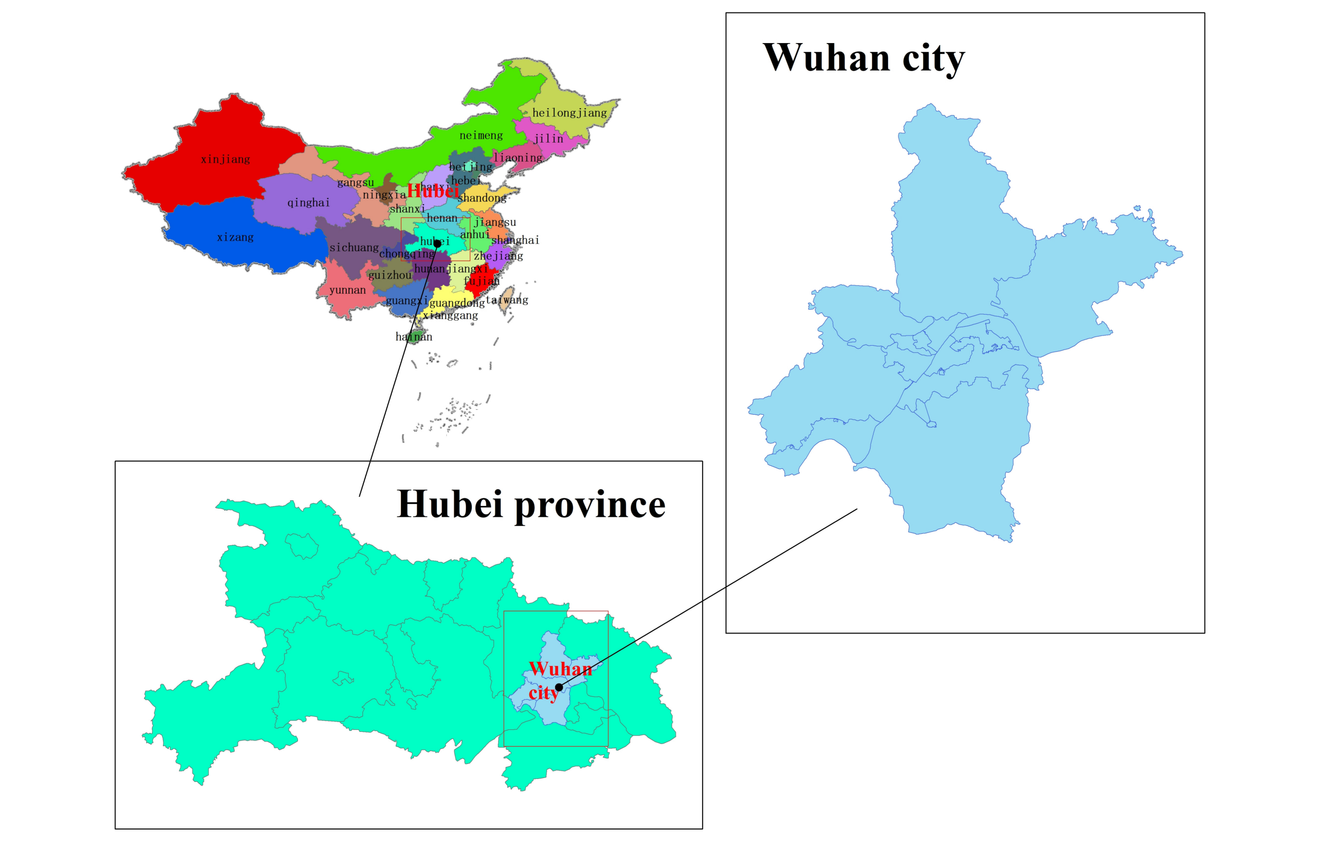

FIGURE 2 | Study population.

High-intensity physical activity results in the form of an immunosuppressant (Wetmore and Ulrich, 2006). Recent studies have suggested that daily physical exercise boosts the immune system and enhances resilience to infections (Gleeson, 2007; Nieman and Wentz, 2019). Besides, it is a physical health concern and a psychological disorder, given the context of social isolation and the perception of alienation. In older adults, even psychological distress symptoms were expected and may lead to psychiatric problems and a higher risk of psychological distress (Calati et al., 2019; Santinis et al., 2020).In the context of psychological wellbeing, physical activity and good quality of sleep have an association. Cross-sectional studies show that those adolescents who are physically active have good quality sleep than physically inactive adolescents (Park, 2014). In neurological disorder is based upon the central and peripheral nervous system diseases. These diseases are categorized as Alzheimer's, epilepsy, dementia, migraine, brain tumors, neuro-infections, and traumatic disorders. Physical activity also has a good impact on neurological functions. During physical activity, our brain mechanism also positively affects the molecular and cellular levels, improving brain health (Neufer et al., 2015). Research studies on aging populations show that cognitive decline can be protected through physical endurance activity (Boucard et al., 2012). Physical activity is a catalyst to improve the central nervous system, such as traumatic brain injuries and stroke. In the traditional context, physical activity enhances the brain's functions through nerve and muscle enhancement (Stroud et al., 2009).

TABLE 1 | Demographic characteristics of the survey participants (N-2200).

Variables	Categories	Frequency
Gender	Male	1086 (49.4%)
	Female	1096 (49.8%)
	Others	5 (0.2%)
	Prefer not to answer	13 (0.6%)
Age	18–24	830 (37.7%)
	25–34	193 (8.8%)
	35–44	390 (17.7%)
	45–54	414 (18.8%)
	55–64	136 (6.2%)
	65 years or older	237 (10.8%)
Education	Less than a high school degree	491 (22.3%)
	Associate degree	323 (14.7%)
	Bachelor's degree	581 (26.4%)
	Graduate degree	595 (27.0%)
	Others	210 (9.5%)
Marital Status	Single (never married)	918 (41.7%)
	Married or in a domestic partnership	1106 (50.3%)
	Widowed	108 (4.9%)
	Divorced	58 (2.6%)
	Separated	10 (0.5%)
Religious Belief	Yes	1993 (90.6%)
	No	128 (5.6%)
	Do not know/Not sure	79 (3.6%)
Ethnicity	Han Ethnicity	2172 (98.8%)
	National minority	28 (1.2%)
Employment status before COVID-19	Employed full time (including self-employed or homemaker)	762 (34.7%)
	Employed part-time (including self-employed or homemaker)	95 (4.3%)
	Unemployed	188 (8.6%)
	Student	695 (31.6%)
	Retired	278 (12.6%)
	Unable to work	182 (8.2%)

The present study was designed to explore the psychological impacts of Wuhan residents' COVID-19 home confinement and physical activity participation level during the lockdown period. Due to the various travel restrictions, outdoor physical activity venues such as playgrounds, dancing squares, and gymnasium were closed. Physical activity levels among the Chinese population but at the global level decreased due to the COVID-19 pandemic. Different exercises with numerous safe, convenient, and rapidly implementable technologies are perfect for preventing and remaining active in the airborne coronavirus. Exercise at home includes walking around the house and store, carrying things, scaling stairs, spinning, sitting and sitting on a chair and from the floor, squatting chairs, sit-ups, and push-ups. Also, as they require little facilities, space and are feasible in all circumstances, classical Tai Ji Quan, Qigong exercises, and yoga should be considered. Sport is a powerful Chinese society component for encouraging a healthy living style (Dai and Menhas, 2020). Other feasible ways of preserving physical function and psychiatric wellbeing during this crucial time include the use of e-Health and exercise videos that encourage and provide physical activity through the internet, mobile technology, and TV. Homestay is a vital measure for the defense that can restrict the spread of pathogens. However, prolonged house stays can lead to inactivity and trigger anxiety and depression, leading to a sedentary lifestyle that can lead to chronic illness. Maintaining regular physical activity and exercising in a clean home environment is essential during the coronavirus epidemic for a healthy lifestyle. The present study explored the psychological impacts of COVID-19 home confinement during the lockdown period and its implications on Wuhan's residents' attitude toward physical activity. The relationship between different variables of the study has been shown in **Figure 1**.

Hypothesis's of the Study

H1: COVID-19 lockdown policy (CLP) negatively influences the behavior and attitude (BA)

H2: There is a negative association between COVID-19 lockdown policy (CLP) and emotional control (EC)

H3: COVID-19 lockdown policy (CLP) positively influences the lockdown period psychological impact (LPPI)

H4: COVID-19 lockdown policy (CLP) has a negative influence on physical activity (PA)
H5: COVID-19 lockdown policy (CLP) has a negative influence on self-belief (SB)
H6: There is a positive effect of behavior and attitude (BA) on physical activity (PA) during COVID-19
H7: Physical activity (PA) positively influence through emotional control (EC)
H8: Physical activity (PA) positively influence through self-belief (SB)
H9: Physical activity (PA) positively influence through lockdown period psychological impact (LPPI)

MATERIALS AND METHODS

Study Locale

The present study was conducted in Wuhan city, shows in **Figure 2** below, the capital of Hubei province China. The research followed the principles of the Helsinki World Medical Declaration, and the ethics committee of Soochow University, Suzhou, approved the study.

Sampling

The population was Wuhan residents (+18 years) who were in home confinement. A convenience sampling technique was used to collect the data through an online survey. A total of 2280 participant's respond to the online questionnaire survey, and after quantifying the data, about 2200 (96.49%); about (49.8%) female, about (49.4%) male, others about (0.2%), and about (0.6%) were not disclosed their gender participants responses were used for analysis. The responses of the 80 participants were excluded because of missing data. The final sample for this study included 2200 surveys.

Data Collection and Procedure

The survey method was used to collect the data, and the survey was developed after review the psychosocial impacts of previous outbreaks of influenza and SARS (Rubin et al., 2010). A cross-sectional online survey was conducted to collect the primary data according to the study objectives. All the survey participants were informed about the purpose of the study and then received their consent. The collected data were proceeding anonymously, and the researchers performed a quality check. The anonymity of the survey participants and collected information privacy were assured. During the informed consent, it was confirmed that all data were used only for research purposes.

Measures

A cross-sectional online survey was conducted from February 20 to March 20, 2020, during Wuhan's lockdown. The questionnaire was based on both open-ended and close-ended questions regarding participants' socioeconomic information, the psychological impact of COVID-19, response to the COVID-19 psychological impact, and participation in physical activity during home confinement.

TABLE 2 | Display the measurement of research model with convergent validity (N-2200).

Constructs	Items	Loadings	VIF	Cα	SCR	AVE
Behavior and Attitude	BA1	0.923	3.89	0.945	0.960	0.858
	BA2	0.927	4.06			
	BA3	0.927	4.08			
	BA4	0.929	4.18			
COVID-19 Lock Down Policy	CLP1	0.893	3.21	0.924	0.943	0.768
	CLP2	0.884	2.92			
	CLP3	0.905	3.51			
	CLP4	0.819	2.16			
	CLP5	0.878	2.89			
Emotional Control	EC1	0.883	4.58	0.990	0.991	0.791
	EC10	0.889	4.65			
	EC11	0.884	4.55			
	EC12	0.890	4.68			
	EC13	0.894	4.90			
	EC14	0.888	4.59			
	EC15	0.886	4.41			
	EC16	0.886	4.58			
	EC17	0.888	4.68			
	EC18	0.887	4.65			
	EC19	0.892	4.96			
	EC2	0.886	4.54			
	EC20	0.891	4.82			
	EC21	0.893	4.82			
	EC22	0.894	4.92			
	EC23	0.895	5.05			
	EC24	0.885	4.56			
	EC25	0.898	5.07			
	EC26	0.892	4.87			
	EC27	0.895	4.92			
	EC28	0.894	4.90			
	EC3	0.883	4.49			
	EC4	0.888	4.61			
	EC5	0.882	4.52			
	EC6	0.890	4.73			
	EC7	0.886	4.67			
	EC8	0.885	4.57			
	EC9	0.892	4.97			
Lockdown Period Psycho-Impact	LPPI1	0.890	4.04	0.972	0.975	0.799
	LPPI10	0.899	4.36			
	LPPI2	0.891	4.14			
	LPPI3	0.896	4.31			
	LPPI4	0.893	4.07			
	LPPI5	0.895	4.15			
	LPPI6	0.891	4.02			
	LPPI7	0.898	4.38			
	LPPI8	0.896	4.30			
	LPPI9	0.886	3.89			

(Continued)

TABLE 2 | Continued

Constructs	Items	Loadings	VIF	Cα	SCR	AVE
Physical Activity during Lockdown	PA1	0.911	4.15	0.955	0.964	0.817
	PA2	0.895	3.58			
	PA3	0.901	3.87			
	PA4	0.906	4.02			
	PA5	0.899	3.71			
	PA6	0.911	4.09			
Self-Belief	SB1	0.928	3.37	0.917	0.947	0.857
	SB2	0.923	3.09			
	SB3	0.927	3.30			

BA = behavior and attitude, CLP = COVID-19 lockdown policy, EC = emotional control, LPPI = lockdown period psychological impact, PA = physical activity, and SB = self-belief.

Demographic Characteristics

Considering previous studies (López-Sánchez et al., 2020), the study included gender, age, education, marital status, religious belief, ethnicity, and employment status during COVID-19 as demographic factors. All variables were self-reported and categorized as gender (male, female, others, prefer not to answer), education (less than a high school degree, associate degree, bachelor's degree, graduate degree, others), marital status (Single; never married, married, or in a domestic partnership, widowed, divorced, separated married), religious belief (yes, no), ethnicity (Han ethnicity, national minority), and employment status (employed full time; including self-employed or homemaker, employed part-time; including self-employed or homemaker, unemployed, student, retired, unable to work).

TABLE 3 | Display discriminant validity analysis (N-2200).

	BA	CLP	EC	LPPI	PA	SB
BA	**0.926**					
CLP	−0.793	**0.876**				
EC	0.827	−0.769	**0.889**			
LPPI	−0.843	0.727	−0.803	**0.894**		
PA	0.743	−0.657	0.711	−0.678	**0.904**	
SB	0.669	−0.620	0.705	−0.667	0.535	**0.926**

BA = behavior and attitude, CLP = COVID-19 lockdown policy, EC = emotional control, LPPI = lockdown period psychological impact, PA = physical activity, and SB = self-belief.

TABLE 4 | Model fit summary **(N-2200).**

Statistical Tests	**Estimated Model**
SRMR	0.076
d_ULS	23.087
d_G	0.654
$\chi 2$	7425.338
NFI	0.954

SRMR = Standardized-root-mean-square-residual, d_ULS = Unweighted least squares discrepancy, d_G = Geodesic discrepancy, $\chi 2$ = Chi-square, NFI = Normed fit index.

The Psychological Impact of COVID-19

National lockdowns and home-confinement policies introduced in most COVID-19-hit countries after China prevent further spread of pathogens. A broad fraction of the global population is primarily limited to their homes (Rubin and Wessely, 2020). The lockdown period psychological impact (LPPI) was assessed by using Likert scale questions about feelings or thoughts during lockdown, behavior, and attitude (BA), self-belief (SB), and emotional control (EC).

Physical Activity

Physical activity is a catalyst for wellbeing and good health. Human biology requires a particular degree of physical activity to sustain good health (Leonard, 2010). Participation in physical activity was affected during lockdown due to the closure of parks, gyms, and public spaces. The survey participants participation in the physical activity was assessed through the questions (have you exercised, how many days in a week did you do vigorous physical activities, where did you do your physical activities most of the time during the Lockdown period, and physical activity levels during the lockdown period).

Statistical Analysis

The collected data were analyzed using Statistical Package for Social Sciences (SPSS) version 23.0 (SPSS Inc., Chicago, IL, United States). The statistical analysis was divided into three parts, univariate, bivariate, and multivariate, to analyze the psychological impact of COVID-19 home confinement and physical activity to achieve the study objectives. Under the multivariate analysis, the structural equation model was used to assess the association between different variables regarding the psychological impact of COVID-19 home confinement, cope with psychological stress due to COVID-19, and physical activity participation COVID-19 home confinement. Moreover, the study employed a structural equation modeling technique (SEM) to examine various variables' relationships. The PLS-SEM research design is a stable, versatile, and advanced tool

TABLE 5 | Final results for the standard beta, T-statistics, and *P*-values (N-2200).

Hypothesis's	Std. Beta (β)	T-Statistics	*P*-Values	Decision
CLP - > BA	−0.793	57.835	0.000	confirmed
CLP - > EC	−0.769	46.766	0.000	confirmed
CLP - > LPPI	0.727	43.968	0.000	confirmed
CLP - > PA	0.101	40.965	0.000	confirmed
CLP - > SB	−0.620	32.078	0.000	confirmed
BA - > PA	0.408	10.103	0.000	confirmed
EC - > PA	0.261	6.729	0.000	confirmed
SB - > PA	−0.033	1.202	0.230	Not-confirmed
LPPI - > PA	−0.073	1.731	0.084	Not-confirmed

BA = behavior and attitude, CLP = COVID-19 lockdown policy, EC = emotional control, LPPI = lockdown period psychological impact, PA = physical activity, and SB = self-belief.

for creating a significant statistical model, and the PLS-SEM role helps achieve the intended goal (Abbas et al., 2019). The structural equation modeling SEM technique was applied through the smartPLS 3.3.0 package. The structural equation modeling (SEM) also enables the study of linear associations between manifest variables and latent constructs (Aman et al., 2019). The structural equation modeling (SEM) for this study is characterized by six observed variables, as mentioned in **Figure 1**. The COVID-19 lockdown policy is used as independent variables, and mediators are behavior and attitude, emotional control, psychological impact, self-belief. In contrast, only physical activity during the lockdown period as dependent variables is used.

RESULTS

Descriptive Analysis

Demographic Characteristics of the Survey Participants

A total of 2200 survey participants completed the online survey, and **Table 1** shows the demographic characteristics of the target population. According to the descriptive statistics of the sample are depicted, the majority of the survey participants, about (49.8%), were female while about (49.4%) were male, others were about (0.2%), and about (0.6%) were not disclosed their gender. Age statistics show that the majority of the participants about (37.7%) belongs to the age group of 18–24, about (18.8%) falls in the age group of 45–54, about (17.7%) in the age group of 35–44, and about (10.8%) belong to the 65 + years, while only about (8.8%) participants in the age group of 25–34. Educational information of the survey participants shows that majority of the participants, about (27.0%) are holding graduate-level education, about (26.4%) have a bachelor degree, about (22.3%) have less than a high school degree, and about (14.7%) have an associate degree, while only about (9.5%) about other kinds of education such vocational and technical skills education. In the context of marital status, the majority of the participants about (50.3%) are married or in a domestic partnership, about (4.9%) are widowed, and about (2.6%) divorced. In comparison, only about (0.5%) are separated from their life partners. The majority of the participants, about (90.6%) have a religious belief, and about (5.6%) do not have any religious belief, while only about (3.6%) are do not know/not sure about religious beliefs.

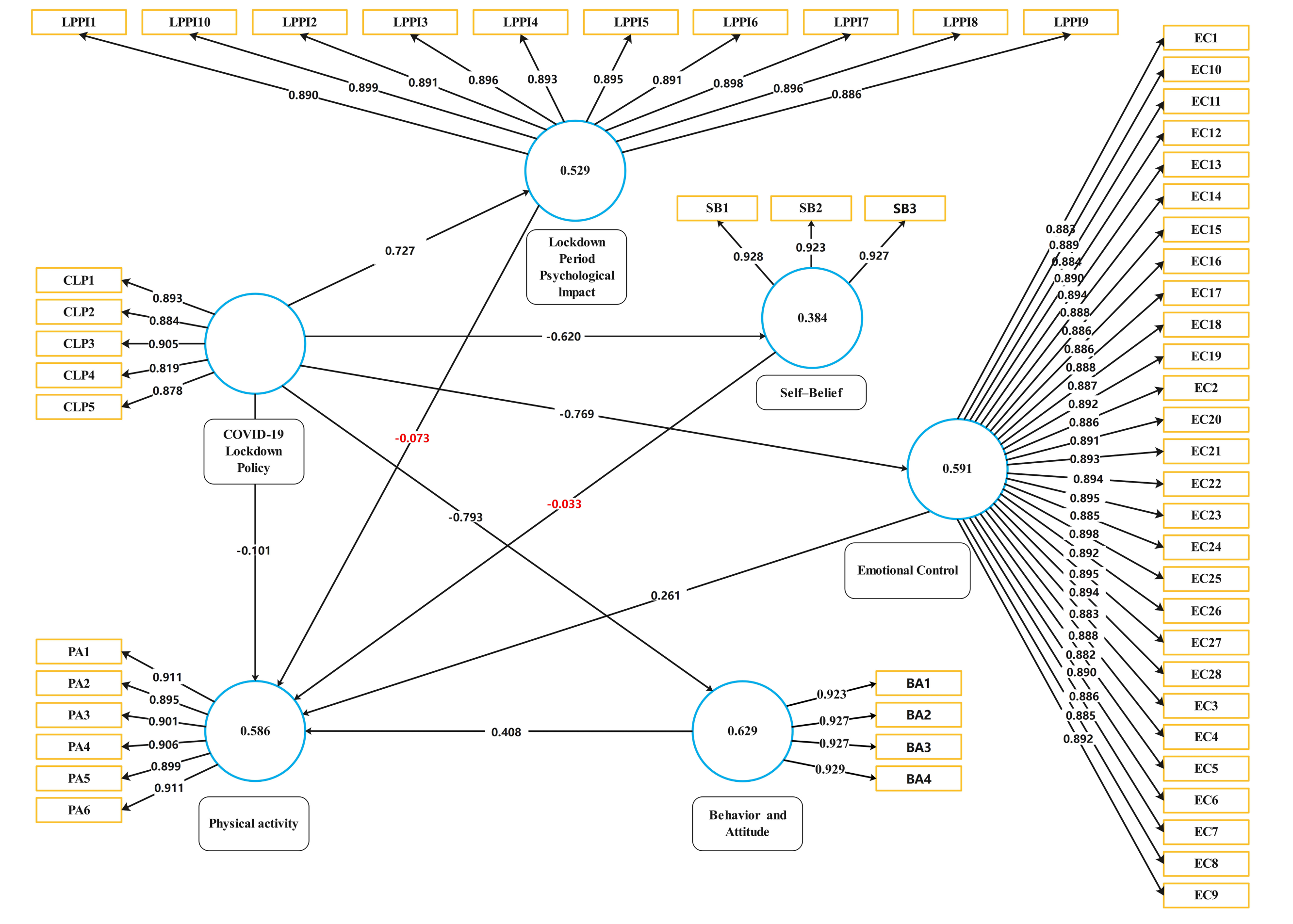

FIGURE 3 | PLS-SEM results.

In the employment context, the majority of the participants about (34.7%) are employed full time (including self-employed or homemaker), about (31.6%) are students, about (12.6%) are retired, about (8.6%) are unemployed, and about (8.2%) are unable to work, while only about (4.3%) are doing a part-time job.

Multivariate Analysis

Measurement of the Conceptual Model

The reliability was examined of included factors and items in an online survey through Cronbach alpha values. Calculated values of Cronbach alpha were 0.945, 0.924, 0.990, 0.972, 0.955, and 0.917 (See **Table 2**). The Cronbach alpha's standardized value for measuring the reliability is above 0.70, documented by Nunnally and Bernstein (1994). Thus, Cronbach alpha of each factor is considered reliable according to standard. Convergent and discriminant validity were determined through confirmatory factor analysis (CFA) for the proposed research model. Campbell and Fiske (1959) documented that the convergent technique assesses construct validity based on the multitrait-multimethod matrix (MTMM). The threshold level of factor loading values is 0.60, factor loading values of this work remained above than range, and the standard range of composite reliability (CR) values is above 0.70. The composite reliability (CR) values for each construct were calculated as 0.960, 0.943, 0.991, 0.975, 0.964, and 0.947 (see **Table 2**). The standard range of average variance extracted (AVE) is described as 0.50, and average variance extracted (AVE) values of this work are above than standard range of 0.858, 0.768, 0.791, 0.799, 0.817, 0.857 (Anonymous, 2018). The discriminant validity (DV) explained the measurement of constructs that theoretically did not relate one to another construct. Discriminant validation aims to provide any evidence of discrimination concerning dissimilarity of all factors (Campbell and Fiske, 1959). A useful evaluation of discriminant validity (DV) depends on a test of factors that are not positively correlated with other factors while calculating the overlap of measures on each other. Discriminant validity (DV) could be determined by comparing the Square Root of the average variance extracted (AVE) values of a factor with the correlation between constructs to other constructs.

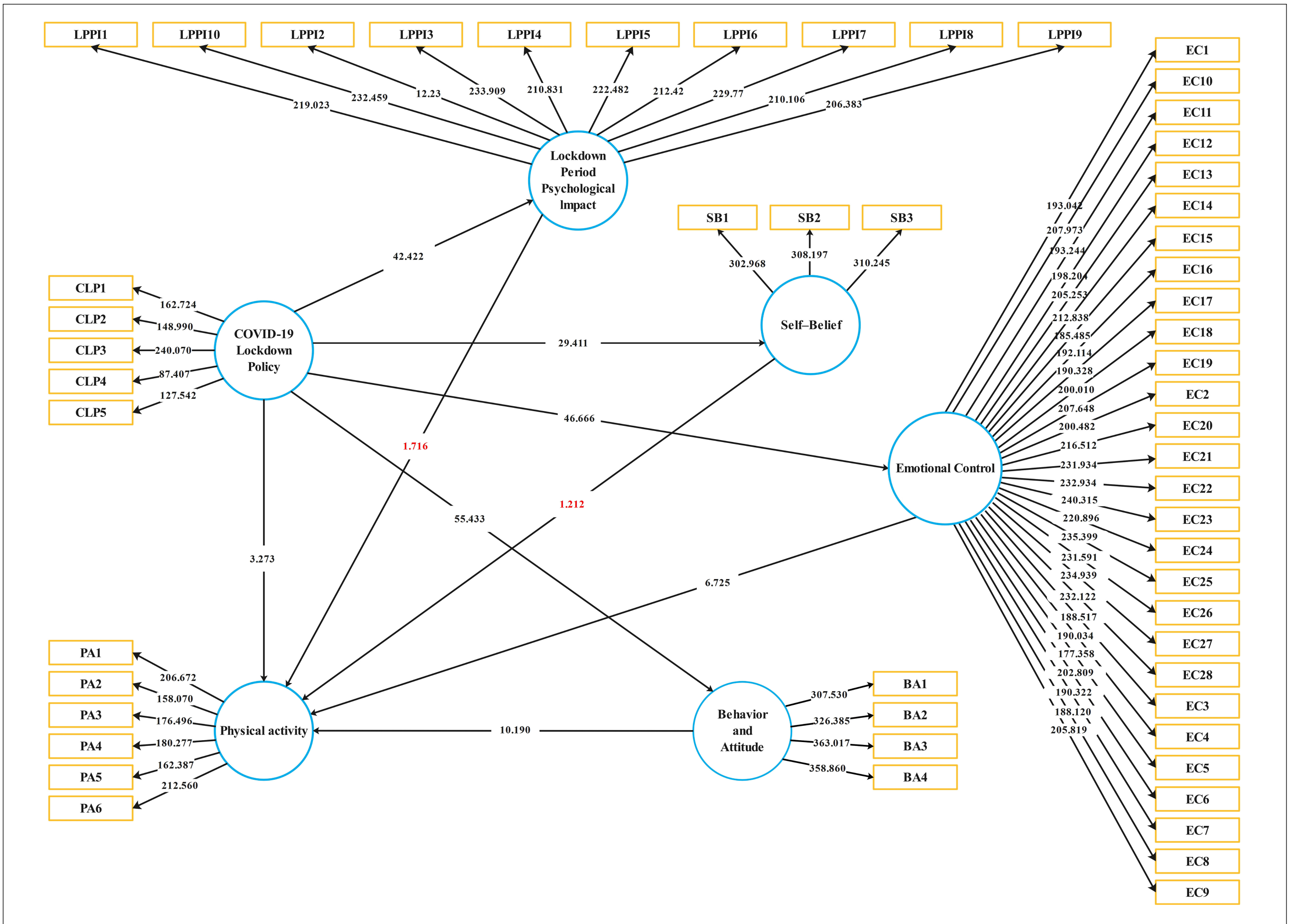

FIGURE 4 | PLS-bootstrapping T-values and observed variables relationship of the study.

Square Root of average variance extracted (AVE) values should be higher than correlations (Campbell and Fiske, 1959). According to the discriminant validity (DV) analysis, all square root of average variance extracted (AVEs) is higher than correlations values (see **Table 3**), which shows good evaluation. Further, the multicollinearity of all items was assessed by variation influence factor (VIF) value. The acceptable range of variation influence factor (VIF) is less than 10, and <5 are considered acceptable (Henseler et al., 2014; Hair et al., 2017). For this work, variation influence factor (VIF) values are less than < 5, which means there is no multicollinearity problem among all formative constructs, as mentioned in the given **Table 2**.

Structural Equation Model

The model fitness of this work was examined by standardized-root-mean-square-residual (SRMR); Normed fit index (NFI), and chi-square (χ^2) values. Standardized-root-mean-square-residual (SRMR) value is a standardized-residuals index that developed among observed covariance and hypothesized matrices, which shows model fitness (Brown, 2006; Chen, 2007). The acceptable range of standardized-root-mean-square-residual (SRMR) value is less or equal to 0.08. According to the results, the estimated standardized-root-mean-square-residual (SRMR) value is 0.076, acceptable as a good model fit. The normed fit index (NFI) value is 0.954, and chi-square (χ^2) shows the value of 7425.338, as shown in **Table 4**. Standard beta was calculated to examine the significance level of the proposed hypothesizes. The beta value explains the possible variation of the dependent factor from the independent factor. According to the hypothesized research model, the standardized beta (β) value for each relationship was calculated (see **Table 5**). If beta (β) values are high and significant, then the substantial effects of endogenous latent variables will be considered high. Further, the T-statistics method was used to verify the significance of the beta value for each path. B Bootstrapping technique was used to obtained beta (β) value to assess and evaluate the significance level of proposed relationships.

Table 5 and **Figure 3** show all beta (β) values of the structural model's proposed relationships for this work. **Figure 4** shows the PLS-bootstrapping T-values and observed variables relationship. The results for H1 statistically document that the COVID-19 lockdown policy reveals a significant negative impact on a person's behavior and attitude. According to results, H1 is supported with $\beta = -0.793$, $t = 57.835$, $p = 0.000$, which claimed a negative association betweenCOVID-19 lockdown policy (CLP) and behavior and attitude (BA). Results for H2 reveals that the COVID-19 lockdown policy have negative influence on emotional control with $\beta = -0.769$, $t = 46.766$, $p = 0.000$ and it is supported. H3 documented a significant positive relationship between COVID-19 lockdown policy (CLP) and lockdown period psychological impact (LPPI), which means lockdown policy, is the main reason to increase the lockdown psychological impact. COVID-19 lockdown policy (CLP) have negative influence on physical activity (PA) (H4) and self-belief (SB) (H5) with $\beta = 0.101$, $t = 32.766$, $p = 0.000$ and $\beta = -0.620$, $t = -6.766$, $p = 0.000$ respectively. H6 stated that there is a positive impact of behavior and attitude toward physical activity. The results for H6, behavior and attitude (BA) affecting the physical activity (PA) with $\beta = 0.401$, $t = 10$, $p = 0.000$ which is supported.

DISCUSSION

Psychological Impact of COVID-19 Home Confinement

The physical environment has a significant impact on behavior and attitude. A specific kind of environment, such as home confinement during the lockdown, created a sudden terror, which negatively impacted human nature. In several countries across the world, the COVID-19 coronavirus pandemic has altered ways of life. Therefore on January 26, 2020, the World Health Organization (WHO) announced a greater risk of an outbreak in China and other regions (Fan et al., 2020). According to the study results, ($\beta = -0.793$, $t = 57.835$, $p = 0.000$) claimed that there is a negative association between COVID-19 lockdown policy (CLP) and behavior and attitude (BA). Through an online survey of 4,872 Chinese people, a rapid assessment was carried out. The results showed a high prevalence of mental health problems among the general population, particularly anxiety and depression, negatively impacting behavior and attitude (Gao et al., 2020). A significant association has been reported by Li et al. (2020) between COVID-19 and different psychological aspects of human nature. In this context, Extreme long-term stress can trigger neuromuscular and autoimmune malfunction, which would impact and undermine the human's natural functions, leading to decreased throughout the body's capacity to prevent infection (Miller and Cohen, 2001). The study results show that there is a significant positive relationship ($\beta = -0.657$, $t = 32.766$, $p = 0.000$ and $\beta = -0.620$, $t = -6.766$, $p = 0.000$) among COVID-19 lockdown policy (CLP) and lockdown period psychological impact (LPPI) which means lockdown policy is the main reason to increase the lockdown psychological impact on Wuhan residents. In line with the results, as mentioned earlier, a higher prevalence of depression among young people has also been reported in recent studies (Huang and Zhao, 2020). Mental health issues among the general population in China were also triggered by the outbreak of COVID-19 (Bao et al., 2020). Further, the study results show that there is a negative influence of COVID-19 lockdown on emotional control ($\beta = -0.769$, $t = 46.766$, $p = 0.000$). Pérez-Fuentes et al. (2020) reported that the perceived threat from COVID-19 positively impacted moods of frustration-depression, anxiety, and hatred-hostility, while panic and resentment-hostility had a significant positive impact on the perception of the epidemic hazard. Time spent under quarantine measures has had a detrimental effect on emotions, and this is consistent with previously reported work on the mental health consequences of the COVID-19 lockdown (Ozamiz-Etxebarria et al., 2020). The impact of such isolation on mental health and wellbeing at personal and population levels is several times greater than physical suffering. Public lockdown enforced by national lockdown systems can generate mass panic, anxiety, and distress due to factors such as cornering feelings and loss of power (Brooks et al., 2020).

Physical Activity Participation During COVID-19 Home Confinement

Some researchers have shown with the COVID-19 epidemic that there is a good health argument for maintaining physical exercise in the home to preserve a balanced immune system function in the current unstable environment. Sports and physical activity contribute to health wellbeing. As lockdown imposed in Wuhan, public places such as dancing squares, playgrounds, and gymnasium were closed to contain the transmission of COVID-19. With the WHO's consultation, the Chinese Government announced various Chinese citizens' measures to keep physically fit while staying at home. Physical activity is one of the preventive measures which the Chinese Government announced. For certain disorders, including cardiovascular diseases and metabolic syndrome, physically active people are less at risk (Hamilton et al., 2014). The study results show a positive impact of behavior and attitude toward physical activity (β = 0.401, t = 10, p = 0.000). Moreover, COVID-19 lockdown policy (CLP) have negative influence on physical activity (PA) (H4) and self-belief (SB) (H5) with (β = −0.657, t = 32.766, p = 0.000) and (β = −0.620, t = −6.766, p = 0.000) respectively. Restrictions on physical movement also impact physical activity, and further social isolation also harms mental health wellbeing (Wilke et al., 20209). Social alienation is correlated with greater chronic illness morbidity and higher mortality from all causes. More than 30% of this impact can be caused by unhealthy health habits such as smoking and decreased physical activity (Valtorta et al., 2016).Moreover, COVID-19 lockdown policy (CLP) have negative influence on physical activity (PA) (H4) and self-belief (SB) (H5) with (β = −0.657, t = 32.766, p = 0.000). The negative influence of the COVID-19 lockdown policy (CLP) on physical activity (PA) shows a decline in daily physical activity. COVID-19 declared a global pandemic, and lockdown imposed across the world in different countries show the decline of physical activity. A study conducted in Canada and indicates a significant decline in step walking, moderate-to-vigorous physical activity (MPVA), and light physical activity (LPA) (Di Sebastiano et al., 2020). In the same paradigm, a study reported that overall physical activity and outdoor physical activity declined due to COVID-19 lockdown (Lesser and Nienhuis, 2020). The decreased levels of physical activity (PA) and sedentary lifestyle activity have been recognized as major problems arising from the outbreak while home detention (Bentlage et al., 2020). In the context of the above results, similar findings have been reported in a study regarding physical activity during Spain's lockdown period. According to the study results, the Spanish population's physical activity level declined in the first week of lockdown from 60.6% to 48.9% (López-Bueno et al., 2020). Health consciousness behavior and attitude play a significant role in the formation of a healthy lifestyle. A study conducted in China that explores the relationship between health consciousness and home-based exercise during the COVID-19 pandemic reported similar results as mentioned above (Pu et al., 2020). A significant driver of home-based exercise is health consciousness. The study participant's attitude and behavior are found positive toward physical activity due to health consciousness.

CONCLUSION

The COVID-19 pandemic created a panic across the globe when a severe lockdown was implemented in Wuhan. COVID-19 home confinement during the lockdown period made negative psychological impacts that further affect the socio-emotional state of the people. Health-based fears due to COVID-19 resulted in the shape of poor health wellbeing. Our study results show that due to the psychological impacts of COVID-19, people faced anxiety, depression, and an imbalance of emotional control state. Physical activity is a natural nutrient to cope with psychological issues and improve the human immune system's efficiency. Participation in physical activity is also affected due to the lockdown policy. According to the study results, the COVID-19 lockdown policy negatively influences physical activity and shows a decline in daily physical activity. Physical movement restrictions harm physical activity, especially on outdoor physical activity. Physical inactivity increased due to lockdown, which was further associated with psychological and health wellbeing issues. Overall regular physical activity has preventive wellbeing effects, especially in health-related psychological problems. Consequently, alternatives should also be provided whenever possible to be physically involved in the outdoors during public health restrictions.

Study Limitations

To participate in the survey, the respondent must be 18 years old and be a literate person. The convenience sampling technique was used under the non-probability sampling (NPS) method according to the study's objective and nature. The study's results can't be generalized to the whole population because it's hard to replicate the convenience sample results.

DATA AVAILABILITY STATEMENT

The datasets for this manuscript are not publicly available. Requests to access the datasets should be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee of Soochow University, Suzhou, China. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

RM developed the study model and hypothesis and drafted the manuscript. XS and YW collected the data through conducting a survey. ZAS and SM analyzed and interpreted the data. WI and BS drew the figures. SK did the proofreading.

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Amateur and Recreational Athletes' Motivation to Exercise, Stress, and Coping During the Corona Crisis

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The COVID-19 pandemic has negatively impacted mobility worldwide. As a corollary, the health of top- and lower-level athletes alike is profoundly reliant on movement and exercise. Thus, the aim of this study is to understand impacts of the COVID-19 pandemic lockdown on athletes' motivation to exercise and train. In detail, we aim to better understand who (i.e., demographic, sport-specific, and psychological state and trait variables) reported a change in motivation to train due to the lockdown, why they reported lower motivation (i.e., open-ended questions on problems), what they did to help themselves, what support they received from others, and what they are looking forward to after the lockdown (i.e., open questions). Questionnaire data and answers to these open-ended questions were assessed via an online questionnaire, completed by 95 amateur and recreational athletes during the first COVID-19 lockdown in Germany (April to mid-May 2020). Results show that greater numbers of female athletes are less motivated to train in comparison to male athletes (p = 0.029). No differences in motivation were found regarding type of sport (individual vs. team sport) and number of competitions during the year. Also, more motivated to train amateur and recreational athletes showed lower athletic identity than athletes who reported no change in motivation to exercise during the lockdown (p = 0.03). Additionally, differences in state emotional, perceived stress, and personality variables (i.e., orientation to happiness, volition) were found between athletes who stated that they were less motivated to train compared to athletes who reported no changes in motivation. In particular, closure of sports facilities and social distancing measures were perceived to be highly problematic. Even though athletes received emotional support, organized themselves via routines and schedules, and trained using online tools, they predominately stated that they wished that their coaches would have supported them more. Understanding the impacts of a pandemic-related lockdown on athletes' motivation, athletes' coping strategies, and their desired support will help better support them in future crises.

Keywords: corona, sport, athletes, coping, control balance theory, future, support

INTRODUCTION

During the first COVID-19 pandemic lockdown, it was as though all movement had come to a standstill. Even though Germany was not impacted as hard as its European neighbors, a nationwide lockdown was announced on March 18, 2020. Schools, restaurants, and sporting facilities were closed and social contacts were regulated at work and prohibited between households. These measures profoundly changed our interactions, including those of the sporting world. Since then, the physical and psychological consequences of COVID-19 pandemic lockdown on athletes have been described in several position papers and editorial statements (e.g., Association for Applied Sport Psychology; International Society of Sport Psychology: Henriksen et al., 2020). Specifically, sport science professionals and scientists have been asked to support athletes in overcoming this *crisis of uncertainty* (Leisterer et al., under review) and to provide guidance both during (e.g., Andreato et al., 2020) and after the crisis. They have, for example, been asked to help prevent health problems due to a potentially tighter competition schedule (Rea, 2020).

To provide adequate guidance from a sport perspective, we first need to adapt theories and models to the context of a lockdown (e.g., see the adapted Scheme of Change for Sport Psychology Practice by Samuel et al., 2020). Further, we need data on psychological variables of (amateur and recreational) athletes relevant to different stages of the COVID-19 pandemic (see Samuel et al., 2020) to gain insights into the mental states of athletes. In detail, this study aims to expand our knowledge on stress, anxiety, and coping during the lockdown (di Fronso et al., 2020, p. 10) and to investigate individuals' motivation or tendency to become physically (more) active when given the chance (Brand et al., 2020; González-Valero et al., 2020; Maher et al., 2020) during this very unusual time. Current developments underline the increasing relevance of being prepared for such crises and the need for developing appropriate intervention strategies (i.e., second lockdowns, canceled competitions).

Stress

The stage-A lockdown following the global COVID-19 pandemic has been implicated in athletes' instability and confusion, strong emotional responses and cognitive appraisal (Samuel et al., 2020). Moreover, the lockdown can be considered a career/transition barrier within a crisis transition (see athletic career transition model in Stambulova, 2011; adapted to corona crisis Stambulova et al., 2020, p. 2). Position papers and editorials published so far emphasize the negative impact of a lockdown on physical and psychological variables for athletes and for the sporting world as a whole (e.g., Andreato et al., 2020; Mehrsafar et al., 2020; see overview by Lim and Pranata, 2020). Stress, anxiety, and/or depression appear to be the most frequently mentioned negative consequences (e.g., Andreato et al., 2020; Frank et al., 2020; Mehrsafar et al., 2020; Schinke et al., 2020; Tingaz, 2020) or as Spitzer summarized it: "When we talk about the psychology of the corona pandemic, we talk about anxiety and loneliness" (2020, p. 279). Additionally, other emotions such as anger, frustration, denial, sadness, helplessness, fear, and/or an enormous sense of loss (AASP (Association for Applied Sport Psychology) Blog, 2020) may be related to the corona crisis. Specifically, interrupted training routines, financial problems (e.g., Andreato et al., 2020), social isolation, and distancing have increased (Schinke et al., 2020). These developments may also include lack of communication among athletes and coaches (e.g., Jukic et al., 2020), reduced training quality and quantity in elite sportswomen (Bowes et al., 2020) and handball players (Mon-López et al., 2020) and the general population (Maugeri et al., 2020). Furthermore, adverse behaviors such as drinking and smoking as well as eating and sleeping problems (e.g., Andreato et al., 2020; Maher et al., 2020), or increased gambling problems also in athletes (Håkansson et al., 2020) are evident. On the other hand, the corona crisis can be considered an *opportunity-provider* according to the corona crisis adapted athletic career transition model Stambulova et al., 2020, p. 6). That is, increased resourcefulness might be beneficial for athletes to overcome obstacles in the long-term. In the same vein, most position statements underline possibilities for personal growth and for stronger relationships that the crisis might offer (e.g., AASP (Association for Applied Sport Psychology) Blog, 2020; Schinke et al., 2020; Wylleman, 2020). These effects have already been empirically shown for an improved coach–athlete relationship (Li et al., 2020).

So far, only a few studies have actually investigated athletes' mental health in response to the lockdown and the few available results are inconsistent. In detail, it has been shown on a descriptive level that the mental state of 199 sport students from Bulgaria and Russia was not negatively impacted by the pandemic and related social isolation (data assessed in the last 2 weeks of April 2020 in Iancheva et al., 2020). On the other hand, elite athletes are reportedly worried about the future of their sport (66% of N = 327) and have reported feeling psychologically worse during the pandemic, according to the measures depression and anxiety (Håkansson et al., 2020). To our knowledge these are the only two studies that have compared data on stress variables prior to and during the COVID-19 lockdown. Results indicate that during the lockdown, perceived stress has increased significantly, and functional and dysfunctional psychobiosocial states have decreased significantly in over 1000 Italian athletes (data assessed April 2020 in di Fronso et al., 2020). On the contrary, however, a study investigating martial arts athletes and other athletes has shown a decrease in perceived stress during compared to the pre-lockdown period (data assessed May-July 2020 in Makarowski et al., 2020). Authors argue that this might be due to habituation, reduced training or competition schedules or a shift in personal priorities (Makarowski et al., 2020). Interestingly, they also found differences between countries. For example, martial arts athletes' intrapsychic stress was the highest in Lithuania, and significantly higher than in Poland or Romania. Differences in stress perception between male and female athletes were also investigated, and most studies have shown that females report higher levels of perceived stress during lockdown (e.g., di Fronso et al., 2020). In a similar vein, female Olympic and Paralympic athletes have shown higher levels of inflexibility and negative feelings compared to their male counterparts during lockdown (Clemente-Suárez et al., 2020). In a qualitative study, 40% of 18 elite athletes stated that they feel anxious and socially isolated during the COVID-19 pandemic (Tingaz, 2020) whereas 26% of the athletes reported an increase in self-awareness. In detail, they discovered something new about themselves that they were unaware of before (Tingaz, 2020). Overall, it can be stated that the COVID-19 pandemic can be considered both a barrier and a stressor (Tingaz, 2020) to which athletes respond and cope with individually.

Coping

Coping is defined as how we manage or regulate our emotions (i.e., problem-focused vs. emotion-focused; Lazarus, 2000). How athletes can cope and what measures they should undertake in the face of the crisis have been described in several psychological guidelines (e.g., Batey and Parry, 2020) and in the recommendations of task forces comprised of sport psychological experts, for example in the United States, Canada, and the United Kingdom (for more details see AASP (Association for Applied Sport Psychology) Blog, 2020). Aspects such as acceptance and adaptation, the importance of how to search for information, or monitoring thoughts and feelings have been mentioned as relevant (i.e., top 3 in Bertollo et al., 2020). The use of technological support and favorable living conditions, including healthy eating, having cardio equipment at home, engaging in alternative sport skills training and organized training at home have also been described as useful (e.g., Jukic et al., 2020). Sport psychologists have reported a higher demand for online psychological counseling (Mehrsafar et al., 2020). Techniques that sport psychologists commonly apply are mindfulness, guided performance imagery, re-setting goals, revisiting competition plans, affirmation exercises, and discussions of holistic life balance and values, depending on an athlete's individual needs (Schinke et al., 2020). In addition, further workshops are currently being developed and evaluated (Leisterer et al., under review).

Again, very few studies have investigated how athletes cope during the crisis and how they can be supported (see also Yang et al., 2020). In the sample of martial arts athletes, a variety of coping strategies emerged: denial, focus on and venting of emotions, alcohol/drug abuse and acceptance (Makarowski et al., 2020). Sport students from Bulgaria and Russia engaged in active planning/cognitive restructuring (i.e., problem-based coping) and emotional calming (i.e., emotion-oriented coping) whereas mentally withdrawing (i.e., distraction-oriented coping) from the situation showed lowest numbers (Iancheva et al., 2020). A similar order of coping strategies can be seen in a sample of 18 elite athletes from Turkey (Tingaz, 2020). Although possibilities were limited, all engaged in physical training (Tingaz, 2020), arguably as emotion-oriented coping. Additionally, athletes trained mentally (33%; i.e., problem-based coping) by watching previous competitions and taking up a new hobby (17%; i.e., distraction-oriented coping). Overall, data on athletes' coping strategies as well as their stress and anxiety levels during this bizarre time are limited and more detailed studies on the topic are needed (di Fronso et al., 2020, p. 10).

Motivation to Exercise

"Motivation refers to the extent to which our behavior is selected, directed, energized, and maintained to satisfy a particular motive" (Kazén and Quirin, 2018, p. 15). Motivation, or rather a lack thereof can be understood as the internally driven part of a COVID-19 career barrier (Stambulova et al., 2020, p. 3). In accordance to the definition, this means a lack of movement toward a particular motive (e.g., affiliation, achievement, power; Kazén and Quirin, 2018, p. 15). Scholars are convinced that this barrier will increase in athletes due to the corona crisis. In detail, they refer to loss of motivation (Clemente-Suárez et al., 2020), problems related the topic of motivation (Iancheva et al., 2020), and modifications in motivation (Samuel et al., 2020).

Thus, sport and exercise scientists have particularly emphasized the relevance of physical training and exercise during the pandemic (e.g., Filipas et al., 2020; Mehrsafar et al., 2020; Paoli and Musumeci, 2020). For example, a decline in physiological functions such as musculoskeletal, neuromuscular, respiratory, and the cardiovascular systems as well as a decrease in physical capacities such as power, strength, flexibility, speed, and endurance may result (see Lim and Pranata, 2020, p. 3). Not only does such a decline lead to an increased risk of injury (Lim and Pranata, 2020) but it may eventually have a negative impact on mental health (Pinto et al., 2020; Slimani et al., 2020).

In this vein, research has shown that frequency of exercise is positively related to mood during the lockdown (Brand et al., 2020). Also, physical activity in college students was positively associated with positive affect independent of the stressful life event (i.e., COVID-19 pandemic; Maher et al., 2020) as well as to mental well-being in the general population (Maugeri et al., 2020). In addition, the mental health status during the first COVID-19 lockdown was better in athletes than in non-athletes, providing support to the notion that physical activity may help protect mental health during times of crisis (Şenışık et al., 2020). Finally, retrospectively assessed data show that individuals with reduced physical activity due to the pandemic are the ones that report a significant decline in well-being, in comparison to pre-COVID-19 (Mutz, 2020). This all underlines the importance for (amateur and recreational) athletes to maintain their motivation to train and exercise. Moreover, this supports our study aims to investigate how many athletes maintain motivation and how they differ (i.e., demographic, sport-specific, and psychological state and trait variables) from athletes who fail to maintain their motivation to exercise.

Personality and Motivation to Exercise

There are several theoretical approaches that (a) provide explanations for a potential change in motivation to exercise (i.e., amotivation according the organismic integration regulation continuum within the self-determination theory, SDT by Deci and Ryan, 2000) and that (b) provide a rational for investigating psychological trait variables in the context of changed motivation, due to the lockdown (i.e., personality systems interaction theory, PSI by Kuhl, 2018; approach and avoidance temperament as personality structure by Elliot and Thrash, 2010).

In reference to SDT, it can be reasoned that due to the lockdown the autonomy to decide for example where, when, and with whom an athlete wants to train dissolves; the relatedness to others for example team mates or the coach vanishes, and finally feelings of competence might be endangered due to absence of a training schedule or the phenomenon of training without a coach. This all may decrease intrinsic motivation–due to the frustration of autonomy, relatedness, competence–and increase the risk of amotivation–due to missing opportunities to perceive competence or value.

According to PSI theory, an excessive increase in stress is characterized by low positive affect and high negative affect, and leads to a decrease in self-regulatory capacity (for further details please see Kuhl, 2018). For example, accessing the extension memory system, including stored action plans (e.g., going to exercise after school/work) as well as the behavioral control which is relevant for executing behavioral routines (e.g., practice went by in no time) needs more self-control or volitional components (Kazén and Quirin, 2018) and thus, not just motivation decreases but eventually, the execution of the behavior (i.e., exercise) will decline.

Finally, approach–avoidance is a motivational distinction (Lewin, 1935) and has been defined as a basic dimension of personality. Individuals with a high approach temperament are high in extraversion, positive emotionality and employ a behavioral activation system (Elliot and Thrash, 2010). During lockdown, these individuals could either experience no change or an increase in motivation to exercise. On the other hand, individuals with avoidance temperament are high in neuroticism, negative emotionality, possess a behavioral inhibition system (Elliot and Thrash, 2010) and might experience a decrease in motivation to train during lockdown. Overall, stress perception might differ between individuals and thus might impact motivation to exercise differently (PIS theory). Also, this impact of stress perception on motivation, might be modulated by differences in personality trait variables such as volitional components (see PSI theory) or extraversion, neuroticism, and anxiety as well as happiness (see approach and avoidance temperament). Thus, in a first step we aim to identify possible differences in these state and trait variables based on grouping individuals depending on their self-reported change in motivation from prior to, to during the COVID-19 lockdown.

So far, research during the COVID-19 crisis has investigated aspects of motivation only indirectly. In detail, it has shown that motivational aspects, which belong to the psychological modalities (i.e., motivation, emotion, cognition, volition) of the biopsychosocial states, have decreased in athletes (see di Fronso et al., 2020). In amateur athletes, rate of commitment to sport has remained high at 61.6% (30.7% moderate; 7.7% low commitment; see Angosto et al., 2020). Another study showed that for the period before to during the confinement, goals shifted and predict the intention to exercise during confinement (Mascret, 2020). In detail, on average, self-approach goals (i.e., improving oneself) decreased and self-avoidance goals (i.e., avoiding regression) increased during the confinement in almost 700 French athletes. Both goals predicted intention to exercise during confinement positively. Thus, the author concludes that situationally dependent adaptation of goals might be beneficial. Data from almost 14,000 individuals from Europe, Asia, as well as South and North America confirm this assumption and show that 44.2% reported no change in their exercise frequency during the COVID-19 lockdown and 31.9% increased their exercise (Brand et al., 2020). However, also 23.7% decreased their exercise frequency. Self-reported data from 631 physically active Germans show that 9% increased their physical activity, 42.4% maintained their level similar to Brand et al. (2020), and 48.7% reduced their level of physical activity (Mutz, 2020). However, postponement of goals such as participating in certain competitions or qualifications might lead to a decrease in motivation to train and exercise (e.g., AASP (Association for Applied Sport Psychology) Blog, 2020; Rea, 2020). Yet, as motivation is controllable, Stambulova and colleagues are convinced that sport psychologists could provide support in such cases (2020, p. 3).

Athletic Identity

Finally, one trait variable of interest is athletic identity, which has been argued makes athletes a special group that may be especially vulnerable during such a crisis due to their high athletic identity (Batey and Parry, 2020). This is considered to be true for high-performance athletes, amateurs and professionals alike (Schinke et al., 2020). Athletic identity is a part of one's self-concept, is considered to be relatively stable and is defined as the degree to which a person identifies with the role of being an athlete (Brewer et al., 1993). Due to social isolation, a strong, potentially narrow athletic identity can be critical as it may include increased anxiety and other mental health concerns (Henriksen et al., 2019). With regard to the construct of athletic identity and in line with this assumption, Costa et al. (2020) found a positive relation between athletic identity and rumination as well as catastrophizing in over 1000 Italian athletes during the corona lockdown in late April and early May. However, the question remains whether there is a difference in athletic identity, depending on athletes' motivation to train and exercise during a lockdown.

The Present Study

So far, little is known about (amateur and recreational) athletes' psychological reactions (i.e., motivation, stress, emotion, coping) to the COVID-19 pandemic lockdown. Further, we lack knowledge about the impact of the lockdown on athletes' motivation to train and exercise. However, lack of exercise can lead to physical and psychological damage (see Mehrsafar et al., 2020). Thus we aim to identify amateur and recreational athletes who have experienced a change in motivation due to the lockdown and who may need targeted support (Stambulova et al., 2020). In detail, we aim to better understand precisely who (i.e., demographic, sport-specific and psychological trait and state variables) has experienced a change in motivation. Further, we aim to explore the problems that amateur and recreational athletes experienced, what they did to help themselves, what support they received from others, which support they missed and what they look forward to following the lockdown (i.e., open questions). Thereby, our combined approach of open and closed questions overall aims to provide detailed information on amateur and recreational athletes' psychological state.

While we are able to put forward hypotheses for most variables, the remaining variables will be exploratory. In detail, we assume that there will be fewer females motivated to train than males due to higher levels of anxiety reported by females, and the relation of anxiety to motivation (Elliot et al., 2013). Older athletes should be less stressed (based on standard values of the general population, see Klein et al., 2016) and thus, their motivation should be less affected (see PSI theory). Regarding type of sport, we expect no differences between individual and team sport athletes based on findings by di Fronso et al. (2020). Athletes with higher training hours under normal circumstances should react less stressed (see stress-buffer hypothesis, e.g., Gerber et al., 2018) and thus, their motivation should be less affected (see PSI theory). Athletes with more competitions per year should experiences a larger decrease in motivation (see SDT).

Athletic identity will be the lowest in athletes who experience no change in motivation due to less rumination (see Costa et al., 2020). Trait anxiety is assumed to be the lowest in athletes who experience no change in motivation (see approach and avoidance temperament). Trait happiness is expected to be the highest in athletes who experience no change in motivation (see approach and avoidance temperament). Volitional components will be the highest in athletes who experience no change in motivation (PSI theory). Athletes high in neuroticism will experience a decrease in motivation to exercise, whereas athletes high in extraversion will show no change in motivation or an increase (see approach and avoidance temperament). Other personality traits (i.e., openness, conscientiousness, agreeableness) and coping strategies that might play an important role in such a crisis, for example in dealing with risks and its assessment (Funke, 2020) will be explored.

The level of perceived stress and negative emotions during the lockdown will be higher in athletes who experience a change in motivation in comparison to athletes who do not (see Tingaz, 2020; PSI theory). Conversely, positive emotions during the lockdown will be higher in athletes who experience no change in motivation (see PSI theory).

Finally, we will explore open questions regarding problems, coping strategies, wanted and received support and athletes' joyful anticipations for the time following lockdown. However, based on the athletic career transition model (in Stambulova, 2011) and based on open questions related to the different topics, we expect that both negative and positive aspects will be mentioned by the athletes.

MATERIALS AND METHODS

Participants and Procedure

Prior to the study, no calculations with respect to sample size was performed. Participants were recruited via social media and personal networks, and participated voluntarily without financial compensation. Unipark web-based survey software was used. One hundred eighty-three athletes started filling out the questionnaire and 51.91% finished with a mean processing time of 21 min.

A total of 95 German athletes (51 females, 44 males; M_{age} = 22.03, SD_{age} = 3.63) completed the cross-sectional online questionnaire during the COVID-19 lockdown in Germany (from April to mid-May 2020). Participants performed individual sports (n = 45) and team sports (n = 43) or both (n = 4). In detail, soccer (n = 13), volleyball (n = 11), fitness (n = 9), track and field (n = 8), triathlon (n = 7), strength training (n = 6), dancing (n = 5), combat sport (n = 5), handball (n = 4), CrossFit (n = 3), "diverse" (n = 3), gymnastics (n = 2), badminton (n = 2), rowing (n = 2), swimming (n = 2), cycling (n = 2), running (n = 2), floorball (n = 2), acrobatics (n = 2), table tennis (n = 1), water polo (n = 1), biathlon (n = 1), tennis (n = 1), climbing (n = 1), endurance (n = 1), fencing (n = 1), ice hockey (n = 1), basketball (n = 1), beach volleyball (n = 1), cross-country skiing (n = 1), pole dance (n = 1), and canoe slalom (n = 1) were mentioned.

Athletes practiced 8 h per week (SD = 4.5 h) and had on average 12 competitions per year (SD = 13.9) prior to the lockdown. The majority of sampled participants were amateur athletes (i.e., recreational athletes: n = 39; athletes competing on a regional level: n = 34). Only a few athletes competed on national (n = 11) and international (n = 11) levels. Almost all participants were students at university level (n = 90), two still went to high-school, and three were employed (i.e., one as a teacher, two provided no further information). Please see **Tables 1**, **2** for details on demographic and sport-specific data.

Measures and Material

Demographic and Sport-Specific Information

Participants were asked to report their age (in years), gender (male vs. female vs. diverse), the type of sport they practice, how often they train under normal circumstances (in hours), and finally, the number of competitions they participate in per year. Please see **Tables 1**, **2** for details on demographic and sport-specific data.

TABLE 1 | Demographic and sport-specific data for the complete sample (N = 95) dependent on motivational change to exercise (less: n = 33; same: n = 39; more: n = 23).

	Change in motivation to exercise from before to during lockdown			
	Less (n)	**Same (n)**	**More (n)**	**Total (n)**
Gender				
Female	23	15	13	51
Male	10	24	10	44
Total	33	39	23	95
Type of Sport				
Individual	15	20	10	45
Team	15	17	11	43
Both	2	2	0	4
Total	32	39	21	92

TABLE 2 | Demographic and sport-specific data for the complete sample (N = 95) dependent on motivational change to exercise (less: n = 33; same: n = 39; more: n = 23).

Change in motivation to exercise	*M*	*SD*	*Min*	*Max*
Age (in years)				
Less	21.85	3.59	15	34
Same	22.64	4.06	18	39
More	21.26	2.80	17	32
Total	22.03	3.63	15	39
Training duration (hours/week)				
Less	8.73	5.29	3	24
Same	9.14	4.41	4	21
More	5.85	2.36	2	11
Total	8.20	4.53	2	24
Competitions/year				
Less	11.79	15.99	0	70
Same	15.08	13.66	0	48
More	08.26	9.84	0	30
Total	12.28	13.86	0	70

Motivation to Exercise

Motivation to exercise and train was assessed via a single item: "How motivated are you to train in the current situation (COVID-19 pandemic) compared to normal circumstances?" In accordance with Brand et al. (2020), we were more interested in generally perceived changes in exercise motivation. Athletes answered *less*, *same* or *more*.

Psychological Trait Variables

Athletic identity

Athletic identity was assessed using the Athletic Identity Measurement Scale-Deutsch (AIMS-D; Schmid and Seiler, 2003). AIMS consists of seven items with three subscales: social identity (3 item, e.g., "I consider myself an athlete."; α = 0.769); exclusivity (2 items, e.g., "Sport is the most important part of my life."; α = 0.819); and negative affectivity (2 items, e.g., "I feel bad about myself when I do poorly in sport."; α = 0.785). On a Likert-scale ranging from 1 = *strongly disagree* to 7 = *strongly agree*, athletes were asked to identify how strongly they agreed with the statement. The total score for athletic identity (α = 0.890) is calculated as the sum of all items.

Anxiety

Trait Anxiety was assessed using the short form of the State-Trait-Anxiety Inventory (STAI; Grimm, 2009). This measure comprises 10 items on a Likert-scale ranging from 1 = *never* to 4 = *almost always*. A sum score of all items is used to describe trait anxiety (α = 0.807; example item: "I am inclined to take things hard.").

Happiness

Happiness was measured using the short form of the Orientation to Happiness Questionnaire (OTH; Ruch et al., 2014), which consists of three subscales with three items per subscale. Participants are asked to rate their life of pleasure (α = 0.727; e.g., "Life is too short to postpone the pleasures it can provide."), life of engagement (α = 0.650; e.g., "Regardless of what I am doing, time passes very quickly."), and life of meaning (α = 0.674; e.g., "My life serves a higher purpose.") on a 5-point Likert scale ranging from 1 = *very much unlike me* to 5 = *very much like me*.

Volitional components

The Volitional Components Questionnaire in Sport (VCQ-SPORT; Elbe and Wenhold, 2005) comprises 60 items, rated on a 4-point scale ranging from 0 = *not true for me at all* to 3 = *exactly true for me*. A total of 23 individual subscales can be organized into 4 more general subscales (lack of activation, self-optimization, loss of focus, and self-impediment).

In this study, we chose 11 items that fit one subcategory of the general subscales: Postponing training (α = 0.696; sample item: "I do not begin a strenuous training until the last minute") as part of lack of activation; goal setting general (α = 0.699; sample item: "I often focus on what I want to achieve in my sport") as part of self-optimization; lack of concentration (α = 0.648; sample item: "During training my thoughts often drift away from things I want to concentrate on") as part of loss of focus; and negative emotionality general (α = 0.652; sample item: "If I get into a bad mood during sport, it is difficult for me to brighten up again") as part of self-impediment.

Coping

To assess different coping strategies, we used the German short version of the Coping Inventory for Stressful Situations (CISS; Kälin, 1995) with 24 items, rated on a 5-point scale ranging from 1 = *not at all* to 5 = *very much*. The questionnaire comprises three subscales with eight items each: task orientation (α = 0.843; e.g., "Go out for a snack or meal."), emotion orientation (α = 0.752; e.g., "Become very tense."), and distraction orientation (α = 0.744). Furthermore, distraction orientation can be divided into distraction (α = 0.535; e.g., "Think about how I have solved similar problems."), and social distraction (α = 0.843; e.g., "Window shop.").

Personality

Based on the Big Five-Model, the Big Five Inventory 10 (BFI-10; Rammstedt et al., 2013) was used. Participants responded on a 5-point Likert scale ranging from 1 = *disagree strongly* to 5 = *agree strongly*. The inventory includes 10 items distributed equally across the five personality dimensions: Extraversion (α = 0.759; e.g., "I see myself as someone who is reserved."), agreeableness (α = 0.057; e.g., "I see myself as someone who tends to find fault with others."), conscientiousness (α = 0.550; sample item: "I see myself as someone who tends to be lazy"), neuroticism (α = 0.647; sample item: "I see myself as someone who gets nervous easily"), and openness (α = 0.373; sample item: "I see myself as someone who has few artistic interests").

Psychological State Variables

Discrete emotions (State)

The Discrete Emotions Questionnaire (DEQ; Harmon-Jones et al., 2016) was translated into German with the help of four bilingual speakers. The DEQ consist of 32 items (i.e., single words as "calm," or " lonely") and 8 subscales (i.e., anger: α = 0.733; disgust: α = 0.807; fear: α = 0.786; anxiety: α = 0.726; sadness: α = 0.790; desire: α = 0.716; relaxation: α = 0.869; happiness:

α = 0.828). Participants indicated how they currently felt using a Likert scale from 1 = *not at all* to 7 = *an extreme amount*.

Stress (State)

The short version of the Perceived Stress Scale (PSS-10; Klein et al., 2016) was used to assess the perceived level of stress within the last 4 weeks. The PSS includes the two subscales perceived helplessness (α = 0.854, e.g., "In the last month, how often have you felt nervous and "stressed"?") and self-efficacy (α = 0.723, e.g., "In the last month, how often have you felt that things were going your way?"). The total score of perceived stress (α = 0.882) is the sum of all perceived helplessness items and reversed perceived self-efficacy items.

Open questions on problems, coping strategies, wanted and received external support, and joyful anticipation

Due to the exploratory nature of the study, we decided to include open questions. In detail, questions assessing problems included: "Please list your three biggest challenges and problems due to the current situation (COVID-19 pandemic)."; for coping strategies: Please list the three most important strategies you use to deal with and overcome your current challenges and problems; for received external support: "Please list the most important help and support you receive in the current situation (COVID-19 pandemic), e.g., from coaches, association, family or friends."; for wanted external support: "Please list three additional concrete types of help and support you would like to receive and from whom you would like to receive it."; and finally for joyful anticipation: "List three things you are most looking forward to following the COVID-19 pandemic."

Data Analysis

Data were first checked for outliers and normal distribution. There were four outliers on the DEQ disgust subscale. Data were not normally distributed for most variables. However, it can be expected that the data represent the actual mean of a variable due to sample size (Bortz and Döring, 2006). Therefore, all analyses were performed using parametric statistics.

Mean differences between groups were tested by running several one-way analyses of variance (ANOVA). Significant main effects were followed up by Bonferroni-adjusted *post hoc* tests. We chose more open *post hoc* tests, for example in comparison to planned comparisons, because we aimed to capture as much information as possible due to the novelty of the research topic. Differences between groups related to gender and type of sport were performed using Chi-Square tests. For all analyses the level of significance was initially set at $p > 0.05$.

Finally, participants' qualitative responses (i.e., problems, coping strategies, wanted and received external support, and joyful anticipation) were exported to an Excel spreadsheet. After two researchers familiarized themselves with the data (Braun et al., 2016), they inductively and independently coded the data into tentative categories based on their own reflections. These categories were then discussed by both researchers (Creswell et al., 2007) and disagreements were resolved by discussion. These resulting categories, including the participants' mentioning each category, were counted and then listed for all participants based on their respective motivation to train and exercise (i.e., less vs. more motivated vs. no change).

RESULTS

Table 3 lists all descriptive statistics for psychological trait variables and **Table 4** for psychological state variables. **Table 5** features a correlation matrix for all variables.

Differences in Demographic and Sport Specific Variables

Age did not significantly differ between athletes with different self-reported motivation, $F(2,92) = 1.11$, $p = 0.334$. However, significantly more female athletes were less motivated to train ($n = 23$) during the corona crisis, χ^2 (2, $N = 95$) = 7.11, $p = 0.029$, $\omega = 0.274$ than male athletes ($n = 10$).

There was no significant difference in athletes' motivation related to the type of sport they practice, χ^2 (4, $N = 92$) = 1.54, $p = 0.82$. However, the one-way ANOVA showed a significant difference in training hours prior to the lockdown with respect to athletes' motivation, $F(2,92) = 4.47$, $p = 0.014$. Bonferroni-adjusted *post hoc* tests showed a higher number of training hours during normal circumstances in athletes who reported no change in motivation in comparison to athletes more motivated to train during lockdown, $p = 0.015$, $d = 0.93$. Finally, there was no difference in the number of competitions, $F(2,92) = 1.81$, $p = 0.170$.

Differences in Psychological Trait Variables

Athletic identity significantly differed depending on athletes' self-reported motivation to train during the COVID-19 crisis, $F(2,92) = 3.35$, $p = 0.035$. *Post hoc* tests showed that athletes who were more motivated to train, showed lower athletic identity than athletes who reported no change in motivation to exercise during the lockdown, $p = 0.03$, $d = 0.72$, 95% CI [−13.53, −0.52].

Trait anxiety showed a tendency, $F(2,92) = 3.35$, $p = 0.053$. Due to the exploratory nature of the study, we decided to investigate the *post hoc* tests (e.g., Lautenbach et al., 2016). We found a tendency for higher trait anxiety in athletes less motivated to train in comparison to athletes who reported no change in motivation to train, $p = 0.059$, $d = 0.53$, 95% CI [−0.72, 5.41].

Meaning, as a subscale of the OTH differed significantly between groups, $F(2,92) = 4.16$, $p = 0.019$, whereas pleasure ($p = 0.519$) and engagement ($p = 0.518$) showed no differences. *Post hoc* tests revealed that meaning was significantly less pronounced in athletes who reported to be more motivated to train during the lockdown, $p = 0.018$, $d = 0.75$, 95% CI [−1.17, −0.08].

Volitional components did not differ with respect to the subscales general goal setting (part of self-optimization; $p = 0.244$), lack of concentration (part of loss of focus; $p = 0.148$), and general negative emotionality (part of self-impediment; $p = 0.133$). However, the subscale postponing training (part of

TABLE 3 | Descriptive statistics of trait variables (i.e., athletic identity, trait anxiety, orientation to happiness, volitional competencies, coping style, BIG 5) for the complete sample (N = 95) dependent on motivational change to exercise (less: n = 33; same: n = 39; more: n = 23).

Change in motivation to exercise	*M*	*SD*	*Min*	*Max*
Athletic identity				
Less	50.79	11.59	16	67
Same	53.72	7.79	34	65
More	46.66	11.40	18	63
Total	51.00	10.40	16	67
Trait anxiety				
Less	33.18	5.23	23	44
Same	30.51	4.19	24	40
More	31.74	4.92	25	48
Total	31.74	4.84	23	48
Orientation to Happiness				
Pleasure				
Less	3.97	0.53	3.00	5.00
Same	3.90	0.72	2.00	5.00
More	4.10	0.67	2.00	5.00
Total	3.98	0.65	2.00	5.00
Engagement				
Less	3.17	0.57	2.33	4.33
Same	3.34	0.66	1.67	4.67
More	3.30	0.71	2.00	5.00
Total	3.27	0.63	1.67	5.00
Meaning				
Less	2.90	0.82	1.00	4.33
Same	3.27	0.79	1.00	4.67
More	2.64	0.99	1.00	5.00
Total	2.99	0.88	1.00	5.00
Volitional components				
Postponing training				
Less	4.79	1.65	3.0	9.0
Same	3.85	1.06	3.0	7.0
More	4.57	1.70	3.0	8.0
Total	4.35	1.50	3.0	9.0
Goal setting				
Less	8.06	1.87	4.0	11.0
Same	8.69	1.58	6.0	12.0
More	8.04	2.08	3.0	12.0
Total	8.32	1.82	3.0	12.0
Lack of concentration				
Less	3.18	1.29	2.0	7.0
Same	3.46	1.27	2.0	6.0
More	3.87	1.29	2.0	6.0
Total	3.46	1.29	2.0	7.0
Negative emotionality				
Less	6.03	2.23	3.0	11.0
Same	5.20	1.66	3.0	10.0
More	5.22	1.65	3.0	9.0
Total	5.49	1.90	3.0	11.0

(Continued)

TABLE 3 | Continued

Change in motivation to exercise	*M*	*SD*	*Min*	*Max*
Coping styles				
Emotion-oriented coping				
Less	2.95	0.85	1.38	4.50
Same	2.66	0.5	1.50	3.88
More	2.82	0.5	1.75	4.00
Total	2.80	0.65	1.38	4.50
Task-oriented coping				
Less	3.54	0.66	2.13	4.88
Same	3.67	0.59	2.13	4.75
More	3.55	0.80	1.00	4.50
Total	3.60	0.67	1.00	4.88
Distraction-oriented coping				
Less	2.77	0.67	1.00	4.13
Same	2.68	0.65	1.63	4.38
More	2.78	0.78	1.00	3.88
Total	2.74	0.68	1.00	4.38
Big Five Personality traits				
Extraversion				
Less	3.45	1.15	1.5	5.0
Same	3.20	1.07	1.5	5.0
More	3.78	0.64	2.0	5.0
Total	3.43	1.03	1.5	5.0
Agreeableness				
Less	3.26	0.87	2.0	5.0
Same	3.42	0.62	2.5	5.0
More	3.28	0.77	1.0	4.5
Total	3.33	0.75	1.0	5.0
Conscientiousness				
Less	3.52	0.86	2.0	5.0
Same	3.62	0.77	2.0	5.0
More	3.57	0.82	2.5	5.0
Total	3.57	0.80	2.0	5.0
Neuroticism				
Less	2.94	0.95	1.0	4.5
Same	2.61	0.90	1.0	4.5
More	2.72	0.99	1.5	5.0
Total	2.75	0.94	1.0	5.0
Openness				
Less	3.59	0.96	1.5	5.0
Same	3.12	0.80	2.0	5.0
More	3.43	1.00	1.0	5.0
Total	3.36	0.92	1.0	5.0

lack of energy), $F(2,92) = 4.1$, $p = 0.02$, was significantly lower in athletes who reported no change in motivation to train compared to athletes who were less motivated, $p = 0.022$, $d = 0.68$, 95% CI [−1.78, −0.10].

Coping strategies did not differ significantly between athletes (task orientation: $p = 0.676$; emotion orientation: $p = 0.157$; distraction orientation distraction: $p = 0.927$; distraction orientation social: $p = 0.833$; distraction orientation total: $p = 0.816$).

TABLE 4 | Descriptive statistics of state variables (i.e., discrete emotions, perceived stress) for the complete sample (*N* = 95) dependent on motivational change to exercise (less: *n* = 33; same: *n* = 39; more: *n* = 23).

Change in motivation to exercise	*M*	*SD*	*Min*	*Max*
Discrete emotions				
Anger (state)				
Less	3.14	1.15	1.50	5.75
Same	2.42	1.01	1.00	6.00
More	2.43	0.93	1.00	4.25
Total	2.67	1.09	1.00	6.00
Disgust (state)				
Less	1.36	0.63	1.00	3.50
Same	1.49	0.84	1.00	4.00
More	1.32	0.62	1.00	3.50
Total	1.40	0.72	1.00	4.00
Fear (state)				
Less	2.06	0.95	1.00	4.75
Same	1.85	1.10	1.00	5.00
More	1.57	0.74	1.00	3.75
Total	1.85	0.98	1.00	5.00
Anxiety (state)				
Less	2.88	1.15	1.00	5.50
Same	2.38	1.02	1.00	4.75
More	2.53	1.04	1.00	5.25
Total	2.59	1.08	1.00	5.50
Sadness (state)				
Less	3.55	1.30	1.50	6.75
Same	2.78	1.25	1.00	6.00
More	2.88	1.05	1.25	5.00
Total	3.07	1.26	1.00	6.75
Desire (state)				
Less	3.73	1.15	1.75	6.00
Same	3.96	1.32	1.50	6.25
More	3.80	1.13	1.50	5.75
Total	3.84	1.21	1.50	6.25
Relaxation (state)				
Less	3.39	1.11	1.25	6.75
Same	4.15	1.25	1.00	6.50
More	4.29	1.42	1.25	6.25
Total	3.92	1.30	1.00	6.75
Happiness (state)				
Less	3.23	1.29	1.00	6.25
Same	3.86	1.21	1.25	6.00
More	4.05	1.12	2.25	6.50
Total	3.69	1.25	1.00	6.50
Perceive stress				
Helplessness				
Less	12.70	4.55	2.0	21.0
Same	9.54	4.54	3.0	20.0
More	11.22	5.28	2.0	21.0
Total	11.04	4.88	2.0	21.0
Self-efficacy				
Less	8.00	2.75	2.0	14.0
Same	9.31	2.58	5.0	13.0
More	8.91	2.29	5.0	14.0
Total	8.76	2.61	2.0	14.0
Total stress				
Less	20.69	6.71	5.0	32.0
Same	16.23	6.57	6.0	31.0
More	18.30	7.14	6.0	31.0
Total	18.28	6.97	5.0	32.0

Personality parameters did not differ significantly between athletes who were less or more motivated to train or reported no change in motivation to train (extraversion: p = 0.1; agreeableness: p = 0.608; conscientiousness: p = 0.84; neuroticism: p = 0.342; openness: p = 0.083).

Differences in Psychological State Variables

Discrete emotions differed significantly between groups, anger: $F(2,92) = 4.97$, $p = 0.009$; sadness: $F(2,92) = 3.99$, $p = 0.022$; relaxation: $F(2,92) = 4.72$, $p = 0.011$; happiness: $F(2,92) = 3.71$, $p = 0.028$. *Post hoc* tests showed that anger is significantly higher in athletes who are less motivated to train in comparison to athletes who reported no changes, $p = 0.014$, $d = 0.67$, 95% CI [0.11, 1.32], and athletes who were more motivated, $p = 0.045$, $d = 0.67$, 95% CI [0.01, 1.39]. Sadness was significantly higher in athletes who were less motivated to train in comparison to those that reported no change, $p = 0.025$, $d = 0.63$, 95% CI [0.07, 1.48]. Athletes that were less motivated to train felt less relaxed in comparison to athletes that reported no change in motivation, $p = 0.033$, $d = 0.66$, 95% CI [−1.49, −0.05], and in comparison to athletes that reported to be more motivated, $p = 0.027$, $d = 0.74$, 95% CI [−1.74, −0.08]. Finally, athletes who were less motivated to train reported to be less happy than athletes who were more motivated to train, $p = 0.045$, $d = 0.61$, 95% CI [−1.62, −0.01].

Perceived stress level within the previous 4 weeks differed significantly the groups, $F(2,92) = 3.901$, $p = 0.024$. *Post hoc* analyses showed a significantly higher stress level in athletes who had less motivation to exercise in comparison to athletes who had no change in motivation, $p = 0.006$, $d = 0.68$, 95% CI [0.57, 8.37]. Also a significant difference in perceived helplessness was detected between groups, $F(2,92) = 4.002$, $p = 0.022$, showing that athletes with less motivation to train during the COVID-19 lockdown compared to athletes who experienced no change in motivation had higher levels of helplessness, $p = 0.006$, $d = 0.71$, 95% CI [0.43, 5.89]. No significant differences were found regarding self-efficacy, $F(2,92) = 2.360$, $p = 0.1$.

Correlations Between Psychological Trait and State Variables

Independent of our specific hypotheses and for purposes of future interest, **Table 5** presents a correlation matrix of psychological trait and state variables.

TABLE 5 | Correlation matrix of psychological trait and state variables.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1. Age	—																																	
2. Exclusivity (AIMS)	0.02	—																																
3. Negative affectivity (AIMS)	−0.16	0.62**	—																															
4. Social identity (AIMS)	0.00	0.62**	0.68**	—																														
5. Athletic identity total (AIMS)	−0.09	0.86**	0.83**	0.85**	—																													
6. Trait anxiety	−0.14	0.10	0.09	0.02	0.11	—																												
7. Pleasure (OTH)	−0.04	−0.02	0.00	0.02	−0.43	−0.23*	—																											
8. Engagement (OTH)	0.02	0.05	0.19	0.07	0.10	−0.36**	0.24*	—																										
9. Meaning (OTH)	0.08	0.06	0.14	0.10	0.05	−0.39**	0.04	0.40**	—																									
10. Postponing training (VCQ-SPORT)	0.00	0.06	−0.17	−0.07	−0.02	0.16	0.01	−0.12	−0.18	—																								
11. Goal setting (VCQ-SPORT)	−0.20	0.51**	0.53**	0.47**	0.58**	−0.03	0.03	0.28**	0.12	−0.05	—																							
12. Lack of conentration (VCQ-SPORT)	0.00	−0.01	−0.09	−0.09	−0.02	0.25*	−0.05	−0.13	−0.13	0.19	−0.05	—																						
13. Negative emotionality (VCQ-SPORT)	−0.02	0.15	0.02	0.09	0.16	0.31**	−0.05	−0.09	−0.12	0.21*	0.05	0.20	—																					
14. Task-oriented coping (CISS)	0.05	−0.06	0.12	0.02	−0.01	−0.56**	0.16	0.38**	0.36**	−0.21*	0.14	−0.28**	−0.11	—																				
15. Emotion-oriented coping (CISS)	−0.31**	0.17	0.16	0.18	−0.24*	0.52**	0.02	−0.17	−0.20*	0.20	0.07	0.23*	0.43	−0.38**	—																			
16. Discration-oriented coping (CISS)	0.02	−0.04	0.03	−0.06	−0.04	−0.25*	0.35**	0.29**	0.29**	0.06	−0.12	0.05	−0.20	0.24*	−0.11	—																		
17. Distraction-oriented coping: Distration (CISS)	0.07	0.08	0.08	−0.01	0.06	−0.12	0.17	0.23*	0.14	0.12	−0.10	0.10	−0.03	0.15	−0.10	0.72**	—																	
18. Distraction-oriented coping: Social (CISS)	−0.02	−0.11	−0.02	−0.08	−0.09	−0.26*	0.36**	0.25*	0.30**	0.00	−0.10	−0.01	−0.25	0.23*	−0.08	0.87**	0.29**	—																
19. Extraversion (BFI-10)	0.03	−0.16	−0.12	−0.11	−0.17	−0.34**	0.32**	0.12	0.13	0.02	−0.07	−0.02	−0.18	0.20	−0.22	0.47**	0.18	0.52**	—															
20. Agreeableness (BFI-10)	0.00	0.00	0.01	0.03	0.00	−0.34**	0.22*	0.25*	0.23*	−0.09	0.05	−0.09	−0.12	0.16	−0.12	0.45**	0.26*	0.44**	0.27**	—														

(Continued)

TABLE 5 | Continued

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
21. Conscientiousness (BFI-10)	0.10	0.22*	0.42**	0.21*	0.27**	0.02	−0.05	0.19	0.10	−0.35**	0.20	0.07	−0.11	0.13	0.06	−0.02	−0.08	0.03	−0.02	−0.07	–													
22. Neuroticism (BFI-10)	−0.14	0.05	0.05	0.03	0.06	0.56**	0.02	−0.19	−0.14	0.03	−0.01	0.27**	0.24	−0.39**	0.60	−0.03	−0.09	0.02	−0.12	−0.09	0.31**	–												
23. Openness (BFI-10)	−0.07	−0.14	−0.15	−0.14	−0.16	0.19	0.13	0.03	0.04	0.05	−0.07	−0.04	0.13	−0.15	0.13	0.26*	0.26*	0.18	0.09	0.00	−0.05	0.34**	–											
24. Anger (DEQ)	0.08	0.37	0.44	0.31	−0.09	0.33**	−0.13	−0.12	−0.18	0.09	−0.08	0.23*	0.28**	0.02	0.08	−0.07	−0.05	−0.06	−0.03	−0.02	0.02	0.17	−0.04	–										
25. Disgust (DEQ)	0.07	0.13	0.03	−0.02	0.05	0.13	−0.07	−0.09	0.02	0.16	0.07	0.14	0.15	0.05	0.01	0.06	0.03	0.07	−0.10	−0.11	−0.09	0.06	0.01	0.35**	–									
26. Fear (DEQ)	0.15	0.22*	0.13	0.08	0.19	0.36**	−0.15	−0.19	−0.13	0.21*	0.03	0.11	0.24*	−0.06	0.13	0.04	0.09	−0.01	−0.07	−0.09	0.00	0.16	−0.10	0.54**	0.54**	–								
27. Anxiety (DEQ)	0.06	0.12	0.05	0.04	0.13	0.43**	−0.20	−0.19	−0.21*	0.16	0.06	0.10	0.32**	−0.05	0.20	−0.10	−0.02	−0.13	−0.13	−0.30	0.02	0.27**	0.04	0.58**	0.37**	0.78**	–							
28. Sadness (DEQ)	−0.17	0.04	0.02	−0.04	0.04	0.54**	−0.06	−0.23*	−0.24*	0.09	−0.16	0.06	0.22*	−0.18	0.24*	−0.13	−0.12	−0.09	−0.14	−0.08	−0.07	0.25*	−0.03	0.59**	0.13	0.53**	0.53*	–						
29. Desire (DEQ)	−0.03	0.03	−0.04	0.03	0.04	0.07	0.12	−0.14	0.04	0.03	0.01	0.06	0.17	0.05	−0.03	0.04	0.06	0.02	−0.01	0.03	0.01	0.01	−0.05	0.28**	0.13	0.20	0.21	0.26*	–					
30. Relaxation (DEQ)	−0.08	−0.05	−0.07	−0.05	−0.12	−0.32**	0.18	0.03	0.18	−0.05	0.10	−0.08	−0.44**	0.04	−0.24*	0.04	0.01	0.05	0.03	−0.02	−0.12	−0.30**	−0.05	−0.48**	0.05	−0.33**	−0.43**	−0.40**	0.00	–				
31. Happiness (DEQ)	0.14	−0.11	−0.05	−0.07	−0.16	−0.25*	0.18	0.03	0.14	−0.07	0.04	0.00	−0.29**	0.03	−0.14	0.06	0.04	0.06	0.00	−0.16	0.07	−0.14	0.03	−0.32**	0.14	−0.12	−0.22*	−0.44**	0.00	0.63	–			
32. Helplessness (PSS-10)	−0.10	−0.01	−0.01	−0.13	−0.02	0.52**	0.02	−0.21*	−0.36**	0.20*	−0.10	0.18	0.30**	−0.23*	0.38**	0.00	−0.05	0.03	0.06	−0.11	0.01	0.40**	0.09	0.56**	0.14	0.57**	0.60**	0.56**	0.221*	−0.54	−0.31**	–		
33. Self-efficacy (PSS-10)	0.13	0.02	−0.02	0.06	0.01	−0.51**	−0.04	0.19	0.26*	−0.06	0.06	−0.19	−0.26*	0.20	−0.28**	0.03	0.06	0.00	−0.09	−0.11	0.12	−0.30**	−0.04	−0.51**	−0.01	−0.32**	−0.37**	−0.59**	−0.14	0.50	0.47**	−0.70**	–	
34. Perceived Stress (PSS-10)	−0.12	−0.02	0.00	−0.11	−0.02	0.56**	0.03	−0.22*	−0.35**	0.16	−0.09	0.20	0.31**	−0.23*	0.37**	−0.01	−0.06	0.02	0.07	−0.04	−0.04	0.39**	0.08	0.58**	0.10	0.52**	0.56**	0.62**	0.21*	−0.56	−0.39**	0.96**	−0.87**	–

*$p < 0.05$. **$p < 0.01$; AIMS, Athletic Identity Measurement; OTH, Orientation to Happiness; VCQ-SPORT, Volitional Components Questionnaire in Sport; CISS, Coping Inventory for Stressful Situations; BFI-10, Big Five Inventory 10; DEQ, Discrete Emotions Questionnaire; PSS-10, Perceived Stress Scale.*

Detailed Data on Problems, Coping Strategies, Wanted and Received External Support, and Joyful Anticipation

In total, 270 problems (n_{less} = 96; n_{same} = 111; n_{more} = 63) were mentioned by the athletes (see **Supplementary Table 2** for details). The most often mentioned problems and challenges during lockdown were closed sports facilities (*n* = 62; 64%), followed by missing social contacts (*n* = 35; 37%), staying in shape (*n* = 25; 26%), issues concerning motivation (*n* = 23; 24%) and the missing social contact in the sport context (e.g., teammates; *n* = 19; 20%). With respect to the groups (i.e., less vs. more motivated vs. no change) however, the distribution differs on a descriptive level. Less motivated athletes reported lack of motivation more often (*n* = 16; 48%) than athletes who report no change in motivation (*n* = 5, 13%) or who were more motivated (*n* = 2[1]; 9%). In addition, missing social contacts was mentioned less often by motivated athletes (*n* = 8; 24%) in comparison to the two other groups (n_{same} = 19; 49%; n_{more} = 8; 35%). Finally, athletes who are less motivated were less concerned about closed sports facilities (n_{less} = 15; 45%; n_{same} = 30; 77%; n_{more} = 16; 70%).

In the category coping strategies, athletes reported a total of 268 responses (see **Supplementary Table 3** for details). The most often mentioned coping strategies were related to training and exercise online (*n* = 63; 97%), organization and structure (e.g., structuring the day; *n* = 44; 61%), using online tools and software to maintain social contact (*n* = 29; 44%) and finding alternative sports or ways to train and exercise (e.g., skating, weightlifting; *n* = 20; 33%). Again, with respect to the groups (i.e., less vs. more motivated vs. no change) however, the distribution of mentioned strategies differed on a descriptive level. Athletes who were less motivated to train mentioned the use of online training less often (n_{less} = 11; 33%; n_{same} = 30; 77%; n_{more} = 22; 96%).

In the category received external support, a total of 122 responses (n_{less} = 45; n_{same} = 51; n_{more} = 26) were provided by the athletes (see **Supplementary Table 4** for details). The most frequently mentioned received external support was from family (*n* = 40; 42%), friends (*n* = 24; 25%), significant others (*n* = 20; 21%), and coach (*n* = 15; 16%).

In the category of wanted external support, a total of 94 replies (n_{less} = 35; n_{same} = 24; n_{more} = 35) were provided by the athletes (see **Supplementary Table 5** for details). The most frequently mentioned desired external support was by coaches (*n* = 21; 22%), the state (*n* = 20; 21%), and the university (*n* = 13; 14%). Finally, 15 athletes (16%) stated that they need no further support.

In the category of joyful anticipation, a total of 220 responses (n_{less} = 97; n_{same} = 57; n_{more} = 65) were provided by the athletes (see **Supplementary Table 6** for details). Athletes who were less motivated to train responded the most. Overall, the most often mentioned joyful anticipation items were social contacts (*n* = 58; 61%), leisure activities (e.g., sitting in a café or restaurant, partying; *n* = 40; 42%), practicing sport with others (*n* = 25; 26%), returning to normal training (*n* = 25; 26%), and open sports facilities (*n* = 24; 25%). On a descriptive level there were, however, differences between groups (i.e., less vs. more motivated

[1]The lack of motivation is related to class work.

vs. no change). Social contacts were mentioned less often by athletes who did not report a change in motivation to train during the lockdown in comparison to those who were more or less motivated (n_{less} = 29; 88%; n_{same} = 7; 17%; n_{more} = 22; 96%).

The **Supplementary Tables 2–6** show all mentions for all categories.

DISCUSSION

Exercising and training is highly important especially during lockdown (Brand et al., 2020; González-Valero et al., 2020; Maher et al., 2020; Mehrsafar et al., 2020). Thus, the aim of the study was to identify athletes who experienced a change in motivation to exercise due to the lockdown. In detail, we aimed to more precisely understand who (i.e., demographic, sport-specific and psychological trait and state variables) experienced a change in motivation. Further, we aimed to explore the problems they experienced and what they did to help themselves, what support they received from others, what support they missed and what they were looking forward to after the lockdown. In doing so, we used a combined approach of open and closed questions to provide in-depth information on the German amateur and recreational athletes' psychological state.

Overall our results show that 41% of amateur and recreational athletes reported no change in motivation to exercise during the lockdown, whereas 35% stated they were less motivated and 24% stated an increase in motivation to train. Although we only assessed motivation to train and not self-reported exercise frequency, our results are comparable to Brand et al. (2020); 44% no change, 24% decrease, 32% increase) as well as to Mutz and Gerke (2020) with respect to individuals who maintained their level of physical activity (42% no change). Especially from a theoretical perspective our results were unexpected as they are not necessary in line with SDT (Deci and Ryan, 2000). In our data, however, 35% of amateur and recreational athletes felt less motivated to exercise; as motivation is related to action (e.g., Heckhausen and Heckhausen, 2008), we would argue that this number is alarming in terms of maintaining athletes' physical and mental health (Mehrsafar et al., 2020). On the other hand, our data show that one quarter of the athletes state an increase in motivation to exercise. At first glance, this may be considered a positive development, especially with regard to the general population (Brand et al., 2020). However, athletes who experienced an increase in motivation showed similar values in trait and state variables as athletes that reported a decrease in motivation. Thus, this increased motivation to exercise might indicate that it has a compensatory function, which may not necessarily be considered positive.

Motivational Differences With Regard to Demographic and Sport Specific Variables

Overall, we found no differences in age, type of sport, and number of competitions per year between the groups (less vs. same vs. more motivation to exercise). However, significant differences were found for gender distribution and amount of exercise prior to COVID-19.

In detail and not in line with our hypothesis, age does not differ between the three groups. We argue that this might be due to more encounters with stressors and lower stress levels in older individuals in the general population (Klein et al., 2016). However, not only did we not detect significant correlations between age and perceived stress (see correlation matrix in the **Supplementary Material**). Specifically, the lockdown and COVID-19 crisis in general presents the new factors uncertainty and lack of control (Clemente-Suárez et al., 2020; Leisterer et al., under review) such that additional life experience does not impact stress perception and thus, motivation (see PSI theory) in our sample. In other words, effects of the lockdown on motivation seem to be irrespective of the amateur and recreational athletes' age. In line with previous research (di Fronso et al., 2020), the type of sport (team vs. individual) does not make a difference with respect to motivation to exercise. In addition to the idea that we should focus on the way the sport is trained (individually vs. with a team; see AASP (Association for Applied Sport Psychology) Blog, 2020), we would argue that athletes who can train individually are less affected by hygiene restrictions in training than those who normally train in teams but have to distance socially during the pandemic. Finally, contrary to our expectations, no difference in the number of competitions prior to lockdown was detected between groups. Athletes prepare for competitions via training, and since competitions were postponed or canceled, we assumed that motivation would decrease especially in athletes with typically more competitive encounters. Future research should assess the importance of competitions as well as athletes' goals in order to understand the impact of competitions on motivation to exercise.

We found differences between groups with respect to gender distribution and training hours prior to COVID-19. In accordance with our hypothesis and in accordance with previous research (di Fronso et al., 2020), we found that more female athletes were less motivated to train in comparison to males. In our sample, female athletes showed higher levels of stress (p = 0.029, d = 0.46) and lower levels of relaxation (p = 0.012, d = 0.57). These medium effects might be explained by the finding that female negative emotions and feelings are often related to avoidance motivation (see Elliot et al., 2013), which in turn might explain why the females are less motivated (see also PSI theory). As expected, a higher number of training hours prior to lockdown were detected in amateur and recreational athletes who reported no change in motivation compared to amateur and recreational athletes who were more motivated to train during the lockdown. Based on the stress-buffer hypothesis, which suggests that better trained individuals cope better with stress due to the availability of increased psychophysiological resources, it could be argued that external stressors such as the corona lockdown result in less psychological and physiological stress in better trained individuals (e.g., Gerber et al., 2018) and therefore have lower impact on their motivation (PSI theory). On the other hand, more motivated athletes may have come to the realization that they have to spend their time differently due to the lockdown, and might in turn become distracted. This line of argument, however, infers causal connections not assessed in this study, and it might also very well be that during concurrent spring season in Germany, people exercised more on average (Pivarnik et al., 2003). Despite our fairly small sample compared to other recent publications on the topic, this effect is large and needs further investigation. In future, not only should motivation be assessed more objectively but motivation to exercise should also be assessed, as this is related to exercise commitment, also during a lockdown (Angosto et al., 2020).

Motivational Differences With Regard to Psychological Trait Variables

Overall, all trait variables (except lack of concentration as a volitional component) show an interesting but unexpected trend: Highest or lowest values in comparison to amateur and recreational athletes that are less and more motivated to exercise. In other words, we observe a U- or inverted-U-shape. On a descriptive level, amateur and recreational athletes that reported no change in motivation show the highest values in athletic identity, engagement and meaning (i.e., happiness), goal setting (part of volitional component), task-oriented coping, agreeableness and conscientiousness (i.e., personality). On the other hand, these athletes have the lowest values in trait anxiety, pleasure (i.e., happiness), postponement of training and negative emotionality (i.e., volitional competence), emotion- and distraction-oriented coping, extraversion, agreeableness, neuroticism, and openness (i.e., personality).

It could be argued that a combination of these factors might protect athletes from experiencing motivational changes in one or the other direction and thus, could be considered positive in providing stability. In accordance with the very broad concept of Control Balance Theory (Tittles, 1995) this would mean that the possible occurrence of *divergent* or, to be more abstract, different behavior is low when received (i.e., external) and perceived (i.e., internal) control is in balance. Due to a decrease in control due to lockdown restrictions, internal resources or skills to regain control must be especially high to restore balance. In view of our data this means that certain trait variables should be more pronounced in order to keep internal control high. However, future research should further investigate such clusters, as our sample size did not allow for clustering to empirically test this idea. Even though it is interesting to observe this pattern in trait variables that might provide stability and continuity, only some of these variables differ statistically between the three groups.

Significant differences between the groups in psychological trait variables were only found in athletic identity, meaning (i.e., happiness), and postponing training as a volitional competence. In contrast to Costa et al. (2020) and our hypothesis, we found the highest athletic identity in athletes that experienced no change in motivation to exercise. It was significantly higher in those athletes in comparison to athletes that reported an increase in motivation to exercise. Athletic identity in the sample by Costa et al. (2020) was divided according to the median value within the sample and thus, might have led to different results. It can be speculated that in contrast to the idea that athletic identity contributes to athletes' vulnerability during a crisis (Batey and Parry, 2020), it may be a protective factor in moderating changes in motivation to exercise.

Higher levels in meaning on the orientation to happiness scale indicate a higher cultivation and orientation toward virtues and their use in service of a greater good, which is frequently but not necessarily of a religious nature (Peterson et al., 2007). Meaning is positively related to subjective well-being which is mediated via prosocial behavior and goal-directed behavior (for more details see e.g., Yang et al., 2017). Thus, individuals actively seek out chances to pursue their goals, which may explain the finding that athletes high in meaning, experience no change in motivation to exercise. Interestingly, we found significant positive correlations between meaning and task-oriented coping ($p < 0.001$, $r = 0.38$). A significantly higher level in meaning has only been detected in athletes who report no change in motivation to exercise compared to athletes with increased motivation. On the one hand this finding contradicts comparable research that detects a positive relation between meaning and motivation at work (Leite, 2018) and on the other, this might suggest that sport is used as compensation for meaning in life for athletes who increased their motivation to exercise. While this is arguably highly speculative, it should not be overlooked. In comparison, athletes who reported an increase in motivation to exercise showed lower levels in athletic identity compared to those reporting no change in motivation. It could be argued that athletes who report no change in motivation to exercise might have shifted their meaning toward their training to adapt to the pandemic. This idea is in line with the argument that the COVID-19 pandemic is such a drastic event that trait-like variables such as athletic identity can be affected (Costa et al., 2020, p. 2). However, due to our cross-sectional design, we cannot further investigate this potentially bidirectional link between meaning and athletic identity. Overall, again we argue that higher levels of meaning could help to stay balanced during situations of crisis (i.e., COVID-19 pandemic) as they foster task-oriented coping and goal-directed behavior.

In a similar line of reasoning, athletes who reported no change in motivation show significantly lower levels of postponing training in comparison to athletes who are less motivated, thereby reporting the lowest lack of energy as one volitional component. This is in accordance to our hypothesis. In addition, it underlines the theoretical assumption that volitional components help individuals to pursue their goals and protect against external disruptions or stressors (PSI theory). However, future research should further explore this particular idea as our data only allow speculation on causal relationships.

Motivational Differences With Regard to Emotions and Stress

Overall, we found that the pattern of state variables is similar to that of trait variables (except relaxation and happiness). The highest values in positive emotions and self-efficacy as well as the lowest values in negative emotions, helplessness and perceived stress can be seen in athletes that reported no change in motivation to exercise. Thus, it can be assumed that these athletes are least affected by the COVID-19 pandemic. Interestingly, in comparison to norm values of the general population (age group 20–29: $M_{helplessness} = 7.6$; $M_{self-efficacy} = 5.8$; $M_{perceivedstress} = 12.74$) amateur and recreational athletes, also those who report no change in motivation, show higher levels in helplessness, perceived stress but also in self-efficacy. The descriptively higher level of perceived stress in comparison to norm values is in line with results from Italian athletes that showed an increase in stress pre- to post-corona lockdown (di Fronso et al., 2020). Successful athletes are known to have high self-efficacy, whereas lack of self-efficacy is related to failure (e.g., Feltz, 2007). Athletes also have generally higher levels of self-efficacy compared to the general population (e.g., Laborde et al., 2016). Thus, it can be considered positive that high levels of self-efficacy are present in athletes even in times of crisis. Based on our data on stress and even in contrast to Iancheva et al. (2020) as well as to Makarowski et al. (2020) who assessed data fairly late after the lockdown, and in line with di Fronso et al. (2020), we argue that the COVID-19 pandemic and lockdown increased athletes' stress levels.

Comparing the different groups (less vs. same vs. more motivation to exercise), we found expected differences in anger, sadness, relaxation, and happiness. In detail, less motivated athletes showed higher levels of anger and sadness compared to athletes who experienced no change in motivation. Additionally, they experience more anger in comparison to athletes who reported more motivation. Anger is known to occur after failure for example due to externally stable difficult tasks, which may eventually have a negative impact on future motivation (Weiner, 1985). For our data this might mean that athletes feel anger and thus, are less motivated. This causal relation, however, is speculative and needs to be investigated in longitudinal studies. The function of sadness on the other hand is to withdraw, heal, seek help, and rebuild energy and formulate new goals (Scarantion, 2018). This can be seen in our data as well. The sadder that athletes feel, the less relaxed ($p < 0.001$, $r = -0.4$), the more helpless ($p < 0.001$, $r = 0.56$), and the more stressed ($p < 0.001$, $r = 0.62$) they feel.

Relaxation and happiness were significantly lower in less motivated compared to more motivated athletes. In addition, relaxation was significantly lower in athletes who had a decrease in motivation to exercise compared to athletes that experienced no change in motivation. State happiness describes the hedonic perspective of making progress toward a goal that we are striving for and can lead to goal-oriented behavior (Lazarus, 2000). Also, positive affect, with respect to PSI theory, employs less self-regulatory capacities, makes it easier to access the extension memory system including stored action plans, and finally, requires less self-control to access the behavioral control relevant for executing routines (Kuhl, 2018). Therefore, actually exercising or being motivated to exercise should be less impacted. Additionally, it could help explain why the level of relaxation is also significantly lower.

Interestingly, athletes more motivated to exercise are descriptively the happiest and the most relaxed, which could be considered contradictory to our previous speculation that they might use sport as some sort of compensation. However, it is important to keep in mind that compensation is not necessarily negative. Exercise is known to have rapid positive impact on mood (see meta analyses Jansen and Hoja, 2018). Thus, the increased motivation to exercise might actually lead to more exercise and thus, a positive impact on mood. This is highly speculative in nature, since we did not assess their actual exercise frequency.

The Interaction of State and Trait Psychological Variables

Combining findings on state and trait variables a picture emerges that is in line with theories on the impact of stress/emotions on motivation, stress and personality (e.g., PSI theory; approach-avoidance temperement). For example, focusing on personality, previous studies have shown that neuroticism is related to distress, more negative emotions and emotion-focused coping whereas conscientiousness predicts task-oriented coping (Matthews et al., 2006). In addition, individuals with higher neuroticism have more difficulties handling their distress (O'Brien and DeLongis, 1996). Finally, higher levels of neuroticism are associated with avoidance motivation (Elliot and Thrash, 2010). The same pattern can be detected in our data.

Neuroticism is significantly positively correlated with trait anxiety ($r = 0.559$, $p < 0.001$), state anxiety ($r = 0.271$, $p = 0.008$) and perceived stress ($r = 0.392$, $p < 0.001$) as well as negatively correlated with self-efficacy to handle stress ($r = -0.302$, $p = 0.003$). Also, negative emotions and feelings are often related to avoidance motivation (see Elliot et al., 2013). Thus unsurprisingly, amateur and recreational athletes with the highest negative emotions were less motivated to train. Finally, extraversion is typically linked to approach motivation (Elliot and Thrash, 2010) and is related to interpersonal coping strategies (Matthews et al., 2006). This fits with our data as we also found that extraversion is significantly related to distraction-social-oriented coping ($p < 0.001$, $r = 0.524$). Overall, athletes that are the least emotionally affected by the pandemic and the lockdown show a different profile of psychological trait variables. It can be speculated that might be the reason for their stable motivation throughout this time of crisis.

Problems, Coping Strategies, Wanted and Received External Support and Joyful Anticipation

Overall, closed sport facilities, limited social contacts and difficulties maintaining physical shape were the most often mentioned problems, and these are in line with those anticipated by experts (e.g., Mehrsafar et al., 2020; Schinke et al., 2020; Spitzer, 2020). Athletes coped with these difficulties by exercising online, organizing and structuring their day and using online tools to stay in contact with others. This is also in line with coping strategies suggested by experts (e.g., Jukic et al., 2020). Most athletes received support from family, friends, and significant others which can be summarized as emotional support and is highly typical for crisis situations (Shumaker and Brownell, 1984). Athletes wished for more help from their coaches, the state, and universities which can be summarized as missing informational and instrumental support (Shumaker and Brownell, 1984). Finally, athletes were most looking forward to social contacts, leisure activities, and practicing sport with others. These findings show that humans are social creatures and highly enjoy the pleasures of life. In turn, missing these activities could lead to their higher appreciation and to a further strengthening of relationships (e.g., coach-athlete; Li et al., 2020).

Descriptive differences between groups were detected concerning problems, coping strategies, and joyful anticipations. First, athletes who reported less motivation to exercise were aware of this issue as almost 50% also explicitly stated that lack of exercise was as a problem. In addition, they stated less that they missed social contacts and were less concerned about closed sport facilities. At first glance, this might be cause for concern as these are also symptoms of depression. However, 88% of the members of this group also stated that they were joyfully anticipating social contacts, which suggests that we do not yet have a reason to be concerned. However, the uncertainty of a second lockdown, other restrictions, or further social isolation could lead to mental health issues. Secondly, athletes who reported less motivation did not mention the use of online training tools as often. This is not surprising and may be indicative of that fact that less motivated athletes also actually exercise less.

Limitation

This study has several limitations and has been conducted under immense time pressure (see also Brand et al., 2020). As a cross-sectional study it allows for no causal conclusions, strictly speaking. Moreover, all data are self-reported and this can lead to bias. Additionally, data were assessed online and this led to selection bias in the sampling process (Bethlehem, 2010). In the same vein, our sample consisted of young athletes on average 22 years of age, which is rather small compared to recent studies on the topic. Thus, results should not be translated to younger or older individuals. However, effect sizes for detected differences are medium to large, which can be considered rather positive in terms of relevance of our results. Nevertheless, our main variable –motivation to exercise compared to pre-COVID-19 – was assessed by a single item only. Nevertheless, with reference to Brand et al. (2020), we were also more interested in generally perceived changes in exercise motivation and in retrospectively questioning the finding that the amount of training leads to biases, poor memory recall, and potential exaggerations. Lastly, only a preselected number of trait variables have been analyzed and the BFI-10 (Rammstedt et al., 2013) shows partially unacceptable Cronbach α-values. Thus, our personality trait results should be interpreted very carefully, even though, this inventory has already contributed to other studies as a useful short-questionnaire (e.g., Mauz et al., 2017). Finally, in future research, listed trait variables could be expanded for example, to include emotional intelligence or resilience, as these personality traits have been shown to have a positive effect on maintaining physical activity during the COVID-19 pandemic (Mon-López et al., 2020).

CONCLUSION

Our study investigated stress, coping, and changes in motivation to exercise in amateur and recreational athletes during the first COVID-19 lockdown (March–April 2020) in Germany. We found that amateur and recreational athletes experienced an increase in stress due to closed sporting facilities and limited social contacts. They experiencing the least stress due to the lockdown, however, showed not only no change in motivation but also presented a different, potentially more positive profile in trait variables which allows us to speculate that this might be the reason for the stability in motivation (in accordance with Funke, 2020). Nevertheless, athletes' self-efficacy was maintained and they reported several coping strategies, mainly using online tools for exercise and for keeping socially connected. Even though our study provides data on the relationship between stress, coping, personality, and motivation, we are convinced that we still need theoretical models relevant for such a crisis and for this specific group (i.e., amateur and recreational athletes). Furthermore, we urgently need intervention measures to support our amateur and recreational athletes so they can master such a crisis of uncertainty. Applied sport psychologists consider this a chance to shift away from deficit-oriented to resource-oriented sport psychological practices that focus more on athletes' well-being (see AASP (Association for Applied Sport Psychology) Blog, 2020). Especially, Acceptance and Commitment Therapy (AASP (Association for Applied Sport Psychology) Blog, 2020) as well as salutogenic approaches (Leisterer et al., under review) might be beneficial in view of further emerging crises. Given the limitations of our study, we tentatively suggest that based on our results, new approaches ought to focus on supporting athletes' staff (especially coaches) to foster athletes' management of daily obstacles (e.g., closed sport facilities). In addition, athletes as well as their staff should learn how to elicit resilience and motivation. Further, coaches and staff should keep an eye on conspicuously more motivated athletes during the COVID-19 pandemic. Overall, athletes as well as their staff should be in the focus of further research, for example in devising targeted workshops (e.g., Leisterer et al., under review) and guidelines (e.g., Bertollo et al., 2020), which attempt to overcome negative impacts of the COVID-19 pandemic.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FL and SL: idea and conceptualization. FL: planning of the study and first draft. SL, NW, A-ME, and OL: revisions. FL and SG: literature research. FL, VP, and OL: data analysis. LK and TM: formatting. A-ME: proofreading. A-ME and FL: resources and supervision. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.611658/full#supplementary-material

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Physical Activity, Loneliness, and Meaning of Friendship in Young Individuals – A Mixed-Methods Investigation Prior to and During the COVID-19 Pandemic With Three Cross-Sectional Studies

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Meaningful social interactions and regular physical activity are inversely associated with loneliness. Using a mixed-methods research design employing quantitative and qualitative research approaches, this research aimed to explore loneliness, physical activity, friendship, and experiences relating to the COVID-19 pandemic both prior to and during the pandemic. Quantitative data of (1) $n = 363$ first-year university students assessed in 2018/2019 and of (2) $n = 175$ individuals aged 18–29 years assessed in 2020 were gathered using independent self-administered online surveys. In addition, (3) $n = 4$ students were recruited for semi-structured, qualitative interviews in 2020 during the onset phase of the COVID-19 pandemic. Correlation and regression analyses as well as analyses of variance were conducted. Thematic analysis as a qualitative method was used to explore the role physical activity, friendship, and social interactions played in loneliness, particularly in times of social isolation and social distancing. Results revealed associations of varying strength between physical activity and loneliness in 2018/2019 ($r = -0.09$, $p \leq 0.05$) and 2020 ($r = -0.20$, $p < 0.01$). In 2020, $n = 73$ (41.7%) participants felt that their loneliness had increased since the COVID-19 social and physical distancing guidelines were introduced, but this was not associated with a perceived change in physical activity ($r = -0.05$, $p > 0.05$). Analyses of qualitative data revealed three main themes: (1) the lack of deep friendships at university, (2) the positive perceived impact of team sports on feelings of loneliness, and (3) the need for real connection in times of crisis. Thus, with regard to feelings of loneliness during the pandemic, being physically active seems to be a small but potentially relevant factor among young individuals. The qualitative study suggests that first-year university students might buffer the lack of deep friendships and meaningful interactions by building social bonds in team sports. In times of physical distancing, young individuals vulnerable to loneliness may therefore require special support such as doing sports with physical distance and perceiving connected with their team for instance by digital devices and emotional coping.

Keywords: relationship status, physical activity (exercise), loneliness, COVID-19, friendship (male/female), mixed-methods

INTRODUCTION

Perceived loneliness denotes the feeling that one's social needs are not being met by existing social relationships (Hawkley and Cacioppo, 2010). It is well established that this feeling is not solely related to a low quantity of social interactions. Indeed, poor social interaction quality (i.e., if individuals are lacking in meaningful interactions) is assumed to be one of the strongest predictors of loneliness (Wheeler et al., 1983; Lee and Ko, 2017). This presumption suggests that existing feelings of loneliness can be eased by generating more deep and meaningful social interactions (Hawkley and Cacioppo, 2010). Numerous studies have demonstrated the importance of examining loneliness when analyzing the impact of the Coronavirus Disease (COVID-19) pandemic (e.g., Cao et al., 2020; Hamermesh, 2020; Heidinger and Richter, 2020; Loades et al., 2020). Some studies have explicitly shown that loneliness has increased since the start of the pandemic (Elmer et al., 2020; Heidinger and Richter, 2020). Other studies have also indicated that chronically lonely individuals remained lonely, whereas those at risk for becoming lonely due to the COVID-19 pandemic consisted of specific groups such as younger individuals and those experiencing social isolation (Heidinger and Richter, 2020).

Several *critical life events* and situations, such as moving out from the parents' house or into a different city for school, starting university, or a new job, may pose very distinct challenges to social life. Consequently, loneliness represents an important issue among young individuals and university students (Vasileiou et al., 2019) and this finding has been reported across several countries (Oezdemir and Tuncay, 2008; Diehl et al., 2018; Hysing et al., 2020). For many university students, the *transition from high school to university* co-occurs with major life changes such as leaving home and building new social relationships. This age group is associated with loneliness and transition-related changes in health behavior (Diehl et al., 2018). Furthermore, recent research suggests an increasing trend in loneliness among university students (Hysing et al., 2020). Research investigating the protective determinants of loneliness among university students is therefore required.

One such protective factor, alongside fostering meaningful friendships, is *physical activity*. Physical activity has been found to be related to loneliness (Lee and Ko, 2017). According to a systematic review by Pels and Kleinert (2016), physical activity can contribute to a decrease in feelings of loneliness. However, little is known about the mechanisms underlying this potential association (Diehl et al., 2018). Another potential protective determinant of perceived loneliness is relationship status. Research has shown that, especially in the context of a romantic partnership, *female* individuals feel lonely more often than males do (Pinquart and Sörensen, 2001). Additionally, *those without a partner or living alone* feel lonely more often than individuals in a committed relationship or those living with others (Beutel et al., 2017; Gyasi et al., 2020). Therefore, this study, using both qualitative and quantitative research methods, aims to examine the relationships between the meaning of friendship and partnership, physical activity, and loneliness in students from international universities in Europe. Moreover, physical activity can be predicted by social-cognitive variables such as intention, planning and self-efficacy (Schwarzer et al., 2008). However, rather little is known on whether such predictors also interrelate with loneliness when controlled for physical activity, and whether the association with partnership status would still be prevalent. Additionally, loneliness and physical activity have both been found to be related to work-life balance and quality of life (Fischlmayr and Kollinger, 2010; Kang et al., 2018) as well as to buffer the effects of the COVID-19 pandemic (Hu et al., 2020). Thus, the question remains as to whether physical activity and its predictors (i.e., social-cognitive variables such as intention, planning and self-efficacy) provide a meaningful addition to the explained variance of work-life balance and quality of life in regard to loneliness in general, i.e., prior to the COVID-19 pandemic.

The *COVID-19 pandemic* has already triggered a range of publications examining its effects on loneliness: Studies have demonstrated that individuals who were alone in lockdown experienced reduced happiness (Hamermesh, 2020). Among older individuals, those living alone were shown to be at higher risk for increased feelings of loneliness (Heidinger and Richter, 2020). Notwithstanding, there is other evidence suggesting that reported loneliness does not interrelate with any state orders and lockdown measures (Luchetti et al., 2020). Therefore, it is crucial to consider one's current circumstance when examining loneliness, particularly since previous research has shown that "Compromised regulation of emotion in lonely individuals explained their diminished likelihood of performing any physical activity, and loneliness also predicted a decrease in physical activity over time" (Hawkley and Cacioppo, 2010, p. 220). Compromised emotion regulation may result from challenges attributed to COVID-19, and those maintaining physical activity might be more prone to negative effects, such as feelings of loneliness. The negative association between physical activity and loneliness might therefore become more pronounced in challenging times such as the COVID-19 pandemic.

Summarizing, in light of challenges brought along by the COVID-19 pandemic such as social distancing and increased feelings of loneliness, *friendship* and coping strategies become even more important. Therefore, this study aims to explore and evaluate various factors relating to perceived loneliness among young individuals and university students using a combination of *quantitative and qualitative research methods*. Given that no studies could be identified that used a mixed-method approach to address younger individuals during the COVID-19 pandemic, the current research aimed to fill this gap.

The following *research questions* were investigated: (1) Does physical activity relate differently to loneliness prior to and during the COVID-19 pandemic? (2) Do sex and relationship status/living situation relate to loneliness? (3a) To what extent does physical activity and its social-cognitive predictors as well as work-life balance and quality of life explain variance of loneliness in general, and (3b) To what extent does physical activity explain variance of loneliness during the COVID-19 pandemic? (4) How does the meaning of friendship relate to feelings of loneliness? and (5) How does the COVID-19 situation affect friendships and feelings of loneliness? We aim to answer research questions 1–3 using quantitative methods and data. Based on qualitative data we aim to study the research questions 1, 2, 4, and 5.

The application of a qualitative approach in addition to a quantitative one is particularly useful as it facilitates the collection of in-depth, detailed data which provide a more holistic view of the studied area (Tuffour, 2017). Quantitative research was conducted on students from an international university in Germany prior to the COVID-19 pandemic, and on a representative sample of the German population younger than 30 years of age during the COVID-19 pandemic. Qualitative research was conducted with students from universities in Europe (see **Table 1**).

MATERIALS AND METHODS

Procedure and Participants

For the *quantitative measures of this study taken prior to the COVID-19 pandemic*, we used a dataset from a first-year student sample from Jacobs University in Bremen, Germany, who were recruited using convenience sampling. The questionnaire-based survey was conducted between February 2018 and February 2019 during a lecture and was facilitated by mail-out recruitment. Students in an onboarding lecture were instructed on the purpose of the study verbally and were asked to access the survey via a link. Those who missed the class and were not in the lecture were identified using the class database and were contacted by email wherein the purpose of the study was explained. Respondents were told the purpose of the assessment was to better understand the experiences and behaviors at the university during the preceding weeks and to collect sociodemographic data. When individuals clicked on the link to the study, they received the short participant information including statements on confidentiality. Subsequently, they were asked to affirm the informed consent form before proceeding to the questionnaire. $N = 363$ (93.6%) of all 388 eligible students completed the questionnaire, provided informed consent, and were included in the analyses. Students were between 17 and 46 years of age. Further sample characteristics are reported in **Table 2**.

For the *quantitative measures of this study taken during the COVID-19 pandemic in 2020*, a representative sample of the German population was recruited, with data of only those aged below 30 years being included in this manuscript. The questionnaire-based survey was conducted between June 08 and June 15 in the year 2020 by the company Bilendi. Using email, the company contacted individuals in their database and explained the purpose of the study. When individuals clicked on the link to the study, they received participant information which included statements on confidentiality. They were subsequently asked to affirm the informed consent form prior to continuing to the questionnaire. Experiences and behaviors during the COVID-19 pandemic and related restrictions[1], as well as sociodemographic data were assessed. $N = 175$ individuals completed the questionnaire and were included in the analyses. Individuals were between 18 and 29 years of age. Further sample characteristics are reported in **Table 3**.

For *qualitative interviews gathered in 2020*, $n = 4$ participants were recruited from four universities in Europe ($n = 2$ from Germany, $n = 1$ from the Netherlands, $n = 1$ from the United Kingdom). The recruitment was conducted via an advertisement for interviews of freshmen interested in reflecting on personal experiences with friendship and loneliness. Furthermore, interviewees would be afforded an opportunity to learn more about qualitative research methods, particularly those for evaluating the topic "Friendship and loneliness among first-year students at university." The advertisement was disseminated to social media platform users on Facebook, Instagram, Twitter, and LinkedIn. Twenty volunteers responded to the advertisement. Only first-year university bachelor students fluent in English who were available for a 45 to 60 min Skype interview were given further information about the study, and asked to provide consent. This resulted in 5 potential study participants. One individual had a conflicting schedule, which therefore led to 4 interview participants. Thus, the participants were initially selected based on their interest in the topic. During the interview phase, the four participants first received a memo informing them about their rights to withdraw from the study and about the voluntariness of their participation before signing a consent form. Interviews were conducted via the telecommunication software Skype and took place in February/March 2020. The study received ethical approval by the Ethics Commission of the German Association of Psychology (Deutsche Gesellschaft für Psychologie, EK-A-SL022013). Dropout resulted only from structural issues such as not having sufficient time, or an unwillingness to being interviewed via the internet. The participants' demographics are displayed in **Table 1**.

Measures

The *self-administered questionnaire in 2018/2019 (pre-pandemic)* contained questions on sociodemographic characteristics, loneliness, quality of life, work-life balance, as well as physical activity, and its social-cognitive predictors.

Loneliness was assessed using the short-form version of the University of California Los Angeles Loneliness Scale (ULS-8) developed by Hays and DiMatteo (1987). The items measured the total perceived loneliness of the respondent using a four-point Likert scale ranging from "I never feel this way" (1) to "I often feel this way" (4). Questions included: (1) "I lack companionship," (2) "There is no one I can turn to," (3) "I am an outgoing person," (4) "I feel left out," (5) "I feel isolated from others," (6) "I can find companionship when I want it," (7) "I am unhappy being so withdrawn," and (8) "People are around me but not with me." Item three was reverse coded. Scoring of the ULS-8 corresponded to a mean aggregation of the eight items, with a minimum loneliness score of 1 and a maximum of 4. The scale has high internal validity (Cronbach's Alpha = 0.84).

[1]Restrictions during the COVID-19 pandemic included closings of schools, shops, sports clubs, swimming pools and restaurants, switching to online teaching and implementing travel restraints in addition to behavioral restrictions to reduce contacts and transmission of the virus (physical distancing included keeping a minimum distance of 1.5 m, mask wearing, prohibition of meetings exceeding more than 2 households and more than 1 person per 10 m^2 in indoor rooms).

TABLE 1 | Characteristics of the participants in the qualitative study.

Pseudonym	Country of Origin	University	Sex	Age
Will	England	University of Sussex	Male	20
Paul	Germany	Jacobs University Bremen	Male	20
Melis	Turkey	University of Groningen	Female	20
Marielle	Honduras	University Bremen	Female	21

TABLE 2 | Means and standard deviations or numbers and frequencies and correlation pattern of main study variables in 2018/2019.

		Kendall's tau-b								
	M **(SD) or** ***n*** **(%)**	**Loneliness**	**PA**	**Sex**	**Age**	**Partner status**	**PA intention**	**PA plans**	**PA self-efficacy**	**Quality of life**
Loneliness in 2018/2019	2.24 (0.67)									
PA	194 (53.4%) physically active	−0.09*								
Sex	187 (51.6%) male	−0.02	0.14**							
Age	19.33 (2.27)	0.02	0.02	0.09						
Partner status	69 (18.5%) with partner	−0.10*	0.05	−0.15**	0.13**					
PA intention	2.85 (0.67)	−0.02	0.14**	0.05	−0.01	−0.02				
PA plans	2.92 (0.91)	−0.10*	0.40**	0.03	0.03	0.03	0.16**			
PA self-efficacy	3.24 (0.82)	−0.15**	0.36**	−0.01	0.03	0.10*	0.20**	0.33**		
Quality of life	3.64 (1.03)	−0.23**	0.16**	0.12*	−0.05	0.06	0.08	0.10	0.18**	
Work-life balance	2.90 (1.27)	0.16**	−0.11*	0.04	0.08	0.05	−0.03	−0.01	−0.03	−0.11*

*PA, physical activity was coded: 0 = not meeting the criterion 5 days per week with 30 min or overall 2.5 h per week, 1 = meeting the criterion. Sex was coded 1 = female, 2 = male. Partner status was coded 1 = single, 2 = close relationship/married. Higher values indicate worse work-life balance. * ≤ 0.05; ** < 0.01.*

TABLE 3 | Means and standard deviations or numbers and frequencies and correlation pattern of main study variables in 2020.

		Kendall's tau-b				
	M (SD) or ***n*** **(%)**	**Loneliness**	**Lonelier since the pandemic**	**PA**	**Sex**	**Living situation**
Loneliness in 2020	1.95 (1.22)					
Lonelier since the pandemic	2.29 (0.93)	0.46**				
PA	81 (46.3%) more physically active	−0.20**	−0.05			
Sex	92 (52.6%) male	−0.11	−0.05	−0.01		
Living situation	137 (78.3%) with partner	−0.10	−0.13	0.04	−0.17*	
Age	24.22 (3.61)	0.05	0.02	−0.15*	0.05	−0.10

*PA, physically active was coded: 0 = less active or equally active, 1 = more active. Sex was coded 1 = female, 2 = male. Living situation was coded 1 = living alone, 2 = livining together with one or more individuals. * ≤ 0.05; ** < 0.01.*

Physical activity was assessed with a single item worded: "Please think about your typical weeks: Do you engage in physical activity at least 5 days per week for 30 min or more (or 2.5 h during the week), in such a way that you are moderately exhausted?" which has been previously validated (Lippke et al., 2009). All individuals who answered "yes" were categorized as being "sufficiently physically active" and those answering "no" were categorized as being "physically inactive."

Additionally, intention to perform physical activity was measured by 3 items: The stem "I have the intention to..." was combined with the three items "...perform strenuous physical activity (heart beats faster, sweating) in the future," "... be moderately physically active (not fatiguing, mild sweating) in the future," and "... be mildly physically active (hardly strenuous, no sweating) in the future" (Lippke et al., 2009). Planning to perform physical activity was also measured with a stem ("For the next month I already planned in detail") combined with the three items "... which concrete physical activity I will pursue (e.g., walking)," "... where I will be physically active (e.g., in the park)," and "... on which days I will be physically active (e.g., every Tuesday)," Cronbach's Alpha = 0.87 (Lippke et al., 2009). Self-efficacy beliefs were measured by a single item: "I feel certain that I can be physically active" adapted from Schwarzer et al. (2008). Answering options for intention, plans and self-efficacy ranged from "Completely Disagree" (1) to "Agree Completely" (4), and for intention and plans a mean score was computed.

Quality of life was measured according to Whoqol Group (1995) using the question "Please think about the last 4 weeks: How would you rate your quality of life?" Answering options were "Very poor" (1), "Poor" (2), "Neither poor nor good" (3), "Good" (4), and "Very good" (5). Work-life balance was measured with the item by Syrek et al. (2011). The statement "Please mark the option on how certain you are that you can perform each task described in the statement: I find it difficult to balance work and private life" could be rated on a scale of (1) for "Strongly disagree" to (5) for "Strongly agree," therefore higher values indicate larger difficulties with work-life balance.

In both quantitative studies, sociodemographic information was assessed by asking participants' sex and age. Partner status (in 2018/2019 pre-pandemic, single vs. close relationship/married) and living situation (in 2020, living alone vs. living with at least one other person) were additionally assessed.

In the 2020 assessment *during the COVID-19 pandemic*, loneliness was surveyed with the item "How often do you feel lonely?" stemming from the Center for Epidemiologic Studies Depression Scale (CES-D) developed by Radloff (1977). Adapted response options were "daily," "multiple times per week," "once per week," "rarely" and "never." Higher levels indicating greater feelings of loneliness. The change in perceived loneliness during the time of the COVID-19 pandemic was also assessed with the question "Do you feel more lonely now than before the restrictions[2]?" with response alternatives being "not applicable at all," "rather not applicable," "rather applicable" and "entirely applicable." Higher values indicated greater feelings of loneliness since the start of the COVID-19 pandemic. Using such a single item measuring loneliness was done before (e.g., Goossens et al., 2014; Pels and Kleinert, 2016).

Increased physical activity during the pandemic was assessed using a single item "I was more active doing physical activities (e.g., running, cycling, back and abdominal exercises, online sports courses)", with response options being "yes" or "no."

For *qualitative interviews in 2020*, a semi-structured interview guide was designed with open-ended questions, with the interview lasting between 30 and 50 min. Questions in the interview mainly ranged from (1) How does the meaning of friendship relate to feelings of loneliness? (2) How does the COVID-19 situation affect your friendships and feelings of loneliness? (3) To what extent does physical activity relate to loneliness prior to and during the COVID-19 pandemic? and (4) How do you think relationship status and living situation relate to loneliness?

Statistical Analysis

The association between loneliness and physical activity (*research question 1*) as well as sex, and relationship status/living situation (*research question 2*) was investigated using Kendall's tau correlation and frequency analyses on a univariate level and linear regression on a multivariate level. *Research question 3* regarding the explained variance in loneliness was investigated by analyzing the adjusted R^2 in multivariate linear regression. Additionally, *research questions 1 and 2* were investigated in more depth: To test whether there was a difference in the relationship between loneliness and physical activity between the two timepoints (*research question 1)*, we compared the correlation coefficients *post hoc* (Hemmerich, 2017). To investigate the interaction between relationship status (single vs. close relationship) or living situation (alone vs. with other individual/s) and physical activity with regard to loneliness (*research question 1 and 2*), factorial 2 × 2 ANOVAs were calculated. A further additional investigation of *research questions 1 to 3* was conducted for the assessment in 2020 by analyzing associations not only with perceived loneliness in general (static loneliness), but also with a perceived increase in loneliness compared to before the pandemic-related restrictions). All quantitative analyses were conducted using IBM SPSS 26.

Thematic Analysis

To test *research questions 1, 2, 4, and 5*, the qualitative approach applied was based on Tuffour's (2017) approach. Thematic analysis was chosen to analyze the data from the semi-structured interview. This method of data collection allows the researchers to have the flexibility of a guided exploration of the topic and to ask the participant to expand on what is said (Britten, 1999). The interviews were audio-recorded and transcribed. The transcriptions were then coded into keywords, which were categorized into themes.

RESULTS

Quantitative Assessment in 2018/2019 Pre-pandemic

For the univariate investigation of *research questions 1 and 2*, **Table 2** shows the means and standard deviations or numbers and frequencies and correlation pattern of main study variables in 2018/2019. On a correlational basis, students being physically active on a regular basis seemed to be less lonely compared to physically inactive students ($r = -0.09$, $p \leq 0.05$). Higher levels of loneliness were significantly correlated with being single ($r = -0.10$, $p \leq 0.05$), but not with sex ($r = -0.02$, $p > 0.05$, see **Table 2** for the full correlation pattern of the main study variables).

In an ANOVA testing the interaction between physical activity and partner status, with sex and age included as covariates (*research questions 1 and 2* in more depth), only physical activity (PA) was significant with $F_{PA}(1{,}357) = 4.28$, $p = 0.04$, Eta$^2 = 0.02$, whereas partner status did not significantly explain variance with $F_{Partner}(1{,}357) = 1.48$, $p = 0.07$, Eta$^2 = 0.01$, and the interaction was not significant [$F_{PA*Partner}(1{,}357) = 1.86$, $p = 0.17$, Eta$^2 = 0.01$]. The associations between loneliness and sex and age were also not significant [$F_{sex}(1{,}357) = 0.72$, $p = 0.72$, Eta$^2 < 0.01$; $F_{age}(1{,}357) = 0.16$, $p = 0.69$, Eta$^2 = 0.01$].

Contrastingly, in the regression model testing whether loneliness was predicted by physical activity, sex and age on a multivariate level (*research questions 1 and 2*), the regression coefficient for physical activity was no longer significant (B = −0.03; 95% confidence interval [−0.07, 0.01]; $p = 0.10$; see

[2]Restrictions "…span moderate recommendations such as physical distancing, up to the closures of shops and bans of gatherings and demonstrations."

model 1 in **Table 1**). When partner status was added, a significant association of partner status and lower levels of loneliness was revealed in model 2 [B = −0.19; 95% confidence interval (−0.37, −0.01); $p = 0.05$]. **Figure 1** shows that the mean loneliness score was slightly lower in physically active students who were in a relationship compared to students who were inactive and single.

In a third step (model 3, **Appendix Table 1**, to test *research question 3a*), social-cognitive predictors of physical activity were included to test whether the independent relationship with partner status remained significant. The model only explained 2% of the variance in loneliness, and 4% after social-cognitive predictors were added. However, only self-efficacy [B = −0.12; 95% confidence interval (−0.21, −0.02); $p = 0.02$] was significantly associated with loneliness. When also psychological correlates of loneliness were included in model 4, the regression coefficients of both quality of life and work-life balance were significant [$B_{QualityofLife} = -0.13$; 95% confidence interval (−0.20, −0.07); $p < 0.01$; $B_{Work-LifeBalance} = 0.10$; 95% confidence interval (0.05, 0.16); $p < 0.01$], explaining additional variance with an overall adjusted $R^2 = 0.11$ (**Appendix Table 1**).

Quantitative Assessment in 2020 During the COVID-19 Pandemic

In 2020, $n = 26$ (14.9%) of the assessed individuals indicated never feeling lonely, $n = 41$ (23.4%) rarely felt lonely, $n = 38$ (21.7%) felt lonely once per week, $n = 55$ (31.4%) felt lonely 2–6 days per week, and $n = 15$ (8.6%) felt lonely every day. When asked whether they felt more lonely during the COVID-19 pandemic restrictions compared to prior, $n = 40$ (22.9%) responded that this was not true at all, whereas $n = 62$ (35.4%) rated the statement as rather not true, $n = 56$ (32%) as rather true, and $n = 17$ (9.7%) agreed completely.

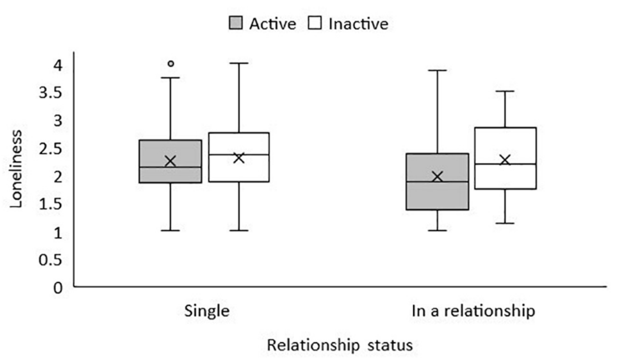

FIGURE 1 | Mean values of loneliness by relationship status and physical activity in 2018/2019. The horizontal line represents the median, the X represents the mean. The boxes include the range of values from first quartile (bottom line of the box) to third quartile (top line of the box). The whiskers represent the minimum and maximum values. In case there are datapoints exceeding the ends of the whiskers, the whiskers represent the highest and lowest values which cover up to 1.5 times the interquartile range. The physical activity*relationship interaction was not significantly associated with loneliness based on 2 × 2 ANOVA.

For the univariate investigation of *research questions 1 and 2*, **Table 3** shows the correlations between the key variables assessed in 2020. A significant correlation coefficient suggested that those individuals who indicated engaging in more physical activity since the start of the pandemic scored lower on the loneliness scale compared to individuals who did not increase their physical activity during the pandemic ($r = -0.20$, $p < 0.01$). Loneliness was neither significantly correlated with sex ($r = -0.11$, $p > 0.05$), nor with living situation ($r = -0.10$, $p > 0.05$, see **Table 3**). There was no significant correlation of perceiving an increase in loneliness during the pandemic restrictions with reporting more physical activity ($r = -0.05$, $p > 0.05$), nor with living situation or sex.

To test explicitly whether physical activity related differently to loneliness prior to and during the COVID-19 pandemic (*research question 1* in more depth), the two cross-sectional correlations for 2018/2019 and 2020 were compared to test whether they would significantly differ. However, the Fisher's z was $z = 1.2136$ with $p = 0.225$. Thus, although the two correlation coefficients appeared descriptively different, we cannot reject the hypothesis that this was observed by chance.

In an ANOVA testing the interaction between physical activity and living situation, with sex and age included as covariates (*research questions 1 and 2* in more depth), physical activity and sex were significantly associated with loneliness with $F_{PA}(1,169) = 6.34$, $p = 0.01$, $Eta^2 = 0.04$ and $F_{sex}(1,169) = 4.17$, $p = 0.04$, $Eta^2 = 0.02$. No other significant associations [$F_{age}(1,169) = 0.12$, $p = 0.73$, $Eta^2 < 0.01$; $F_{Living}(1,169) = 2.53$, $p = 0.11$, $Eta^2 = 0.02$] and no significant interaction [$F_{PA*Living}(1,169) = 0.12$, $p = 0.73$, $Eta^2 < 0.01$] were found.

In the regression model (testing *research question 1, 2, and 3b*) examining whether loneliness was predicted by physical activity, sex, age, and living situation, the regression coefficient for physical activity was significant [B = −0.52; 95% confidence interval (−0.88, −0.16); $p < 0.01$, see **Appendix Table 2**]. This finding was accompanied only by a significant association of sex and higher levels of loneliness as well [B = −0.38; 95% confidence interval (−0.74, −0.02); $p = 0.04$]. However, the model only explained 6% of the variance in loneliness. **Figure 2** shows that the mean loneliness score was slightly lower in physically more active individuals who were not living alone compared to inactive individuals living alone.

In the regression model examining predictors of a perceived increase in loneliness since the start of the pandemic restrictions (**Appendix Table 3**, additional testing of *research question 3b*), only the static loneliness in 2020 was a significant predictor of the perceived increase in loneliness [B = 0.42; 95% confidence interval (0.32, 0.52); $p < 0.01$]. Overall, 28% of the variance in the perceived increase in loneliness could be explained (see **Appendix Table 3**), of which 27.7% could be attributed to the static loneliness. This indicated that the ones who felt that their loneliness had increased since the start of the pandemic-related restrictions also reported higher levels of loneliness in general compared to individuals who did not perceive their loneliness to have increased since the start of the pandemic.

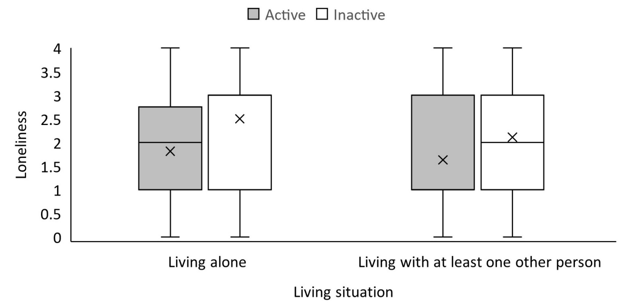

FIGURE 2 | Mean values of loneliness by living situation and physical activity in 2020. The horizontal line represents the median, the X represents the mean. The boxes include the range of values from first quartile (bottom line of the box) to third quartile (top line of the box). The whiskers represent the minimum and maximum values. In case there are datapoints exceeding the ends of the whiskers, the whiskers represent the highest and lowest values which cover up to 1.5 times the interquartile range. The physical activity*living situation interaction was not significantly associated with loneliness based on 2 × 2 ANOVA.

Qualitative Part in 2020 During the COVID-19 Pandemic

To better understand qualitative aspects of loneliness and friendship among students (to test *research question 1, 2, 4, and 5*), interviews were conducted and three major themes transpired: (1) the lack of deep friendship and meaningful connection at university, (2) physical activity and team environment, and (3) the need for real connection in times of crisis. The themes are illustrated by exemplary quotes listed in **Table 4**.

The Lack of Deep Friendship and Meaningful Connection at University

The theme of *lacking deep friendships and meaningful connections at university* was especially prominent throughout the interviews. Most of the friendships the students stated having at university distinguished "real friends" from "university friends." Real friends were described as being special to the student and are those with whom the student has a meaningful and deep connection. University friendships, on the other hand, were described as temporary, shallow, and not of the same quality as real friendships. All students described feeling as though many of the university friendships would not exist if they did not go to university together.

These data illustrated a hesitation among the students to confide in their university friends, which they interpreted as being due to not having meaningful interactions. Meaningful interactions were described as being the key to not feeling lonely at university. In order to prevent feelings of loneliness, the students suggested having meaningful interactions via friendships that go beyond university, as well as to form close, personal bonds. In addition, university friendships were described as existing to fulfill a specific purpose and never going beyond said purpose. For example, university friendships were deemed to only having emerged because the students shared a common goal such as succeeding academically or having a good time together.

As a sub-theme, the positive impact of being in a *supportive romantic relationshi*p emerged. Two participants indicated being in a close, romantic relationship. They described the relationships as providing a feeling of support and fostered a feeling of gratitude for having someone to turn to when feeling low. Furthermore, they mentioned being much closer to their partner than to their friends and family, and that they were able to confide everything personal to their partner.

Physical Activity and Team Environment

Students outlined that rather than it being the physical activity itself that makes them feel better and less lonely, underlying factors instead are involved in physical activity participation. All interviewed students agreed that there is more to participating in a sport than the exercise itself. Two main factors were deemed determinants of the positive impact of performing physical activity on feelings of loneliness: (1) the team spirit on campus, and (2) having an extroverted personality.

Being in a *team* was reported as providing a feeling of being closer to fellow students because of the shared emotions that come with winning or losing a game. It further entails getting to know team members on a more personal level that is not directly linked to the university. Most importantly, being in a team meant feeling as being a part of something as well as providing a sense of belonging, which in turn was assumed to reduce loneliness.

Personality was mentioned by the interviewed students as being an important factor in perceived loneliness. Also, personality was perceived as an accumulation of certain characteristics within the context of a team sport, namely being more extroverted. Essentially, the types of individual personalities that are more commonly found in team sports seem to find it easier to approach people and bond with new friends.

The Need for Real Connection in Times of Crisis

Given the current crisis associated with the COVID-19 pandemic, there was one theme prevalent in the data. The interviewees noticed a *need for a real connection*. This need was not perceived to be met by staying in touch via smartphone, as having a call or video chat was not considered as being meaningful. The interviewees acknowledged multiple times that staying in contact by talking on the phone did not create the same intimacy as talking face-to-face does. It was described as not enabling the same conveyance of feelings and often led conversations to feel less meaningful.

Furthermore, the fear of being geographically separated from friends and relatives was salient. Students reported wanting to physically see or experience their loved ones during times of crisis, and felt scared of not being able to do so due to travel restrictions.

DISCUSSION

This study used a mixed-methods approach to evaluate the associations between loneliness and factors such as the meaning

TABLE 4 | Exemplary quote by identified theme.

Theme	Quote	Participant, line number
The lack of deep friendship and meaningful interaction at the university	"They are not people you go to. You may have 300 people you would go and have a night out with or... go to a sports tournament because you are in the team but they are not the people you would talk to when you need to talk to someone and wouldn't talk to any of them"	1, 124–126
	"We are no longer friends we just had something in common THEN, it was so superficial"	3, 46–47
	"They probably like you for interest like if you were a good student and just with you because of that interest, or if you were good at parties"	3, 49–51
Subtheme: Supportive romantic relationships	"I have a person I can meet anytime. A person who writes to me and asks about me and worries about me"	3, 67–68
	"You have always somebody to talk to or somebody to be there with"	1, 423–423
Physical activity and team environment	"I guess your friendship in your TEAM, there will be more friction, but often it will lead you to being close"	2, 132–133
	"You would feel less lonely in comparison to, I imagine someone who just goes to lectures and seminars"	2, 143–146
	"For me personally it's the group situation, I ONLY play team sports. You BECOME a team"	1, 187–188
The need for real connection in times of crisis	"It's just staring at a screen, it's not real"	4, 198–198
	"It makes certain situations more challenging because obviously people aren't physically there to support you and the phone might just not do it"	3, 155–157
	"If you're having a deep conversation and then you want to hug the person you cannot do it"	4, 171–172
	"I'm more...CONNECTED to a person by seeing them"	2, 160–161

of friendship, relationship status, sex, and physical activity among university students and young individuals. The quantitative data were gathered prior to and during the COVID-19 pandemic, enabling the investigation of loneliness among young individuals during "regular" times and also during the COVID-19 pandemic, which is characterized by challenges exacerbating loneliness such as physical and social distancing.

Summarizing the findings and answering the *research question 1*, namely "Does physical activity relate differently to loneliness prior to and during the COVID-19 pandemic?" the results indicate that physical activity tends to be inversely related to feelings of loneliness. The strength of this association seemed to differ between prior- and during-pandemic assessments, but a *post hoc* analysis comparing the correlation coefficients revealed that the difference was not statistically significant. The extent of the association between physical activity and loneliness was relatively small and was not found consistently in the data: After adjusting for covariates in linear regression, a significant association was only found in individuals assessed during the pandemic. This finding matches theoretical considerations that loneliness hampers physical activity or vice versa, and could suggest that those individuals maintaining their physical activity may have been able to protect themselves from negative influences related to the pandemic (Hawkley and Cacioppo, 2010). Perceived increased physical activity since the start of the pandemic, however, was not found to be related to perceived increased feelings of loneliness since the start of the pandemic-related restrictions as the only significant correlate was the general (static) loneliness. Previous studies such as a United Kingdom study found that active students were less likely to experience loneliness compared to inactive students (Budzynski-Seymour et al., 2019). The same result was also found in the general population on a meta-analytical level (Pels and Kleinert, 2016). Thus, helping young individuals to be aware of the general importance of physical activity, and to become or remain physically active even when feeling lonely may represent a potential strategy contributing to decreasing loneliness, which, however, may not be easy (Hu et al., 2020).

Nevertheless, other factors could play an important role in loneliness, which was tested with the *research question 2* "Do sex and relationship status/living situation relate to loneliness?" We found that *sex* only seems to partially interrelate with feelings of loneliness in this study, which also matched previous results (e.g., Pinquart and Sörensen, 2001). Having a *partner* was not related to loneliness pre-pandemic after inclusion of relevant psychological correlates, which is not in line with previous studies reporting such an association (Beutel et al., 2017; Gyasi et al., 2020). Just *living together* with other individuals was not related to loneliness even without controlling for relevant psychological correlates, pointing toward the importance of the relationship quality (Wheeler et al., 1983; Lee and Ko, 2017).

The findings obtained with data in 2018/2019 further shed light on the differential ability of selected determinants to predict students' loneliness in times prior to the pandemic (*research question 3a*). The results revealed that partner status was only related to loneliness until social-cognitive predictors of physical activity, i.e., self-efficacy beliefs, were included. Self-efficacy remained a significant predictor after adding quality of life and work-life balance, and while quality of life was negatively correlated with loneliness (e.g., Kang et al., 2018), work-life balance problems were positively correlated (agreement to the item "I find it difficult to balance work and private life" was associated with a higher likelihood of reporting feelings of loneliness; Fischlmayr and Kollinger, 2010). This also might hint toward a potential mechanisms of physical activity in this association: If students have difficulties balancing their different duties and recovery from strains, physical activity can help to detach from work or studying but it could vice versa contribute to feeling more stressed by having to perform physical activity despite being busy with work (Schwarzer et al., 2008; Lippke et al., 2009). To answer the *research question 3a* "To what extent does physical activity and its predictors as well as work-life balance and quality of life explain variance of loneliness in general" we can conclude that 11% of the variance could be explained, but only if social-cognitive predictors of physical activity, quality of life and work-life balance were included. Without the latter, only 4% of the variance could be explained and without social-cognitive predictors, only 2% could be explained.

Comparing these findings to the data from 2020 during the pandemic (*research question 3b*), the model containing sex, age. living situation and physical activity explained 6% of the variance in loneliness. To answer the *research question 3b* "To what extent does physical activity explain variance of loneliness during the COVID-19 pandemic" we can conclude that the contribution of physical activity to explaining the variance in loneliness was rather small but slightly higher during the pandemic compared to before the pandemic. With regard to a perceived increase in loneliness, on the other hand, physical activity barely contributed to the 28% of explained variance in the perceived increase in loneliness, but it was mostly due to including static loneliness in the model. As social-cognitive predictors of physical activity, quality of life and work-life balance were not measured in 2020, only sex, age, physical activity and living situation could be regarded and relating to the general finding from pre-pandemic, the importance of other aspects become clear.

We were able to address the *research questions 4* "How does the meaning of friendship relate to feelings of loneliness?" and "How does the COVID-19 situation affect friendships and feelings of loneliness?" in more depth with qualitative data. The results showed that *friendships* among university students were perceived to be lacking a deeper and meaningful component. Physical activity was considered as having a protective function against loneliness due to not only its physical but also its strong social component. This finding is corroborated by studies reporting that social aspects are deemed as being important determinants of physical activity participation (Pels and Kleinert, 2016).

Furthermore, the *COVID-19 situation* seemed to greatly affect the interviewed students' perceived loneliness, as they expressed a need for real connection rather than virtual substitutes (*research question 5*). The qualitative results further supported the quantitative findings of higher physical activity levels being associated with lower feelings of loneliness (*research question 1*). Additionally, it appears it is not only the physical activity itself that makes students feel less lonely but also other *social aspects* that are involved in participating in physical activity, such as communicating with others, having a common goal, and spending time with like-minded team players. This social aspect connects the experience of physical activity with the feeling of belonging to a team. Theories postulate this link between *attachment* and a range of mental well-being factors, such as loneliness. This may explain this association between physical activity and connectedness, i.e., loneliness (Baumeister and Leary, 1995).

The association between *relationship status* and *loneliness* was also found with the qualitative approach (*research question 2*). This pattern is not unique and has been reported in studies with adults before: For instance, Adamczyk and Segrin (2015) found that single individuals reported higher social loneliness. Thus, loneliness depends on the quality of the relationships present during interactions including during the interaction and physical activity. Regardless of whether they were in a relationship or not, deep connections appeared crucial to students' feelings of loneliness, and were regarded as providing emotional support. Young individuals nevertheless reported a lack of those meaningful relationships at their university, and described their university friendships as shallow, temporary, and goal-driven.

CONCLUSION

In conclusion, this research further highlights issues related to loneliness among young individuals in the midst of *times of change* due to university and job entrance, but also due to the COVID-19 crisis and increased digitalization in form of online-classes and media-facilitated communication. Self-isolation and social distancing might be potential reasons for perceived increases in feelings of loneliness among young individuals. With our findings we could contribute to this assumption yet not confirm it. We found that virtual communication does not appear to feel as meaningful as close physical contact does. Recent publications on the COVID-19 pandemic indeed reveal that students not having as much direct contact with family and friends as they did pre-pandemic were at a higher risk of feeling isolated (Loades et al., 2020). Individuals at increased risk for both isolation and the development of mental health problems included those who lived alone and were female, those whose integration in the student social network was weaker, and those who did not receive much social support (Elmer et al., 2020). Other research on Chinese students further highlights the impact of COVID-19 stressors on mental wellbeing as it found that COVID-19-related stressors are positively associated with anxiety symptoms among students. *Social support*, however, was negatively correlated with students' anxiety and deemed to be a protective factor against the stressors posed by the pandemic (Cao et al., 2020). This matches our findings as it suggests a need for real, physical contact because the social environment and social support by colleagues seem to influence wellbeing and perceived loneliness.

The strengths of this study include the consideration of multiple relevant aspects for the investigation of loneliness in evaluative examinations. The application of a mixed-methods approach enabled a holistic and in-depth exploration of loneliness among university students and young individuals. The data were collected before and during the COVID-19 pandemic, enabling the exploration of the two very distinctive timepoints. However, even though this study was conducted at international universities, insights regarding cultural differences with respect to loneliness were not researched which clearly is a *limitation*. Another shortcoming of this study was that the data stem from cross-sectional surveys of different groups of participants and no longitudinal data were collected. Furthermore, only four participants were included in the qualitative interviews, which cannot be regarded as a representative sample. An additional weakness is that the analyzed quantitative data were gathered with different loneliness measures, which is why results cannot be simply interpreted together. Furthermore, other studies comparing a multiple indicator measure with single item assessment (such as the one in the study during the pandemic) have found "that attenuation of validity coefficients due to the shortening of the loneliness measure seems minimal, except for single-item indicators" (Goossens et al., 2014; p. 3). Thus, in further studies advanced measures instead of a single item measure should be employed whenever possible.

Also, physical activity was only assessed on a binary level, indicating whether individuals were sufficiently active according to recommendations or not in 2018/2019 and whether they were more physically active or not in 2020. A more detailed assessment might have enabled a more differentiated investigation of the association between loneliness and physical activity. Another aspect that should be further researched is the long-term effects of the COVID-19 crisis on loneliness in young individuals. The interviews were conducted during the onset of the COVID-19 crisis, and the cross-sectional nature of all three studies represents a further methodological limitation. Additionally, because recruitment for the qualitative study was conducted via social media advertisements, and interviews were performed via the internet, technologically illiterate individuals were excluded. Furthermore, selection bias could have resulted from time conflicts, interest in qualitative research methods and in the topic of friendship and loneliness. This should be taken into account when interpreting the results and when planning future studies.

Furthermore, as we explicitly selected only first year students with the quantitative study prior to 2020 and the qualitative study in 2020, the perception of friendships might not be representative for university students in general. First year students had only spent a short time at university and friendships might require more time to become meaningful. Thus, the participant selection could have affected the results as the lack of depth of university friendships can be related to this special phase of this life and friendships being relatively new. Whether this finding is generalizable to all university friendships is therefore questionable and should be tested in future studies.

Suggestions for further research are that it might be of great interest to longitudinally explore how perceived loneliness develops as social distancing guidelines continue over a long period, as has been done before. For instance, Luchetti et al. (2020) did not find any impact of the governmental restrictions on individuals' loneliness in the United States. This should be validated in other countries, too. A Swiss study comparing students' social networks and mental health before and after the lockdown recently pointed out that students' loneliness, depressive symptoms, stress and anxiety worsened. This was attributed to stressors ranging from worries about missing out, health-related worries, to worries about the future (Elmer et al., 2020). It could also indicate that there are *vulnerable subgroups* within this crisis, and can explain why on the population level Luchetti et al. (2020) did not find any interrelations between loneliness and state orders. Such a subgroup could be, for instance, physically inactive individuals. This aspect should also be tested in the subsequent studies. Moreover, the association between physical activity and loneliness should be tested longitudinally with according data over time, also incorporating tests on psychological mechanisms and their potential buffering or causal effects.

Evidence on the importance of loneliness stemming from the COVID-19 pandemic might be used to inform the development of *policies and programs to combat the potential negative impact the COVID-19 pandemic* could have on the mental wellbeing of young citizens. This study could further be useful for university and company counselors and other staff who could benefit from insights into reasons for loneliness at schools, university, and companies. Such insight may thereby enable them to encourage the building of appropriate social environments and team sport participation as means of improving health, wellbeing, and feelings of loneliness and belonging.

To conclude, performing physical activity and engaging in meaningful social interactions seem to be relevant correlates of loneliness in young individuals but need to be further researched with appropriate measures and longitudinal study designs. There is a need to address the perceived lack of meaningful and deep friendships among peers and the demand for personal interactions. This highlights the potential negative impact of COVID-19 related restrictions such as social distancing and self-isolation on individuals' feelings of loneliness.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article can be obtained from the first author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Commission of the German Association of Psychology (Deutsche Gesellschaft für Psychologie, EK-A-SL022013). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

SL and MF contributed to the development of this protocol and the analytical strategy as well as the overall methodology.

SL collected and analyzed the quantitative data, and drafted the final manuscript. MF contributed to qualitative data collection and analysis and wrote the first draft. TR contributed to the drafting process and revising the manuscript on basis of the reviewers' feedback. All authors contributed to this work and agreed on the submission of the final manuscript version.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

APPENDIX

APPENDIX TABLE 1 | Linear regression analysis of loneliness with 2018/2019 pre-pandemic data.

	Model 1 R^2 = 0.008				Model 2 R^2 = 0.019				Model 3 R^2 = 0.039				Model 4 R^2 = 0.114			
			95% CI				95% CI				95% CI				95% CI	
	t	B	LB	UB	*t*	B	LB	UB	*t*	B	LB	UB	*t*	B	LB	UB
Sex	−0.040	−0.003	−0.142	0.136	−0.376	−0.027	−0.167	0.114	−0.471	−0.034	−0.174	0.106	−0.167	−0.012	−0.149	0.126
Age	−0.107	−0.002	−0.032	0.029	0.248	0.004	−0.027	0.035	0.208	0.003	−0.027	0.034	0.114	0.002	−0.028	0.031
Physical activity	−1.674	−0.030	−0.065	0.005	−1.555	−0.027	−0.062	0.007	−0.265	−0.005	−0.046	0.035	0.395	0.008	−0.031	0.047
Partner status					−2.016	−0.186	−0.368	−0.005	−1.858	−0.171	−0.353	0.010	−1.905	−0.170	−0.346	0.005
PA intention									0.039	0.002	−0.106	0.110	0.189	0.010	−0.094	0.114
PA plans									−0.485	−0.022	−0.111	0.067	−0.575	−0.025	−0.111	0.061
PA self-efficacy									−2.401	−0.118	−0.214	−0.021	−2.138	−0.102	−0.195	−0.008
Quality of life													−4.018	−0.134	−0.200	−0.069
Work-life balance													3.891	0.104	0.051	0.156

Linear regression results are depicted as unstandardized coefficients with corresponding 95% confidence-intervals. Adjusted R^2 is reported. 95% CI, 95% confidence interval; t, t-value; B, unstandardized regression coefficient; LB, lower bound; UB, upper bound; PA physical activity.

APPENDIX TABLE 2 | Linear regression analysis of loneliness with data from 2020 during the COVID-19 pandemic.

	Model 1 R^2 = 0.011				Model 2 R^2 = 0.051				Model 3 R^2 = 0.060			
			95% CI				95% CI				95% CI	
	t	B	LB	UB	*t*	B	LB	UB	*t*	B	LB	UB
Sex	−1.771	−0.326	−0.690	0.037	−1.819	−0.328	−0.684	0.028	−2.073	−0.377	−0.736	−0.018
Age	1.007	0.026	−0.025	0.076	0.507	0.013	−0.037	0.063	0.346	0.009	−0.041	0.059
Physical activity					−2.855	−0.523	−0.885	−0.161	−2.827	−0.516	−0.876	−0.156
Living situation									−1.660	−0.368	−0.805	0.070

Linear regression results are depicted as unstandardized coefficients with corresponding 95% confidence−intervals. Adjusted R^2 is reported. 95% CI, 95% confidence interval; t, t-value; B, unstandardized regression coefficient; LB, lower bound; UB, upper bound.

APPENDIX TABLE 3 | Linear regression analysis of increased loneliness with data from 2020 during the COVID-19 pandemic.

	Model 1 R^2 = −0.009				Model 2 R^2 = −0.013				Model 3 R^2 = 0.002				Model 4 R^2 = 0.281			
	t	B	95% CI		*t*	B	95% CI		*t*	B	95% CI				95% CI	
			LB	UB			LB	UB			LB	UB	*t*	B	LB	UB
Sex	−0.552	−0.078	−0.357	0.201	−0.553	−0.078	−0.358	0.201	−0.856	−0.122	−0.403	0.159	0.290	0.035	−0.206	0.277
Age	0.348	0.007	−0.032	0.046	0.231	0.005	−0.035	0.044	0.048	0.001	−0.038	0.040	−0.160	−0.003	−0.036	0.031
Physical activity					−0.628	−0.090	−0.374	0.193	−0.586	−0.084	−0.366	0.198	1.060	0.131	−0.113	0.376
Living situation									−1.885	−0.327	−0.669	0.015	−1.169	−0.173	−0.466	0.119
Static loneliness													8.189	0.417	0.317	0.518

Linear regression results are depicted as unstandardized coefficients with corresponding 95% confidence-intervals. Adjusted R^2 is reported. 95% CI, 95% confidence interval; t, t-value; B, unstandardized regression coefficient; LB, lower bound; UB, upper bound.

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Serious Game Platform as a Possibility for Home-Based Telerehabilitation for Individuals With Cerebral Palsy During COVID-19 Quarantine – A Cross-Sectional Pilot Study

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Introduction: There is a need to maintain rehabilitation activities and motivate movement and physical activity during quarantine in individuals with Cerebral Palsy (CP).

Objective: This paper sets out to evaluate the feasibility and potential benefits of using computer serious game in a non-immersive virtual reality (VR) implemented and evaluated completely remotely in participants with CP for Home-Based Telerehabilitation during the quarantine period for COVID-19.

Methods: Using a cross-sectional design, a total of 44 individuals participated in this study between March and June 2020, 22 of which had CP (14 males and 8 females, mean age = 19 years, ranging between 11 and 28 years) and 22 typically developing individuals, matched by age and sex to the individuals with CP. Participants practiced a coincident timing game[1] and we measured movement performance and physical activity intensity using the rating of perceived exertion Borg scale.

Results: All participants were able to engage with the VR therapy remotely, reported enjoying sessions, and improved performance in some practice moments. The most important result in this cross-sectional study was the significant increasing in rating of perceived exertion (through Borg scale) in both groups during practice and with CP presenting a higher rating of perceived exertion.

Conclusion: Children with CP enjoyed participating, were able to perform at the same level as their peers on certain activities and increased both their performance and physical activity intensity when using the game, supporting the use of serious games for this group for home therapy and interactive games.

Clinical Trials Registration: https://Clinicaltrials.gov, NCT04402034. Registered on May 20, 2020.

Keywords: cerebral palsy, motor rehabilitation, telerehabilitation, physical functional performance, serious game

INTRODUCTION

Individuals with Cerebral Palsy (CP) present motor disorders that are commonly associated with changes in sensation, learning, body perception, communication, behavior, and secondary complications such as epilepsy and musculoskeletal disorders that impair the individual's functional performance (Bax et al., 2005). Considering these difficulties in different sensorimotor areas it is crucial for individuals with cerebral palsy to have continuous access to rehabilitation services (World Health Organization, 2004; Bax et al., 2005; Colver et al., 2014).

Although an effective rehabilitation program is important for people with cerebral palsy, in most countries, the resources available for adequate, regular rehabilitation for young people with neurological conditions are insufficient (World Health Organization, 2004). Moreover, with the new coronavirus (COVID-19), which has spread from human to human relentlessly and rapidly all over the world (Jakovljevic et al., 2020), access to health care services is even more limited, since most countries instigated a quarantine, i.e., through separation and restriction of movement of people who have potentially been exposed to a contagious disease to ascertain if they become unwell, the risk of infecting others is reduced (Brooks et al., 2020).

However, new technologies provide exciting opportunities for maintaining treatment for individuals with cerebral palsy through home-based telerehabilitation (HBTR) (Hosseiniravandi et al., 2020). A recent systematic review reveals evidence of HBTR to promote motor performance and self-care for children and adolescents with CP (Novak et al., 2020). HBTR offers the possibility of streamlining rehabilitation services, reducing therapist time, and permitting extended regular practice at times that are convenient for the users (Szturm et al., 2020). HBTR also provides the opportunity to increase the frequency of skills training, for people who find it difficult to regularly attend rehabilitation centers (Lloréns et al., 2015).

Serious-games, provide an interesting and effective way to support HBTR (da Silva et al., 2020a, Novak et al., 2020). Serious-games in non-immersive virtual reality (VR), can incorporate a range of learning elements with interactive motor and cognitive challenges, in an engaging environment providing opportunity for individuals with neurological disorders to participate in repetitive, adaptive, meaningful, and challenging motor skill practice (Gama et al., 2012; Levac et al., 2015; Lloréns et al., 2015; Schröder et al., 2019; de Moraes et al., 2020; Novak et al., 2020; Szturm et al., 2020). VR can motivate players to produce larger body movements and abandon a static position in front of the television or computer in order to play these interactive games (Crocetta et al., 2015). Gross motor function (Arnoni et al., 2019), motor performance (Leal et al., 2020), gait performance, balance abilities, leg strength (Cho et al., 2016) and reaction times (Pourazar et al., 2018) have been shown to improve when VR technology is used in children with CP. However, despite the potential benefits, evidence of the benefit of serious games (especially in HBTR) to date is limited, with studies tending to be of low methodological quality, across a range of methodologies, training doses and settings, making it difficult to draw uniform conclusions (Schröder et al., 2019).

Considering the above deliberation, this paper sets out to evaluate the feasibility and potential benefits of using computer software with a serious game implemented and evaluated completely remotely in participants with Cerebral Palsy in an HBTR during the quarantine period for COVID-19. Thus, we used a protocol with a coincident timing game to verify if participants with CP and a group of typically developing (TD) participants (TD group) (matched by age and sex) presented improved motor performance and increased physical activity intensity levels and motivation with a telerehabilitation program. We hypothesize that all participants would be able to present performance improvement (assessed through the game), with increases in physical activity intensity levels (assessed through rating of perceived exertion -RPE- scale) and motivation (assessed through visual analogue scale – (VAS) scale for satisfaction and motivation). However, considering all the sensorimotor difficulties that characterize CP, the improvements and benefits will be more evident for the TD group. If this hypothesis is confirmed, the results of this study will be relevant for the use of HBTR for individuals with CP.

MATERIALS AND METHODS

Study Design

This paper was conducted during the strict quarantine period established by the state of São Paulo to reduce the transmission of COVID-19, between March 24 2020 and Jun 11 2020. Thus, this study used 100% telerehabilitation, in which the rehabilitation team and participants only had interaction through

Abbreviations: AE, absolute error; CP, cerebral palsy; GMFCS, gross motor function classification system; HBTR, home-based telerehabilitation; RPE, rating perceived exertion; TD, typical development; VAS, visual analogue scale; VE, variable error; VR, virtual reality.

telephone contact, a communication application (WhatsApp), and software (MoveHero Software). The research was approved by Ethical Committee of the University of São Paulo, under CAAE: 03851012.7.0000.5390 and modified in March 2020 (adapted to COVID-19 research), registered on ClinicalTrials.gov NCT04402034, and reported in accordance with the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) (Chan et al., 2013).

Participants Recruitment

Researchers contacted 60 individuals with cerebral palsy through family members referred by the coordinators of two clinics in Brazil: Intertherapy and School-Clinic of the Fundação Hermínio Ometto (FHO-UNIARARAS), located in São Paulo state, and through posts on social media. The participants from TD group were recruited by social media (all from São Paulo state).

Inclusion Criteria

Participants were included if they had: age between 11 and 30 years old (adolescents and young adults); an agreement to participate in the research signed by themselves [by signing assessment form (Massetti et al., 2018)] and their legal guardians (by signing a consent form); a clinical diagnosis of CP carried out by a neuropediatric clinician (this information was provided by their parents); with GMFCS levels I to IV (these data were collected by video conference – the researcher contacted the family and was able to analyse motor function from a video).

Exclusion Criteria

Participants were excluded if they (1) did not understand the tasks — the understanding of the task was evaluated through 2 min of practicing the task (the individual was excluded if they did not understand the task during the first 2 min of practicing); (2) motor difficulties that impeded the completion of the virtual tasks (the individual was excluded if did not present motor ability to perform the task during 2 min); (3) did not have technology devices to perform the virtual task (computer or tablet) or to contact the researcher (cell phone or a second computer); and (4) were precluded from completing the task due to some technological failure (such as internet crash).

Contact and assessment scales

The parents of the individuals with CP were contacted by phone and were asked to help the participants to perform the task at home. The tasks were conducted by the researcher over the phone, via a video call. It is important to emphasize that all participants with CP and the Typically Developing (TD) group were assisted by their parents or their caregivers. First, they received a link with research information and the assent and consent form to fill out. The inclusion criteria were then checked by a researcher, and the Gross Motor Function Classification System (GMFCS) assessment was performed. After they agreed to participate, a link to access a questionnaire was sent with the Rating of Perceived Exertion (RPE) scale and sociodemographic information. When the parents and participants had completed the scales, the game platform was accessed, and the participant started the protocol. After finishing the intervention, the participants completed the visual analogue scale (VAS) scale for satisfaction and motivation (Heller et al., 2016; Sung and Wu, 2018).

Materials and Apparatus

Instrument

In this study, we used a platform called MoveHero, available for free use in Portuguese https://movehero.com.br/ and English https://movehero.com.br/en/. The individual's representant (family member) was required to access the Internet, and once they were online, create their own account, inserting the participant's name and email and creating a password (all data collected were saved in the software system and only the principal investigator had access). The platform presents different levels of difficulty, so after the participant was connected to the platform, the researcher directed the participant to the protocol developed for this research.

Presented by Martins et al. (2019), MoveHero is considered a coincident timing task and presents several spheres falling down the computer screen, with a musical rhythm to increase engagement. The participant is positioned in front of a computer and when the game starts the webcam captures the participant's movements and a representation of the player appears on the computer screen as an avatar (**Figure 1**). The goal of the game is to intercept all falling spheres using upper limb wave movements at the exact moment the spheres reach their specific target at the bottom of the computer screen. The game presents four columns with fixed parallel targets allocated at two height levels (e.g., two on the left - targets A and B; two on the right – targets C and D). The game also provides sensory feedback (visual - hit and miss feedback; auditory – anticipatory and delay error) – if the individual reaches the spheres correctly, the game presents feedback with the spheres changing the color of the target to blue, with little stars around it (hit information). On the other hand, if the participant does not reach the spheres correctly, the spheres change color to red and the letter X appears inside the target (miss information) together with a sound indicating an error.

FIGURE 1 | Participant positioning and game design.

Software Score

During the games, the participant can follow the score determined by the number of spheres hit (i.e., the information from each sphere hit appears in the bottom left side of the screen at all times) and at the end of each game the participant receives feedback with their total score (when the game is finished a total score appears in the middle of the computer screen).

Assessments

Characterization

(1) The Gross Motor Function Classification System (GMFCS): is a reliable and valid standard classification system of gross motor function for cerebral palsy that analyses an individual within 5 levels according to his/her ability to move, functional limitations, need to use assistive devices for walking, or need for a wheelchair (González-Alonso and Matía Cubillo, 2018).

(2) Sociodemographic Information: some questions are asked, regarding age, sex, income, level of CP, etc. (see **Table 1**) in order to understand the studied sample.

Outcome measures

(1) RPE scale: The Rating of Perceived Exertion was used to measure the subjective intensity of effort. The RPE is based on the sensations felt during exercise, such as muscle fatigue, increased heart rate, and increased breathing (Andrews et al., 2013). The RPE, although subjective, is used in several studies with the CP population (Maltais et al., 2004; Maanum et al., 2010; Runciman et al., 2016; Hjalmarsson et al., 2020) and can be considered a valuable indicator to monitor the tolerance to exercise and signalize imminent fatigue (ACSM).

(2) Motor performance: assessed during the game, through accuracy and precision of movement, as well as number of hits and mistakes.

(3) Motivation and satisfaction with the games and telerehabilitation were measured using a visual analogue scale (VAS) from 0 to 4.

Intervention

Practicing the Task

Participants performed the task individually in their own homes with at least one family member helping and giving support throughout the protocol. The researcher contacted the family member using a video call and gave the following instructions (researcher interacted with the family member and the participant throughout the protocol): (1) place the computer on a table and login to the platform; (2) position the cell phone (to provide video call) on the side of the computer to receive instructions; (3) provide a comfortable sitting position in a chair (individual should be positioned at a distance of approximately 1.5 m meters from the computer monitor) and adjust the height according to the needs of the individual (if applicable, participants could use their own wheelchair); (4) after the participant was seated and connected to the platform, the researcher explained the task verbally to all participants and a 2 min demonstration of how to perform the game was given for the family member. Next, the family member was asked to setup the game for their child/adolescents to play; (5) after the demonstration, the family member was asked to pick up the mobile phone (to have the opportunity to move the phone and show the participant's performance to the researcher during the protocol); and (6) thus, the therapist (by video call) instructed the participant to stay still and wait for the first sphere to appear on the screen. Once the first sphere appeared, the individual was required to move his or her hand in front of the camera to reach the sphere exactly at the moment coinciding with the target and the game continued with different spheres falling down the computer screen.

Intervention Game Protocol

The MoveHero protocol was divided into 4 different matches (M0, M1, M2, and M3). M0 was the first contact with the task and was considered a familiarization phase to limit the interference caused by the use of new technologies. According to Lopez et al. (2016), the familiarization phase should be assessed *per se*, based on the principles of errorless learning. During familiarization the required actions are learned progressively in order to limit the production of errors and favor solid understanding of the rules of use (Lopez et al., 2016). Thus, in M0 all participants had the opportunity to learn how to play the game during a maximum of 3 min. After this familiarization period and on the second day, participants started M1, M2, and M3, each game consisting of 3 min of playing the MoveHero software with an interval of approximately 20 s between games to see the score and answer the RPE scale. The RPE scale was used at 4 moments: before starting M1 – baseline, after M1, after M2, and a final RPE after M3 (the study design depicted in **Figure 2**).

DATA ANALYSIS

We considered the timing error provided by the game (in milliseconds) the dependent variable. The timing error was defined as the difference between the time the sphere started dropping and the time the individual managed to hit the target with the avatar's hand. As used by de Mello Monteiro et al. (2014; 2017), Bezerra et al. (2018), and Martins et al. (2019), we analyzed the absolute error (AE), which demonstrates the accuracy of the movement; and the variable error (VE), which identifies the precision of the movement (for details about these errors, see de Mello Monteiro et al., 2017). As well as AE and VE we used as dependent variables the percentage of hits and misses and Rating of Perceived Exertion (RPE). As the assumption of normality was not met, non-parametric tests were used. We used Independent-Samples Mann-Whitney for comparisons between groups (CP and TD) and the Friedman test to compare matches (M0, M1, M2, and M3) and moments (Mo0, Mo1, Mo2, and Mo3), with Bonferroni as *post hoc* test. The effect size was calculated by using G*Power software, version 3.1, and interpreted as d = 0.2 be considered a "small" effect size, 0.5 represents a "medium" effect size and 0.8 a "large" effect size (Lakens, 2013).

For the analysis of sample characterization, we used the independent samples t-test to compare groups (to attest homogeneity of groups) when the data were continuous and the chi-square test for categorical data. Values of $p < 0.05$ were

TABLE 1 | It described the characterization of the group.

Variables		Group CP	Group TD	*p*-value
		Mean ± SD	***Mean ± SD***	
Weight		48.3 ± 11.7	56.5 ± 21.8	**0.004**
Height		1.51 ± 0.14	1.60 ± 0.17	0.100
Age		17.8 ± 9.9	16.8 ± 8.4	0.532
		n (%)	***n (%)***	
Sex	Female	9 (41)	9 (41)	1.000
	Male	13 (59)	13 (59)	
GMFCS	I	6 (27)	–	–
	II	4 (18)	–	
	III	7 (32)	–	
	IV	3 (14)	–	
	V	2 (9)	–	
Intellectual disability	Yes	3 (13)	0 (0)	0.073
	No	19 (87)	22 (100)	
Learning difficulty	Yes	8 (36)	0 (0)§	**0.002**
	No	14 (64)	22 (100)§	
Seizure	Yes	4 (18)	0 (0)§	**0.036**
	No	18 (82)	22 (100)§	
Sight disability	Yes	11 (50)	0 (0)§	**<0.001**
	No	11 (50)	22 (100)§	
Hearing disability	Yes	2 (9)	0 (0)	0.148
	No	20 (91)	22 (100)	
Therapy (type)	Physiotherapy	14 (64)	0 (0)§	**<0.001**
	Occupational Therapy	1 (4)	0 (0)	
	Physical Activity	4 (18)	16 (73)§	
	None	3 (14)	6 (27)	0.385
Hours of therapy	1–2 h / week	8 (36)	3 (14)	
	3–5 h / week	8 (36)	10 (45)	
	6–9 h / week	1 (4)	2 (10)	
	>10 / week	2 (10)	1 (4)	
	none	3 (14)	6 (27)	
During the COVID-19 pandemic, did your child stop any of the following therapy / activities?	No	6 (28)	3 (14)	**0.013**
	Yes, totally	10 (45)	8 (38)	
	The activities were adapted by the therapists to be performed at home	5 (23)	1 (4)	
	I adapted the activities at home by myself	1 (4)	9 (43)§	
Dominant hand	Right	15 (68)	20 (91)	0.062
	Left	7 (32)	2 (9)	
Does your child use a smartphone?	Yes	15 (68)	17 (73)	0.401
	No	7 (32)	5 (27)	
Does your child use a laptop?	Yes	2 (9)	5 (27)	0.064
	No	20 (91)	17 (73)	
Does your child use a tablet/iPad?	Yes	4 (18)	3 (14)	0.680
	No	18 (82)	19 (86)	
Does your child use a desktop?	Yes	2 (9)	6 (27)	0.118
	No	20 (91)	16 (73)	
Does your child use a videogame?	Yes	3 (14)	6 (27)	0.262
	No	19 (86)	16 (73)	
Does your child watch TV?	Yes	5 (23)	2 (9)	0.216
	No	17 (77)	20 (91)	

(Continued)

TABLE 1 | Continued

Variables		Group		*p*-value
		CP	TD	
		Mean ± SD	*Mean ± SD*	
How long does your child use these devices (all together) per week?	<2 h/week	1 (4)	1 (4)	0.747
	2–5 h/week	1 (4)	0 (0)	
	5–10 h/week	6 (28)	5 (23)	
	>10 h/week	14 (64)	16 (73)	
Does your child use video-game?	No	9 (41)	10 (46)	0.553
	Yes, 1–2 h/week	12 (55)	11 (50)	
	Yes, 2–3 h/week	0 (0)	1 (4)	
	Yes, >3 h/week	1 (4)	0 (0)	
Does your child use Cell phone/tablet to play?	Yes	16 (73)	16 (73)	1.000
	No	6 (27)	6 (27)	
Use of Virtual Reality	Yes	9 (41)	0 (0)§	**0.001**
	No	13 (59)	22 (100)§	

CP, cerebral palsy group; TD, typical development group; SD, standard deviation; GMFCS: gross motor function classification scale. §p < 0.05 found by Bonferroni post hoc test in the chi-square comparisons.

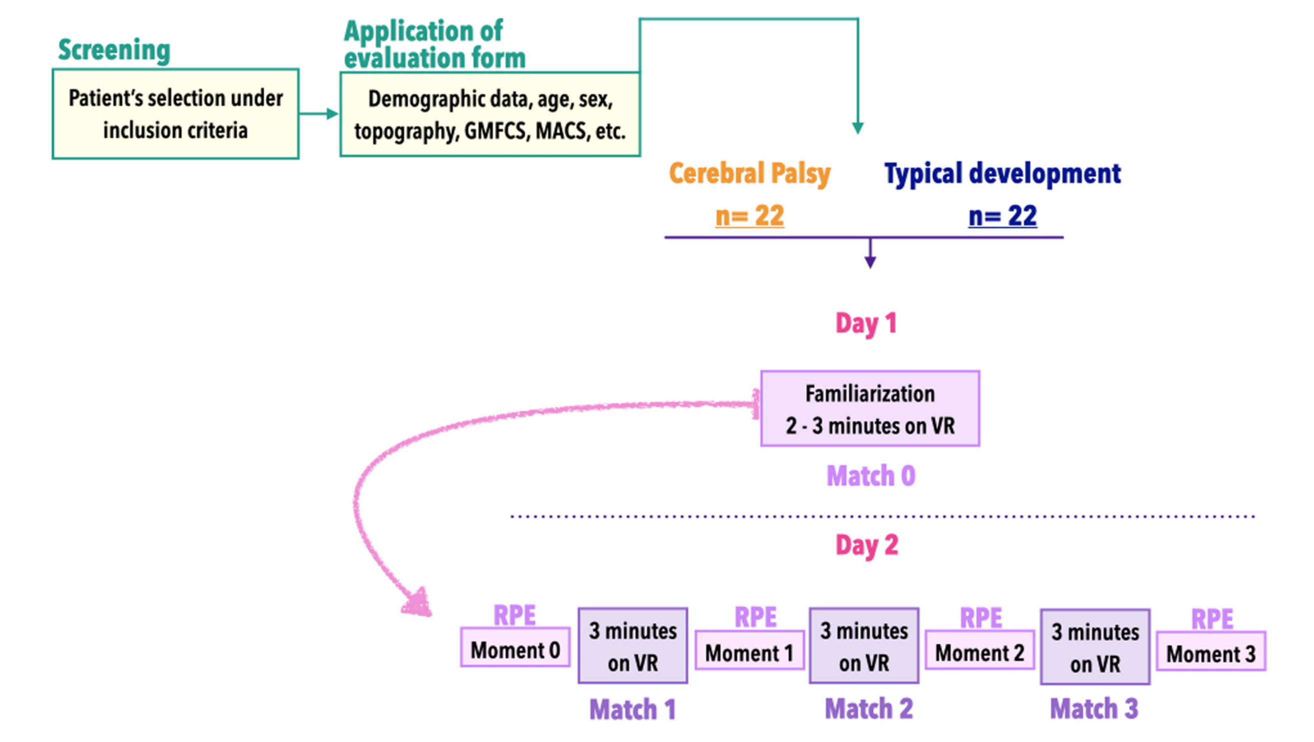

FIGURE 2 | Overview of study design.

considered significant. The statistical package used was SPSS (IBM Corporation, Armonk, NY, United States), version 20.0.

RESULTS

After being given an explanation of the task, 60 participants agreed to participate. Potential and interested volunteers underwent a detailed screening using the eligibility criteria and attended an initial selection for enrolment in the study. A total of 44 individuals were eligible and participated in this study, 22 of which had CP (14 males and 8 females, mean age = 19 years, ranging between 11 and 28 years.) and 22 typically developing individuals, matched by age and sex to the individuals with CP. Within the CP-group, there were 10 individuals with diparetic spasticity, 8 with right spastic hemiparesis, 8 with left spastic hemiparesis and 6 with choreoathetosis.

Motor Performance – Absolute Error – AE

Differences were observed between CP and TD groups in position 1 (left) at match 3 (Mann-Whitney U: 131, $p = 0.015$, $d = 0.68$), and in position 4 (right) at match 1 (Mann-Whitney U: 77, $p < 0.001$, Cohen's $d = 0.84$) and 2 (Mann-Whitney U: 118.5, $p = 0.006$, $d = 0.78$). The descriptive values are depicted in **Figure 3**.

Regarding comparisons within matches, the significant differences occurred within M0 and the other three matches in all positions (M0 versus M1: *P1* = 0.035, *d* = 0.84, *P2* = 0.006, *d* = 0.76, *P3* = 0.008, *d* = 0.82, *P4* = 0.002, *d* = 0.75; M0 versus M2: *P1* = 0.006, *d* = 0.73, *P2* = < 0.001, *d* = 0.87, *P3* = 0.002, *d* = 0.91, *P4* = < 0.001, *d* = 0.96; M0 versus M3: *P1* = 0.003, *d* = 0.82, *P2* = < 0.001, *d* = 0.83, *P3* = < 0.001, *d* = 0.79, *P4* = < 0.001, *d* = 0.82) (**Figure 3**).

Motor Performance – Variable Error – VE

There were differences between the CP and TD groups only in position 4 (right) at matches 1 (Mann-Whitney U: 118, $p = 0.010$, $d = 0.70$) and 2 (Mann-Whitney U: 102.5, $p = 0.002$, $d = 0.89$). The descriptive values are depicted in **Figure 4**.

Regarding comparisons within matches there were no significant differences between M0 and the other three matches in all positions for both CP and TD-groups (**Figure 4**).

Motor Performance – Percentage of Hits

Similarly, to AE, there were differences between the CP and TD groups in position 1 (left) at match 3 (Mann-Whitney U: 346, $p = 0.021$, $d = 0.73$), and in position 4 (right) at matches 1 (Mann-Whitney U: 357, $p = 0.001$, $d = 0.78$) and 2 (Mann-Whitney U: 334, $p = 0.002$, $d = 0.98$). The descriptive values are depicted in **Figure 5**.

Regarding comparison within matches the significant differences occurred between M0 and some of the other three matches, depending of the position of the targets and position: (M0 versus M1: *P4* = 0.018, *d* = 0.64; M0 versus M2: *P2* = 0.003, *d* = 0.81, *P3* = 0.007, *d* = 0.85, *P4* = 0.001, *d* = 0.92; M0 versus M3: *P2* = 0.047, *d* = 0.84, *P3* = 0.001, *d* = 0.98, *P4* = 0.023, *d* = 0.75) (**Figure 5**).

RPE, Game Score, Hits Percentage, and Misses Percentage (All Positions Together)

There were differences between groups for (a) RPE, (b) Score in the game, and (c) % of hits, at matches M1 [(a) Mann-Whitney U: 165, $p = 0.051$, $d = 0.59$; (b) Mann-Whitney U: 330.5, $p = 0.038$, $d = 0.64$; (c) Mann-Whitney U: 346, $p = 0.015$, $d = 0.72$], M2 [(a) Mann-Whitney U: 132, $p = 0.009$, $d = 0.80$; (b) Mann-Whitney U: 332, $p = 0.014$, $d = 0.71$; (c) Mann-Whitney U: 330, $p = 0.039$, 0.60], and M3 [(a) Mann-Whitney U: 133.5, $p = 0.004$, 0.84; (b) Mann-Whitney U: 383.5, $p = 0.001$, $d = 0.92$; (c) Mann-Whitney U: 316, $p = 0.061$. $d = 0.52$]. In % of misses there was a significant difference only at M3 ($p = 0.040$, $d = 0.68$).

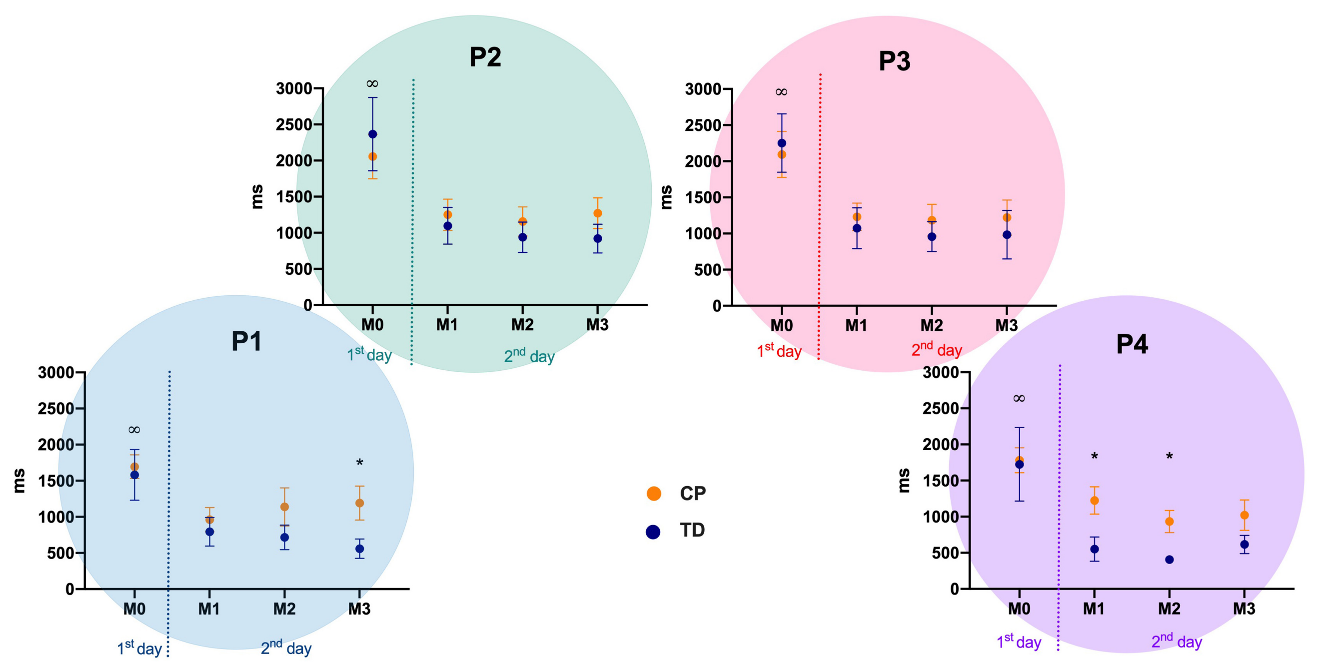

FIGURE 3 | Absolute Error mean and standard error for both CP and TD-groups during familiarization phase (M0) and the three following matches (M1 to M3), in the four positions of the targets (P1 to P4). P1 to P4: positions of the targets of the MoveHero task; M0 to M3: Matches of the task, in which M0 is the familiarization phase and M1 to M3 are the three matches; CP, cerebral palsy group; TD, typical development group. *$p < 0.05$ between CP and TD groups; $^{\infty}p < 0.05$ between match 0 and all other matches.

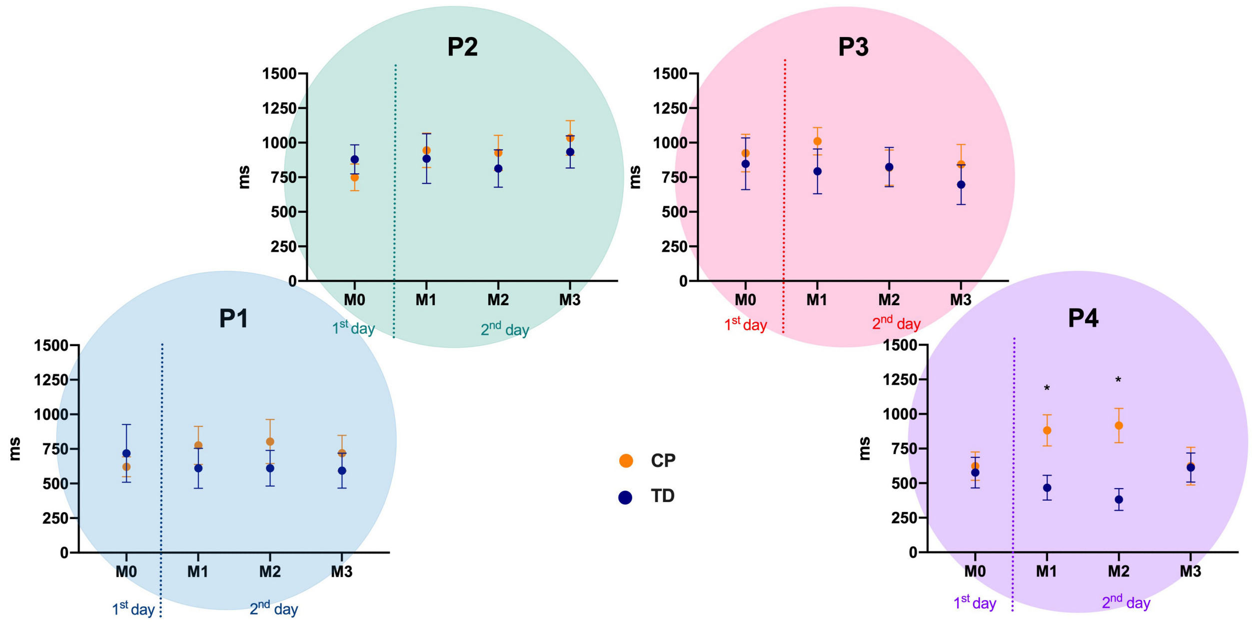

FIGURE 4 | Variable Error mean and standard error for both CP and TD-groups during familiarization phase (M0) and the three following matches (M1 to M3), in the four positions of the targets (P1 to P4). P1 to P4: positions of the targets of the MoveHero task; M0 to M3: Matches of task, in which M0 is the familiarization phase and M1 to M3 are the three matches; CP, cerebral palsy group; TD, typical development group. *$p < 0.05$ between CP and TD groups.

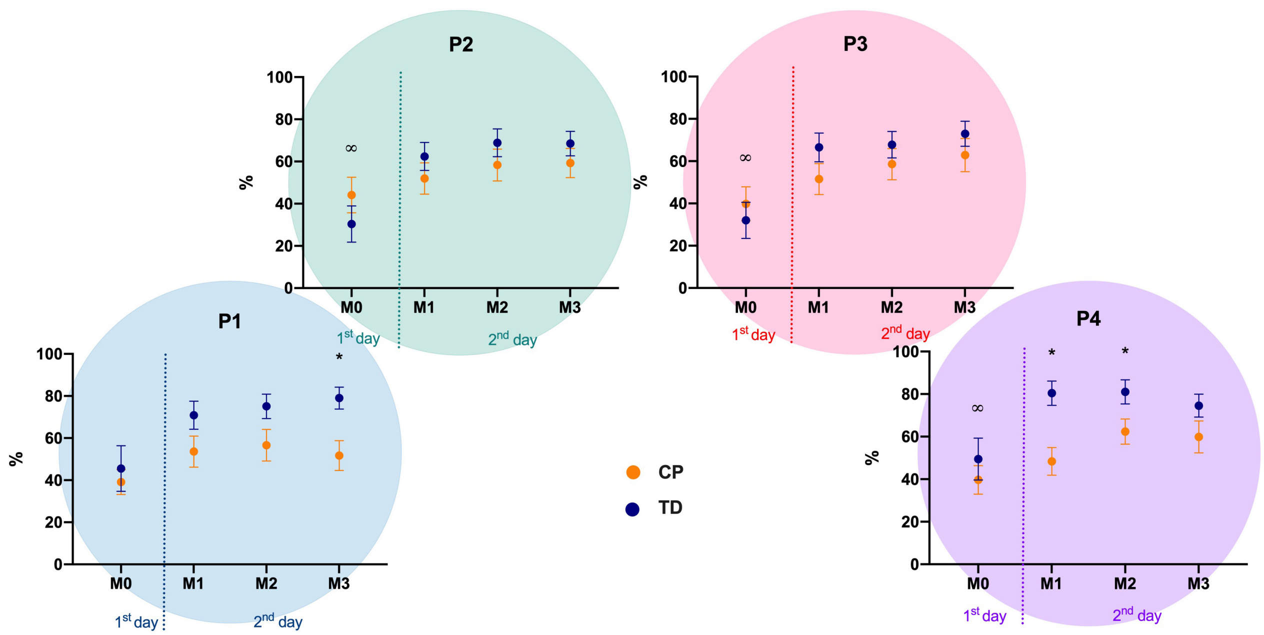

FIGURE 5 | Mean and standard error of the percentage of hits for both CP and TD-groups during familiarization phase (M0) and the three following matches (M1 to M3), in the four positions of the targets (P1 to P4). P1 to P4: positions of the targets of the MoveHero task; M0 to M3: Matches of task, in which M0 is the familiarization phase and M1 to M3 are the three matches; CP, cerebral palsy group; TD, typical development group. *$p < 0.05$ between CP and TD groups; ∞$p < 0.05$ between match 0 and all other ma.

For % of hits there were significant findings within M0 and all the other three matches (M0 versus M1, $p = 0.011$, 0.73; M0 versus M2, $p < 0.001$, 0.96; M0 versus M3, $p < 0.001$, 0.97). For matches score there were significant effects between M1 and M2 ($p = 0.001$, $d = 0.82$) and M1 and M3 ($p < 0.001$, $d = 0.90$). For % of misses no significant effects were found (**Figure 6**).

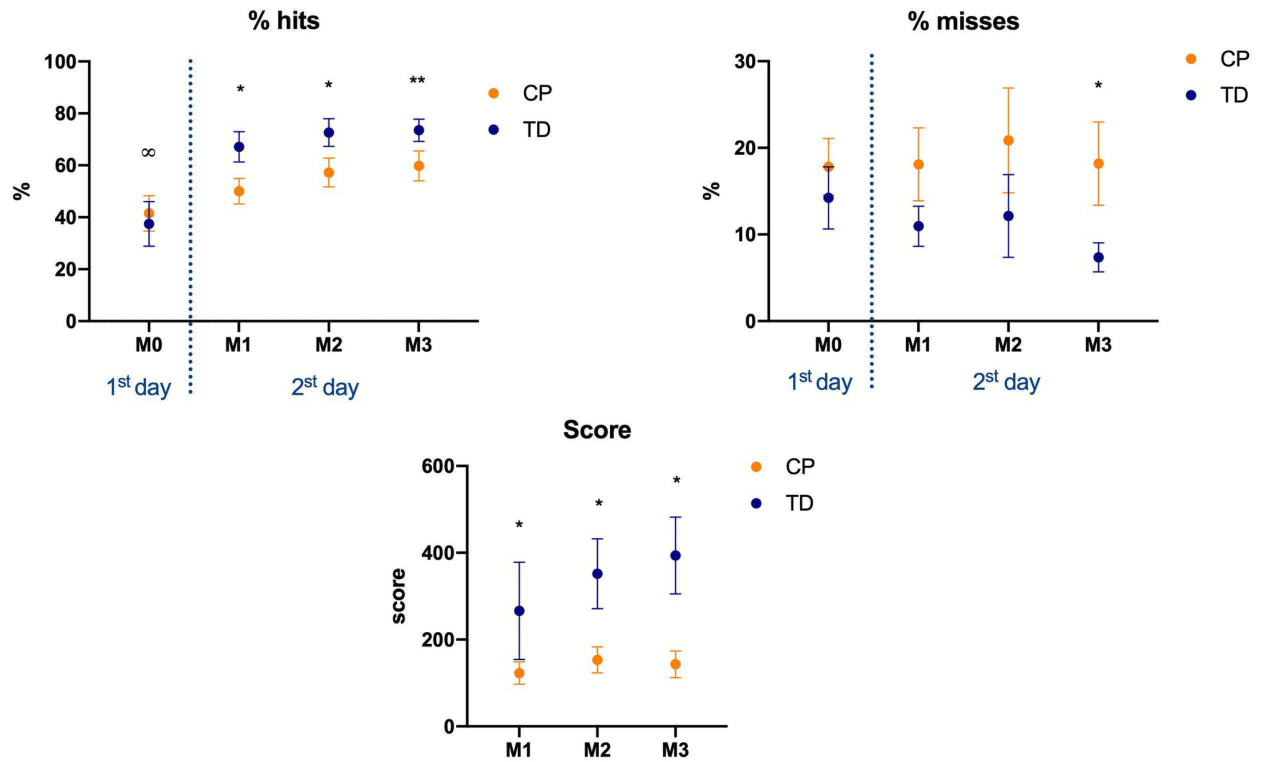

FIGURE 6 | Mean and standard error of percentage of hits, misses, and the continuous score, for both CP and TD-groups during the familiarization phase (M0) and the three following matches (M1 to M3), in the four positions of the targets (P1 to P4). M0 to M3: Matches of task, in which M0 is the familiarization phase and M1 to M3 are the three matches; CP, cerebral palsy group; TD, typical development group. $^*p < 0.05$ between CP and TD groups; $^{\infty}p < 0.05$ between match 0 and all other matches.

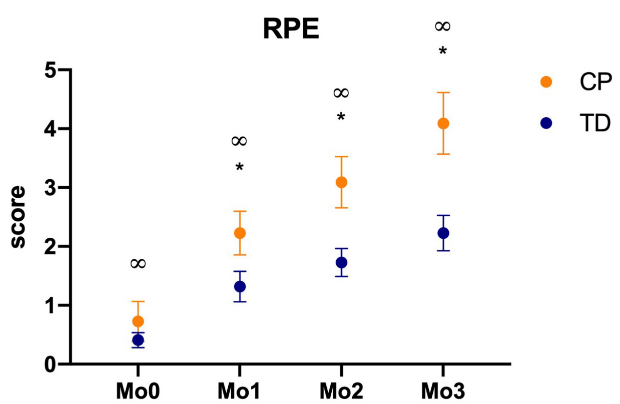

FIGURE 7 | Mean and standard error of RPE score, for both CP and TD-groups before first match (Mo0), after first (Mo1), second (Mo2), and third matches (Mo3), in the four positions of the targets (P1 to P4). M0 to M3: Moments of task, in which M0 is the familiarization phase and M1 to M3 are the three games; CP, cerebral palsy group; TD, typical development group. $^*p < 0.05$ between CP and TD groups; $^{\infty}p < 0.05$ between moments.

A very interesting result was found regarding RPE (**Figure 7**). When comparing moments within them, there are significant effects between all moments for both CP and TD-groups (Mo0 versus Mo1, $p = 0.001$, $d = 0.87$; Mo1 versus Mo2, $p < 0.001$, 0.93; Mo2 versus Mo3, $p < 0.001$, $d = 0.95$) (**Figure 7**).

Game Engagement

Regarding engagement, **Figure 8** shows the results of the participants who found the game fun (**Figure 8A**), felt tired after the intervention (**Figure 8B**), would like to continue using the game in the rehabilitation clinic (**Figure 8C**), and would like to keep using the game at home (**Figure 8D**).

Correlation

In order to establish the influence of age, body mass index, level of CP and time spent in technological devices over the increase in RPE (delta: Mo3-Mo0) and performance in the game, we conducted a correlation analysis. It showed no influence of any of the independent variables over the dependent variables.

DISCUSSION

Due to the world problem with quarantine and the impossibility of individuals with CP maintaining traditional rehabilitation activities (i.e., presential rehabilitation), the current study investigated the possibility of setting up and delivering a home-based telerehabilitation (HBTR) protocol using a serious

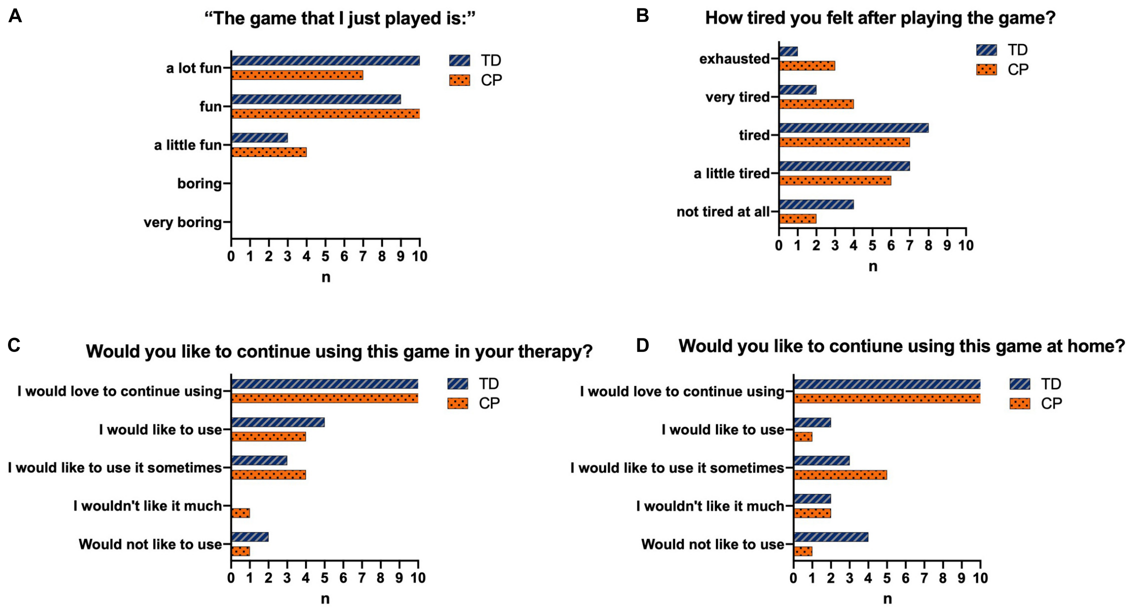

FIGURE 8 | Representation of the answers of the individuals from both CP and TD groups regarding their satisfaction with the game. TD, Typical Development; CP, Cerebral Palsy; *n* = number of participants who chose this option. **(A)** shows the results of the participants who found the game fun. **(B)** shows the results of the participants who felt tired after the intervention. **(C)** shows the results of the participants who would like to continue using the game in the rehabilitation clinic. **(D)** shows the results of the participants who would like to keep using the game at home.

game platform to improve motor performance, and increase physical activity and motivation in individuals with CP during a strict quarantine period. Our initial hypothesis was partially supported as all participants were able to engage with the therapy remotely and demonstrated improved performance, increasing their physical activity in this cross-sectional study, providing a positive base for developing HBTR in this group. However, contrary to our hypothesis the TD group did not present better motor performance in all aspects of the protocol compared to the CP group opening opportunities for motivating competitions with TD peers and siblings. These results will be explained below.

Motor Performance

Considering motor performance, all participants presented improvement when comparing M0 (familiarization match) with other matches (M1, M2, and M3). According to Wadden et al. (2019), a higher degree of challenge, when the motor response or task-demands are more complex, affects the conditions of learning. Therefore, to provide improvement in performance, individuals first need to know how to perform the task. Thus, as we used an unknown task, in our study we provided a familiarization match, in order to allow participants to understand the task. Our results showed improvement from the familiarization match (M0) to the first practice match (M1), which means that both groups understood the task and were able to play the MoveHero game, although they did not improve performance during the practice. This supports the use of a familiarization practice session for CP and TD group.

The performance improvement was not observed continuously, i.e., there was no improvement in performance considering absolute error and number of hits between M1, M2, and M3 matches. It is well known that after familiarization, to execute a task and acquire fluency of movement, the participant requires practice with repeated experience to achieve automation, accuracy, and precision of movement (Kawahira et al., 2004; Gabitov et al., 2014; Magallón et al., 2016). Thus, we can speculate that a longer period of practice (more days practicing), and greater experience with the task would be positive to learn how to use feedback from the virtual environment (with no haptic feedback) and could provide higher automation to the task, with performance improvement, and, actually that is what happens in serious game players; the more they play, the better they get.

Considering performance comparisons between groups, the TD group performed better than the experimental group only in some positions and matches, contrary to our initial hypothesis, as we expected better performance from the TD group in all positions and matches. Our hypothesis was based on the studies of de Mello Monteiro et al. (2014), Martins et al. (2019), and Prado et al. (2017) that compared motor learning between individuals with CP and their typically developing peers during tasks in a non-immersive VR environment and identified that timing accuracy was significantly worse in individuals with CP than in the TD group.

However, in our study, the TD group presented better performance only in lateral targets considering absolute error and target hits (i.e., the TD group presented better performance in M3 in A1 position – left side; and M1 and M2 in A4 position – right side). As presented before, in all other matches and positions we did not find statistical differences. This is quite intriguing and it is interesting that all the difficulties that characterize individuals with CP caused differences from the TD group only in the lateral targets and in some matches. This data provides support for the use of serious games in young people with CP and the possibility for direct competition with TD young people on some serious games activities. It is probable that the CP difficulties such as permanent neurological impairment (Panteliadis et al., 2015) associated with significant sensorimotor dysfunction (Reid et al., 2015), muscular weaknesses (Soares et al., 2019), high levels of co-activation (Soares et al., 2019), abnormal muscle recruitment with spasticity (Booth et al., 2019; Ko et al., 2020) and slowness of movement (da Silva et al., 2020b) disturbed the performance of individuals with CP when they were required to use a bigger range of movement with accuracy (i.e., targets more distant in the lateral position needed bigger range of movement and accuracy). According to Fernani et al. (2017) who evaluated CP and a TD group in a computer task to verify movement speed-accuracy trade-off, by changing width and distance of targets, the authors identified a worse movement time in the CP group when compared with typically developing individuals and the authors suggested that the difference could be explained by considering specific motor control difficulty, which means that individuals with CP presented worse accuracy and velocity of movement with more distant objects than their TD peers, which could explain the difficulty with the lateral targets.

Physical Activity

Another important finding was that the serious game led to increasing rating of perceived exertion, measured through the Borg scale, suggesting that the game used promotes an increase in physical activity. A review by Mitchell et al. (2012) argued that to date the emphasis has been on establishing the feasibility of serious game as a therapeutic modality for rehabilitation and that there is less research investigating the usability of serious game systems to increase physical activity in people with disabilities. This is a very important finding due to the growing evidence of the higher prevalence of metabolic syndrome, cardiovascular disease risk factors, and autonomic nervous system dysfunctions in adults with CP, because of their limited mobility since childhood, which leads to sedentary behavior, disposing them to chronic disorders such as heart conditions and hypertension (Heyn et al., 2019; Katz-Leurer and Amichai, 2019; da Silva et al., 2020a). This emphasizes the importance of new research with a view to the practice of physical activity in individuals with CP, since more active behaviors contribute to health promotion.

Differences Between Moments of Physical Activity Practice

Considering differences between moments, we believe that this increase in the rate of perceived exertion in both groups could be due to high engagement promoted by serious game tasks. For this engagement to have occurred, three elements are essential: Repetition, Feedback, and Motivation (Pereira et al., 2014), as explained below:

Repetition: Considering motor learning and level of physical activity, one of the essential factors for success is repetition, and serious games have the potential to increase the repetition of the task, providing different intensities of movement and functional activities (French et al., 2016). Thus, as the participants execute body movements, such as the repetition of muscle contractions (Alvarez et al., 2017) during the serious game, the level of physical activity will gradually enhance (Gomes et al., 2019) with an adaptation to an aerobic activity and improvement in physical capacity and efficiency of the cardiorespiratory system (Powell et al., 2011). This is in accordance with Sheehy et al. (2016), who stated that serious game is enjoyable and may motivate patients to perform more repetitions of their movement in a ludic environment, with goal-oriented movements, contributing to increased intensity and, consequently, physical activity.

Feedback: Our study did not use tactile or haptic feedback, since these experiences in VR require gloves or other expensive devices that were not available and the main objective of the MoveHero software used, is to provide a possibility for promotion of physical activity and/or rehabilitation with the lowest possible financial cost, by using auditory and visual feedback from just a computer or tablet and internet connection. The software provided constant visual and auditory feedback for hit or miss and, although this was not enough to improve performance during our protocol, it was sufficient to create an engaging environment, maintaining the motivation and participation of the participants (Shafer et al., 2019).

Motivation: the music and coloured spheres falling down are additional motivation factors and the most important contribution to guarantee player engagement in order to increase the rate of perceived exertion. According to Villiger et al. (2013), sensorimotor network activation can be enhanced when the individual plays interactively and with high motivation. Fortier et al. (2011) guarantee that motivation is an important factor to engage in physical activity interventions.

In this context, our results (**Figure 8**) demonstrate that all participants liked the game and the majority reported that they would like to keep practicing at home as a rehabilitation possibility (for the CP group) or physical activity intervention (for TD group). It is probable the MoveHero software provides the player with a new experience and a way of having fun at home. In a study by Bryanton et al. (2006) the authors observed that children are often not compliant in following a conventional home exercise program because they find the exercise meaningless and uninteresting. Therefore, the VR task allows the participant to experience stimulating environments, providing challenging tasks (Booth et al., 2019), fun, interest in making their scores higher (Zangirolami-Raimundo et al., 2019) and autonomy to the player, optimizing their motivation to continue practicing and allowing them to feel "good" about themselves (Wulf and Lewthwaite, 2016), with maintenance of movement practice of the task and, consequently, improved physical activity.

Differences Between Cerebral Palsy and TD Group in Physical Activity Level

Another interesting result was that the CP group presented a higher rate of perceived exertion than the TD group (**Figure 8**). The first justification for this result is that, considering no difference between groups in motor performance in most positions, as presented before, the individuals with CP expended more energy to finish tasks requiring body movements than typically developing individuals. According to Kerr et al. (2008) individuals with CP have been known to require greater energy consumption in some tasks as a consequence of the spectrum of the condition, such as spasticity and impaired postural control. It is probable the difficulty in practicing a sequential motor task in individuals with CP (Steenbergen et al., 2013) and the use of a strategy to avoid muscular perturbation caused by movement execution while reaching a target (Soares et al., 2019) were compensated by a higher neuromuscular cost (Fernani et al., 2017). Thus, during a new task, individuals with CP tend to avoid a bad performance and, consequently, need to pay more attention to motor tasks that are not automatic, (Krajenbrink et al., 2018) which probably increases the rate of perceived exertion.

A second justification is that individuals with CP participate in leisure-time physical activities less often, with less intensity, and with reduced diversity than their typically developing peers (Reedman et al., 2017). A review by Carlon et al. (2013) showed that young people with cerebral palsy performed significantly less habitual physical activity with consequent lower physical conditioning, and poor level of cardiorespiratory fitness when compared to a peer TD group.

Conclusions and Clinical Considerations

Considering the importance of being active and maintaining an exercise routine as an essential target for physical health even during quarantine (Lippi et al., 2020), new possibilities to be active inside the home are essential, especially for people with CP in order to avoid cardiovascular disease risk factors, metabolic syndrome, and autonomic nervous system dysfunctions. In this context, our results show that active video games can elicit increased energy expenditure and translate into increased physical activity, representing a powerful tool to be used by therapists and families, such as home-based telerehabilitation.

We believe that another great differential of our study is that the use of a serious game in a non-immersive virtual reality software provides the possibility of a home-based telerehabilitation that can include not only the participation of the health professional, but also of their family, which is preconized for a successful intervention. Adult supervision of motor skills is required for ongoing motivational purposes and to support the cognitive and problem-solving processes during practice (White, 2017), encouraging the individuals with CP to participate and improve. Therefore, the possibility for parents and therapists to work together (and support each other) to adjust the difficulty of the task, and provide security during the practice was essential for understanding the task and increased physical activity. According to Cramer et al. (2019) and Gibbs and Toth-Cohen (2011), although more studies are needed on home-based telerehabilitation provided by a rehabilitation team working together with parents and patients, it seems to be safe, is rated favourably by patients, is associated with excellent treatment adherence, and produces substantial gains in function as well as interventions delivered in clinics.

Limitations and Future Studies

Although we found interesting results, we can point out some limitations of the present study: (1) this was a 1 day protocol and a protocol with training lasting at least 10 days could provide better results in improving performance, physical activity, and adherence to serious game as Home-based telerehabilitation; (2) we did not analyze patterns of movement, because although these data could be important to identify quality of movement, they are difficult to assess in a telerehabilitation intervention; (3) we used a classification system to identify level of motor difficulty in the CP group (GMFCS), but it would be interesting to develop an assessment to be used for telerehabilitation, as this was proven to have potential for future interventions; (4) we should have measured the therapist and family influence during the practice, as these data could be important to define future interventions; and (5) this study misses a control group that would perform conventional interventions in telerehabilitation (without serious games).

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of the University of São Paulo, under CAAE: 03851012.7.0000.5390. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

TS designed the study, performed the statistical analyses, interpreted the data, and revised the manuscript critically for intellectual content. PS, EV, AS, MC, and AF collected patient data and drafted the manuscript. AS and CA drafted the manuscript. ED provided assistance on patient data collection and revised the manuscript. LA and MB developed the game used and revised the manuscript. HD revised the manuscript critically for intellectual content. CM coordinated the study, drafted the manuscript, and revised the manuscript critically for intellectual content. All authors read and approved the final manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.622678/full#supplementary-material

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No Evidence for a Decrease in Physical Activity Among Swiss Office Workers During COVID-19: A Longitudinal Study

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Purpose: The COVID-19 lockdown interrupted normal daily activities, which may have led to an increase in sedentary behavior (Castelnuovo et al., 2020). The aim of this study was to investigate the effect of the COVID-19 pandemic on the level of physical activity among Swiss office workers.

Methods: Office workers from two Swiss organizations, aged 18–65 years, were included. Baseline data from January 2020 before the COVID-19 pandemic became effective in Switzerland were compared with follow-up data during the lockdown phase in April 2020. Levels of physical activity were assessed using the International Physical Activity Questionnaire. Paired sample *t*-tests or Wilcoxon signed-rank test were performed for statistical analysis.

Results: Data from 76 participants were analyzed. Fifty-four participants were female (71.1%). The mean age was 42.7 years (range from 21.8 to 62.7) at baseline. About 75% of the participants met the recommendations on minimal physical activity, both before the COVID-19 pandemic and during the lockdown. Weak statistical evidence for a decline in total physical activity in metabolic equivalent of task minutes per week (MET min/week) was found (estimate = −292, 95% CI from $-\infty$ to 74, p-value = 0.09), with no evidence for a decrease in the three types of activity: walking (estimate = −189, 95% CI from $-\infty$ to 100, p-value = 0.28), moderate-intensity activity (estimate = −200, 95% CI from $-\infty$ to 30, p-value = 0.22) and vigorous-intensity activity (estimate = 80, 95% CI from $-\infty$ to 460, p-value = 0.74). Across the three categories "high," "moderate," and "low" physical activity, 17% of the participants became less active during the lockdown while 29% became more active.

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Conclusion: The COVID-19 pandemic did not result in a reduction in total physical activity levels among a sample of Swiss office workers during the first weeks of lockdown. Improved work-life balance and working times may have contributed to this finding.

Clinical Trial Registration: www.ClinicalTrials.gov, NCT04169646. Registered 15 November 2019 – Retrospectively registered, https://clinicaltrials.gov/ct2/show/NCT04169646.

Keywords: coronavirus, COVID-19, SARS-CoV-2, lockdown, physical exercise, health promotion, public health, shutdown

INTRODUCTION

Following the declaration of coronavirus disease (COVID-19) as a global pandemic by the World Health Organization on 11th of March 2020, many countries worldwide have enforced a societal-level lockdown. In Switzerland, the lockdown began 5 days later. Stores, schools, colleges, and sports facilities were temporarily closed, office workers were advised to work from home, and the public was recommended to stay at home if possible. Open spaces and green areas, however, remained open as long as the social distancing rules were respected. In comparison to other countries, the lockdown in Switzerland can be described as soft, as a curfew or restrictions to movement outside of the house were never imposed.

Nevertheless, the national restrictions interrupted normal daily activities, especially physical activity, and people spent more time at home, often lying down or sitting (Chandrasekaran and Ganesan, 2020). This may result in an increase in sedentary behavior, which is considered a major risk factor for the development or worsening of chronic diseases such as obesity, cancer, and cardiovascular diseases (Gibbs et al., 2015). Moreover, these three chronic diseases are among the leading causes of deaths worldwide (World health statistics, 2020) and are all risk factors for the development of a more severe COVID-19 outcome (Zheng et al., 2020). In addition, the level of physical activity is associated with the risk of a community-acquired pneumonia in women, with pneumonia being a major complication of COVID-19 (Baik et al., 2000). It is also known that greater physical activity is associated with a lower risk of musculoskeletal pain (Kirsch Micheletti et al., 2019) and improves mental health issues, such as mood and depression, which is particularly relevant during social isolation (Hammig et al., 2011; Cooney et al., 2013; McDowell et al., 2019; Denay et al., 2020; Meyer et al., 2020). Physical activity in fact has been shown to be similarly effective as psychological therapy and drug therapy in depression (Cooney et al., 2013). Furthermore, being physically active is associated with a 22% reduced risk of becoming depressed and having a better mood than being physically inactive (Hammig et al., 2011). A strong positive association was also found between physical activity and reaction time and memory (Magnon et al., 2018). In contrast, anxiety had a negative influence on the intention to be physically active (Chirico et al., 2020).

The known benefits of exercise have prompted several research groups to investigate the topic of physical activity and COVID-19. A study conducted in Spain demonstrated that the number of participants who followed the World Health Organization recommendations on levels of physical activity decreased from 60.6% before the lockdown to 48.9% in the first week of isolation (López-Bueno et al., 2020). In another study, 75% of participants met the physical activity guidelines during the lockdown, with women achieving higher values than men (Smith et al., 2020). A Belgian study came to a similar conclusion and showed that physically active adults, who normally exercised in a group setting and did not use online training tools during social distancing, were less active than before (Constandt et al., 2020). The same applied to many patients with type 2 diabetes mellitus, heart failure, cystic fibrosis, or neuromuscular diseases, who experienced increasing physical inactivity during home confinement (Di Stefano et al., 2020; Radtke et al., 2020; Ruiz-Roso et al., 2020; Vetrovsky et al., 2020). Two large surveys also showed that the lockdown had a negative effect on physical activity levels (Ammar et al., 2020; Qin et al., 2020). In contrast, one study reported that adults who were physically less active before the lockdown were more active during the lockdown (Constandt et al., 2020). An analysis of Google's relative search rates also showed that the general population's interest in physical activity increased during the lockdown (Ding et al., 2020).

Previous literature on physical activity and COVID-19 has mainly focused on the general population, frail individuals (elderly or sick), health care professionals or athletes. Office workers are clearly underrepresented, although they accounted for about 13% of the Swiss workforce (600,000 office workers) during the lockdown (Bundesamt für Statistik (BFS), 2020), so investigating this sample seems highly relevant. Further, a common limitation of the existing literature is that data collection did not commence until the outbreak of COVID-19, which is subject to recall bias, and that the changes in physical activity were sparsely quantified. In the present study, baseline data were collected before the COVID-19 pandemic and a validated tool was used to enable quantification of the physical activity levels and comparison with international guidelines. The aim of this analysis was to quantify the effect of the COVID-19 pandemic on physical activity levels among Swiss office workers. Considering the current literature, we hypothesized that total physical activity decreased during the first few weeks of the COVID-19 lockdown phase.

MATERIALS AND METHODS

Design and Participants

This is a longitudinal study based on data from an ongoing randomized controlled trial (Aegerter et al., 2020). The study was approved by the Ethics Committee of the Canton of Zurich, Switzerland (swissethics no. 2019-01678). Participants were recruited between October and December 2019 from two Swiss organizations in the Cantons of Zurich and Aargau. Inclusion criteria were Swiss office workers aged 18–65 years, working more than 25 h per week (0.6 full-time equivalent) in predominantly sedentary office work, able to communicate in German (written, spoken), and provided written informed consent (Aegerter et al., 2020). Exclusion criteria were severe health conditions such as previous trauma or injuries of the neck, inflammatory disease, any history of cervical spine surgery, pregnancy or if exercise was contraindicated (Aegerter et al., 2020). For this analysis, only participants in the control cohort (similar to a waiting list) between January and April 2020 were included (**Figure 1**).

Procedure

Baseline data used in this analysis is the level of physical activity 10 weeks before the COVID-19 pandemic became effective (first case) in Switzerland (January 2020), while the follow-up data represent the physical activity during the fourth (and fifth) week of lockdown (April 2020). All data were collected through a 30-min online questionnaire, but only the International Physical Activity Questionnaire: short last 7 days self-administered format – German Version (IPAQ-SF) data were analyzed for this study. UNIPARK© (Berlin, Germany) was the platform used to host the online questionnaire. Participants without follow-up measures were excluded from the analysis (n = 4/80). The STROBE Statement checklist was used for the reporting of this study (von Elm et al., 2007).

Outcomes and Measures

Physical Activity

Physical activity was assessed using the IPAQ-SF. The IPAQ-SF is a validated, reliable (Craig et al., 2003), and cost-effective method for assessing physical activity (Lee et al., 2011). The IPAQ-SF asks for physical activity (e.g., during leisure time, housework, gardening, work, and transportation) within the last 7 days, and distinguishes three activity types (walking, moderate-intensity activity, and vigorous-intensity activity). Data processing and analysis were performed according to the IPAQ-SF guidelines (IPAQ group, 2020).

Physical activity as a continuous measure

Metabolic equivalent of task minutes per week (MET min/week) was calculated for the three types of activity (walking = 3.3

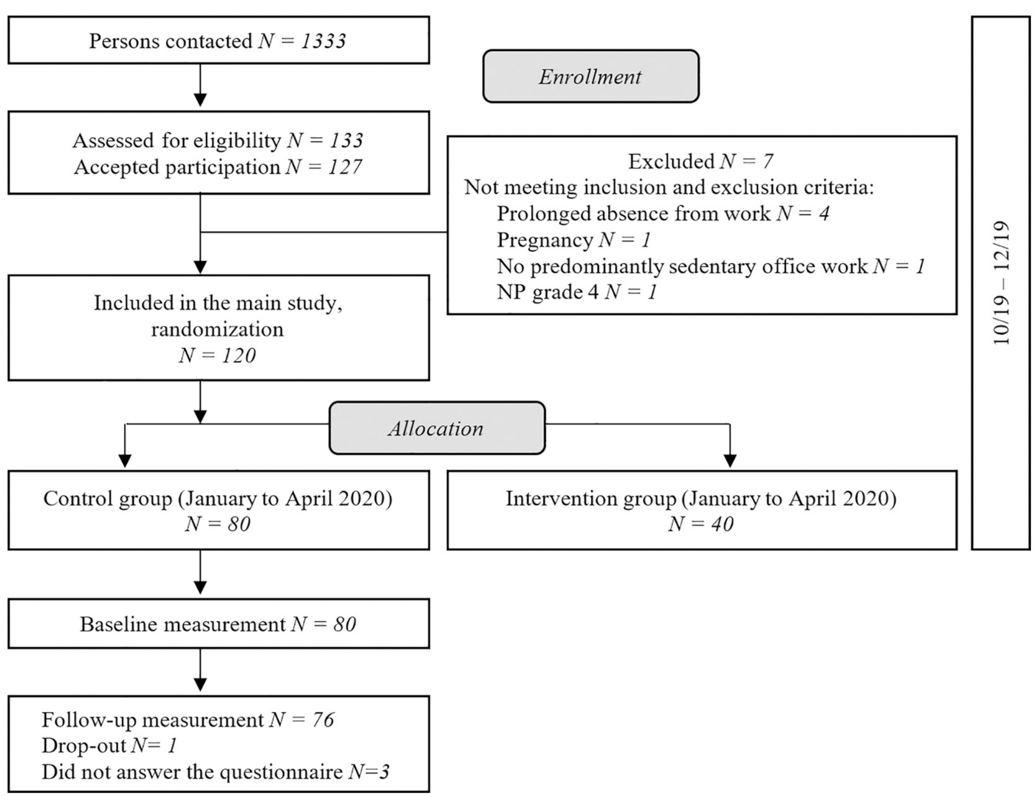

FIGURE 1 | Study flow-chart.

× walking minutes × walking days; moderate-intensity activity = 4.0 × moderate-intensity activity minutes × moderate days; vigorous-intensity activity = 8.0 × vigorous-intensity activity minutes × vigorous-intensity days), whereas the sum of the three types equaled the total physical activity level (primary outcome). According to the IPAQ-SF guidelines, participants who indicated "not sure" about the number of physically active minutes in an activity type were considered as "missing" in the corresponding type of activity, but included in the total physical activity calculation (IPAQ group, 2020). There are no studies available on the minimal clinically important difference in MET min/week of the IPAQ-SF.

Physical activity categories

Based on their weekly physical activity level, participants were classified into one of the three categories "low," "moderate," and "high" (Pedersen et al., 2009; U.S. Department of Health and Human Services, 2018). The category "high" was assigned if participants performed 3 days or more of vigorous-intensity activity achieving a minimum total physical activity of at least 1,500 MET-min/week or 7 days of any combination achieving a minimum total physical activity of at least 3,000 MET-min/week (IPAQ group, 2020). Criteria for the category "moderate" were: 3 days or more of vigorous-intensity activity of at least 20 min per day; 5 days or more of moderate-intensity activity and/or walking of at least 30 min per day; or 5 days or more of any combination achieving a minimum total physical activity of at least 600 MET-min/week (IPAQ group, 2020). Participants who could not be categorized as "high" or "moderate" were classified as "low" (IPAQ group, 2020). Only the categories "high" and "moderate" meet the recommendations on minimal physical activity of the U.S. Department of Health and Human Services and the World Health Organization (Pedersen et al., 2009; World Health Organization, 2010; U.S. Department of Health and Human Services, 2018).

Participants' Characteristics

Data on participants' age, gender, and body-mass-index (BMI) were obtained. At follow-up, participants rated their work-life balance and their working times (including start of work, end of work, work duration, and breaks) on a numeric rating scale (NRS) with a score from 1 (clearly better than before the COVID-19 pandemic) to 5 (clearly worse than before the COVID-19 pandemic).

Statistical Analysis

Participants' characteristics were analyzed using descriptive statistics with mean or median values (including standard deviation or quartiles), minimum and maximum value or, in the case of factor variables, with absolute and relative frequencies.

The normality assumption was investigated by Q-Q plots, boxplots, and Shapiro–Wilk test. To test the mean difference in total physical activity (MET min/week) between baseline and follow-up measures, one-sided paired sample t-test was used. If the assumption of normal distribution was not met, Wilcoxon signed-rank test was performed. The same procedure was applied for the analysis of each of the three types of physical activity (walking, moderate-intensity activity, and vigorous-intensity activity), including Bonferroni-Holm correction for multiple comparisons. In addition, an exploratory graphical analysis of the effect of BMI and gender on the MET min/weeks was conducted.

For the categorical analysis of physical activity, absolute frequencies of participants classified into the categories "low," "moderate," and "high" physical activity at baseline and follow-up were calculated. Changes in categories between baseline and follow-up measurement were presented graphically by a mosaic plot. The percentage of participants meeting the recommendations for minimal physical activity level, which means a classification into "high" or "moderate" physical activity category, was evaluated for baseline and follow-up.

All analyses were conducted in R Project for Statistical Computing (R Core Team, 2020), version 4.0.2, using the base packages and the following analysis-specific packages: beeswarm, car, dplyr, ggplot2, lubridate, tableone, vcd. Significance level alpha was set at 0.05. The p-values were expressed as the strength of evidence with very strong evidence ($p \leq 0.001$), strong evidence ($0.001 < p \leq 0.01$), evidence ($0.01 < p \leq 0.05$), weak evidence ($0.05 < p \leq 0.1$), and little or no evidence ($p > 0.1$) (Bland, 2015). The data analyst was blinded to the identity of the participants.

RESULTS

Participants

Four participants were excluded including one who withdrew and three who did not complete the online questionnaire at follow-up, resulting in 76 participants remaining for the analysis (**Figure 1**). The average time between completion of the questionnaire at the two time points was 102 days (±9 days).

The mean age of the participants was 42.7 years (range: 21.8 to 62.7 years) at baseline. About 70% of the participants were female (n = 54). The average BMI was 23.9 kg/m^2 (±3.5 kg/m^2) at baseline and 23.7 kg/m^2 at follow-up (±3.5 kg/m^2). Approximately, 80% (n = 60) of participants had Swiss nationality. Seventy-six percent (n = 58) of the participants had a tertiary level education, 22% (n = 17) completed upper secondary education and 1.3% (n = 1) primary compulsory education. There was no statistical evidence for a difference in participant's characteristics between baseline and follow-up.

A better work-life balance during the lockdown than before the COVID-19 pandemic was reported by 43.4% of participants (n = 33), while it remained unchanged in 28.9% (n = 22) and worsened in 22.4% of participants (n = 17; missing values in 5.3%, n = 4). Similarly, working times were rated to be better by 38.2% of the participants (n = 29), unchanged by 21.1% (n = 16) and worsened by 35.5% of the participants (n = 27; missing values in 5.3%, n = 4).

Continuous Measure of Physical Activity

The descriptive statistics of the outcomes at baseline and follow-up are shown in **Table 1**. The assumption of the data being normally distributed was met for the physical activity type of walking (p-value = 0.21), but not for the types of activity:

TABLE 1 | Participant characteristics at baseline (before the COVID-19 pandemic) and follow-up (during the lockdown).

	Baseline (*N* = 76)	**Follow-up (*N* = 76)**
Age [years]		
Mean (SD)	42.7 (9.2)	
Median (Min, Max)	42.2 (21.8, 62.7)	
Gender		
Female (%)	54 (71.1)	
Male (%)	22 (28.9)	
Nationality		
Swiss (%)	60 (78.9)	
Other (%)	16 (21.1)	
Education		
Tertiary level education (%)	58 (76.3)	
Upper secondary education (%)	17 (22.4)	
Primary compulsory Education (%)	1 (1.3)	
Body-Mass-Index (BMI)		
Mean (SD)	23.9 (3.5)	23.7 (3.5)
Total physical activity [MET minutes/week]		
Mean (SD)	2150 (2310)	2370 (2150)
Median (Min, Max)	1390 (0, 8760)	1890 (0, 10800)
Vigorous-intensity activity [MET minutes/week]		
Mean (SD)	749 (1060)	705 (1050)
Median (Min, Max)	360 (0, 4800)	280 (0, 5760)
Missing	5 (6.6%)	6 (7.9%)
Moderate-intensity activity [MET minutes/week]		
Mean (SD)	727 (1160)	929 (1020)
Median (Min, Max)	380 (0, 5040)	600 (0, 5040)
Missing	16 (21.1%)	10 (13.2%)
Walking [MET minutes/week]		
Mean (SD)	1030 (1030)	981 (890)
Median (Min, Max)	693 (0, 4160)	792 (0, 4160)
Missing	11 (14.5%)	5 (6.6%)

Max, maximum; MET, metabolic equivalent of task; Min, minimum; SD, standard deviation.

moderate-intensity activity, vigorous-intensity activity, and total physical activity (all with a p-value < 0.05). There was only weak evidence for a decline in total physical activity measured by MET min/week between baseline and follow-up (estimate = −292, 95% CI from $-\infty$ to 74, p-value = 0.09). However, no evidence was found for a decline in the three types of activity: vigorous-intensity activity (estimate = 80, 95% CI from $-\infty$ to 460, p-value = 0.74), moderate-intensity activity (estimate = −200, 95% CI from $-\infty$ to 30, p-value = 0.22), and walking (estimate = −189, 95% CI from $-\infty$ to 100, p-value = 0.28) between both measurements (**Figure 2**). An explorative graphical analysis showed no effect of BMI and gender on the result (**Supplementary Material**).

Categorical Measure of Physical Activity

The mosaic plot in **Figure 3** shows the classification into the three physical activity categories ("high," "moderate," and "low") at baseline and follow-up as well as the change in category between these two points in time. At baseline, 29% (n = 22) of participants were classified as "high," 42% (n = 32) as "moderate," and 29% (n = 22) as "low." Among the participants at baseline being classified as "high," 77% (n = 17) remained in the same category during the follow-up. Correspondingly, 75% among those classified as "moderate" remained in the same (44%, n = 14) or advanced to the "high" (31%, n = 10) category at follow-up. In the category "low," 55% of the participants (n = 12) increased to a higher category at follow-up. Furthermore, the mosaic plot shows that 71% of participants (n = 54) fulfilled the recommendations on minimal physical activity level at baseline, compared to 75% of the participants (n = 57) at follow-up.

DISCUSSION

Summary of Findings

About three-quarter of the study participants met the recommendations for minimal physical activity before the COVID-19 pandemic. This high percentage remained unchanged during the COVID-19 lockdown. Across the three physical activity categories of "high," "moderate," and "low," about 17% of the participants became less active during the lockdown phase, 54% of participants maintained their physical activity level, and an increase was recorded in 29%. Regarding the primary outcome of total physical activity in MET min/week, our hypothesis was rejected, i.e., total physical activity did not decline during the first weeks of the COVID-19 lockdown. Similarly, there was no evidence of a decline in any of the three types of physical activity (walking, moderate-intensity activity, and vigorous-intensity activity). The majority of participants rated their work-life balance (72.2%) and the working times (59.3%) as better or unchanged during the lockdown compared to before the COVID-19 pandemic.

Interpretation and Comparison With Literature

Our primary outcome of total physical activity and the three types of physical activity (walking, moderate-intensity activity, and vigorous-intensity activity), all of which are expressed as MET min/week, showed no evidence for a statistical significant difference under the lockdown compared to the situation before the COVID-19 pandemic. This result contrasts with the results of two large international surveys (Ammar et al., 2020; Qin et al., 2020), which showed that the lockdown had a negative effect on physical activity levels. However, both surveys had a risk of recall bias and no baseline measurement was performed before the COVID-19 pandemic. Nevertheless, the question arises for this unexpected result with several possible explanations. First, the baseline data collected in January 2020 could have been artificially increased or decreased due to New Year's resolution, winter breaks in sports clubs or bad weather conditions (e.g., no cycling to work or jogging because of snow). Second, the follow-up data could also be affected positively or negatively, for example through the individual fear of an infection (e.g., risk group versus non-risk group), working from home (e.g., no way to work),

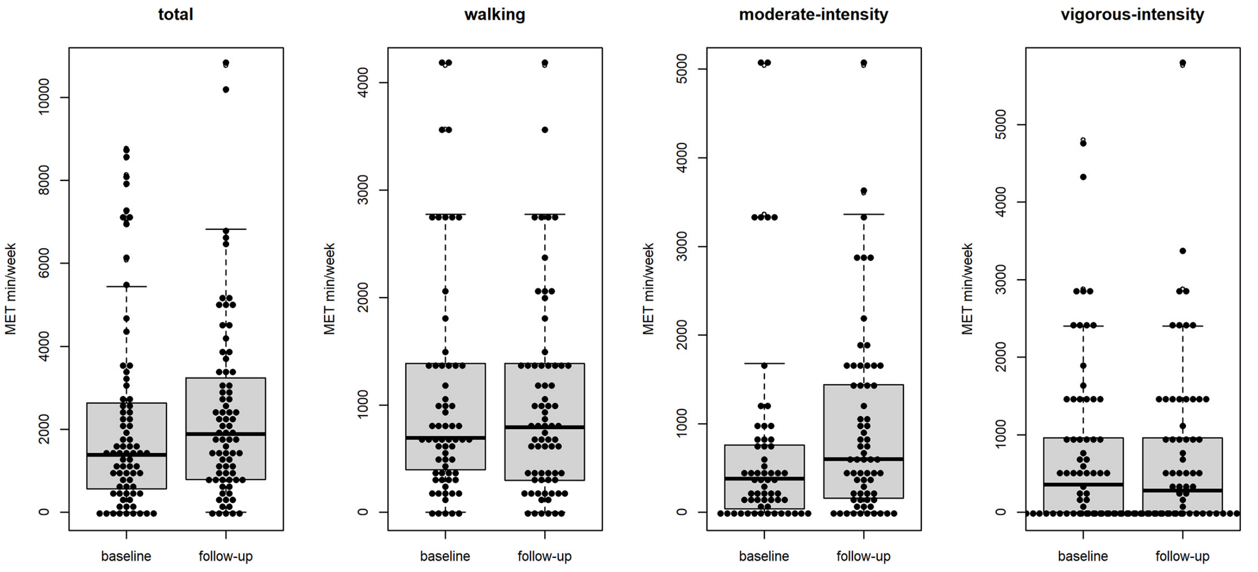

FIGURE 2 | Physical activity in MET min/week at baseline (before the COVID-19 pandemic) and follow-up (during the lockdown).

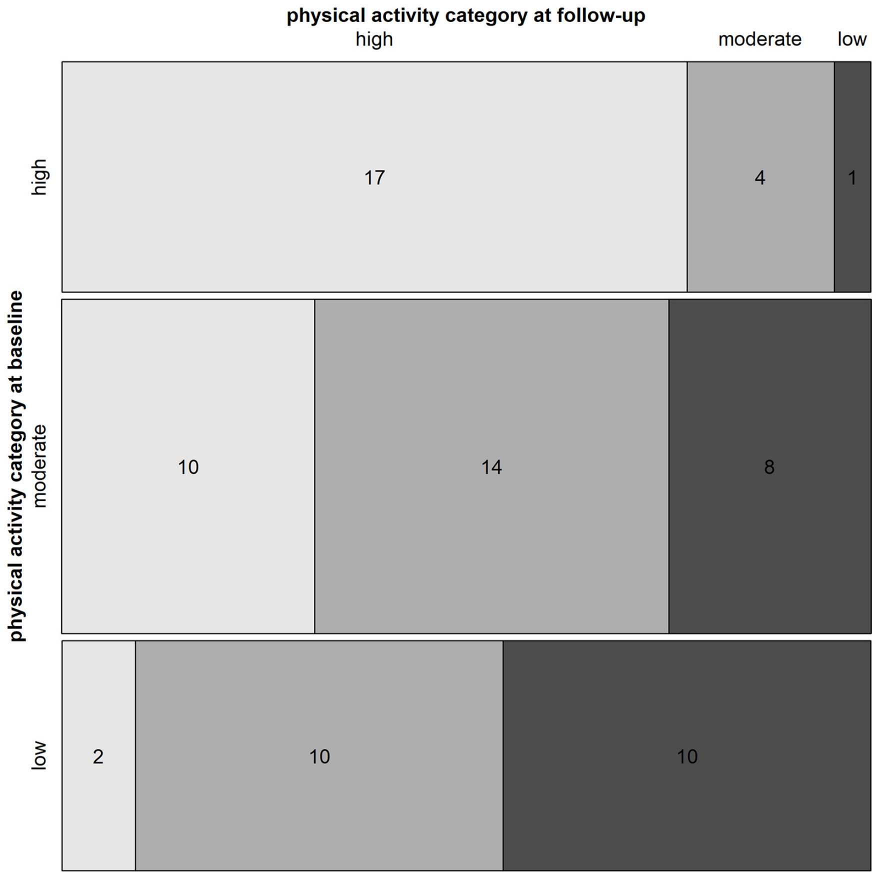

FIGURE 3 | Physical activity categories at baseline (before the COVID-19 pandemic) and follow-up (during the lockdown). The mosaic plot shows three horizontal bars, with one bar per category of physical activity ("low," "moderate," and "high"). The colored areas of the horizontal bars represent the proportion of the study participants which reached the physical activity categories "high" (light gray), "moderate" (gray), and "low" (dark gray) at follow-up. The numbers represent the number of participants.

fewer low-intensity activities (e.g., shopping), the good weather during the lockdown [(MeteoSchweiz, 2020), e.g., spending more time outside compared to January], the increased leisure time or changed working hours. The latter two reasons can be supported by the results of our study, which show that work-life balance and working times seem to be better during the lockdown. Third, the main motives for doing sports are "for my health" and "to be fit" (Lamprecht et al., 2020). Therefore, it is possible that the participants consciously were more physically active during the lockdown in order to compensate for the loss in their freedom to move around. Fourth, not enough time may have elapsed since initiation of the lockdown to see a real change in physical activity levels. It may be that office workers will compensate for their physical activity level with different strategies over the time course of the pandemic. Fifth, and probably most important, countries like Spain had stricter lockdown measures, such as a ban on physical activity outside the home, which could explain the different results.

The recently published Swiss Health Survey showed that 75% of Swiss respondents followed the recommendations for minimal physical activity before the COVID-19 pandemic, which is supported by our finding of 71% (Lamprecht et al., 2020). Compared to other countries, such as Spain, the percentage of participants meeting the recommendations before the COVID-19 pandemic is 15% higher in Switzerland (López-Bueno et al., 2020). A similar finding was made by Ting et al. (2019), who reported that only 66% of Australian office workers were sufficiently physically active to promote health before the COVID-19 pandemic. This indicates that the country and the culture are important determinants of physical activity levels. Other findings of interest might be that, in contrast to a pilot study from Turkey, it could not be confirmed that men were more physically active than women (Tek et al., 2020). The Swiss Health Survey also found no gender-specific differences in physical activity, but for region, nationality, age and education level (Lamprecht et al., 2020). More physical activity is performed in the German-speaking regions and by Swiss nationals compared to foreigners living in Switzerland (Lamprecht et al., 2020). Furthermore, physical activity reductions were found with age and lower education level (Lamprecht et al., 2020).

The percentage of participants who met the recommendations for minimal physical activity during the lockdown phase is in line with the results of a study on United Kingdom adults, both achieving 75% (Smith et al., 2020). This can be explained by the fact that the governmental restrictions and the COVID-19's spread were quite similar in both countries. Again in Spain, where the regulations were very restrictive, a considerable decline below 50% of participants meeting the minimal physical activity recommendations during the lockdown was found (López-Bueno et al., 2020). In contrast, a study among Canadians found that 22.4% of physically active participants who performed at least 150 min of moderate-vigorous physical activity per week became less active during the lockdown (Lesser and Nienhuis, 2020). Using the definition of "physically active" as participants in the category "high" or "moderate," our study achieves a very similar result with 24% (n = 13 out of 54) of participants who became less active during the lockdown. This reduction in physical activity could be explained by the fact that moderately or highly physically active participants usually performed their exercises in training groups, fitness centers, and sports clubs, that were temporarily closed during the lockdown (Constandt et al., 2020). Further reasons could be less time, the lack of a competitive element in the training or being at risk for developing COVID-19 (Constandt et al., 2020; Di Stefano et al., 2020; Ruiz-Roso et al., 2020; Vetrovsky et al., 2020). Interestingly, 33% of inactive participants were reported to be more active during the lockdown in Canada (Lesser and Nienhuis, 2020), while this was the case for as many as 55% (n = 12 out of 22) in our study on Swiss office workers. This result is also in line with the findings of a Belgian study, which argued that the health benefits of training seemed important enough to motivate less active people to increase their activity level (Constandt et al., 2020).

Another point to discuss is whether the mean value of the total physical activity, which was in our case 2,150 MET min/week at baseline and 2,370 MET min/week at follow-up, is generally considered high or low. One of the main reasons for this is that there are no official reference values. Further difficulties in comparison may arise from the fact that some studies included other MET values in their calculations, e.g., values between four and six MET for moderate-intensity activity (Nelson et al., 2007), compared to three MET used in our calculation and in the official IPAQ-SF guidelines. In consequence comparability is limited. As an example, a study on university students yielded total physical activity of 5,373 MET min/week, which is more than twice as high as in the present study (Fagaras et al., 2015). Another study on young adults concluded that total physical activity was 1,655 MET min/week, which they classified as low (Tek et al., 2020). Since we know that the IPAQ-SF tends to underestimate physical activity (Craig et al., 2003), the mean value of our participants can be considered comparatively high.

Strengths and Limitations

A major strength of the present study is that the baseline data were collected before the COVID-19 pandemic using a validated instrument, which allowed a quantification of the physical activity levels. A limitation is that the sample size is rather small compared to other studies and possible differences would be more obvious in a larger group. All participants were from the German-speaking region of Switzerland, had a very high educational level and were mostly Swiss nationals, resulting in comparatively high MET min/week values being reported. They were employed by the local government and were working mainly from home at the time of the lockdown, so there was no reduction in working hours, and employment level (full-time vs. part-time) did not change. Thus, our results cannot be generalized to all (office) workers, especially not to those in the private sector, where the COVID-19 pandemic may have led to substantial changes in work organization and increased unemployment (e.g., more leisure time).

Regarding the measurement tool IPAQ-SF, the recall bias seems to be rather low compared to other questionnaires with only 7 days (Sember et al., 2020). However, the IPAQ-SF does not distinguish between different domains of physical activity (i.e., occupational, domestic, transportation, and leisure time), and these usually provide different effects on health. In addition, the IPAQ-SF is known to underestimate the true values of physical activity (Lee et al., 2011) and no minimal clinically important difference in MET min/week was declared, which would be necessary for the correct interpretation of the results.

As all data were collected using an online questionnaire, social desirability bias and response bias cannot be excluded (subjectivity). Participants completed the IPAQ-SF for the first time in January, which may have resulted in a higher questionnaire bias of the baseline data. The follow-up in April included some holidays, so these values may be less representative for this time point (more leisure time).

Implementation

To remain physically and mentally healthy during the ongoing COVID-19 pandemic, it is important to follow the recommendations for minimal physical activity while respecting the rules of social distance. In view of a possible further lockdown in the coming months, the authorities and government should educate (Chtourou et al., 2020), inform, and raise awareness of the need for sufficient physical activity. Lockdown induced reduction of physical activity can be compensated by individuals by increased leisure-time activity.

Further Research

Further research in larger study populations is warranted to investigate physical activity more closely, especially with the use of an objective measurement tool, where a minimal clinically important difference is known. It would also have to be investigated to what extent the season has an influence on the values of physical activity and whether a correction based on the season would be necessary. The comparison of our data with those of other countries would also be relevant, especially when comparing the different governmental restrictions.

CONCLUSION

The COVID-19 pandemic forced many countries into a societal-level lockdown. In this study, we investigated the effect of the COVID-19 pandemic on the physical activity among Swiss office workers. The hypothesis of a reduction in total physical activity levels during the lockdown in April 2020 compared to the level before the COVID-19 pandemic became effective in Switzerland (January 2020) was rejected. Before the lockdown phase 71% met the minimum level of recommended total physical activity. During the first weeks of the lock-down 54% of participants maintained their physical activity level and 29% showed an increase.

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DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethical Commission of the Canton of Zurich, Switzerland (15.10.2019, swissethics No. 2019-01678). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AMA and MD wrote the manuscript. MD, AMA, and TV performed the statistical analysis. GS, VJ, TV, HL, JD, HD, OD, MM, and AE revised the manuscript. All authors read and approved the final manuscript.

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SUPPLEMENTARY MATERIAL

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Habits and Psychological Factors Associated With Changes in Physical Activity Due to COVID-19 Confinement

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The confinement that COVID-19 has brought about has had a negative influence on people's psychological health. However, this impact is not widespread throughout the population, and men and women may be affected differently and it is not known what protective factors may exist. In this sense, physical activity has classically been shown to be a habit associated with psychological health. The study aimed to analyze the impact of confinement on psychological health (psychological well-being, coping, emotions, and perception of daily difficulties), taking into account gender, and perceived changes in physical activity. After the project was approved by the University's Ethics Commission, the participants, after signing the informed consent, completed the online questionnaires during the days from 6 to 20 April, the time when, in Spain, confinement was in place and the highest peak of deaths and infections from COVID-19 occurred. A total of 457 Spanish participants (247 men and 210 women) were evaluated in psychological well-being, in its adaptation to Spanish, in coping, with the Spanish adaptation of the COPE Inventory, in daily habits and difficulties (*ad hoc* questionnaire) and the level of physical activity they had (sedentary, active, and federated players) was recorded. Besides, the perceived change in physical activity due to confinement was recorded. The results showed that perceived emotions, difficulties for certain routines, psychological well-being, and coping differed according to sex. On the other hand, depending on the change in physical activity habits, it was observed that participants who increased their physical activity responded differently in the perception of emotions, and difficulties for routines and in psychological well-being. Finally, differences were also observed in most variables between sedentary, active, and federated participants. Results are discussed highlighting the importance of physical activity as a moderating factor of the impact of confinement.

Keywords: habits, COVID-19, coping, physical activity, psychological well-being

INTRODUCTION

COVID-19 disease has caused an alarming number of deaths and is a threat to society in terms of health, economy and healthy lifestyles (Ferreira-Júnior et al., 2020; Jaenes et al., 2020; Woods et al., 2020). The World Health Organization (WHO) declared a global pandemic by COVID-19 on March 11, 2020, and the most affected countries have limited freedom of movement within cities, generated restrictions, closed spaces (sports facilities, parks, and playgrounds, etc.), social distancing, hygiene measures, imposed a quarantine and established confinement of citizens to their homes (Lesser and Nienhuis, 2020; López-Bueno et al., 2020b; Mon-López et al., 2020).

Different studies during COVID-19 confinement, in countries such as China, Spain, Italy, Iran, United States, Turkey, Nepal, and Denmark, highlight that around 30% of the general population have suffered from anxiety, depression, psychological distress, adjustment disorder and insomnia, so the attention of researchers has focused on analyzing the factors that intensify or reduce negative emotional experience (Clemente-Suárez et al., 2020; Fu et al., 2020; Maugeri et al., 2020; Pieh et al., 2020; Rossi et al., 2020; Xionga et al., 2020).

Regarding gender differences studies tend to indicate that, during the confinement, women had a worse emotional response than men, with women presenting risk factors for poorer mental health in general (Pieh et al., 2020; Rossi et al., 2020), as well as in emotional states of irritability, anxiety and distress (Alsalhe et al., 2020; Fu et al., 2020; Jaenes et al., 2020; Mon-López et al., 2020; Xionga et al., 2020).

On one side, physical activity and sports, practiced regularly and in moderation, has been proved as a habit associated with people's health and psychological well-being (García-Naveira and Locatelli, 2014), this being a key strategy for improving physical and mental health while the difficult situation of confinement by COVID-19 (Callow et al., 2020; Choi and Bum, 2020; Maugeri et al., 2020; Woods et al., 2020). Physical activity has been shown to be a good moderator of negative and unpleasant emotions (anger, fatigue, anxiety, and depression) (Alsalhe et al., 2020; Ingram et al., 2020; Jaenes et al., 2020), and has been associated with psychological well-being during confinement (Brand et al., 2020; Lesser and Nienhuis, 2020).

In Spain, confinement by the COVID-19 was decreed during the months of March to May 2020, and has led to a paralysis of sport and physical activity in the country, closing sports facilities, suspending training, competitions, major leagues and championships (Moscoso-Sánchez, 2020). Restrictive measures have limited the individual's ability to engage in physical activity outdoors or in gyms, as well as regular training and competition in clubs, increasing the risks of chronic diseases related to a sedentary lifestyle and greater psychological vulnerability due to confinement (Ferreira-Júnior et al., 2020). Given their relevance, it is crucial to assess behavioral changes during periods of confinement, as active people suffer from the negative effects of the social context and those of the cessation of physical activity and sport (Brooks et al., 2020; Jaenes et al., 2020; Jukic et al., 2020).

During this period of isolation or quarantine, lifestyle and healthy habits have been modified due to individual and environmental differences (Brooks et al., 2020; Constant et al., 2020; Ingram et al., 2020; Jungmann and Witthöft, 2020; Liu et al., 2021), as is the case with the variation in frequency and duration of physical activity (Brand et al., 2020; Choi and Bum, 2020; Clemente-Suárez et al., 2020). Some studies warn that people in general reduced the length (days and hours) and intensity of physical activity during their confinement (Filho et al., 2020; Jimeìnez-Pavoìn et al., 2020; Mon-López et al., 2020; Xiang et al., 2020), mainly during the first week (changes in routines), although it may increase afterward (adaptation of routines) (López-Bueno et al., 2020b). COVID-19 home confinement has shown negative changes in population habits, both in terms of intensity levels of physical activity and eating patterns, being the last ones, unhealthier during confinement. Therefore, although isolation is a necessary measure to protect public health, physical activity and eating behaviors have been altered in a direction that undermines health (Ammar et al., 2020a). Recent research by COVID-19 suggests the existence of significant sleep problems and psychological disorders (e.g., stress, anxiety, and depression) associated with reduced movement and activity, as well as reduced social interaction; suggesting physical exercise at home, exergaming, dance with music and yoga, among the possible tactics to overcome the negative effects of confinement by recommending adults to do at least 150 min of moderate-intensity activity, and 75 min of vigorous activity per week divided into 5-7 sessions, and, reducing the volume of training in children and teenagers (Chtourou et al., 2020). A recent study determined that the levels of physical activity of Spanish population decreased significantly, up to 20%, in the first week of confinement for COVID-19, this reduction being especially relevant in men with a low educational level (López-Sánchez et al., 2020).

However, other studies analyze the pre-existing profile of people, classifying them as active or inactive in relation to physical activity. 40.5% of inactive subjects became even less active, 33% became more active and 26.5% remained as such, while 22.4% of active individuals became less active, 40.3% became more active and 37.3% remained as such (Lesser and Nienhuis, 2020).

Other studies indicate that, in general, less active people increased their physical activity (Brand et al., 2020; Schnitzer et al., 2020) and even those who exercised frequently before confinement tended to maintain or increase it (Brand et al., 2020).

In terms of changes in physical activity and emotional status during confinement, people who have remained physically active during confinement have better scores on quality of life, physical condition, psychological health, social relationships and environmental conditions than those who were inactive (Slimani et al., 2020). Those who were inactive before the pandemic, and slightly increased their frequency of exercise during the pandemic, reported no change in mood compared to those who remained inactive during the pandemic (Brand et al., 2020). These authors further noted that those who reduced their exercise frequency during the pandemic reported worse mood compared to those who maintained or increased their pre-pandemic exercise frequency.

Another relevant issue is the study of coping strategies used, such as adaptive emotional regulation which has been a buffer for reducing anxiety during a pandemic (Jungmann and Witthöft, 2020; Ye et al., 2020). Asmundson et al. (2020) conclude that there were no significant differences in the perceived effectiveness of coping strategies between the anxiety and mood disorder group vs. the non-pathological group during confinement, while Fu et al. (2020) note that passive coping with COVID-19 stress was relatively higher than before the pandemic. In addition, lack of fear control and cognitive avoidance are associated with poorer healthy lifestyle (Constant et al., 2020) with emotional intelligence and mood variables being predictors of training and athlete performance (Mon-López et al., 2020).

Finally, special mention should be made of the differentiation between high-performance athletes, other levels of competition and amateur practitioners in relation to confinement. One of the populations that could suffer most from confinement is sportsmen and women, especially professional ones, since their daily routines in which primary outdoor activities counteract the current situation of home confinement (Clemente-Suárez et al., 2020). For 2 months, high-performance sportsmen and women have been training at home, suffering great anxiety about their future, because the opportunity cost of a sports career is high (Moscoso-Sánchez, 2020). To keep training, without the certainty of a competition calendar is not an easy task. Constancy in training seems to have been an effective moderator of uncertainty, anxiety, stress, and in general of the negative emotions that had been so much anticipated (Jaenes et al., 2020), recommending emotional expression with other athletes as a strategy (Jaenes et al., 2020; Schinke et al., 2020), knowing that there may be some resistance from them not to be seen as weak in a culture that perceives athletes as mentally tough (Sherwin, 2017). Finally, studies indicate that male professional sportsmen trained more days and hours than semi-professional and amateur players (Mon-López et al., 2020).

Based on this review, there is a need for further research on the behavioral effects of the COVID-19 crisis during confinement. Specifically, this study focuses on gender differences (men and women), physical activity habits (no change, increase or decrease) and physical activity engagement (sedentary, physically active, and federated) in relation to the psychological impact (emotions, perception of difficulties, coping skills, and psychological well-being) that it has on people. We hypothesize that women will have poorer psychological health and that participants with a higher degree of physical activity will have higher scores on psychological health and coping strategies than those who are sedentary. Additionally, those participants who increased their physical activity habits during confinement will show higher scores on psychological health and coping.

MATERIALS AND METHODS

A cross-sectional online survey was conducted to evaluate physical exercise habits and psychological variables (psychological well-being and coping) during the COVID-19 pandemic.

Design and Procedure

The study was approved by the Ethics Committees of the Miguel Hernandez University. All participants signed the informed consent. The participants completed the online questionnaires from April 6th to April 20th, while confinement was still in effect in Spain, and the highest peak of deaths and infections from COVID-19 occurred. The link to the survey was distributed on social networks (Telegram, WhatsApp, and email) to general population and athletes, all of legal age, for them to sign an informed consent, and to fill it out, and send it to their family or friends to fill it out as well. Afterward, generating groups by changes in physical activity frequency during confinement. Participants were asked about the daily frequency of different physical activities, before and during the confinement (walking, functional training, yoga/Pilates, bodybuilding, exercise bike, running, specific sport). To generate three different groups a difference between these two scores per activity.

Generating groups by changes in physical activity frequency during confinement: once differences were calculated for each activity, all differences were added up to obtain a value for each subject that could be 0 (no change in frequency of physical activity due to confinement), greater than 1 (increase in physical activity during confinement) or less than 1 (decrease in frequency of physical activity during confinement). Once the scores were obtained, the subjects were classified into the three groups indicated: no change in frequency of physical activity, increase in physical activity, and decrease in physical activity during confinement.

Participants

A total of 457 Spanish participants (247 men and 210 women) with an average age of 31.1 (dt = 11.37) and with different levels of exercise practice (sedentary, active and federated) were evaluated through an on-line questionnaire regarding their exercise habits before and during the period of confinement by COVID-19.

Variables and Instruments

Socio-demographic and sport variables were measured with an "*ad hoc*" questionnaire with answers on a Likert scale. This questionnaire evaluates daily habits of sports, emotions, as well as perception of difficulties during confinement, and the level of physical activity (sedentary, active, and federated). Through the "*ad hoc*" questionnaire, we inquired about their concerns and perception of difficulties in practice, changes in their training frequency, their emotional state due to confinement and how the difficulties due to the situation affected them in certain health and sports behaviors ("keeping a routine" or "falling asleep").

Psychological well-being

This instrument measures were evaluated in psychological well-being, (SPWB-Van Dierendonck, 2004) in its adaptation to

Spanish (Díaz et al., 2006) was used to psychological well-being and the Spanish version of this questionnaire has adequate psychometric properties ($\alpha = 83/\alpha = 68$). The EBP comprises 39 items, each of which contains six dimensions (Self-acceptance, positive relationships, autonomy, environment mastery, purpose in life, personal growth). Cronbach's alpha in our sample was 0.90.

Coping

Coping strategies have been evaluated with Coping Inventory (COPE, Carver et al., 1989) with the Spanish adaptation (Crespo and Cruzado, 1997) through 60 items containing 15 coping strategies. This questionnaire measures the coping styles used by people when confronting a stressful event. The subscales that make up the questionnaire are Positive reinterpretation, Active coping, planning, Emotional Social Support, Instrumental Social support, Suppression competing activities, Religious, Acceptance, Restrain, Venting emotional, Behavioral disengagement, Denial, Mental disengagement, and Substance abuse. The Spanish version of the Coping Inventory to have adequate psychometric properties ($\alpha > 0.60$). In our sample we obtained a $\alpha = 0.89$.

Data Analysis

First, outliers were eliminated (+2.5 standard deviations) and the normality of the variables was calculated. No variable was normal. The variables were transformed into log10 and normality was recalculated. Since the data showed that the variables were not normal, the statistical analyses were carried out using non-parametric tests. The Mann-Whitney U parameter was used to compare the scores between the groups. The effect size is presented with the r parameter. All statistical analyses were performed with the SPSS 23 statistical package, with a significance level of 0.05.

TABLE 1 | Characteristics of the study population.

N = 457	***n* (%)**	**Mean (SD)**
Age		31.10 (11.37)
Gender		
Men	247 (51)	
Women	210 (46)	
Shared housing space		
Alone	25 (5.5)	
With couple	99 (21.7)	
Family	325 (71.1)	
Others	8 (1.7)	
Number of people living together*		
0	21 (4.6)	
1	72 (15.8)	
2	71 (15.5)	
+3	147 (32.2)	
Type of Housing*		
Flat	224 (49)	
Duplex	30 (6.6)	
House with plot	56 (12.3)	
Have a dog		
Yes	324 (70.9)	
No	133 (29.1)	

**147 missing values.*

RESULTS

Sex Differences

Scores obtained during confinement differed between men and women. The characteristics of the study population are indicated in **Table 1**. Specifically, women had more negative thoughts about their physical condition [$U = 14.265$ ($Z = -3.087$), $p = 0.002$, $r = 0.18$] and about their health status as a trend ($p = 0.061$), women scored more in sadness [$U = 30.837$ ($Z = -4.229$), $p < 0.001$, $r = 0.19$], tension [$U = 29.618$ ($Z = -3.221$), $p = 0.001$, $r = 0.15$] and support by others [$U = 30.967$ ($Z = -3.769$), $p < 0.001$, $r = 0.17$] and lower energy scores [$U = 22.49$ ($Z = -2.521$), $p = 0.012$, $r = 0.11$], compared to men. Also, women reported greater difficulty in training than men. Complementarily, they had greater difficulty following feeding [$U = 28.491$ ($Z = -3.769$), $p = 0.05$, $r = 0.08$], sleeping [$U = 28.764$ ($Z = -3.769$), $p < 0.001$, $r = 0.09$], and following daily routines [$U = 28.761$ ($Z = -3.769$), $p = 0.038$, $r = 0.09$]. Complementarily, men scored higher on the positive perception of confinement [$U = 22.703$ ($Z = -3.769$), $p < 0.001$, $r = 0.11$].

In the questionnaires, women used significantly more emotional support seeking coping strategies [$U = 14.674$ ($Z = -3.769$), $p < 0.001$, $r = 0.19$], as well as venting [$U = 16.290$ ($Z = -3.769$), $p < 0.001$, $r = 0.30$] and mental disengagement [$U = 13.898$ ($Z = -3.769$), $p < 0.001$, $r = 0.13$], compared to men. On the other hand, men score more on psychological well-being, specifically on autonomy [$U = 10.302$ ($Z = -3.769$), $p < 0.001$, $r = 0.12$], environmental mastery [$U = 10.411$ ($Z = -3.769$), $p = 0.04$, $r = 0.11$], and purpose in life [$U = 10.439$ ($Z = -3.769$), $p = 0.044$, $r = 0.11$] (see **Table 2**).

Physical Activity Habit Changes

When physical activity frequency habit change is analyzed there were differences between participants that increased or decreased or did not change their habits (see **Table 3**).

Differences Within Participants With no Change in Frequency and the Increased/Decreased Frequency

The group that increased frequency scored higher in following feeding [$U = 5.505$ ($Z = -2.393$, $p = 0.017$, $r = 0.14$] and training routines [$U = 5.154$ ($Z = -3.006$), $p = 0.003$, $r = 0.17$] and having goals [$U = 5.426$ ($Z = -2.505$), $p = 0.012$, $r = 0.14$] than the group that did not change their weekly workout frequency. Likewise, this group that did not modify its frequency had different scores in mental disengagement than the group that increases its frequency [$U = 2.551$ ($Z = -2.445$), $p = 0.014$, $r = 0.17$].

In addition, the group that reduced their physical activity differed significantly in perceived energy [$U = 4.616$ ($Z = -2.152$), $p = 0.031$, $r = 0.13$] positive coping in comparison to the subjects in the group that does not change their training frequency [$U = 1.776$ ($Z = -2.678$), $p = 0.007$, $r = 0.21$].

TABLE 2 | Mean and standard deviation (SD) of men and women in the measured variables after 1 month of confinement.

	Men $N = 247$		Women $N = 210$		Significant differences
	Mean	SD	Mean	SD	
Mood					
Confinement feelings	1.68	1.04	1.81	0.93	n.s.
Health thoughts	0.68	0.62	0.79	0.63	t
Physical condition thoughts	0.86	0.87	1.13	0.86	*
Sadness	0.83	0.80	1.15	0.83	*
Tension	0.89	0.82	1.18	0.93	*
Irritability	1.20	0.99	1.12	0.90	n.s.
Energy	1.97	1.16	1.68	1.14	*
Fatigue	0.87	0.93	0.98	0.95	n.s.
Others support	1.67	1.23	2.09	1.11	*
Positive confinement perception	1.21	0.40	1.12	0.33	*
Perceived difficulties					
Initial Training Difficulty	4.10	3.18	4.74	3.27	n.s.
Current training difficulty	3.89	2.82	4.54	2.99	n.s.
Sleep difficulties	1.36	1.33	1.61	1.36	*
Feeding difficulties	1.11	1.22	1.27	1.14	*
Daily Routines difficulties	1.27	1.26	1.51	1.31	*
Training plan difficulties	1.38	1.28	1.44	1.31	n.s.
Reaching aims difficulties	1.51	1.33	1.64	1.36	n.s.
Coping					
COPE_Positive_ reinterpretation	7.73	2.57	7.79	2.40	n.s.
COPE_Active coping	6.39	2.15	6.25	2.23	n.s.
COPE_planning	6.21	2.77	6.09	2.36	n.s.
COPE_Emotional Social Support	5.74	3.03	6.84	2.87	*
COPE_Instrumental Social support	5.25	2.51	5.70	2.52	n.s.
COPE_Suppression competing activities	5.05	2.18	4.88	1.99	n.s.
COPE_Religious	1.15	2.17	1.38	2.39	n.s.
COPE_Acceptance	6.65	2.39	6.88	2.58	n.s.
COPE_Restrain	3.95	2.06	4.63	2.41	n.s.
COPE_Venting emotional	3.87	2.23	5.19	2.36	*
COPE_Behavioral disengagement	1.77	1.93	1.83	2.01	n.s.
COPE_Denial	1.47	1.81	1.41	1.79	n.s.
COPE_Mental disengagement	5.00	2.06	4.86	2.07	*
COPE_Substance abuse	0.56	1.44	0.57	1.83	n.s.
COPE_Humor	4.81	3.60	4.32	2.92	n.s.
Psychological well being					
PWB_Self_acceptance	23.01	3.85	22.52	3.60	n.s.
PWB_Positive_relations	24.39	3.64	24.07	4.36	n.s.
PWB_Autonomy	29.97	4.42	28.75	4.63	*
PWB_Environmental_ mastery	23.44	3.11	22.59	3.14	*
PWB_Personal_growth	27.76	3.69	27.99	3.01	n.s.
PWB_Life_purpose	24.04	3.95	23.21	3.87	*
Habits changes					
Physical_Activity_ Frequency_change (PAFch)	−0.008	4.05	0.171	5.53	n.s.
Physical_Activity_ Duration_change (PADch)	−2.44	3.41	−1.70	3.10	n.s.

*n.s., non-significant; *, significant; t, trend.*

Differences Between Increased Frequency and Decreased Frequency

A trend toward significance has been obtained among participants who increased their physical activity frequency that are more affected by the confinement situation than those who reduced their activity frequency ($p = 0.06$). On the other hand, it was observed that participants who reduced their frequency have higher scores in perceived energy compared to groups who increase their activity [$U = 22.135$ ($Z = -2.664$), $p = 0.008$, $r = 0.13$].

In addition, those who increased their frequency have greater difficulty training than participants who reduced their activity frequency [$U = 14.661$ ($Z = -4.082$), $p < 0.001$, $r = 0.20$]. Also, the group that increases their frequency has greater difficulty following feeding patterns [$U = 16.130$ ($Z = -2.868$), $p = 0.004$, $r = 0.14$], the daily routines [$U = 16.652$ ($Z = -2.363$), $p = 0.018$, $r = 0.11$], training plan [$U = 14.282$ ($Z = -4.545$), $p < 0.001$, $r = 0.22$], or having daily goals [$U = 16.565$ ($Z = -2.424$), $p = 0.015$, $r = 0.12$] compared to those who reduced their frequency. However, this group scored significantly higher on seeing confinement as something positive, than the group that reduces its activity frequency [$U = 17.035$ ($Z = -1.993$), $p = 0.046$, $r = 0.10$].

Finally, when coping styles were studied, it was observed that those who increased their activity frequency had lower scores on positive coping [$U = 10.636$ ($Z = -2.988$), $p = 0.003$, $r = 0.18$], suppression of competitive activities [$U = 10.142$ ($Z = -2.630$), $p = 0.009$, $r = 0.13$], and acceptance [$U = 10.547$ ($Z = -2.841$), $p = 0.005$, $r = 0.17$] compared to the group that reduced their physical activity.

Comparison Between Sedentary, Physically Active, and Federated Players Participants

When the participants' responses were analyzed according to their degree of involvement with physical activity, the following results were found (see **Table 4**).

Sedentary vs. Physically Active Participants (1 vs. 2)

Sedentary participants significantly increased their physical activity frequency [$U = 3.607$ ($Z = -4.442$), $p < 0.001$, $r = 0.29$] and duration [$U = 6.275$ ($Z = -6.403$), $p < 0.001$, $r = 0.08$] compared to physically active participants. In addition, sedentary participants had less difficulty in having daily objectives during confinement [$U = 6.567$ ($Z = -1.949$), $p = 0.05$, $r = 0.12$], although at the beginning of the confinement, they had more difficulty training than physically active participants [$U = 3.988$ ($Z = -3.636$), $p < 0.001$, $r = 0.23$].

Sedentary vs. Federated Players Participants (1 vs. 3)

When sedentary were compared with federated players participants, the former significantly increased the frequency [$U = 5.606$ ($Z = -3.845$), $p < 0.001$, $r = 0.22$] and duration [$U = 5.762$ ($Z = -5.046$), $p < 0.001$, $r = 0.20$] of physical activity compared with the latter, which remained stable in terms of frequency and moderately reduced the duration of training.

TABLE 3 | Mean and standard deviation (SD) of participants depending on the increase, decrease or no change in their daily frequency of physical activity in the measured variables after 1 month of confinement.

	No change ($n = 63$)		Frequency increase ($n = 216$)		Frequency decrease ($n = 178$)		Significant differences
	Mean	SD	Mean	SD	Mean	SD	
Mood							
Confinement feelings	1.62	0.92	1.83	0.99	1.67	1.02	1 vs. 2
Health thoughts	0.72	0.63	0.73	0.62	0.73	0.64	n.s.
Physical condition thoughts	0.86	0.67	1.03	0.87	1.04	0.94	n.s.
Sadness	0.87	0.82	1.01	0.81	0.97	0.85	n.s.
Tension	0.98	0.79	1.11	0.97	0.93	0.81	n.s.
Irritability	1.00	0.81	1.11	0.95	1.27	0.98	n.s.
Energy	1.71	1.12	1.72	1.19	2.02	1.12	1 vs. 2 0 vs. 2
Fatigue	0.77	0.84	0.99	0.97	0.89	0.94	n.s.
Others support	1.76	1.16	1.85	1.23	1.92	1.18	n.s.
Positive confinement perception	1.17	0.37	1.20	0.40	1.13	0.33	1 vs. 2
Perceived difficulties							
Initial training difficulty	3.92	3.07	4.74	3.34	4.15	3.13	n.s.
Current training difficulty	4.05	2.81	4.81	3.05	3.49	2.61	1 vs. 2
Sleep difficulties	1.40	1.30	1.59	1.37	1.35	1.34	n.s.
Feeding difficulties	0.95	1.06	1.38	1.23	1.03	1.14	1 vs. 2 0 vs. 1
Daily routines difficulties	1.33	1.25	1.53	1.33	1.21	1.23	1 vs. 2
Training plan difficulties	1.16	1.24	1.73	1.36	1.11	1.12	0 vs. 1 1 vs. 2
Reaching aims difficulties	1.29	1.32	1.77	1.40	1.42	1.26	1 vs. 2 0 vs. 1
Coping							
COPE_Positive_reinterpretation	7.09	2.65	7.46	2.36	8.42	2.44	0 vs. 2
COPE_Active coping	6.02	2.28	6.10	1.99	6.71	2.37	n.s.
COPE_planning	5.63	2.32	6.00	2.53	6.54	2.64	n.s.
COPE_Emotional Social Support	6.09	3.24	6.16	2.87	6.66	3.06	n.s.
COPE_Instrumental Social support	5.19	2.57	5.45	2.39	5.66	2.69	n.s.
COPE_Suppression competing activities	5.14	2.25	4.66	1.89	5.30	2.22	1 vs. 2
COPE_Religious	1.42	2.60	1.27	2.29	1.23	2.17	n.s.
COPE_Acceptance	6.33	2.72	6.48	2.36	7.34	2.50	1 vs. 2
COPE_Restrain	3.49	2.14	4.53	2.28	4.34	2.27	n.s.
COPE_Venting emotional	4.67	2.31	4.52	2.39	4.62	2.45	n.s.
COPE_Behavioral disengagement	2.00	1.97	1.88	2.09	1.62	1.79	n.s.
COPE_Denial	1.28	1.57	1.65	1.96	1.21	1.61	n.s.
COPE_Mental disengagement	4.77	1.90	5.00	2.21	4.89	1.94	0 vs. 1
COPE_Substance abuse	0.65	1.66	0.66	1.97	0.42	1.11	n.s.
COPE_Humor	4.37	3.68	4.62	3.22	4.51	3.16	n.s.
Psychological well being							
PWB_Self_acceptance	23.16	2.60	22.57	3.96	22.83	3.76	n.s.
PWB_Positive_relations	25.09	2.91	23.91	4.08	24.30	4.32	n.s.
PWB_Autonomy	29.19	4.04	29.34	4.67	29.33	4.65	n.s.
PWB_Environmental_mastery	22.91	2.77	22.84	3.15	23.20	3.29	n.s.
PWB_Personal_growth	27.53	3.35	27.77	3.37	28.18	3.30	n.s.
PWB_Life_purpose	23.88	3.31	23.31	4.02	23.88	3.99	n.s.

0, no daily training activity changes; 1, increasing daily training activities; 2, decreasing daily training activities; n.s., no significant differences.

On the other hand, the confinement situation affected negatively and significantly more the federated players compared to the sedentary ones [$U = 9.374$ ($Z = -2.231$), $p = 0.026$, $r = 0.12$]. On the other hand, sedentary participants presented lower irritation scores [$U = 9.36$ ($Z = -3.405$), $p < 0.001$, $r = 0.20$] and felt more supported by others [$U = 6.430$ ($Z = -2.561$), $p = 0.010$, $r = 0.14$] than federated. In contrast, federated players had significantly higher energy scores [$U = 9.298$ ($Z = -2.078$), $p = 0.038$, $r = 0.12$] and had less difficult to train than sedentary individuals [$U = 5.390$ ($Z = -2.139$), $p = 0.032$, $r = 0.24$]. Regarding the difficulties experienced by the participants, it was found that the sedentary

TABLE 4 | Mean and standard deviation (SD) of participants depending on the physical activity before confinement (Sedentary, Physically active and Federated players) in the measured variables after 1 month of confinement.

	Sedentary		Physically active		Federated Players		Significant differences
	Mean	SD	Mean	SD	Mean	SD	
Mood							
Confinement feelings	1.51	1.05	1.72	0.88	1.83	1.05	1 vs. 3
Health thoughts	0.71	0.62	0.73	0.65	0.74	0.62	n.s.
Physical condition thoughts	0.90	0.85	1.04	0.83	1.03	0.98	n.s.
Sadness	0.94	0.81	1.06	0.82	0.93	0.85	n.s.
Tension	1.01	0.90	1.19	0.86	0.91	0.89	2 vs. 3
Irritability	0.87	0.86	1.01	0.80	1.36	1.04	1 vs. 3 2 vs. 3
Energy	1.72	1.11	1.57	1.07	2.06	1.20	1 vs. 3 2 vs. 3
Fatigue	0.99	0.92	0.86	0.94	0.94	0.96	n.s.
Others support	2.06	1.13	2.06	1.19	1.66	1.20	1 vs. 3 2 vs. 3
Positive confinement perception	1.15	0.36	1.16	0.37	1.18	0.38	n.s.
Perceived difficulties							
Initial training difficulty	5.94	3.14	4.23	3.09	4.03	3.24	1 vs. 2
Current training difficulty	4.92	3.12	4.11	3.02	4.02	2.75	1 vs. 3
Sleep difficulties	1.49	1.30	1.41	1.35	1.51	1.38	n.s.
Feeding difficulties	1.08	1.08	1.16	1.18	1.23	1.23	n.s.
Daily routines difficulties	1.49	1.26	1.49	1.33	1.27	1.27	n.s.
Training plan difficulties	1.20	1.26	1.53	1.37	1.39	1.25	n.s.
Reaching aims difficulties	1.25	1.28	1.62	1.35	1.63	1.36	1 vs. 2 1 vs. 3
Coping							
COPE_Positive_reinterpretation	8.13	2.48	7.58	2.53	7.81	2.38	n.s.
COPE_Active coping	6.55	2.27	6.12	2.21	6.49	2.09	n.s.
COPE_planning	6.27	2.54	5.79	2.56	6.74	2.49	2 vs. 3
COPE_Emotional Social Support	6.61	2.69	6.22	3.19	6.31	2.88	n.s.
COPE_Instrumental Social support	5.70	2.24	5.24	2.66	5.80	2.48	n.s.
COPE_Suppression competing activities	5.39	2.02	4.80	2.12	4.89	2.06	n.s.
COPE_Religious	1.34	2.20	1.23	2.25	1.33	2.47	n.s.
COPE_Acceptance	7.00	2.52	6.94	2.45	6.24	2.53	2 vs. 3
COPE_Restrain	4.51	2.14	4.33	2.36	4.13	2.24	n.s.
COPE_Venting emotional	5.08	2.23	4.62	2.51	4.05	2.21	1 vs. 3
COPE_Behavioral disengagement	1.79	1.83	1.98	2.06	1.46	1.90	2 vs. 3
COPE_Denial	1.62	1.82	1.45	1.81	1.25	1.75	n.s.
COPE_Mental disengagement	4.90	2.04	4.98	2.10	4.85	2.05	n.s.
COPE_Substance abuse	0.41	1.12	0.69	1.95	0.48	1.41	n.s.
COPE_Humor	4.80	3.30	4.28	3.17	4.85	3.38	n.s.
Psychological well being							
PWB_Self_acceptance	22.46	3.79	22.40	3.69	23.70	3.63	1 vs. 3 2 vs. 3
PWB_Positive_relations	23.68	4.49	24.34	3.89	24.44	3.96	n.s.
PWB_Autonomy	29.03	4.68	29.21	4.66	29.80	4.29	n.s.
PWB_Environmental_mastery	22.61	2.78	22.84	3.25	23.59	3.22	1 vs. 3 2 vs. 3
PWB_Personal_growth	28.34	3.15	27.65	3.46	27.95	3.27	
PWB_Life_purpose	23.72	3.46	23.00	4.06	24.68	3.84	1 vs. 3 2 vs. 3
Habits change							
Physical_Activity_Frequency_change (PAFch)	2.55	4.99	−0.93	4.69	0.01	4.53	1 vs. 2 1 vs. 3
Physical_Activity_Duration_change (PADch)	−0.25	3.38	−2.73	3 .10	−2.23	3.20	1 vs. 2 1 vs. 3

1, sedentary; 2, physically active; 3, federated players; n.s, no significant differences.

subjects had less difficulty in having objectives than the federated ones [$U = 9.30$ ($Z = -2.080$), $p = 0.038$, $r = 0.12$].

Finally, with respect to the differences obtained when comparing the coping and psychological well-being scores, it was obtained that sedentary participants had significantly higher scores on the emotional venting scale [$U = 2.116$ ($Z = -2.749$), $p = 0.006$, $r = 0.22$]. However, federated scored significantly higher on self-acceptance [$U = 3.383$ ($Z = -2.032$), $p = 0.042$,

$r = 0.16$], environmental mastery [$U = 3.460$ ($Z = -2.325$), $p = 0.020$, $r = 0.18$] and purpose in life [$U = 3.350$ ($Z = -1.911$), $p = 0.056$, $r = 0.15$] compared to sedentary participants.

Physical Active vs. Federated Players Participants (2 vs. 3)

It has been obtained that there were no significant differences in the change of total frequency nor in the total duration of training, maintaining both groups a similar level of frequency of physical activity with respect to the previous confinement period and slightly reducing the duration of training.

However, the physically active group scored significantly higher on perceived tension [$U = 14.410$ ($Z = -3.441$), $p = 0.001$, $r = 0.17$] and irritability [$U = 20.180$ ($Z = -3.105$), $p = 0.0.002$, $r = 0.16$] than the federated group. In addition, the federated players group scored higher on perceived energy [$U = 22.210$ ($Z = -3.936$), $p < 0.001$, $r = 0.20$]. On the other hand, the active group felt more supported by the others than the federated players group [$U = 14.415$ ($Z = -3.429$), $p = 0.001$, $r = 0.17$].

When coping and well-being questionnaires were analyzed, results showed that the federated subjects significantly use the planning coping strategy [$U = 7.675$ ($Z = -2.533$), $p = 0.011$, $r = 0.16$], but have less acceptance [$U = 5.378$ ($Z = -2.029$), $p = 0.042$, $r = 0.13$] and less behavioral disengagement [$U = 5.386$ ($Z = -2.040$), $p = 0.040$, $r = 0.13$] than the physically active subjects. Finally, in the psychological well-being questionnaire, federated participants scored more on self-acceptance [$U = 7.812$ ($Z = -2.796$), $p = 0.005$, $r = 0.18$] and environmental mastery [$U = 7.410$ ($Z = -2.002$), $p = 0.045$, $r = 0.12$] and less on purpose in life [$U = 7.969$ ($Z = -3.108$), $p = 0.002$, $r = 0.20$], compared to the physically active group.

DISCUSSION

During the health alert by COVID-19 many sectors of society have been affected and have had to adapt their lives and habits to the new context. The first objective of this work was to analyze whether there were gender differences in the population confined to emotions, perception of training difficulties, coping strategies and psychological well-being.

In relation to this objective, the results of the present study confirm the existence of statistically significant differences between men and women, in which women present higher scores than men in negative thoughts (state of health, physical condition, and about confinement), negative emotions (sadness, tension, and energy) and worse psychological well-being (less autonomy, environmental dominance and purpose in life). These data are in line with prior research indicating that women have a worse emotional response and mental health than men during confinement (Alsalhe et al., 2020; Fu et al., 2020; Jaenes et al., 2020; López-Bueno et al., 2020c; Mon-López et al., 2020; Pieh et al., 2020; Rossi et al., 2020; Xionga et al., 2020). Some studies have found that home confinement by COVID-19 had a negative effect on both psychological well-being and mood by increasing depressive symptoms and increasing psychosocial stress caused by home confinement. Interdisciplinary intervention is needed in addition to promoting an active and healthy confinement lifestyle to mitigate this high risk of mental disorders (Ammar et al., 2020c).

In addition, this study shows that women perceive greater difficulty in leading a healthy life in general in this situation (daily routines, eating and sleeping patterns), issues that may be related to the worst emotional response during confinement. In addition, women are more focused on coping strategies that focus on emotional support (letting go and mental disconnection), issues that may be limited by social restrictions and alienation.

Therefore, gender differences are an important area of study during periods of confinement, in this case derived from COVID-19, requiring special attention for the female population, developing coping strategies that are adaptive to the situation and to the perceived difficulties in relation to certain healthy habits, with the aim of improving their emotional state and psychological well-being. In addition to greater attention to women, it would be interesting if the different national and international bodies agreed to implement healthy recommendations for each subgroup, for example, older or sick women (Bentlage et al., 2020), taking advantage of the technological tools available in homes (Ammar et al., 2020b).

The second objective analyzed was the changes in the frequency of physical activity (increase, maintenance, or decrease) on emotions, perceived difficulties, coping and psychological well-being.

It is perceived that there is a variation in physical activity during confinement (444 people; 86.3%), as indicated in previous works (Brand et al., 2020; Choi and Bum, 2020; Clemente-Suárez et al., 2020). In the present study, there is mainly an increase in physical activity (266 participants; 47.26%), although there is also a high number of people who decrease their practice (178 individuals; 38.51%), an issue that is reinforced by studies that perceive an increase in physical activity (Brand et al., 2020; Schnitzer et al., 2020) and those who obtain a decrease in practice (Filho et al., 2020; Jimeìnez-Pavoìn et al., 2020; Lesser and Nienhuis, 2020; López-Bueno et al., 2020a; Mon-López et al., 2020; Xiang et al., 2020; Ammar et al., 2021), although a period of time is required to adapt to the new context and routines (López-Bueno et al., 2020b).

This change and variation in physical activity depends on certain pre-existing individual variables (lifestyle, healthy habits, personal variables, etc.) and contextual variables (sports equipment, space in the home, doing physical activity accompanied, with an online trainer, etc.), as indicated by other authors (Brooks et al., 2020; Constant et al., 2020; Ingram et al., 2020; Jungmann and Witthöft, 2020; Liu et al., 2021).

Secondly, the data obtained indicate that when participants increase their physical activity, they perceive greater difficulties in training, in following their eating patterns, training plan, and daily objectives. Furthermore, they are more affected by the confinement situation, although they perceive confinement as positive and use mental disconnection coping strategies.

This person profile may be concerned about the limitations (personal and contextual) of being locked in at home and perceive the need for and benefit of physical activity during confinement. These participants require greater order and organization to resolve the difficulties they perceive, although this does not prevent them from increasing their physical activity, which makes the confinement more manageable and helps them to disconnect from the worries. On the other hand, the group that reduced their physical activity was perceived as having more energy and positive coping (suppression of competitive activities and acceptance), which could represent accepting the situation and saving resources for day-to-day life, at least for a period of time, especially if they do not have the resources to be physically active or if they decide not to.

In their case, the confinement of sportsmen and women was more emotionally affecting than that of sedentary or even physically active sportsmen and women. Thus, the athletes showed high scores in irritation and felt less support than the sedentary ones, although they were, in turn, less tense and irritated than the physically active ones. The cancelation of all the competitions, together with the uncertainty of returning to them, meant that they experienced negative emotional changes as well as difficulties in setting goals. These findings are in line with other works that stress the important role played by emotions in competitive athletes (Jaenes et al., 2020; Jukic et al., 2020). To cope with this situation, athletes have used active coping strategies such as planning, and have accepted the situation despite having lost their purpose in life, a logical consequence of losing the possibility of competing and achieving their goals. Undoubtedly, the role that coping strategies have played has been relevant as a moderator between the stressful event of a pandemic and well-being (Rettie and Daniels, 2020; Ye et al., 2020).

Therefore, there are several future challenges in minimizing the psychological impact of confinement during a pandemic. Firstly, it will be necessary to design specific psychological interventions to improve coping strategies (Pfefferbaum and North, 2020), focusing, among others, on interventions aimed at improving cognitive flexibility, as recommended by other researchers, facilitating adjustment and adaptation to changes in athletes' lives due to the pandemic (Clemente-Suárez et al., 2020). Another future challenge will focus on finding out to what extent the practice of physical activity is producing psychological benefits in times of confinement, and on what specific variables, given that the emotional effects of such activity and physical exercise habits appear to be moderated by numerous variables. Future lines of work include the evaluation of new psychological variables that could shed light on the data obtained, such as the type of motivation to practice among participants, the design of specific intervention programs according to the level of practice, as well as analyzing the psychological impact of the pandemic among elite athletes, taking into account gender differences. In view of the results obtained in this study, it would be advisable to monitor the emotional states and healthy habits of the athletes, both daily, weekly and even monthly, following the recommendations of other works, that have suggested that exercises should be adapted to the participant's level of physical condition and a progressive model of training intensity and volume should be used, preferably monitored by telephone applications and portable sensors (Chtourou et al., 2020). It is also essential to generate spaces for communication so that the technical body and the team members themselves can share their state at an emotional, cognitive and behavioral level, generating feelings of identity and affiliation. Another recommendation is that, during times of confinement, professional attention should be received from the psychologist, both as a preventive measure, psychological attention and mental preparation, since it is essential that the athlete be prepared and psychologically balanced for when training and competition resume. Finally, given the cancelations and changes in competition calendars, it is important to help the athlete to plan and organize his/her life and sporting activity, despite the uncertainty of the situation, focusing on the "here and now" and regulating the negative emotions that may arise (e.g., relaxation, positive internal self-dialogue and self-instruction, engaging in enjoyable activities, social support, etc.) by helping them to set short-term goals (e.g., for each day or week). In short, if we are to make effective and healthy interventions in exercise habits in future confinement, it will be necessary to understand what difficulties they encounter in alleviating them. Similarly, we need to consider where the differences lie between people who, prior to the pandemic, did not engage in any form of physical activity and those who did. Without doubt, complementing this information with the inclusion of qualitative variables can broaden the possibilities of understanding the results obtained in the face of such an unusual event as a confinement.

Among the limitations of this study, we can include the absence of sociodemographic variables such as income or previous psychological diagnoses, such as anxiety or depression, which could affect the results obtained since they could be associated with the emotional impact of the pandemic (Fu et al., 2020; Jungmann and Witthöft, 2020; Pieh et al., 2020; Xionga et al., 2020). In addition, other possible limitation would be of the study was that the sample through convenience sampling, which could lead to a bias regarding the representativeness of the sample. Another limitation is the size of the effect obtained, which limits possible practical interpretations of the results. This research is cross-sectional, which makes it impossible to follow up on the participants once the confinement has ended.

The results found in this research about the changes produced in the exercise habits and their relationship with coping and emotions will allow the design of psychological interventions that take into account both gender differences and the different levels of involvement in physical activity given the different repercussions on the psychological variables analyzed.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The study was reviewed and approved by the Ethics Committee of Miguel Hernandez University. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

EL-Z and AM-T developed the design of the research. AG-N reviewed the literature. MS-R and SB performed the data analyses. All authors participated in the development of the study, contributed in writing the first draft and reviewed the final draft. The manuscript has been approved by all authors.

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Exercise and Physical Activity eHealth in COVID-19 Pandemic: A Cross-Sectional Study of Effects on Motivations, Behavior Change Mechanisms, and Behavior

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Objectives: The aims of this research were (1) to compare the levels of physical activity of eHealth users and non-users, (2) to determine the effects of these technologies on motivations, and (3) to establish the relationship that could exist between psychological constructs and physical activity behaviors.

Methods: This cross-sectional study involved 569 adults who responded to an online questionnaire during confinement in France. The questions assessed demographics, usage of eHealth for exercise and physical activity, and behavioral levels. The questionnaire also measured the constructs of Social Cognitive Theory, the Theory of Planned Behavior, and automaticity facets toward eHealth for exercise and physical activity.

Results: Participants who were users of eHealth for exercise and physical activity presented significantly higher levels of vigorous physical activity and total physical activity per week than non-users ($p < 0.001$). The chi-square test showed significant interactions between psychological constructs toward eHealth (i.e., self-efficacy, behavioral attitudes, intentions, and automaticity) and physical activity levels (all interactions were $p < 0.05$). Self-efficacy was significantly and negatively correlated with walking time per week. Concerning the automaticity facets, efficiency was positive and significantly correlated with vigorous physical activity levels per week ($p < 0.05$). Then, regressions analyses showed that self-efficacy and automaticity efficiency explained 5% of the variance of walking minutes per week ($\beta = -0.27$, $p < 0.01$) and vigorous physical activity per week ($\beta = 0.20$, $p < 0.05$), respectively.

Conclusion: This study has shown that people during confinement looked for ways to stay active through eHealth. However, we must put any technological solution into perspective. The eHealth offers possibilities to stay active, however its benefits and the psychological mechanisms affected by it remains to be demonstrated: eHealth could be adapted to each person and context.

Keywords: self-effcacy, intentions, attitude, digitalization, habits, automaticity

INTRODUCTION

The COVID-19 pandemic has led half of the world's population to stay home or be confined to reduce the spread of the virus (Sandford, 2020). Among all the measures adopted to avoid a health crisis, many different countries affected by the virus chose to apply spatial distancing as a means to slow its spread (Abel and McQueen, 2020). This measure had three undeniable effects: the exacerbation of Internet use (Effenberger et al., 2020), the digitalization of human activity linked to health (Ting et al., 2020), and a high acceptance rate for the use of technological solutions (Ammar et al., 2020c). For this reason, the use of electronic health (eHealth) for exercise and physical activity has become an alternative for staying active during this period (Chen et al., 2020; Hammami et al., 2020). eHealth is defined broadly as the use of information and communications technology, especially the Internet, to improve or enable health and healthcare (Vandelanotte et al., 2016). In the case of exercise and physical activity, we could operationalize eHealth as digital, online, or Internet tools intended to help people for practice exercise or physical activity (e.g., an application, websites, videos, communities or social media, connected watches).

The World Health Organization (WHO) (2020), the French Ministry of Sport, and the French National Observatory of Physical Activity and Sedentary (ONAPS; Duclos et al., 2020)—as well as similar bodies in other countries – have proposed on their websites some recommendations and online platforms on how to be active during this period (e.g., Bougez-chez-Vous). Additionally, regular physical activity has been indicated as an essential factor to prevent severe complications in any future pandemic viruses similar to COVID-19 (Jakobsson et al., 2020).

Physical activity is a protective factor by directly promoting health (Jakobsson et al., 2020) and by preventing from physical inactivity as a risk factor (van der Ploeg and Hillsdon, 2017). For some authors, levels of physical inactivity could be even worse during the COVID-19 pandemic (Burtscher et al., 2020), affecting negatively all physical activity intensities (Ammar et al., 2020a). Paradoxically, confinement also became an excellent opportunity to promote physical activity. In the case of France and Italy, physical exercise was one of the rare opportunities for the population to get "out of confinement" sporadically, although limited to a few hundred meters around one's home for an hour at a time.

The COVID-19 pandemic is unprecedented; thus, there is no information about previous users' adoption of eHealth for exercise and physical activity during a period of confinement and what the effects are on the motivations and mechanisms of behavioral change with regards to levels of physical activity. Despite this, some elements are known regarding eHealth users under an ordinary context. Some authors suggest that the people who use them are, unsurprisingly, mainly young (Wang et al., 2016; Goodyear et al., 2019) and with a high level of education (Åkerberg et al., 2017). Although the number of people using eHealth to practice physical activity and exercise is increasing, as well as the techniques of behavioral change incorporated in these technologies, studies on the social–psychological mechanisms they influence are scarce (Hoj et al., 2017).

In the present research, we address the effect of eHealth on physical activity behaviors and mechanisms for changing the behavior of its users during confinement through the constructs of Theory of Planned Behavior (TPB; Ajzen, 1991) and Social Cognitive Theory (SCT; Bandura, 1989). These constructs are the most commonly used to underpin physical activity behaviors and eHealth (Zhao et al., 2016), and both theories have been found to predict the use of eHealth physical activity (Webb et al., 2010). Furthermore, we aim to understand if these mechanisms are related to the levels of automatic properties of habits (Bargh, 1994) during confinement. The conditions of this period could also be conducive to the development of habits based on the use of these technologies (Larose, 2015), which could be related to levels of physical activity.

Physical Activity Levels of eHealth Users and Non-users

In terms of physical activity levels, studies show mixed results when comparing the physical activity levels of eHealth users versus non-users. On the one hand, some studies have indicated that people who use eHealth for physical activity have higher levels of physical activity than those who do not (Bort-Roig et al., 2014; Romeo et al., 2019). On the other hand, other studies have indicated that there would be no significant differences in the physical activity levels between these two groups (Milne-Ives et al., 2020). This difference could be due to the methods of measuring behaviors as well as the types of physical activity that eHealth affects. These technologies affected mainly minutes walked (Rabbi et al., 2015) and vigorous physical activity (van Drongelen et al., 2014). Although the results related to physical activity levels are unclear. Some studies suggest that people using eHealth meet the recommended levels of physical activity for health (Carroll et al., 2017).

Psycho-Social Theories Applied to eHealth for Exercise and Physical Activity

The theoretical model of the Theory of Planned Behavior assumes that positive intentions are more likely to predict behavioral adoption than unfavorable intentions (Chatzisarantis et al., 2019). They are influenced by three factors: attitudes, subjective norm, and perceived behavioral control (Ajzen, 1991). Attitudes refer to whether the person thinks that performing a physical activity is good or bad. Subjective norm refers to people's belief about how other people who are important to them view physical activity. Perceived behavioral control is whether people feel they can perform physical activity. This construct can be characterized by control beliefs which refer to an individual's beliefs about the presence of factors that may facilitate or hinder the performance of the behavior (Ajzen, 2001). The results of a recent study (Herrmann and Kim, 2017) showed that eHealth usage for physical activity over 5 months appears to have a connection to usefulness (attitude) and to perceived difficulties of exercising using eHealth (perceived behavioral control). The same study showed that exercise and exercise using eHealth are not influenced by peer influence (subjective norm). Intention to exercise using eHealth had low advocacy (behavioral intention), and those who used the eHealth were more likely to have high attitude (Herrmann and Kim, 2017; Gabbiadini and Greitemeyer, 2019) and behavioral belief advocacy about the physical activity in eHealth (Hoj et al., 2017). In terms of physical activity behaviors, positive attitudes are associated with high daily walk time (Füssl et al., 2019; Gabbiadini and Greitemeyer, 2019), and positive intentions are more likely to predict physical activity levels than unfavorable intentions (Chatzisarantis et al., 2019).

The literature indicates that eHealth technologies positively influence self-efficacy, social support (Wang et al., 2019), and attitudes toward physical activity (Hosseinpour and Terlutter, 2019). Perceived self-efficacy refers to a belief in one's own capabilities to organize and execute the courses of action required to produce given outcomes (Bandura, 1997). The use of eHealth for physical activity affects self-efficacy by including two kinds of support: individual interaction (i.e., feedback, goal settings, and reward) and social interaction (i.e., social sharing and competition) (Hosseinpour and Terlutter, 2019). The feedback, goal settings, and reward provide users with information about the progress of their actual physical activity. This information allows the individual's reflection on their performance (Prestwich et al., 2016). Subsequently, they could increase individuals' awareness of their real ability to perform physical activity (Harries et al., 2013; Lubans et al., 2014). As a consequence, they develop self-efficacy. It is personal success that raises their belief in possessing the capability to master physical activity (Harries et al., 2013). Another study showed that goal setting and rewards could make eHealth users confident to perform physical activity, which, in turn, also increases self-efficacy (Fukuoka et al., 2012).

Behavior Change Mechanism of eHealth and Physical Activity Levels

The eHealth convey individuals' impression that they can perform physical activity, and as a result, they are more likely to increase their self-efficacy and engage in more physical activity behavior (van der Weegen et al., 2015; Lewis et al., 2016). In the same vein, high self-efficacy score was associated with higher physical activity levels (Wang et al., 2019). Concerning reinforcement, Maher et al. (2014) observed that most of eHealth do not incorporate characteristics of a popular social network such as communication and emphasizing interactions. However, when these features were incorporated, the social sharing with familiar users (i.e., family, friends, or colleagues) of eHealth increases the levels of physical activity (Consolvo et al., 2006). When it comes to people who are not familiar, the results reflect a phenomenon called "awkward," with users asking themselves "why anyone would be interested in their workout" (Ahtinen et al., 2008). Regarding sharing in social networks with familiar or strangers, users sometimes also felt disappointment when they did not receive reactions from the familiar ones and that sharing results with strangers impacted negatively their motivations toward physical activity (Munson and Consolvo, 2012). Social support was associated with high levels of physical activity (Wang et al., 2019). In confinement conditions, particularly with spatial distancing (Abel and McQueen, 2020), we could expect social support in terms of physical activities to be reduced and therefore less perceived. This condition could result in minor advocacy for reinforcement about eHealth for physical activity and present fewer levels of physical activity.

The Theory of Planned Behavior (Ajzen, 1991) and Social Cognitive Theory (Bandura, 1989) have been widely applied in studies using emerging technologies such as mobile phones and exercise applications (Gao, 2017). These theories and their constructs represent motivations and the conscious or controlled plan to enact behavior (Conner and Armitage, 1998). However, research over the last decade suggests that much of our interaction with these technologies occurs through habitual processes (Larose, 2010), which are characterized by more or less unconscious thinking (Bayer and Campbell, 2012). Habits are learned sequences of acts that have become automatic responses to specific signals and are functional in obtaining particular objectives or final states (Verplanken and Aarts, 1999). This definition implies that habits are formed through an initially intentional process that allows for the repetition of behaviors (i.e., frequency) in stable contexts (Wood and Neal, 2016), which, in turn, will lead to an increase in the automaticity of this process (Lally et al., 2010). The concept of automaticity can be understood as any cognitive process with lack of intentionality, lack of control, and lack of awareness, and it is highly efficient (Bargh, 1994). In this vein, the everyday use of mobile devices has been described as performed in a minimally conscious manner or automatically (Bayer et al., 2016). In fact, the use of eHealth could be highly influenced by the automaticity of habits, as these technologies have been incorporated into daily lives and underlying cognition (Bayer et al., 2016). This characteristic can be determined and reinforced by the cues that mobile devices emit (Larose, 2015), explaining their habitual use (Bayer and Campbell, 2012).

In terms of physical activity levels, a meta-analysis of studies on the link between habits and physical activity showed positive correlations between automaticity of habits and physical activity behavior (Gardner et al., 2011). Further research has confirmed that people with strong habits are more physically active than people with weak habit scores (Boiché et al., 2016; Rebar et al., 2016). Concerning the frequency of physical activity, behavior reflects its regularity, and it is one habit dimension (Rhodes et al., 2010).

This study represents thus an attempt to:

1. Compare the levels of physical activity of users and non-users of eHealth for exercise and physical activity,
2. Determine how these technologies affect the psychological mechanisms of eHealth users, and
3. Evaluate the relationship between these mechanisms and the levels of physical activity during the confinement period.

Based on the above-reported literature, the following leading group of hypotheses can be stated:

H1: We expected no difference of physical activity levels between eHealth users and non-users during confinement.

H2: We hypothesize that eHealth users would increase perceived self-efficacy and attitudes toward physical activity.

H3: We hypothesize that self-efficacy and attitudes would be positively associated with physical activity levels.

H4: Finally, similar to previous work, we expect a positive relationship between automaticity of habit levels (Larose, 2015) toward eHealth and the levels of physical activity behavior (Gardner et al., 2011; Boiché et al., 2016).

MATERIALS AND METHODS

Recruitment

The study sample comprised of respondents who were recruited through Drag n Survey®, posting invitations in social media (Facebook, Instagram, and LinkedIn), and university website. Drag n Survey is an online questionnaire provider that allows one to develop and customize questionnaires according to the type of study. The sample was limited to respondents who were 18 years or older and residents in France during confinement. The global results will be sent to the participants who completed the questionnaire as an incentive. In order to prevent that a single user fills in the same questionnaire multiple times, only one response per IP address was possible. The completion or internal consistency of specific (or all) items was enforced using server-side techniques (i.e., after submission displaying the questionnaire and highlighting mandatory but unanswered items). According to Baruch and Holtom (2008), the average level of response rate of Internet survey for social sciences, to be acceptable, is approximately 53%.

Ethics Statement

The Institution Ethics and Review Board approved the study (2218023v0-CNIL), and it was carried out by the French methodological reference MR-001. This reference indicates that each participant must be informed of the purpose of the research. This statement was in accordance with the Declaration of Helsinki, and the participants were requested to be honest and as accurate as possible in their responses. The duration of the survey was clarified. The participants were assured that the results would be used only for this study and that their privacy would be guaranteed. If the participants did not want to participate in the survey, they could turn off the electronic questionnaire and drop out. If the questionnaire was completed and submitted, the participant was considered to have provided informed consent. Only those who voluntarily agreed to participate in the survey were included in the research.

Procedure

An electronic survey constructed through Drag n Survey® web-based software was used to collect data. The survey was available in Drag n Survey server from 24th of April 2020 to 10th of May 2020 (the end of French confinement during COVID-19 first pandemic wave). A total of 602 respondents visited the website of the study. The survey gathered information regarding self-report measures of Theory of Planned Behavior, Social Cognitive Theory, automaticity, and self-reported physical activity behavior.

Sample

The final sample ($N = 569$) comprised of 64.1% women. The participants were between 18 and 73 years of age ($M = 31.89$, SD = 13.59).

Measures

Demographic information was gathered, and the respondents were asked to report their age, gender, and the highest level of education obtained (**Table 1**). Additional information relating to eHealth usage was also gathered. The participants indicated if they were users or non-users of eHealth physical activity tools (i.e., "When we say 'online' or 'the Internet,' we are referring to content that you use regularly"), for example, WhatsApp or Snapchat contacts, an Application, websites like YouTube, online communities or social media. Then, the participants answered if they use an eHealth to practice physical activity/exercise by answering yes or no. The participants were also asked to choose what eHealth they use to practice a physical activity/exercise. The options were: Application, Website, Internet videos, and others. The next question was about when did they start using this eHealth tool for physical activity/exercise/sport (i.e., before confinement or during confinement) and how many times per

TABLE 1 | Sample characteristics.

Demographics	
Age ($n = 569$), mean (SD)	31.89 (13.59)
18–25	254(44.6%)
26–34	103(18.1%)
35–54	139(24.4%)
55–64	42(7.4%)
65 or older	31(5.4%)
Gender ($n = 548$)	
Male	197(36%)
Female	351(64%)
Education ($n = 541$)	
Primary school	51(9%)
Secondary	149(28%)
University	341(63%)
eHealth user for physical activity ($n = 513$)	
User	299(58%)
No-User	214(42%)
Type of eHealth for practice physical activity and exercise ($n = 299$)	
Application	123(41%)
Website	56(19%)
Videos	117(39%)
No answer	3(1%)
Starting to use a eHealth for physical activity ($n = 290$)	
Before the lockdown	129(45.5%)
During the lockdown	161(55.5%)

week. We then asked about how many eHealth tools they used to practice physical activity before and during confinement.

The participants were also asked to name their favorite eHealth tool for physical activity/exercise/sport during confinement, what was the price, and how did they find out about the eHealth tool they currently use to practice physical activity during confinement.

Instruments

The eHealth to practice physical activity was defined in this section as follows: "We focus on digital, online, or Internet tools." When we say "online" or "the internet," we are referring to eHealth that you use regularly to practice physical activity or exercise (for example, WhatsApp or Snapchat contacts, an Application, websites like YouTube, online communities or social media, connected watches).

The Social Cognitive Theory and Theory of Planned Behavior items had been translated especially for this research without any previous validation. They were adapted from English to French, following a reverse translation (Brislin, 1986). First, the scale was translated by two bilingual people from English to French. Then, two other bilingual persons translated it from French to English to analyze the degree of coincidence with the wording and the meaning of the original items. Then, this sequence was repeated by a linguist and a professional translator. After that, it was verified as to whether the original sense of the scale had been maintained. Finally, the French format of the scales was drafted.

Theory of planned behavior constructs

Attitudes. Attitudes were assessed for eHealth use toward physical activity with five items to tap the instrumental aspect of attitude as suggested by Ajzen (2001). The first was "Using the eHealth for physical activity has increased (my motivation to be physically active) during the confinement." The second was "Using the eHealth for physical activity has increased (my attitudes about the importance of physical activity in preventing disease) during the confinement." The third was "Using the eHealth for physical activity has increased (my desire to be physically active) during the confinement." The fourth was "Using the eHealth for physical activity has increased (my desire to be healthy) during the confinement." The fifth was "Using the eHealth for physical activity has increased (my motivation to set goals to be physically active) during the confinement." All items were scored on a five-point scale from strongly disagree (1) to (5) strongly agree. The internal consistency for the five items was acceptable ($\alpha = 0.80$).

Subjective norms. Subjective norms were measured by one item using the same five-point Likert scale from strongly disagree (1) to (5) strongly agree "Using the eHealth for physical activity has increased (my belief that people important to me want me to be physically active) during the confinement." This component was a single item from a scale based on the findings of Rhodes and colleagues (Rhodes et al., 2006).

Behavioral belief. Behavioral belief was measured with four items for eHealth use toward physical activity and standard to the Theory of Planned Behavior (Ajzen, 2002). The first item was "Using the eHealth for physical activity has increased (my belief that physical activity can prevent disease) during the confinement." The second item asked was "Using the eHealth for physical activity has increased (my belief that physical activity is important in preventing disease). The third was "Using the eHealth for physical activity has increased (my belief that physical inactivity leads to disease) during the confinement." The fourth item was "Using the eHealth for physical activity has increased (my belief that diseases related to physical inactivity are harmful) during the confinement." All items were scored on a five-point scale from strongly disagree (1) to (5) strongly agree. The reliability of the four items was good ($\alpha = 0.88$).

Intention. Intention was assessed by one item recommended by Courneya and McAuley (1994): "Using the eHealth for physical activity has increased (my intentions to be physically active) during the confinement." The item was scored on a five-point scale from strongly disagree (1) to (5) strongly agree. This item was used to create the intention–behavior profiles because it has demonstrated excellent test–retest reliability and predictive validity as a single-item measure of intention (Courneya and McAuley, 1994; Rhodes and Courneya, 2003).

Social cognitive theory constructs

Self-efficacy. Three items measured self-efficacy. The first was "Using the eHealth for physical activity has increased (my ability to be physically active)." The second was "Using the eHealth for physical activity has increased (my confidence that I can be physically active)." Finally, the third was "Using the eHealth for physical activity has increased (my ability to achieve my physical activity goals) during the confinement." The reliability was acceptable ($\alpha = 0.77$).

Subjective knowledge. Three items assessed subjective knowledge. The first item was "Using the eHealth for physical activity has increased (my knowledge of ways in which I can be physically active) during the confinement." The second item was "Using the eHealth for physical activity has increased (my knowledge of the diseases that are caused by physical inactivity)." The third was "Using the eHealth for physical activity has increased (my knowledge of the benefits of being physically active) during the confinement." All items were scored on a five-point scale from strongly disagree (1) to (5) strongly agree. The internal consistency was adequate ($\alpha = 0.69$).

Reinforcement. Two items measured reinforcement. The first item was "Using the eHealth for physical activity has increased (the social support I have received for being physically active)." The second item was "Using the eHealth for physical activity has increased (the positive feedback I have received for being physically active) during the confinement." The two items were scored on a five-point scale from strongly disagree (1) to (5) strongly agree. The Pearson r value was good ($r = 0.75$).

Automaticity. Automaticity was measured by nine items of the Generic Multifaceted Automaticity Scale, a validated scale in French (Boiché et al., 2016). This instrument assesses three dimensions of automaticity—lack of intentionality, lack of control, and efficiency—with three items for each one. The nine items were scored on a five-point scale from 1 (strongly disagree) to 5 (strongly agree). The internal consistency of the nine items was acceptable (α = 0.78).

Lack of intentionality. Three items measured lack of intentionality. The first item was "To use my app for practicing my physical activity is something (that I use instinctively, no need to mark it down in my agenda) during the confinement." The second was "To use my app for practicing my physical activity is something (that I use without having to think about it before) during the confinement." The third was "To use my app for practicing my physical activity is something (about which I do not wonder whether I am going to use it or not, I just use it) during the confinement." The measure showed borderline adequate internal consistency (α = 0.64).

Lack of control. Three items assessed lack of control. The first item was "To use my app for practicing my physical activity is something (I would find hard not to use it) during the confinement." The second was "To use my app for practicing my physical activity is something (that would require effort not to use it) during the confinement." The third was "To use my app for practicing my physical activity is something (that makes me feel weird if I do not use it) during the confinement." The reliability was borderline adequate (α = 0.66).

Efficiency. Efficiency was assessed with three items. The first item was "To use my app for practicing my physical activity is something (on which I do not have to focus to use it properly) during the confinement." The second item was "To use my app for practicing my physical activity is something (that I could use "eyes closed" once I'm started) during the confinement." The third item was "To use my app for practicing my physical activity is something (that I can use in 'automatic pilot') during the confinement." The reliability was acceptable (α = 0.72).

Physical activity behavior. Physical activity behavior was measured using the International Physical Activity Short Form (IPAQ-SF; Craig et al., 2003). Three types of physical activity were assessed—walking, moderate activity, and vigorous activity—as sitting time as well. This instrument is considered to estimate the total physical activity in minutes per week at metabolic equivalent (MET) and time spent sitting. For example, for the vigorous physical activities, the items were "During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?" and "How much time did you usually spend doing vigorous physical activities on one of those days?" For each of these four types of activities, the subjects were also asked to estimate the total time (in hours and/or minutes) spent doing that activity in the past week.

Data Analyses

First, the analysis of the data included the identification of the users and non-users of eHealth for physical activity. The next step was to classify the participants into active or inactive according to WHO recommendations for levels of physical activity for health in adults (i.e., 150 min of moderate to vigorous physical activity per week). Student's t-tests were calculated to determine if there were differences between the physical activity levels of eHealth users and non-users. The chi-square was also calculated to determine the number of eHealth users and non-users who reached the physical activity levels recommended for health.

Then, in order to evaluate how eHealth affects the psychological constructs (i.e., TPB, SCT, automaticity facets), the averages and trends of the scores were analyzed, comparing each construct by Student's t-test.

Next, to evaluate the relationship between psychological constructs and physical activity levels, two categorizations were carried out. The first was a symmetry/asymmetry analysis of the psychological constructs of the Theory of Planned Behavior, Social Cognitive Theory, and automaticity. We divided each variable of the psychological constructs of the Theory of Planned Behavior, Social Cognitive Theory, and automaticity into three groups: low advocacy (< 2, disagreement response options), ambivalence (> 1.9 and ≤ 3.9, neither disagreement nor agreement response options), and high advocacy (> 4; agreement response options). These variable categorizations were done purposefully using absolute values (i.e., not simple median splits) to examine symmetry across scale responses. The second was classifying the subjects into three groups on the basis of three IPAQ profile groups. The first group corresponds to the high level of physical activity that reaches (a) vigorous-intensity activity on at least 3 days (20 min minimum, achieving a minimum total physical activity of at least 1,500 MET minutes/week) or (b) seven or more days of any combination of walking and moderate-intensity or vigorous-intensity activities, achieving a minimum total physical activity of at least 3,000 MET minutes/week. The second group was moderate, in which individuals reached (a) three or more days of vigorous-intensity activity of at least 20 min per day or (b) five or more days of moderate-intensity activity and/or walking of at least 30 min per day or (c) 5 or more days of any combination of walking, moderate-intensity activities, or vigorous-intensity activities, achieving a minimum total physical activity of at least 600 MET minutes/week. The third group is called low, where individuals did not reach the levels described above.

After that, a series of chi-square analyses was calculated to test the independence between the advocacy of psychological constructs and IPAQ physical activity profiles (i.e., low, moderate, and high).

Finally, a correlation analysis was calculated to determine the relationship between psychological constructs and physical activity levels. Multiple regressions analysis were also calculated with physical activity in MET minutes per week as dependent variable and psychological constructs (i.e., SCT, TPB, and automaticity) and frequency of behaviors as independent variables.

Statistical significance was set at $p < 0.05$ in all the analyses.

RESULTS

Preliminary Analyses

Concerning the usage of eHealth for physical activity and exercise, 58.3% (299/569) of the respondents reported being users. These participants used the eHealth at least three times per week ($M = 3.77$, SD = 2.12), were significantly younger (M = 29.88 years old, SD = 12.13) than non-users (M = 35.37 years old, SD = 15.06), $t(511) = 4.40$, $p < 0.001$. From these respondents, 55.7% started to use the eHealth during confinement. The types of eHealth for physical activity used in confinement were applications = 42% (125/299), Internet videos = 39% (118/299), and websites = 19% (56/299). Only 36% (108/299) of the respondents reported using a single physical activity eHealth, whereas 19.3% (58/299) reported using two physical activity eHealth and 8% (24/299) had three physical activity eHealth. There were 63 different applications reported by the study respondents, and most were free. The sources of information about the eHealth tool for physical activity were as follows: Internet = 125 (22%), word of mouth = 116 (20.4%), advertising = 18 (3.2%), mail (0.2%), others = 12 (2.1%), television = 5 (0.9%), and social networks = 3 (0.5%). **Table 1** presents study sample descriptive statistics. There were no significant differences ($p > 0.05$) between participants in terms of confinement days (M = 46.58, SD = 4.2) for the variables of interest.

Physical Activity Levels of eHealth Users Versus Non-users

Table 2 presents the comparison of physical activity levels between eHealth users and non-users. The t-test analysis showed that eHealth users practiced significantly more MET minutes of vigorous physical activity per week (M = 3,799.17, SD = 3,415.61) than non-users (M = 2,343.42, SD = 2,849.54), $t(407) = -4.6$, $p < 0.001$. The eHealth users also presented significantly more MET minutes of total physical activity per week (M = 6,202.76, SD = 4,750.03) than non-users (M = 4,745.17, SD = 4383.55), $t(407) = -3.2$, $p = 0.001$. According to WHO recommendations for physical activity, eHealth users were more likely to be classified as active (80 versus 63%) than non-users [$X^2(2) = 17.8$, $p < 0.001$]. **Figure 1** shows that there are significantly more eHealth users classified as active than non-users. The widths of the boxes are proportional to the percentage of non-users (42%) and users (58%), respectively. The heights of the boxes are proportional to the percentage of people who were classified as active and inactive. Among the people classified as active, 64% were users and 36% were non-users.

The eHealth Usage Effect on Perceived Self-Efficacy and Attitudes Toward Physical Activity

In terms of SCT, perceived self-efficacy scored (M = 3.66, SD = 0.91) significantly ($p < 0.001$) higher than reinforcement (M = 2.87, SD = 1.10) and knowledge (M = 3.31, SD = 0.93). For the TPB constructs, intention scores (M = 3.94, SD = 1.02) were significantly higher than behavioral attitudes (M = 3.75, SD = 0.81), behavioral beliefs (M = 3.49, SD = 1.04) and subjective norms (M = 2.87, SD = 1.32), $p < 0.001$. These results showed that descriptive scores of self-efficacy, behavioral attitude, and intention had medium–strong mean score. Knowledge, reinforcement, and subjective norms had a mean of around the center of the scale, suggesting ambivalence.

Relationship Between Psychological Constructs and Physical Activity

From **Figures 2–6**, when the observed frequency of a cell was higher than expected, the box rises above the baseline; otherwise, the box falls below the baseline. **Figure 2** shows that there were significant interactions [$X^2(2) = 11.17$, $p = 0.004$] between high self-efficacy advocacy and one vigorous physical activity profile (i.e., $\geq$ 3 days of vigorous physical activity $\geq$ 20 min/day). High self-efficacy advocacy and people who reached at least 3 days of vigorous physical activity during 20 min per day were significantly and positively associated ($p = 0.005$). **Figure 3** shows that the association of high advocacy of behavioral attitude and people who reached at least 3 days of vigorous physical activity 20 min per day was statistically significant [$X^2(2) = 7.28$, $p = 0.026$)]. **Figure 4** shows a significant interaction between intention advocacy and $\geq$ 3 days of vigorous physical activity $\geq$ 20 min/day [$X^2(2) = 6.92$, $p = 0.031$]. Users of eHealth for physical activity who present high advocacy for self-efficacy and attitudes were more likely to reach $\geq$ 3 days of vigorous physical activity during $\geq$ 20 min a day than those with ambivalence or low advocacy for those psychological constructs. Concerning automaticity facets and users who reached $\geq$ 3 days of vigorous physical activity during $\geq$ 20 min per day, a significant interaction was found for lack of intentionality advocacy [$X^2(2) = 22.34$, $p < 0.001$] and efficiency advocacy [$X^2(2) = 34.50$, $p < 0.001$]. **Figures 5**, **6** indicate that there are significantly more individuals with high lack of intentionality and high efficiency advocacy reaching at least 3 days of vigorous physical activity during 20 min per day.

As can be seen in **Table 3**, only two psychological constructs, self-efficacy and efficiency, were associated with the physical activity levels. Self-efficacy was significantly and negatively correlated with walking MET minutes per week. Concerning the automaticity facets, there was a positive and significant correlation between efficiency and vigorous physical activity MET per week. The eHealth frequency usage was positive and significantly associated with the automaticity facets, vigorous

TABLE 2 | Comparison of physical activity levels of non-users and users of eHealth.

	Non-users (n = 196)		Users (n = 213)		95% CI for mean low, high	p	t	df
Outcome IPAQ-SF	M	SD	M	SD				
vPA MET/week	2,343.42	2,849.54	3,799.17	3,415.61	−2,070.03, −841.45	0.000	−4.65	407
mPA MET/week	1,625.51	1,704.62	1,604.56	1,698.48	−3,10.06, 352.04	0.901	0.12	407
Walk MET/week	776.173	1,267.09	799.00	1,261.66	−2,68.82, 223.16	0.855	−0.18	407
Total MET/week	4,745.17	4,383.55	6,202.76	4,750.03	−2,348.36, −566.80	0.001	−3.21	407

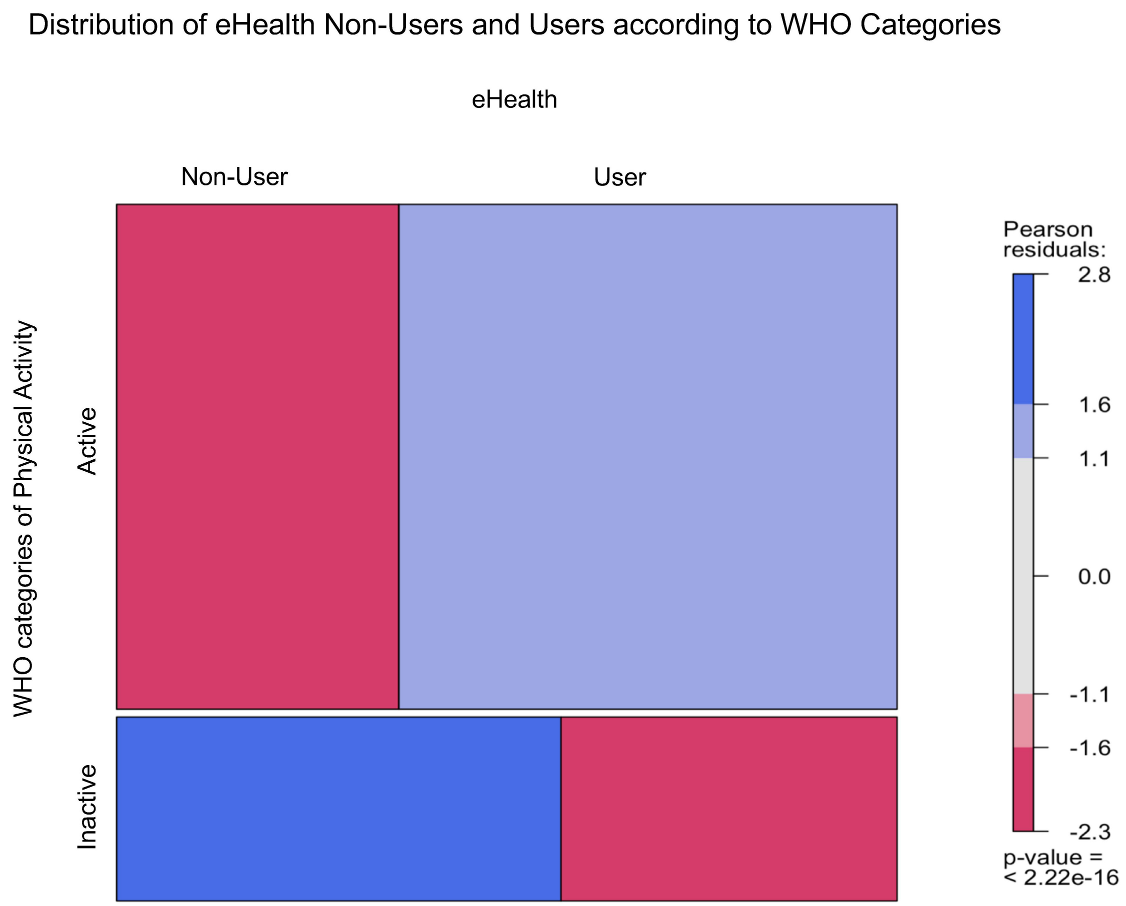

FIGURE 1 | Distribution of eHealth users and non-users according to WHO categories of physical activity.

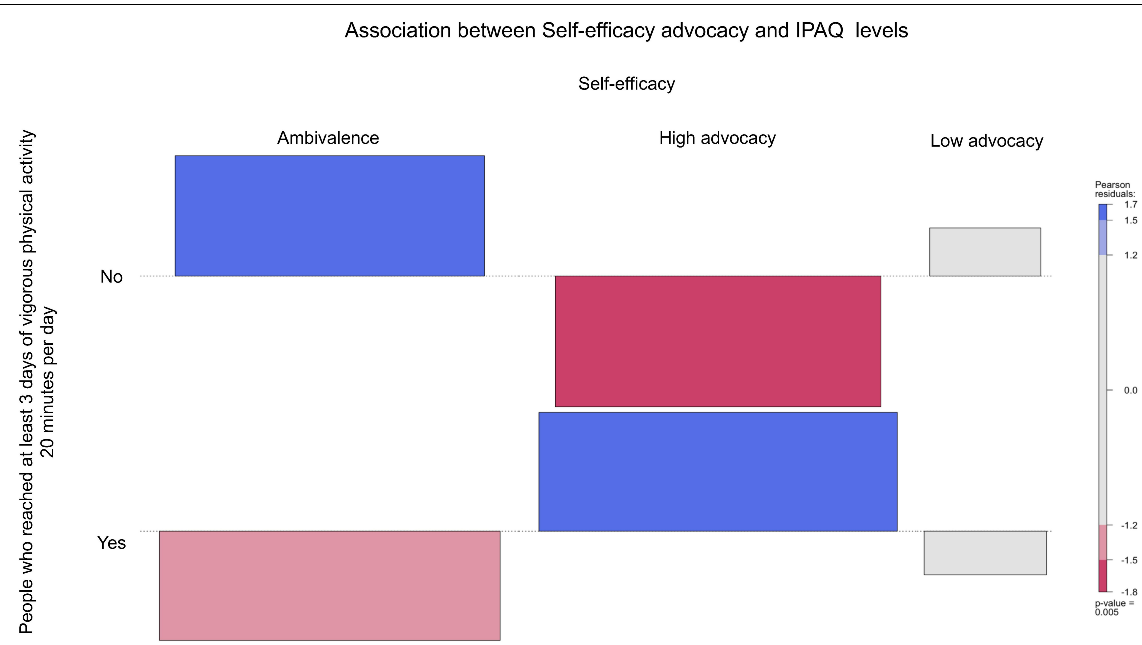

FIGURE 2 | Self-efficacy advocacy of people who reached at least 3 days of vigorous physical activity 20 min per day.

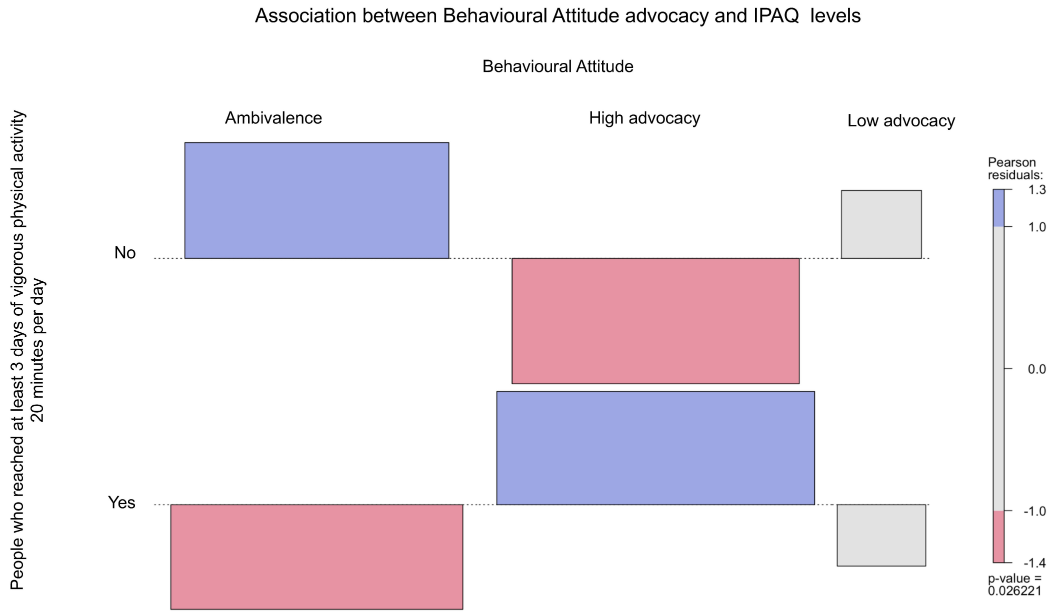

FIGURE 3 | Behavioral attitude advocacy of people who reached at least 3 days of vigorous physical activity 20 min per day.

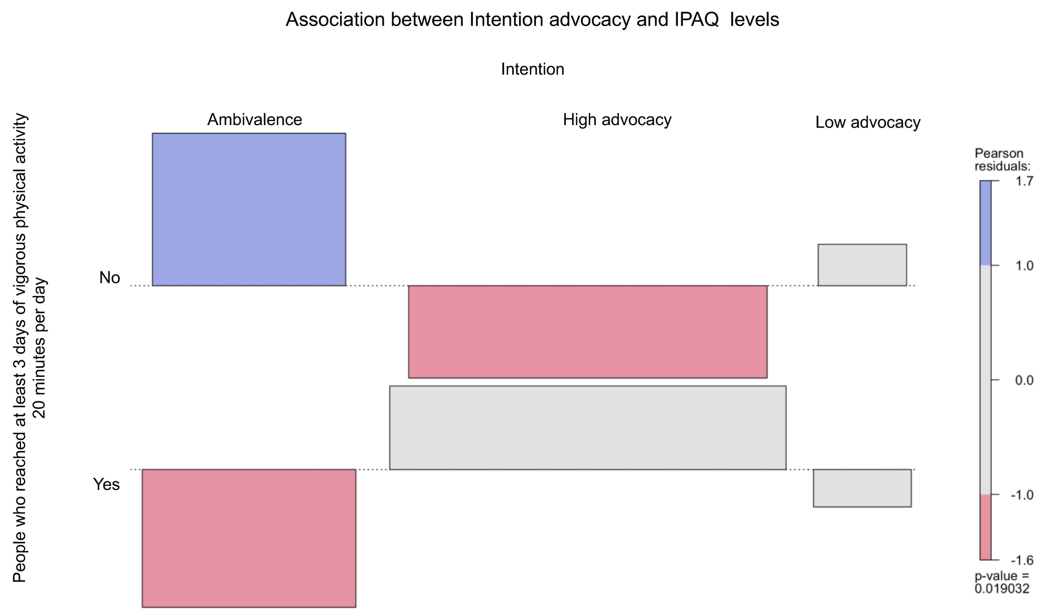

FIGURE 4 | Intention advocacy of people who reached at least 3 days of vigorous physical activity 20 min per day.

physical activity MET minutes per week, and total physical activity MET minutes per week.

Association Between Physical Activity Levels, Psychological Constructs, and eHealth Frequency

Figure 7 highlights the associations between physical activity levels, Social Cognitive Theory, and automaticity facets. Self-efficacy was negatively and significantly associated to walking MET minutes per week (ß = −0.27, $p < 0.01$), explaining 5% of the variance [$F(3, 168) = 3.34$, $p < 0.02$, $R^2 = 0.05$, R^2-adjusted = 0.04]. As far as the concepts of the Theory of Planned Behavior are concerned (i.e., attitudes, behavioral belief, subjective norms, and intention), regressions showed that none of them were associated with physical activity levels related to eHealth use. For the automaticity facets, the efficiency was positively and significantly associated

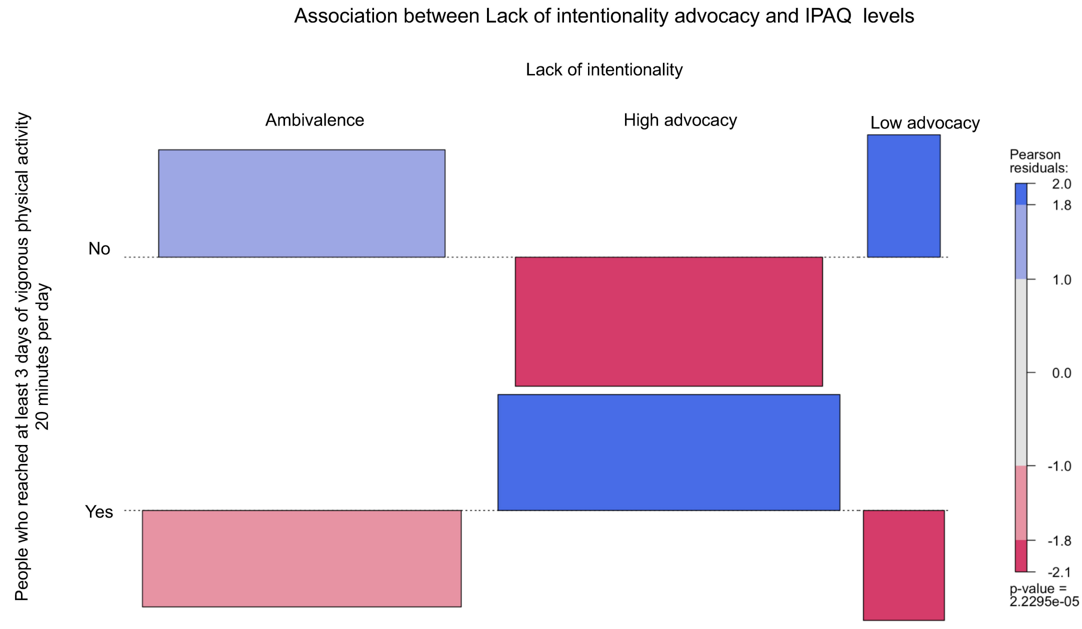

FIGURE 5 | Lack of intentionality advocacy of people who reached at least 3 days of vigorous physical activity 20 min per day.

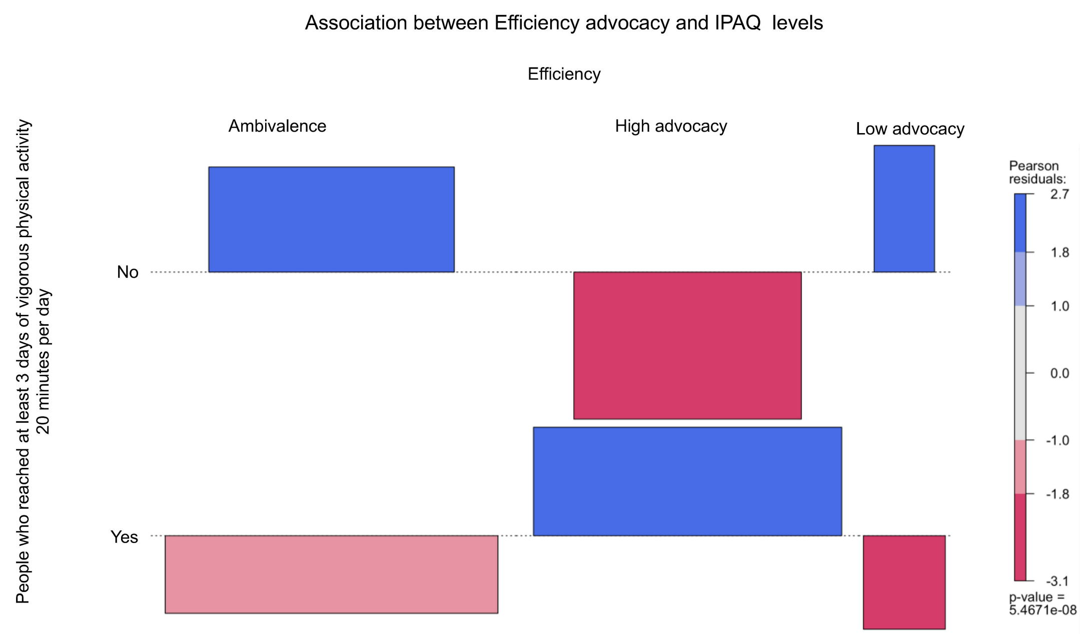

FIGURE 6 | Efficiency advocacy of people who reached at least 3 days of vigorous physical activity 20 min per day.

with vigorous MET minutes per week (ß = 0.20, $p = 0.021$), explaining 5% of the variance [$F(3, 175) = 3.20$, $p < 0.03$, $R^2 = 0.05$, R^2-adjusted = 0.04). Simple linear regressions showed that frequency of eHealth usage predicted self-efficacy (ß = 0.15, $p = 0.016$), behavioral attitude (ß = 0.14, $p = 0.040$), and automatic properties of eHealth usage (i.e., lack of intentionality: ß = 0.22, $p = 0.001$; lack of control: ß = 0.32, $p < 0.001$; and efficiency: ß = 0.28, $p < 0.001$).

DISCUSSION

The context of the COVID-19 pandemic led many countries to implement containment. This context increased the use of the Internet and, in particular, the pursuit of eHealth-related physical activity (ReportLinker, 2020). For that reason, this study had three objectives: the first was to see if eHealth use impacted physical activity levels; the second was to assess the

TABLE 3 | Descriptive and correlations of physical activity, frequency of eHealth, Social Cognitive Theory, Theory of Planned Behavior, and automaticity constructs.

	5	6	7	8	9	10	11	12	13	14	15	*M*	SD
vMET—min/week	0.03	0.04	0.02	0.07	0.07	−0.07	0.04	0.13	0.02	0.21**	0.36**	3,140.42	3,237.01
mMET—min/week	0.00	−0.00	0.01	−0.04	−0.08	−0.02	0.01	−0.08	−0.09	0.01	0.11	1,603.49	1,697.54
Walk MET—min/week	−0.19**	−0.02	0.05	−0.10	−0.02	−0.05	−0.11	−0.06	−0.06	−0.07	0.01	776.93	1,252.80
Total MET—min/week	−0.02	0.02	0.03	0.01	0.02	−0.07	0.00	0.04	−0.03	0.14	0.31**	5,520.87	4,601.00
Self-efficacy	1	0.57**	0.28**	0.79**	0.42**	0.22**	0.73**	0.38**	0.30**	0.16*	0.19*	3.66	0.91
Knowledge	1	0.39**	0.69**	0.66**	0.34**	0.48**	0.23**	0.22**	0.06	0.13	2.87	1.10	
Reinforcement		1	0.42**	0.33**	0.40**	0.36**	0.19*	0.16*	0.13	0.04	3.31	0.93	
Behavioral attitude		1	0.62**	0.31**	0.78**	0.25**	0.21**	0.06	0.10	3.75	0.81		
Behavioral belief			1	0.43**	0.35**	0.20**	0.22**	0.11	0.02	3.49	1.04		
Subjective norms			1	0.16*	0.09	0.24**	0.00	−0.04	2.87	1.32			
Intention				1	0.32**	0.22**	0.11	0.09	3.94	1.02			
Lack of intentionality				1	0.38**	0.49**	0.23**	3.75	0.83				
Lack of control					1	0.29**	0.27**	2.70	0.89				
Efficacy					1	0.25**	3.58	0.99					
eHealth frequency (times/week)						1	3.71	2.19					

vMET = vigorous physical activity; mMET, moderate physical activity.
**p < 0.05, **p < 0.01.*

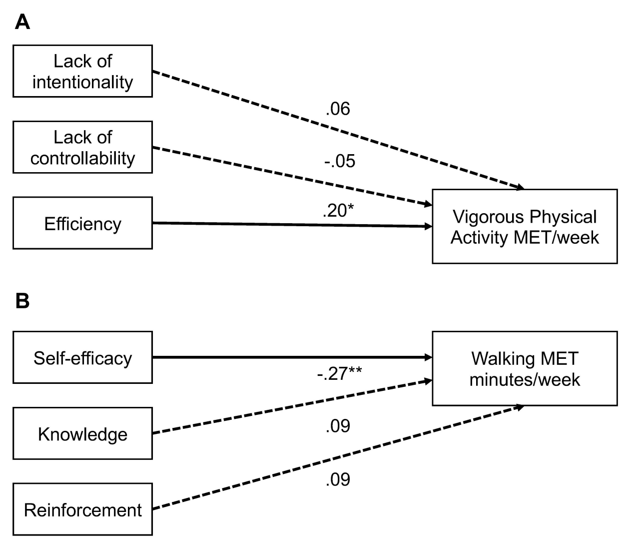

FIGURE 7 | The path **(A)** shows association between automaticity facets and vigorous physical activity MET per week. The path **(B)** shows association between social cognitive theory constructs and walking minutes MET per week. *$p < 0.05$, **$p < 0.01$.

impact of eHealth use on the psychological mechanisms in a COVID-19 pandemic context; and, third, to explore what was the relationship between those mechanisms and the levels of physical activity assessed by questionnaires.

The first hypothesis was that there would be no difference in physical activity levels between eHealth users and non-users for physical activity during confinement. This hypothesis was partially supported. There were no differences in levels of walking and neither in moderate physical activity, but there were differences in vigorous physical activities and total levels. A consequence of the use of eHealth in the practice of physical activity is that it would positively impact only vigorous physical activity, confirming previous findings (van Drongelen et al., 2014). A possible explanation would be that the specific context of the confinement limited physical activity practice in terms of the time (i.e., 1 h) and the area (e.g., alone, within a maximum radius of 1 km from home), which could translate into similar levels of physical activities as far as moderate intensity (e.g., walking, running) is concerned. Another reason that may explain this difference in vigorous physical activity is the type of eHealth used (i.e., health and fitness).

In general, these e-health applications involve vigorous, short-term physical activity, and this can be done in small spaces (e.g., the living room of an apartment or a balcony). For this reason, it is likely that users were more numerous in reaching the recommended levels of physical activity for health than non-users. These results confirmed that eHealth users outnumbered non-users in reaching these levels (Carroll et al., 2017).

The second hypothesis corresponded to a group of hypotheses on the influence of the use of eHealth on the psychological mechanisms of behavior change (i.e., SCT, TPB, and automaticity). In our study, one of the mechanisms positively affected by the use of eHealth for physical activities was self-efficacy. One of our hypotheses indicated that eHealth users would present high levels of this psychological construct (Hoj et al., 2017). The eHealth technologies for physical activity use feedback, goal setting, and reward as behavior change techniques that directly affect self-efficacy (Hosseinpour and Terlutter, 2019). Thus, as people use eHealth for physical activity, this makes them increasingly aware of their results, and as a consequence, this could increase the perception of their ability to perform the exercises proposed in them (Harries et al., 2013). However, self-efficacy also could be negatively affected if people do not achieve their goals or if the goals proposed by eHealth are too high, either in terms of technical difficulty or physical activity intensities. The differences in self-efficacy are associated with variations in skill level, perceptions influenced by personality, motivation, and the task itself.

In contrast, the other variables of Social Cognitive Theory incorporated in this study, knowledge and reinforcement, presented lower levels than self-efficacy. These results could be analyzed from two perspectives. The first would be considering that the eHealth for exercise and physical activity would be focusing mainly on the instructions to execute the exercises (Conroy et al., 2014), for example, the position of the body and the type of movement to complete the exercise. When these tools present more information, there is an idea of the physical capabilities worked on (e.g., strength, flexibility, aerobic capacity). Thus, the second angle of analysis would have to consider the neglect of information that might be relevant in guiding people in understanding the benefits of staying active and in reducing the risks associated with physical inactivity. The literature shows that people who know the benefits of physical activity tend to be more active (Fredriksson et al., 2018). However, recent studies show that this knowledge represents a basic understanding that physical activity is "good" for health (Fredriksson et al., 2018), and even when knowledge about the benefits of physical activity and the participation requirements for achieving those benefits are increased, this does not necessarily represent increased motivation to engage in physical activity (Segar et al., 2020).

For this reason, one option for improving this information could take into account the four levels of knowledge proposed by Chapman and Liberman (2005) and adapt them to physical activity by Fredriksson et al. (2018). The first level (level 1) has to do with knowing that physical activity is beneficial for health and physical inactivity is harmful to health. The second level (level 2) of knowledge involves knowing that a lack of physical activity can lead to particular diseases, such as cardiovascular disease (e.g., heart attack). The third level (level 3), knowledge of how much physical activity (frequency, duration, intensity), is needed to gain health benefits. Furthermore, the fourth level (level 4), is knowledge that involves people agreeing and understanding that their physical (in)activity poses significant risks or benefits to their health.

Reinforcement was the psychological construct that obtained the lowest levels, evidencing that eHealth does not impact this aspect the most. One possible explanation is that most of the applications have been used in free mode that does not include the features that allow sharing the results of the exercise performed. This mode, then, limits the possibility of interacting or exchanging information with other people, whether they are close (e.g., family, friends) or not (e.g., other users). Furthermore, it should be taken into account that, in times of confinement, the possibility of practicing a physical activity in groups was prohibited and limiting, even more with the possibility of having asocial reinforcement regarding the exercise practiced. A possible solution would be to incorporate this function in the free modality so that, during a period of confinement, one can interact and share the experiences of physical activity. According to recent research, more individuals were socially connected through digital technology during confinement (Ammar et al., 2020b). Taking these results into account, one could take advantage of the fact that people who share their results in eHealth exercise and physical activity tend to practice more physical activity (Consolvo et al., 2006).

As far as the Theory of Planned Behavior is concerned, attitudes, the perceived social pressures to perform the behavior (subjective norm), and control of perceived behavior determine the intention of the behavior—the proximate determinant of behavior (Ajzen and Fishbein, 1980). The results of this study showed that eHealth users perceived mainly a more important effect on their intentions and behavioral attitude toward physical activity during confinement.

The intention to engage in physical activity is one of the determinants of whether or not an individual engages in that behavior (Chatzisarantis et al., 2019). The intention is reflected in a person's will and in the effort that such individual plans to exert to carry out the behavior. Therefore, if eHealth succeeds in increasing intentions toward physical activity, eHealth users will be more likely to engage in that behavior (Tuman and Moyer, 2019). Therefore, if someone had a clear intention to use the application to exercise during confinement, it is likely that that person would have done so.

The other psychological construct that was influenced by the use of eHealth for physical activity was attitude, which represents an individual's positive or negative assessment of performing a behavior. This effect could be explained by behavioral beliefs, which refer to the perceived consequences of carrying out a specific action and our assessment of each of these consequences. When practicing a physical activity via eHealth, the person evaluates the consequences of each of these beliefs. Common behavioral beliefs for physical activity include believing that it improves fitness or health, improves physical appearance, is fun and enjoyable, increases social interactions, and improves psychological health (Bellows-Riecken et al., 2013). For example, people may have a negative attitude toward walking in the neighborhood during confinement but rather have a positive attitude toward physical activity in their home.

In contrast, subjective norms or the probability that individuals and relevant reference groups approve or disapprove physical activity during confinement presented the lowest level. Subjective norm reflects the perceived social pressure that individuals feel to perform or not perform a behavior. Subjective norm is believed to be a function of normative beliefs, which are determined by the perceived expectations of other significant people (e.g., family, friends, physician) or groups (e.g., classmates, teammates) and by the individual's motivation to meet the expectations of these significant people. For example, an individual may feel that his or her friends think he or she should exercise three times a week. However, this person may not be inclined to act on these perceived beliefs. This result could be due to two conditions, confinement and spatial distancing, combined with the absence of interaction among eHealth users. These conditions may not be conducive to the development of subjective norms related to physical activity.

The third group of hypotheses considered that self-efficacy and attitudes would be positively associated with physical activity levels. This hypothesis was partially confirmed. The relationship between these psychological constructs and physical activity measured by questionnaires was mixed. When the total minutes of each intensity measured with the IPAQ (i.e., walk, moderate, vigorous) were taken into account, self-efficacy was negatively associated with walking levels, and the efficacy of automaticity positively predicted vigorous physical activity levels. This result could be explained by the type of physical activity proposed by the eHealth, fitness. The proposed exercises include abdominals, arm exercises, and no major movements such as walking or running, two of the main types of moderate physical activity (Prince et al., 2019). In contrast, when considering levels of vigorous physical activity in segments of at least 20 min over 3 days, people with high self-efficacy, high behavioral attitude, and high intention advocacies outnumbered those with ambivalence and low advocacy in reaching those levels. These results demonstrate that physical activity levels measured by IPAQ should not only consider the total minutes of each type of physical activity but also how these minutes accumulate (Di et al., 2017).

The fourth hypothesis, a positive relationship between automaticity of habits toward eHealth and the levels of physical activity, was confirmed. Several authors have proposed that the cognitive processes that guide healthy behaviors such as physical activity should include not only intentional processes but also automatic processes such as habits (Evans and Frankish, 2009; Gardner et al., 2011; Marteau et al., 2012). However, to our knowledge, these elements had not been studied in eHealth for exercise and physical activity. Therefore, this study would be the first to address this issue. Within the theoretical framework of habits, frequency (Verplanken, 2006), context stability (Wood and Neal, 2016), and automaticity (Gardner, 2012) have been described as the three pillars of habits (Orbell and Verplanken, 2015). In this research, the frequency and automaticity of eHealth were shown to be positively related to its adoption and levels of physical activity.

Similarly, confinement “forced” the stability of exercise and physical activity practice contexts. At the same time, at the beginning of this period, confinement may have been experienced as a moment of disruption of daily life (Wood et al., 2005). Nevertheless, as the days went by 55 in France, it became a habitual context.

In this way, the incorporation of the use of eHealth for exercise and physical activity acquired automatic properties that facilitated the habit development of these technologies (Larose, 2015) and the practice of physical activity. These elements combined together are highly conducive to habit formation (Lally et al., 2010). Thus, these results demonstrated that higher levels of habit automaticity of using eHealth for physical activity mean higher levels of physical activity (Gardner et al., 2011). Our results also showed, as pointed out by Bargh (1994), that the unidimensional definition of automaticity is no longer tenable. Using eHealth for exercise and physical activity requires the intention to use it, but it also could develop automatic properties (at least for the regular eHealth user). In this study, the property of the automaticity of eHealth use for exercise and physical activity that had the most significant influence on behaviors was efficiency. Once eHealth for exercise and physical activity use has started, eHealth users can present a lack of need for attentional resources (Bargh, 1994), making the eHealth utilization very efficient. This result translated into more minutes of physical activity (Boiché et al., 2016), confirming the importance of considering automatic properties of habits in eHealth for exercise and physical activity behaviors.

Limitations

Although this study is a first insight into the effects of eHealth for exercise and physical activity on the motivations, psychological mechanisms, and behavior in this COVID-19 pandemic, this study is not exempt from some limits that should be taken into account when interpreting our results. The use of the Internet to distribute and complete questionnaires could represent a bias in the sample. In fact, the demographics of the respondents to our online survey may differ from that of the sample population as a whole. For example, Sue and Ritter (2012) note that an online population may contain a higher proportion of individuals of higher socioeconomic status than the total population and does not reflect the population as a whole. Another aspect that should be considered is the absence of analysis of the quality of eHealth. For example, videos or applications may have had different qualities in terms of their content, which could translate into factors that contribute to or undermine motivations. Despite widespread Internet access, the use of physical activity eHealth is still limited to one age group, so Internet access alone is not enough, and how and where information about eHealth is presented, organized, and disseminated are equally important. Currently, limited information exists about how to operationalize content and strategies best to maximize eHealth use among underserved populations (e.g., over 50 years old or less qualified population). The measurement of physical activity behavior has been via questionnaires that may present cognitive biases due to their subjectivity (Silfee et al., 2018). However, the context of the COVID-19 pandemic has not made possible the measurement of behaviors with objective methods (e.g., accelerometers).

CONCLUSION

In conclusion, the use of a physical activity eHealth modified the practice of physical activities of its users during confinement. Indeed eHealth users affected mainly the levels of vigorous physical activity. This change in behavior could also be due to the positive impact that eHealth would have on self-efficacy and attitudes toward physical activity. Particular attention should be paid to the automaticity of eHealth use habits for physical activity, as people who had high levels of these properties practiced more physical activity. The eHealth for physical activity and exercise should incorporate information to guide people on recommended levels, frequency, and intensity of physical activity for health to go beyond the simple notion of knowing that physical activity is “good” for health. Similarly, in the context of confinement, eHealth should enable a more significant interaction between users, and the effects of eHealth could be explored to reduce the time people spend sitting down. Our results appear to be encouraging regarding the use of eHealth for exercise and physical activity. However, its effectiveness remains to be demonstrated. Besides, our study confirms that eHealth for exercise and physical activity incorporates only a few behavioral change techniques. The developers of these technologies should consider including more behavior change techniques to more accurately increase physical activity levels.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Commission Nationale de l'Informatique et des Libertés. French methodological reference MR-001. This statement was in accordance with the Declaration of Helsinki and the participants were requested to be honest and as accurate as possible in their responses. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

GM contributed to research design, data collection, management and coordination responsibility for the research activity planning and execution, and manuscript writing. MB contributed to conceptualization, formulation and evolution of overarching research goals and aims, and manuscript writing. FB and EG contributed to critical review, commentary, and revision. All authors contributed to the article and approved the submitted version.

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Self-Perception of Changes in Routines in Adults and Older Adults Associated to Social Distancing Due to COVID-19—A Study in São Paulo, Brazil

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COVID-19 is an acute respiratory illness with higher mortality in older adults. This condition is spread person-to-person through close contact, and among policies employed to decrease transmission are the improvement of hygiene habits and physical distancing. Although social distancing has been recognized as the best way to prevent the transmission, there are concerns that it may promote increased depression symptoms risk and anxiety, mainly in older adults. This cross-sectional study aimed to verify self-concept of social distancing in adults compared to older adults. All participants, over 18 years and residents of São Paulo state (Brazil), were invited to join this research study by a message application and answered an interdisciplinary questionnaire during the period from May 23 to June 23, 2020. The questions were divided into the following aspects: sociodemographic data, financial conditions, routine-related perception, perception of health, physical and emotional state, and eating habits. The younger adult group was composed of 139 participants, with a mean age of 43.15 years (±10.92), and the older adult group was composed of 437 participants with a mean age of 67.59 years (±6.13) of both sex. Changes in routine during the period of social distance were reported by 95% of adults and 96.8% of older adults, but adults indicated more significant alterations in routine. Although there was no difference between groups for several aspects, adults revealed greater alterations in sleep quality, evacuation frequency, and more difficulty to perform daily activities at home. Further studies are necessary to follow up the impacts of social distancing among adults and older adults in different socioeconomic contexts to better understand the long-term alterations and the necessity of interventions.

Keywords: adults, aged, COVID-19, perception, social distance

INTRODUCTION

The aging process is complex and multifactorial, related to morphological, physiological, biochemical, social, and psychological decline (Carmona and Michan, 2016), including the increased risk of infections and decrease of immunological mechanisms (Pawelec, 2018). In addition, older adults have multiple comorbidities, which increase the chance of hospitalizations and may be considered an additional complicating factor in this pandemic moment (Shahid et al., 2020). Taken together, these facts could explain the higher severity of COVID-19 in the older adult population (Greve et al., 2020). COVID-19 is an acute respiratory illness caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), an enveloped, positive single-stranded large RNA virus that infects humans, but also a wide range of animals (Velavan and Meyer, 2020).

In Brazil, the absence of effective health public politics by the Federal Government became more difficult to combat COVID-19 (Lancet, 2020), which promoted high rates of infected people and deaths. According to official data (Sistema Único de Saúde, 2020) since March 2019, Brazil ranks among the countries with the highest numbers of infected people and deaths caused by COVID-19. At this scenario, São Paulo, the largest State in the country accounts for the greatest cases reported (Prefeitura de São Paulo, 2020).

As COVID-19 is spread person-to-person through close contact, by droplets and aerosols (Jayaweera et al., 2020; Perisetti et al., 2020a), several policies have been employed to decrease transmission, such as improvement of hygiene habits, mask wearing, and in most countries, physical distancing recommendations (Chu et al., 2020; Perisetti et al., 2020a). Although social distancing is recognized as the best way to prevent the contamination, there are concerns that it may promote the increased depression symptoms risk and anxiety in older adults (Armitage and Nellums, 2020; Castelnuovo et al., 2020; Santini et al., 2020).

For the aged, the impact of physical distancing could be worse because they have less online social interaction (Berg-Weger and Morley, 2020). Moreover, it has been widely proposed that the maintenance of daily activities are fundamental to keep the quality of life and physical and mental health of older adults (Manini et al., 2006; Britto et al., 2018; Chen et al., 2020; Hammami et al., 2020). Therefore, the present study aimed to evaluate the perception of the impacts of social distancing among younger adults and older adults in Brazil using an interdisciplinary questionnaire.

MATERIALS AND METHODS

Participants

This is a cross-sectional study approved by the Ethics Committee (Universidade São Judas Tadeu), No. 4.067.240.

The invitation was performed by a multiplayer app for instant messaging for smartphones (WhatsApp). If interested, the probable participant received the consent terms and questionnaire by Google Forms link. Inclusion criteria were 18 years or older, able to read and respond to the online questionnaire, and a resident of São Paulo State (Brazil). The invitation letter was restricted to people living in São Paulo; however, in case of response from people living outside São Paulo, they were not included. In addition, exclusion criterion was not completing the questionnaire. All invited participants fulfilled the inclusion criteria, during the period from May 23 to June 23, 2020, since social distancing was instituted by the state government on March 22, 2020.

Procedures

An interdisciplinary questionnaire was developed specifically to this study, to evaluate the cross-section of the moment to this population using *Google Forms* tool (Google LLC, CA, United States). The questions were divided into the following aspects: sociodemographic data, financial conditions, perceptions of routine, health, physical and emotional status, and eating habits regarding the recall and perception, respectively, of the periods before and during social distancing. All participants had access to the instrument after virtually signing the informed consent form.

Statistical Analyses

Data related to perception before and during the social distancing were compared between adult (18–59 years) and older adult ($\geq$60 years) groups, and a categorical chi-square test was applied (Statistical Package for the Social Sciences® SPSS software, version 25, IBM, NY, United States). Perception of sleep quality, practice of physical activity, and tiredness sensation before and after the beginning of social distancing were compared using the Wilcoxon test for intragroup analysis and Mann–Whitney *U* test for intergroup analysis (GraphPad Prism® 8.0, GraphPad Software Inc., CA, United States). The significance level for all statistical tests was established at 5%.

RESULTS

All questions have been answered, since all the questions were mandatory to submit the forms. There was no missing data.

The adult group (20–59 years) was composed of 139 participants and the older adult (60–98 years) group was composed of 437 participants of both sex. Changes in routine during the period of social distance were reported by 95% of adults and 96.8% of older adults. Demographic characteristics of adults and older adults are presented at **Table 1**.

Adults reported greater income impairment ($p = 0.002$) and received more financial assistance from the government due to the pandemic ($p = 0.006$) than older adults. Most older adults were at least 15 days away from meeting relatives or friends who did not live with them ($p = 0.025$). Older adults reported higher time of remaining at home since the beginning of social distancing than adults ($p < 0.0001$) (**Table 2**).

Data of health perception and physical status are shown in **Table 3**. Adults had greater changes related to stool frequency when compared to older adults ($p < 0.0001$). Adults referred to

TABLE 1 | Sociodemographic characteristics of adults (n = 139) and older adults (n = 437) included in the present study.

	Adults (%)	Older adults (%)	χ^2 (p)
Age (mean ± standard deviation years)			
	43.15 ± 10.92	67.59 ± 6.13	Does not apply
Sex			
Male	31 (22.3)	137 (31.4)	4.179
Female	108 (77.7)	300 (68.6)	(0.041)*
Years of study			
1–4	2 (1.4)	34(7.8)	16.100 (≤0.001)*
5–8	2 (1.4)	32 (7.3)	
9–11	22 (15.8)	77 (17.6)	
>12	113(81.3)	294 (67.3)	
Marital status			
Single	40 (28.8)	40 (9.2)	43.806 (≤0.001)*
Married	74 (53.2)	259 (59.3)	
Widowed	4 (2.9)	69 (15.8)	
Divorced/Separated	21 (15.1)	69 (15.8)	
Number of people living with you			
0	16 (11.5)	77 (17.6)	40.078 (≤0.001)*
1	27 (19.4)	161 (36.8)	
2	31 (22.3)	110 (25.2)	
>3	65 (46.8)	89 (20.4)	
Brazil minimum monthly wage#			
1–3	25 (18.0)	118 (27.0)	3.652 (0.161)
4–6	45 (32.4)	116 (26.5)	
>6	69 (49.6)	203 (46.5)	

*Represents statistical difference between the groups by chi-square test.
1 Brazil minimum monthly wage = 197.71 USD.
https://www.bcb.gov.br/en#!/n/EXCHANGERATES (accessed on September 13, 2020).

TABLE 2 | Perception of financial conditions and social distancing-related aspects of adults (n = 139) and older adults (n = 437).

	Adults *n* (%)	Older adults *n* (%)	χ^2 (p)
Did you have compromised income due to the pandemic?			
There was no compromise	58 (41.7)	243 (55.6)	17.479 (0.002)*
Decreased less than 50%	31 (22.3)	111 (25.4)	
Decreased 50%	19 (13.7)	31 (7.1)	
Decreased more than 50%	20 (14.4)	34 (7.8)	
There was no income	11 (7.9)	18 (4.1)	
Do you have any financial assistance during the pandemic?#			
Family members	12 (8.8)	35 (8.0)	0.078 (0.450)
Extra services	27 (5.1)	17 (3.9)	0.387 (0.341)
Savings	37 (27.0)	104 (23.9)	0.559 (0.261)
Financial loan	1 (0.7)	8 (1.8)	0.819 (0.326)
Government aid	14 (10.2)	17 (3.9)	8.177 (0.006)*
How many days have you not met face to face relatives or friends who don't live in your house?			
0	6 (4.3)	13 (3.0)	9.356 (0.025)*
1–7	27 (19.4)	46 (10.6)	
8–15	14 (10.1)	37 (8.5)	
>15	92 (62.2)	341 (78.0)	
Have you received support from your relatives?			
No—1	19 (13.7)	70 (16.1)	4.364 (0.359)
2	13 (9.4)	23 (5.3)	
3	22 (15.8)	55 (12.6)	
4	19 (13.7)	66 (15.2)	
Very—5	66 (47.5)	223 (50.8)	
When was the last time you went out?			
Did not go out	4 (2.9)	94 (21.5)	32.472 (≤0.001)
1–7 days	113 (81.3)	251 (57.4)	
>8 days	22 (15.8)	92 (21.1)	

*Represents statistical difference between the groups by chi-square test.
More than one answer was allowed for these variables.

greater difficulties while most older adults reported no difficulties in carrying out their activities at home ($p < 0.0001$).

When asked about sleep quality, adults and older adults reported a good quality of sleep before social distancing, and no statistical difference was detected between these groups (p = 0.959). Intragroup analysis showed that both adults and older adults pointed out an impairment in sleep quality when compared before and during the social distancing imposed by COVID-19 (**Figure 1A**, $p < 0.0001$ for adult and older adult comparisons). In addition, for adults, there was a worsening in sleep quality in comparison to all older adult groups during social distancing caused by the COVID-19 pandemic (**Figure 1A**, $p < 0.0001$ for adult and older adult comparisons). The confidence level of the median was 95.02% for adults before and during social distancing, while the confidence level was 95.05 and 95.56% for aged before and during social distancing, respectively.

Adults and older adults showed good levels of physical activities before and during social distancing, without significant difference between the moment before (p = 0.743) and during (p = 0.060) social distancing caused by the COVID-19 pandemic (**Figure 1B**). However, both groups showed significant reduction of physical activities after the beginning of social distancing (**Figure 1B**, adults $p < 0.0001$ and older adults $p < 0.0001$). The confidence level of median to adults was 95.86 and 95.02%, and for the aged, the actual confidence level was 95.56 and 95.05% before and during social distancing, respectively.

Older adults and adults had different levels of tiredness before and during social distancing (**Figure 1C**, both $p < 0.0001$). Both groups related significantly increased levels of tiredness during the social distance period (**Figure 1C**, $p < 0.001$), although perception of tiredness in adults has remained higher than in the older adults (**Figure 1C**, $p < 0.0001$). The confidence level of median was 95.86% for adults before and during and social distancing, while for the aged, the confidence level was 95.56 and 95.61% before and during social distancing, respectively.

There was no difference in relation to sun exposition between groups, and most subjects of both groups, adults (65.5%) and older adults (62.7%), related a sun daily exposition around 1 to 3 h while one third of the adults (33.1%) and older adults (33.4) were not exposed to the sun (p = 0.549).

Moreover, older adults consumed fruits ($p < 0.0001$) and vegetables (p = 0.046) more frequently when compared

TABLE 3 | Perception of health and physical state of adults (n = 139) and older adults (n = 437) during social distancing due to the COVID-19 pandemic.

	Adults *n* (%)	Older adults *n* (%)	$\chi^2(p)$
How would you rank your health?			
Really bad—1	0	1 (0.2)	8.457 (0.133)
2	1 (0.7)	2 (0.5)	
3	4 (2.9)	6 (1.4)	
4	49 (35.5)	180 (41.2)	
Excellent—5	57 (40.6)	196 (44.9)	
Are you more concerned with your hygiene habits?			
No, nothing—1	3 (2.2)	20 (4.6)	1.677 (0.795)
2	1 (0.7)	3 (0.7)	
3	9 (6.5)	30 (6.9)	
4	23 (16.5)	72 (16.5)	
Yes, a lot—5	103 (74.1)	312 (71.4)	
Did social distancing change your stool frequency?			
Yes, decreased	22 (15.8)	31 (7.1)	
No	93 (66.9)	370 (84.7)	21.132 (≤0.001)*
Yes, increased	24 (17.3)	36 (8.2)	
Do you have difficulties carrying out your daily activities at home?			
No, nothing—1	47 (33.8)	225 (51.7)	52.730 (≤0.001)*
2	18 (12.9)	84 (19.3)	
3	31 (22.3)	77 (17.7)	
4	17 (12.2)	37 (8.5)	
Yes, a lot—5	26 (18.7)	12 (2.8)	
Did you suffer from any kind of fall in this period of social distancing?			
No	130 (93.5)	413 (95.2)	0.568 (0.451)
Yes	9 (6.5)	21 (4.8)	

**Represents statistical significance between groups (p ≤ 0.05).*

to adults, who had higher frequency of protein ingestion ($p < 0.0001$) (**Table 4**).

Regarding the perception of emotional status, adults and older adults indicated a similar mood during social distancing. Most participants of both groups recorded intermediate levels between discouraged/excited and sad/cheerful. However, adults felt more insecure (p = 0.003), while older adults felt more cautious (p = 0.004). Moreover, adults missed traveling (p = 0.005) while older adults missed walking, going wherever they wanted (p = 0.038), and going out (p = 0.005) (**Table 5**).

DISCUSSION

The results showed a perception of routine alterations independent of age, and both groups reported a decrease in physical activity level and sleep quality as well as an increased tiredness perception during social distancing when compared to their reported previous status.

The decrease in physical activity level was an expected consequence of the "stay at home" recommendations. Lippi et al. (2020) reported that this decrease is greater for older adults, since it is well-known that regular physical activity is essential to maintain and/or improve muscle strength, gait, and postural

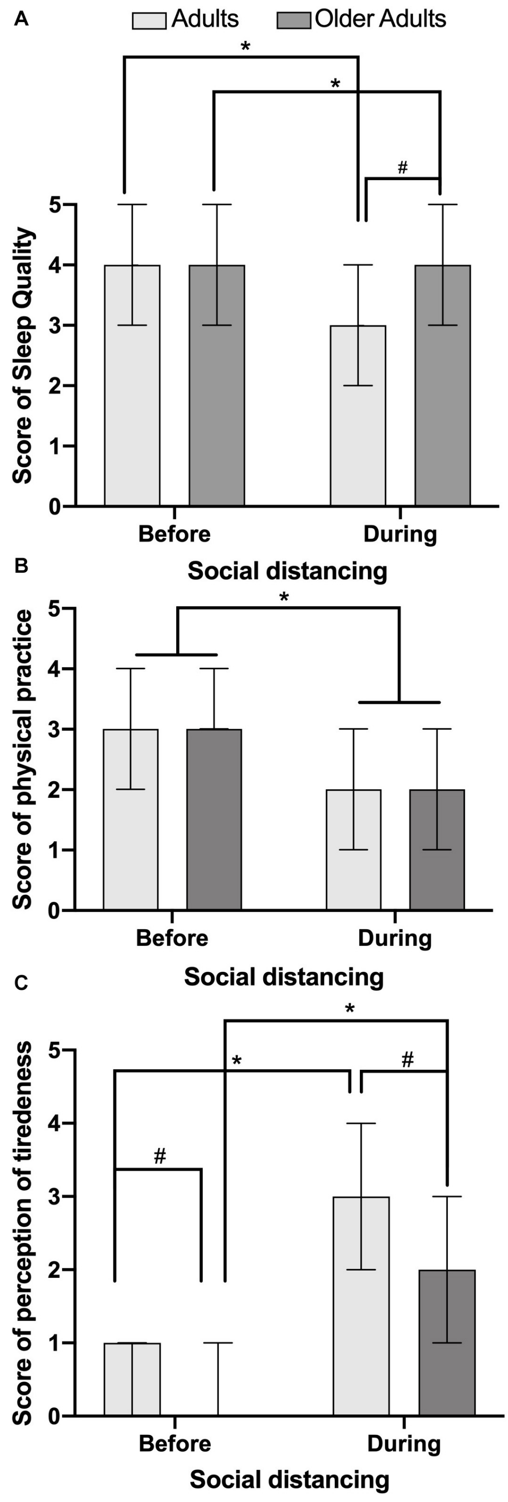

FIGURE 1 | Recall and perception of sleep quality **(A)**, physical practice **(B)** and tiredness level **(C)** for adults and older adults residents in São Paulo, respectively of periods before and during the social distancing due to COVID-19. *Represents statistical differences intragroup before and during the social distancing by Wilcoxon test (p < 0.05). #Represents statistical difference intergroups, before and during the social distancing due COVID 19 pandemic by *U* Mann-Whitney test (p < 0.05).

TABLE 4 | Dietary habits of adults (n = 139) and older adults (n = 437) during social distancing due to the COVID-19 pandemic.

	Adults n (%)	Older adults n (%)	χ^2 (p)
How many fruits or fruit juice did you consume per day?			
None	9 (6.5)	14 (3.2)	28.715 (≤0.001)*
1	56 (40.3)	91 (20.8)	
2	40 (28.8)	159 (36.4)	
3	23 (16.5)	112 (25.6)	
4	8 (5.8)	29 (6.6)	
≥5	3 (2.2)	32 (7.3)	
How many vegetables did you consume per day?			
None	9 (6.5)	10 (2.3)	11.300 (0.046)*
1	53 (37.7)	148 (33.9)	
2	50 (36.2)	213 (48.7)	
3	12 (8.7)	27 (6.2)	
4	6 (4.3)	18 (4.1)	
≥5	9 (6.5)	21 (4.8)	
How much meat, chicken, fish, or egg did you consume per day?			
None	6 (4.3)	8 (1.8)	20.255 (≤0.001)*
1	41 (29.5)	187 (42.9)	
2	61 (43.9)	178 (40.8)	
3	11 (7.9)	29 (6.7)	
4	2 (1.4)	14 (3.2)	
≥5	18 (12.9)	20 (4.6)	
How much milk, cheese, or yogurt did you consume per day?			
None	7 (5.0)	37 (8.5)	4.949 (0.422)
1	53 (38.1)	158 (36.2)	
2	44 (31.7)	158 (36.2)	
3	15 (10.8)	43 (9.8)	
4	9 (6.5)	22 (5.0)	
≥5	11 (7.93)	22 (5.0)	

Represents statistical significance between groups ($p \leq 0.05$).

TABLE 5 | Perception of the emotional status for adults (n = 139) and older adults (n = 437) during social distancing due to the COVID-19 pandemic.

	Adults n (%)	Older adults n (%)	χ^2 (p)
What is the closest point of your feeling in the last 15 days?			
Discouraged—1	15 (10.9)	25 (5.8)	9.016 (0.061)
2	29 (21.2)	65 (15.0)	
3	59 (43.1)	202 (46.7)	
4	25 (18.2)	96 (22.2)	
Excited—5	9 (6.6)	45 (10.4)	
What is the closest point of your feeling in the last 15 days?			
Sad—1	8 (5.8)	20 (4.6)	7.650 (0.150)
2	26 (18.7)	65 (15)	
3	74 (53.2)	201 (46.3)	
4	20 (14.4)	108 (24.9)	
Cheerful—5	11 (7.9)	40 (9.2)	
Did spirituality help you at this time?			
Never—1	7 (5)	32 (7.40)	7.772 (0.100)
2	8 (5.8)	25 (5.8)	
3	29 (20.9)	51 (11.8)	
4	24 (17.3)	84 (19.4)	
Frequently—5	71 (51.1)	242 (55.8)	
Which items most explain what you are experiencing right now?#			
Insecure	70 (50.4)	158 (36.2)	8897 (0.003)*
Cautious	56 (40.3)	237 (54.2)	8206 (0.004)*
Hopeful	55 (39.6)	208 (47.6)	2740 (0.098)
Boring	51 (36.70)	139 (31.8)	1137 (0.286)
What are you missing with social distancing?#			
Traveling	96 (69.1)	343 (59.5)	6.888 (0.005)*
Walking and going wherever	95 (68.3)	337 (77.1)	4327 (0.038)*
Going out	82 (59)	287 (65.7)	6888 (0.005)*
Being with my family	96 (69.1)	329 (75.3)	2110 (0.146)

*Represents statistical significance between groups ($p \leq 0.05$).
#These variables permitted more than one answer.

balance, influencing functional independence, quality of life (Liu-Ambrose et al., 2019; Greve et al., 2020), and falls prevention (Pelicioni and Lord, 2020). Although the number of falls could not be determined, it should be considered that the mean age of the older adults in the present study was relatively low. Furthermore, data collection was performed after a period of 30–60 days of social distancing and falls report depended on participants' memory and comprehension of what should be considered as a falling event.

Although sleep quality is also influenced by physical activity (Gothe et al., 2019), only adults reported sleep impairment during social distancing. It has been shown that adults increased screen time exposure during social distancing due to work and study demands and to keep informed (Majumdar et al., 2020). Screen blue light exposure may negatively impact sleeping due to the suppression of melatonin production (Calvo-Sanz and Tapia-Ayuga, 2020). Moreover, adults probably had more activities outside their homes and used to stay less at home before social distancing than older adults, which may be related to the reported changes in physical activity level. Poorer sleep quality may also be related to the greater difficulty to perform activities of daily living compared to older adults and the fact that the financial impact of pandemic was greater for adults, as they reported in the present study. Economical instability, income decrease, and unemployment concerns may have influenced sleep quality among adults (International Labour Organization, 2020).

There is also a great concern about the impact of social distancing on loneliness, mainly among older adults, due to its association with overall functionality decline and depressive and anxiety symptoms (Meng et al., 2020; Monahan et al., 2020; Tyrrell and Williams, 2020). According to our results, older adults usually live alone or with fewer people and have been reported to stay at home for more consecutive days and to spend longer periods without meeting people who do not live with them. Older adults also reported more frequently to miss meeting relatives, when asked about what they miss more with social distancing. However, these aspects seem to have no influence on their mood. Surprisingly, no difference was found for mood between older adults and younger adults, with both groups presenting an intermediate status from "sad" to "happy" and from "discouraged" to "excited," suggesting that social distancing was not related to noteworthy emotional alterations between the groups. This result may be due to the relatively short period of social distancing at the time of data collection; therefore, further longitudinal studies on these aspects are necessary (Montemurro, 2020; Wang et al., 2020). In agreement with the literature, we also suggest that older adults should be followed up by health professionals in order to early identify conditions that require intervention (Fessell and Cherniss, 2020; Lades et al., 2020).

As related before, adults felt more insecure and older adults felt more cautious, which may be explained by the fact that older adults present higher risk of COVID-19 complications (Shahid et al., 2020) and, therefore, caution has been emphasized for them. Regarding the question of what people miss with social distancing, adults reported more frequently to miss traveling (Chudyk et al., 2015). In general, adults continued working at home, so traveling could bring possibilities of enjoying diverse experiences and leisure activities. Older adults reported to miss the possibility of going out. The possibility of deciding when going out, regardless of the activity involved, is related to autonomy and functionality (Armitage and Nellums, 2020).

With social distancing, people are modifying their social bonds, and this could result in a negative impact on the eating habits of the participants, especially the older adults (Allès et al., 2019). There is a correlation between social bonds and eating habits (Campos et al., 2000; Silveira et al., 2015). However, with stress, there may be changes in the quantity and the quality of the food consumed, a decrease in appetite (Petrowski et al., 2014; Reichenberger et al., 2018), as well as an increase in high caloric density food consumption. These alterations may lead to changes in glycemia, lipid profile, and consequently increased risk for the development of chronic diseases (Evers et al., 2010; Van Strien et al., 2012; Sinha, 2018). In the present study, adults reported lower frequency of fruit and vegetable intake and higher frequency of protein intake in comparison to older adults. Sidor and Rzymski (2020) have shown a decrease in fruit and vegetable consumption and a greater tendency to consume meat during social distancing among adults. Older adults usually eat less proteins, fruits, and vegetables, which may be related to the presence of chronic disease or with oral cavity alterations (Gaspareto et al., 2017; Ibge, 2019), reflecting on implications in muscle mass, such as sarcopenia and other adverse outcomes (do Nascimento Ferreira et al., 2017).

Adults reported irregularity in stool frequency, some with increased and some with decreased frequency, and this may be related to possible irregular dietary habits, lesser physical activity, and changes in sleep quality. It is important to note that microbial gut composition may be affected by stool frequency (Kwon et al., 2019), and this composition is related to health and many diseases such as obesity, diabetes (Pascale et al., 2019), and neurodegenerative diseases (Roy Sarkar and Banerjee, 2019), indicating that social distancing may be related to gut dysbiosis.

Furthermore, gastrointestinal manifestations have been increasingly recognized in patients with COVID-19 (Aziz et al., 2020; Kopel et al., 2020; Perisetti et al., 2020c). There is a silent transmission among the community starting with gastrointestinal infection, leading to changes in bowel pattern in a number of individuals (Perisetti et al., 2020b). Whereas, the incidence of COVID-19 is high in Brazil (Lancet, 2020; Sistema Único de Saúde, 2020), it should be considered that there is a chance that some participants in our sample presented asymptomatic or mild infection. However, this chance is probably small, since the majority of participants reported to observe social distancing for more than 15 days at the time of data collection.

Despite the impairments reported in physical activity and tiredness during social distancing, the majority of both groups presented a very good or excellent self-rated health status. A longitudinal study has assessed Swedish older adults and observed that self-rated health status increased during the COVID-19 pandemic. The authors have suggested that this finding could be related to the "contrast effect," i.e., people consider their health satisfactory when compared to the potential negative effects of COVID-19 (Kivi et al., 2020).

In the present study, participants lived in São Paulo (SP-Brazil) and presented a high level of education (12 years) when compared to the average in Brazil (9.3 years) (PNAD, IBGE, 2018). Also, reported income was higher than the average in the country (1 minimum monthly wage/per person) (Ibge, 2019). These aspects may have contributed to minimize the impacts of social distancing in this sample. Furthermore, participants were recruited online; i.e., only people with internet access and digital literacy to respond to an online questionnaire were included. São Paulo is the biggest city in Brazil and has the highest economy and the highest Human Development Index of the country (0.5) (Duarte, 2020). Although the findings should not be generalized to the general Brazilian population, they represent differences between adult and older adult perceptions that are probably more related to social distancing itself than to its economical consequences.

LIMITATION

Although there are relevant findings in the present study, some limitations should be highlighted. Data were subject to participant recall, which may have potential influence on results, mainly on the comparisons between pre- vs. during social distancing periods. There is also possible selection bias, since participants might respond in clusters. Furthermore, these results are specific to the urban population of São Paulo, Brazil, and although we have not included participants who declared living in other states, that information also depended on participant reports. Other sample characteristics were not assessed, such as comorbidities, COVID-19 infection, emotional conditions, employment status, and type of diet consumption before social distancing. Finally, this is a cross-sectional study and, therefore, the results must be interpreted with caution.

FINAL CONSIDERATIONS

There are great concerns regarding the impact of social distancing on health, mainly among older adults, considering that aging is related to biopsychosocial decline. Therefore, we have hypothesized that older adults would present greater health and behavioral alterations than adults. However, while there was no difference between groups for several aspects, adults have presented a perception of greater alterations in others, such as poorer sleep quality, alterations in evacuation frequency, and more difficulty to perform daily activities at home. It is possible that adults presented more significant alterations in routine, despite the great perception of alterations reported by both groups. The reasons for our findings were related to some aspects, but alternative explanations may exist for these findings as well. Further studies are necessary to follow up the impact of social distancing among adults and older adults in different socioeconomic contexts and to better understand the long-term alterations and the necessity of interventions. Finally, it should be highlighted that, besides the impact in several aspects, social distancing is essential to slow the spread of COVID-19 and to save lives (Courtemanche et al., 2020).

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

This is a cross sectional study approved by the Ethics Committee (Universidade São Judas Tadeu), No. 4.067.240. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AM-L, PL, and SM-O: writing-review and editing. AA and MB: formal analysis. DG, GZ, GB, and JM: investigation and writing-original draft. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.607559/full#supplementary-material

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Corrigendum: Self-Perception of Changes in Routines in Adults and Older Adults Associated to Social Distancing Due to COVID-19—A Study in São Paulo, Brazil

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A Corrigendum on

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In the original article, there was an error. A citation was inserted incorrectly at the end of a paragraph.

A correction has been made to *Discussion*, *Paragraph 6.* The corrected paragraph is shown below.

With social distancing, people are modifying their social bonds, and this could result in a negative impact on the eating habits of the participants, especially the older adults (Allès et al., 2019). There is a correlation between social bonds and eating habits (Campos et al., 2000; Silveira et al., 2015). However, with stress, there may be changes in the quantity and the quality of the food consumed, a decrease in appetite (Petrowski et al., 2014; Reichenberger et al., 2018), as well as an increase in high caloric density food consumption. These alterations may lead to changes in glycemia, lipid profile, and consequently increased risk for the development of chronic diseases (Evers et al., 2010; Van Strien et al., 2012; Sinha, 2018). In the present study, adults reported lower frequency of fruit and vegetable intake and higher frequency of protein intake in comparison to older adults. Sidor and Rzymski (2020) have shown a decrease in fruit and vegetable consumption and a greater tendency to consume meat during social distancing among adults. Older adults usually eat less proteins, fruits, and vegetables, which may be related to the presence of chronic disease or with oral cavity alterations (Gaspareto et al., 2017; Ibge, 2019), reflecting on implications in muscle mass, such as sarcopenia and other adverse outcomes (do Nascimento Ferreira et al., 2017).

The authors apologize for this error and state that this does not change the scientific conclusions of the article in any way. The original article has been updated.

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Effects of High-Intensity Interval Training and Moderate-Intensity Training on Stress, Depression, Anxiety, and Resilience in Healthy Adults During Coronavirus Disease 2019 Confinement: A Randomized Controlled Trial

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Objective: This study aimed to compare the effects of two intervention programs, (1) high-intensity interval training (HIIT) and (2) moderate-intensity training (MIT), on anxiety, depression, stress, and resilience during the confinement caused by the coronavirus disease 2019 (COVID-19) in healthy adults.

Methods: A total of 67 adults who participated were randomly assigned to two groups: HIIT and MIT groups. The MIT group had to perform a home-based intervention based on aerobic exercises, whereas the HIIT group had to perform a home-based intervention based on HIIT exercises. The two groups (HIIT and MIT) had to complete the same physical exercise volume, 40 min per session (6 days per week) during the confinement period (6 weeks). Depression, anxiety, stress, and resilience were assessed before and after the intervention.

Results: Results showed that HIIT and MIT significantly reduced the stress, anxiety, and depression as well as increase the resilience ($p < 0.05$). Moreover, the improvements obtained in the HIIT group seem to be greater than those of the MIT group in depression ($p < 0.05$).

Conclusions: HIIT and MIT decreased anxiety, stress, and depression as well as increased resilience during the COVID-19 confinement. In addition, the HIIT intervention seemed to be more beneficial to reduce depression than the MIT intervention.

Keywords: confinement, COVID-19, HIIT, MIT, mental health

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INTRODUCTION

In December 2019, a series of pneumonia cases with unknown causes emerged in Wuhan, Hubei, China (Lu et al., 2020). Days later, Chinese health authorities confirmed that this group was associated with a new coronavirus [severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)] (Hui et al., 2020), known as coronavirus disease 2019 (COVID-19). On 30 January 2020, the Emergency Committee of the International Health Regulations of the World Health Organization declared the outbreak of COVID-19 a public health emergency of international interest (PHEIC) (World Health, 2020). In this regard, Spain, one of the most affected countries worldwide, declared the "state of alarm" for the entire national territory. Thus, displacement restrictions were imposed on citizens, indicating the confinement in their homes. People could only circulate in public spaces to carry out activities such as purchasing food, pharmaceuticals, or essential goods.

Previous studies showed that confinement has a negative impact on the general psychological health (Mihashi et al., 2009), which could lead to emotional disorders (Yoon et al., 2016) such as depression (Hull, 2005), stress (Digiovanni et al., 2004), and anxiety (Fancourt et al., 2020; Husky et al., 2020). In this regard, a key psychological variable to manage stressful situations (Rutter, 2007), resilience, which is defined as an individual's capacity to overcome adversity, is also affected during the confinement (Carriedo et al., 2020). Before the COVID-19 outbreak, some studies reported that regular physical exercise was a useful tool to reduce symptoms of depression and anxiety, increasing self-esteem and even a decrease in the idea of suicide (Vancampfort et al., 2018; Werneck et al., 2019), counteracting the effect of the confinement or isolation (Bonnet and Arand, 2001; Schneider et al., 2013). Thus, physical exercise was used during COVID-19 as a strategy to combat the psychological and physical consequences of the confinement, and its practice has been widely recommended during this period (Polero et al., 2021).

However, a recent systematic review did not find a consensus in the recommendations, the type, nor the intensities of the physical exercise during the confinement. Among all these recommendations, some studies recommended high-intensity interval training (HIIT) (Eirale et al., 2020; Narici et al., 2020) and others moderate-intensity training (MIT) (Chen et al., 2020; Fallon, 2020; Halabchi et al., 2020; Jiménez-Pavón et al., 2020) as an alternative for exercising during the confinement. HIIT is a high-intensity [greater than or equal to 85% of the heart rate maximum (HRmax)] interval training with short recovery periods (Weston et al., 2014), whereas MIT consisted of exercises between 70 and 85% HRmax. Previous evidence suggests that both HIIT (Martland et al., 2020) and MIT (Moholdt et al., 2009; Health and Human, 2018; Byrd et al., 2019) improve physical and psychological outcomes, anxiety, or depression, although adherence to physical exercise seems to be greater in HIIT (Heinrich et al., 2014).

Due to the lack of consensus and the relevant role of intensity in physical training (Macinnis and Gibala, 2017), it is needed to investigate, through randomized controlled trials, if HIIT or MIT has the same or different impacts on people's psychological health during the confinement situation. To date, there is no study comparing the effects of HIIT and moderate-intensity exercises (MIT) on the mental health of adult people during the COVID-19 confinement. Only one article analyzed the effects of physical training during the confinement (Vitale et al., 2020). This article studied the effects of home-based resistance training on physical fitness (measured by the chair-stand test). However, this article is not focused on the psychological health (which has another aspect that is dramatically affected by this situation) (Ammar et al., 2020). Therefore, the aim of the present randomized controlled trial was to evaluate the effects of two home-based exercise programs (one focused on HIIT and another on MIT) in the psychological health of adults during the COVID-19 confinement. As a primary objective, we analyzed the PRE-to-POST improvements (within and between groups) on depression after 6 weeks of home-based physical exercise. As secondary objectives, we analyze the PRE-to-POST improvements (within and between groups) on stress, anxiety, and resilience after 6 weeks of the COVID-19 confinement. We hypothesized that both home-based interventions (HIIT and MIT) would determine positive effects on the psychological health (i.e., depression, anxiety, stress, and resilience), being even greatest in the HIIT group. The rationale was that home-based exercise could be a useful and effective tool to maintain the psychological health during the COVID-19 confinement.

METHODS

Study Design

The study is a randomized, single-blind controlled trial. Participants were divided into two groups: the MIT group, which underwent an aerobic exercise-based training program, and the HIIT group, which performed a HIIT exercise-based training program. The primary outcome, symptoms of depression [using the 13-item Beck Depression Inventory (BDI-13) (Beck et al., 1974)], and the secondary outcomes of stress [through the Perceived Stress Scale (PSS-10) (Cohen, 1988)], state of anxiety [using the State-Trait Anxiety Inventory (STAI-E) (Spielberger et al., 1971)], and resilience [through Connor-Davidson Resilience Scale (CD-RISC) (Campbell-Sills and Stein, 2007)] were assessed before and after 6 weeks of the intervention (the whole duration of strict confinement).

Some inclusion criteria were defined: (a) men or women aged between 18 and 65 years; (b) do not suffer from any musculoskeletal injury; (c) have been infected by COVID-19 or having symptoms of it; (d) do not practice other physical activities apart from prescribed by our research team during the duration of this trial; and (e) do not have any absolute contraindication for physical exercise practice. Participants who did not fulfill these criteria were not group-allocated.

The research ethics committee approved all the procedures of the University of Extremadura (approval number: 56/2020). Participants were informed of the procedures and gave their written consent prior to enrolment.

This trial was registered in the Australian New Zealand Clinical Trials Registry (ACTRN12620000482965), and the protocol was also published at https://www.anzctr.org.au/ACTRN12620000482965.aspx.

Participant Screening

Once the Spanish government declared the "state of alarm" (March 2020) for the entire national territory and that people must be confined in their homes (people could only circulate in public spaces to carry out activities such as purchasing food, pharmaceuticals, or essential goods), two of the researchers announced in social media (Instagram and Facebook) for volunteers who wanted to participate in a home-based physical activity program during the COVID-19 confinement. Interested people contacted by direct message the researchers. A total of 76 participants contacted the researchers and met the inclusion criteria. Any of the participants were professional sportsmen or sportswomen. The majority of the participants included in this study manifested a low level of physical activity (55.23%). In contrast, moderate and high levels of physical activity were detected on 19.40 and 23.37% of the participants, respectively, according to the data extracted from the International Physical Activity Questionnaire (IPAQ) (Craig et al., 2003) when asked about their physical activity habits before the COVID-19 home confinement. Further characteristics of the sample can be checked in **Table 1**.

Participants were randomly allocated into the two groups (HIIT or MIT) by a technician using random numbers. This researcher did not take part in the acquisition, intervention, or data analysis. Another technician performed the intervention, and another collected the daily adherence as well as initial and final tests. Furthermore, participants were also blinded to group allocation since physical training sessions were individually sent.

A Google Form was created to collect sociodemographic data (such as age, sex, or physical activity habits) and primary and secondary outcomes (symptoms of depression, state of anxiety, perceived stress, and resilience). These online questionnaires were administrated at two pointlines: before and after the home-based interventions.

Training Protocol

The two groups (HIIT and MIT) had to complete the same physical exercise volume, 40 min per session (6 days per week) during the confinement period (6 weeks). A kinesiologist with more than 5 years of experience provided a video session uploaded to YouTube. A WhatsApp message was individually sent to each participant with a session link that they had to complete.

- MIT group. This group had to perform a home-based intervention based on aerobic exercises. Each session had the following:

1. A warm-up (10 min): joint mobility exercises.
2. Main part: three to four blocks of 6–8 min with 1- to 2-min hydration pause between them (i.e., boxing squats, jumping jacks, skipping, or skaters). All the exercises were performed with their own weight or with an extra weight when needed, using small (≈500 g) or large (≈1,500 g) water bottles, at 4–6 of their maximum perceived effort, which corresponds to a 70–85% HRmax (Borg, 1970; Buceta, 1998; Edwards and Brown, 2003). Participants were informed about the rate of perceived exertion (RPE) on a 0–10 scale and were encouraged to maintain the required intensity during the sessions (Borg, 1970). The exercise description, sets, duration, repetitions resting time, exercise progression, and load are detailed in **Table 2**.
3. Cooldown: For the main body muscles (mainly back, neck and upper and lower limbs), which were involved during the training session, static stretching exercises were conducted, lasting 30–40 s.

TABLE 1 | Descriptive of the sample.

	Total Mean (SD)	HIIT group Mean (SD)	MIT group Mean (SD)	*p*-value
Sample size (*n*)	67	36	31	
Age (years)	26.13 (7.17)	25.22 (5.23)	27.19 (8.88)	0.668
Sex [women (men)]	45 (22)	21 (15)	24 (7)	0.097
STAI-E	46.64 (9.90)	47.33 (9.31)	45.84 (10.62)	0.541
BDI-13	4.64 (3.87)	5 (4.10)	4.23 (3.62)	0.531
PSS-10	18.52 (6.21)	19 (6.51)	18 (5.90)	0.650
CD-RISC10	30.28 (6.26)	31.14 (5.2)	29.29 (7.27)	0.371
IPAQ level of physical activity				
Low[a]	37 (55.23%)	19 (52.78%)	18 (58.06%)	0.547
Moderate[b]	13 (19.40%)	6 (16.67%)	7 (22.58%)	
High[c]	17 (25.37%)	11 (30.57%)	6 (19.35%)	

BDI-13, 13-item Beck Depression Inventory; CD-RISC10, Connor-Davidson Resilience Scale; HIIT, high-intensity interval training; IPAQ, International Physical Activity Questionnaire; MIT, moderate-intensity training; PSS-10, Perceived Stress Scale; SD, standard deviation; STAI, State-Trait Anxiety Inventory.

[a] *The participants did not meet any of the criteria for either moderate or high levels of physical activity according to the IPAQ.*

[b] *Participant performed some activity equivalent to 0.5 h of at least moderate intensity on most days.*

[c] *Participant performed ∼1 h of activity per day or more of at least a moderate-intensity activity level.*

TABLE 2 | Description of the MIT intervention exercises performed during the central part of the home-based intervention.

Exercise type	Number of sets	Duration	Resting time	Exercise progression	Intensity	Load
Boxing squats 	3	6–8 min	1–2 min	Increase of sets (up to $n = 4$) and/or execution time (up to 8 min) and/or decrease resting time (up to 1 min)	4–6 of RPE	Body weight
Jumping jacks 				Increase of sets (up to $n = 4$) and/or execution time (up to 8 min) and/or decrease resting time (up to 1 min)	4–6 of RPE	Body weight
Skipping 				Increase of sets (up to $n = 4$) and/or execution time (up to 8 min) and/or decrease resting time (up to 1 min)	4–6 of RPE	Body weight
Skaters 				Increase of sets (up to $n = 4$) and/or execution time (up to 8 min) and/or decrease resting time (up to 1 min)	4–6 of RPE	Body weight
Climbers 				Increase of sets (up to $n = 4$) and/or execution time (up to 8 min) and/or decrease resting time (up to 1 min)	4–6 of RPE	Body weight

MIT, moderate-intensity training; RPE, rate of perceived exertion.

- HIIT group. This group had to perform a home-based intervention based on HIIT exercises. Each session had the following:

1. A warm-up (10 min): joint mobility exercises.
2. Main part: core, arm, and leg exercises, with 10–12 sets of 30–90 s with 15–60 s of rest between sets (i.e., push-ups,

squats, splits, or deadlifts). All the exercises will be performed with their own weight at 7–9 of their maximum perceived effort, which corresponds to an 85–95% HRmax (Borg, 1970; Buceta, 1998; Edwards and Brown, 2003). Participants were informed about the RPE on a 0–10 scale and were encouraged to maintain the required intensity during the sessions (Borg, 1970). The exercise description, sets, duration, repetitions resting time, exercise progression, and load are detailed in **Table 3**.

3. Cooldown: For the main body muscles (mainly back, neck, and upper and lower limbs), which were involved during the training session, static stretching exercises were conducted, lasting 30–40 s.

Training adherence was controlled daily by one of the researchers. All participants had to send a WhatsApp message when they ended the training session. The minimum acceptable adherence to interventions was 75%. Participants who did not reach this percentage were considered as having discontinued the intervention.

Psychological Profile Monitoring

Participants completed the following questionnaires before and after the intervention: Symptoms of depression were assessed using the Spanish version of the BDI-13 (Beck et al., 1974; Bobes et al., 2004), showing a reliability of 0.83 (Sanz and Vázquez, 1998). It consists of 13 items with four possible response options ranging from 0 to 3 points: 0 = I don't feel sad, 1 = I feel sad, 2 = I feel sad continuously and I can't stop being sad, and 3 = I feel so sad that I can't bear it. The total score varies from 0 to 39 points, considering absent depression from 0 to 4 points, mild depression from 5 to 7 points, moderate depression from 8 to 15 points, and severe depression at more than 15 points (Beck et al., 1974; Collet and Cottraux, 1986).

State of anxiety, in its Spanish version, was assessed through the STAI-E (Spielberger et al., 1971; Buela-Casal et al., 1982), showing a Cronbach's alpha of 0.94 (Guillén-Riquelme and Buela-Casal, 2011). It consists of 20 items; and when responding, the subjects report their state of anxiety at that time through their responses, which can be 1 = nothing, 2 = little, 3 = a lot, and 4 = a lot. The score range for the test is 20–80, indicating a higher level of anxiety with a higher score (Spielberger et al., 1971).

The Spanish version of the stress scale (PSS-10) was used to measure the stress, showing a Cronbach's alpha = 0.82 and a test–retest, r = 0.77 (Remor, 2006). This scale consists of 10 items scored as follows: 0 = never, 1 = almost never, 2 = from time to time, 3 = often, and 4 = very often. The total score is between 0 and 40 points, considering those with the highest score with the highest stress (Cohen, 1988).

Resilience was evaluated using the Spanish version of the CD-RISC (Campbell-Sills and Stein, 2007; Soler Sánchez et al., 2016), which has shown a Cronbach's alpha = 0.87. The short version of this scale was administered to assess the resilience to problems. It consists of 10 items with five answer options: 0 = not at all, 1 = rarely, 2 = sometimes, 3 = often, and 4 = almost always. The scale range goes from 0 to 40. The higher the score, the more resilience (Campbell-Sills and Stein, 2007).

In order to characterize the participants in their level of physical activity prior to the COVID-19 home confinement, the Spanish version of the IPAQ was administered (Craig et al., 2003; Roman-Viñas et al., 2010). Participants were encouraged to think about the physical activity behaviors before the start of the home confinement. Therefore, each participant's level of physical activity was calculated: high, moderate, or low level. High level was achieved by participants who performed vigorous-intensity activity on at least 3 days, achieving a minimum total physical activity of at least 1,500 metabolic equivalent of task (MET) minutes a week or performed seven or more days of any combination of walking, and moderate-intensity or vigorous-intensity activities, achieving a minimum total physical activity of at least 3,000 MET minutes a week. Moderate level was achieved by participants engaged in three or more days of vigorous-intensity activity and/or walking of at least 30 min per day; or five or more days of moderate-intensity activity and/or walking of at least 30 min per day; or five or more days of any combination of walking, and moderate-intensity or vigorous-intensity activities, achieving a minimum total physical activity of at least 600 MET minutes a week. Low levels of physical activity were achieved by participants who did not fulfill the criteria for either moderate or high physical activity levels (Craig et al., 2003; Committee, 2005). The Spanish version of the IPAQ showed a good reliability coefficient for total physical activity (r = 0.82, $p < 0.05$), vigorous activity (r = 0.79, $p < 0.05$), moderate activity (r = 0.83, $p < 0.05$), and time spent walking (r = 0.73, $p < 0.05$) (Roman-Viñas et al., 2010).

Data Analysis

The STAI was employed in order to estimate the sample size using the PASS software (version 11; NCSS, LLC, Kaysville, Utah, USA) (Hintze, 2008). Taking into account the data from a previous research (Mailey et al., 2010), 37 participants per group were estimated in order to detect differences (α value 0.05 and 99% of power) in a repeated measures design.

The SPSS statistical package (version 20.0; SPSS, Inc., Chicago, Ill.) was used to analyze the data. Non-parametric tests were performed based on the results of the Shapiro–Wilk and Kolmogorov–Smirnov tests.

Data from the initial 67 participants were used to perform the intention-to-treat analysis using multiple imputations (MIs) of missing values, following the guidelines of Sterne et al. (2009). Thus, the missing data were classified as missing at random.

Mann–Whitney *U*-test was used to study differences at baseline in age, gender, and scores on the STAI-E, BDI-13, PSS-10, and CD-RISC10 questionnaires. A chi-squared test was used to study differences between groups in the physical activity level extracted from the IPAQ.

The difference between the post and the pre was also calculated for each variable. These differences were used to study the between-group effects of the intervention by the Mann–Whitney *U*-test in the different variables. Within-group effects were explored using the Wilcoxon test between pre-test and post-test.

TABLE 3 | Description of the HIIT intervention exercises performed during the central part of the home-based intervention.

Exercise type	Number of sets	Duration	Resting time	Exercise progression	Intensity	Load
Pushup  	3	30–90 s	15–60 s	Increase of sets (up to $n = 4$) and/or execution time (up to 90 s) and/or decrease resting time (up to 15 s) and/or start kneeling on the extending arms into a high plank position	6–9 of RPE	Body weight
Squat  	3	30–90 s	15–60 s	Increase of sets (up to $n = 4$) and/or execution time (up to 90 s) and/or decrease resting time (up to 15 s) and/or use of one bottle as extra weights	6–9 of RPE	Body weight or bottles
Split 	3	30–90 s	15–60 s	Increase of sets (up to $n = 4$) and/or execution time (up to 90 s) and/or decrease resting time (up to 15 s) and/or use of two bottles as extra weights	6–9 of RPE	Body weight or bottles
Dead lift  	3	30–90 s	15–60 s	Increase of sets (up to $n = 4$) and/or execution time (up to 90 s) and/or decrease resting time (up to 15 s) and/or use two bottles as extra weights	6–9 of RPE	Body weight or bottles
Plank 	3	30–90 s	15–60 s	Increase of sets (up to $n = 4$) and/or execution time (up to 90 s) and/or decrease resting time (up to 15 s)	6–9 of RPE	Body weight

HIIT, high-intensity interval training; RPE, rate of perceived exertion.

Effect sizes [r] were calculated for the non-parametric tests, which is classified as follows: 0.5 is a large effect, 0.3 is a medium effect, and 0.1 is a small effect (Fritz et al., 2012; Coolican, 2018).

RESULTS

The flowchart is shown in **Figure 1**. A total of 76 were randomly allocated in the two groups. However, seven participants from the MIT group and two participants from the HIIT group did not start the intervention. Therefore, 67 adults started the intervention (36 from the HIIT and 31 from MIT groups). However, during the home-based intervention, eight participants from the HIIT group and six participants from the MIT group dropped out of the intervention (due to demotivation with the exercise interventions). Nevertheless, intention-to-treat analyses were applied to the data of these participants.

Baseline characteristics are reported in **Table 1**. No significant differences ($p > 0.05$) were observed between the HIIT and MIT groups in age, gender, and the total score of stress (PSS-10), depression (BDI-13), anxiety (STAI-E), resilience (CD-RISC10), or physical activity levels (IPAQ) at baseline.

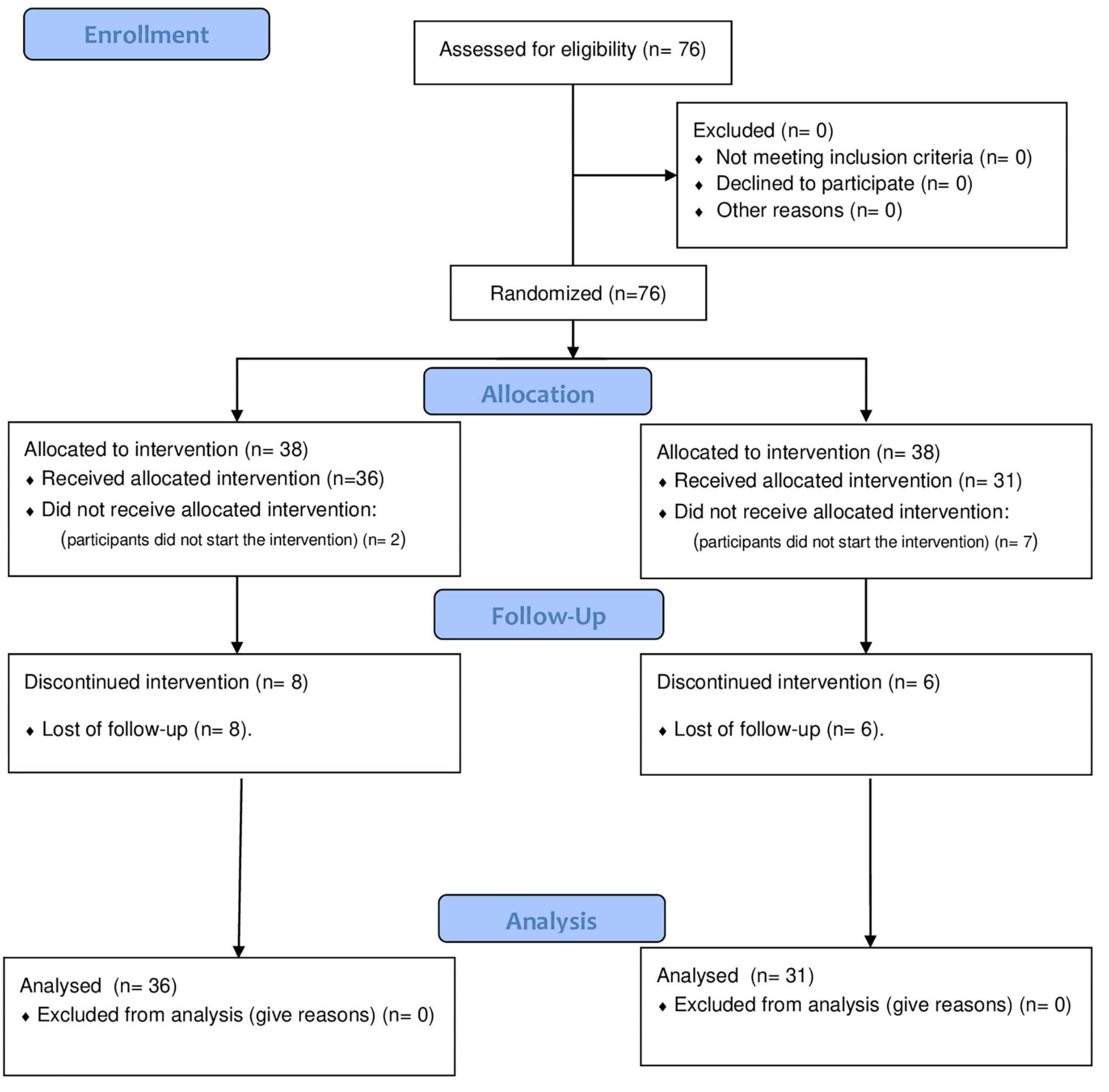

FIGURE 1 | Flow chart of participants.

Table 4 shows the effect of HIIT and MIT on anxiety, depression, stress, and resilience. Wilcoxon signed-rank tests showed significant effects in both groups for all the studied variables: anxiety (HIIT $p = 0.014$; MIT $p = 0.034$), depression (HIIT $p \leq 0.001$; MIT $p = 0.016$), stress (HIIT $p \leq 0.001$; MIT $p = 0.013$), and resilience (HIIT $p = 0.049$; MIT $p = 0.004$). Based on the effect size [r], the effects could be classified as medium/large in all the variables.

Mann–Whitney U-tests showed that the HIIT intervention significantly reduced the depression symptoms more than the MIT intervention [$p = 0.046$; [r] = 0.244] with an effect size that can be classified as medium. However, significant differences were not observed in anxiety ($p = 0.501$), stress ($p = 0.743$), or resilience ($p = 0.304$).

Considering the 75% attendance criterion, the final adherence was 77.78% and 80.64% for the HIIT and MIT, respectively. No side effects derived from any of the interventions were detected.

DISCUSSION

This study aimed to compare the effects of two intervention programs (HIIT and MIT) on anxiety, depression, stress, and resilience during the confinement caused by COVID-19 in healthy adults. Results showed that HIIT and MIT reduced stress, anxiety, and depression as well as increase resilience. Moreover, the improvements obtained in the HIIT group seem to be greater than those of the MIT group in depression.

The COVID-19 home confinement increased the level of sedentarism among the general population (Fuentes-García et al., 2020; Narici et al., 2020). This, linked to a high uncertainty and stress (Lin et al., 2020), led to a significant decrease in the psychological health (Ammar et al., 2020). Previous studies indicated that the COVID-19 home confinement had a significant impact on stress, anxiety, and depression (Fancourt et al., 2020; Husky et al., 2020). Thus, due to the positive effects of physical exercise on the psychological and physical health, it was highly recommended during this the COVID-19 home confinement (Polero et al., 2021). Our results confirm that regular home-based exercise could fight the negative impact of the COVID-19 confinement on the psychological health, decreasing stress, anxiety, and symptoms of depression while increasing resilience.

Furthermore, previous studies have focused on the importance of physical exercise during the COVID-19 confinement (Chtourou et al., 2020; Jiménez-Pavón et al., 2020). In this regard, our results are consistent with a previous cross-sectional study, which reported that those people who were not enrolled in physical exercise during the COVID-19 confinement showed a higher level of stress, anxiety, and depression (Silva et al., 2020). Moreover, same as this study, another one conducted a randomized controlled trial focused on the effects of a home-based resistance training on the physical fitness of older adults. Results highlighted the importance of home-based physical training to reduce the impact of the COVID-19 confinement on the physical fitness. However, this study was focused on the physical dimension, whereas our study showed, for the first time, that home-based intervention could improve the relevant psychological outcomes such as stress, anxiety, or depression.

Importantly, the HIIT and MIT interventions improved resilience (ability to recover and maintain adaptive behavior after a stressful event) (Garmezy, 1991). This is relevant since resilience is quite important to face uncertain situations under stress, such as the COVID-19 pandemic (Bryce et al., 2020; Nitschke et al., 2020). Thus, a previous study claimed for factors that could promote resilience during this period (Vinkers et al.,

TABLE 4 | Effects of 6 weeks of HIIT and MIT on anxiety, depression, stress, and resilience after applying intention-to treat analysis.

Variables				Within-group analyses			Between groups analyses		
		Pre Mean (SD)	Post Mean (SD)	*Z*	*p*-value	Effect size	*Z*	*p*-value	Effect size
STAI-E									
Anxiety	HIIT	47.33 (9.31)	42.45 (10.76)	−2.449	0.014	0.408	−0.673	0.501	0.082
	MIT	45.84 (10.62)	42.72 (11.75)	−2.120	0.034	0.381			
BDI-13									
Depression	HIIT	5 (4.10)	2.5 (2.74)	−4.161	<0.001	0.693	−1.998	0.046	0.244
	MIT	4.23 (3.62)	2.61 (2.68)	−2.419	0.016	0.434			
PSS-10									
Stress	HIIT	19 (6.51)	14.83 (6.92)	−4.184	<0.001	0.697	−0.327	0.743	0.039
	MIT	18 (5.90)	14.65 (6.62)	−2.481	0.013	0.445			
CD-RISC10									
Resilience	HIIT	31.14 (5.2)	32.04 (5.93)	−1.961	0.049	0.327	−1.028	0.304	0.125
	MIT	29.29 (7.27)	32.06 (6.16)	−2.861	0.004	0.514			

BDI-13, 13-item Beck Depression Inventory; CD-RISC10, Connor-Davidson Resilience Scale; HIIT, high-intensity interval training; MIT, moderate-intensity training; PSS-10, Perceived Stress Scale; SD, standard deviation; STAI, State-Trait Anxiety Inventory.

2020). Therefore, both HIIT and MIT home-based physical exercise interventions could be used to improve resilience during the COVID-19 home confinement. This idea is supported by a previous study, which showed that those who were enrolled in vigorous physical exercise obtained higher values of resilience during the confinement (Carriedo et al., 2020). Nevertheless, we did not observe statistically significant differences between HIIT and MIT. However, differences between groups were found between HIIT and MIT in the symptoms of depression (with significantly lower values in the HIIT group after the home-based intervention than in the MIT group). Hypothetically, this could be explained by the work done per unit time, which is greater in the HIIT than in the MIT. This is in line with a previous study (Luo et al., 2019) where the HIIT group obtained a greater effect on depression than did the MIT group. In this regard, HIIT training has been related to endogenous opioid activation, contributing to greater stress relief (Schwarz and Kindermann, 1992) as well as mood and depression (Firth et al., 2015; Schuch et al., 2016).

Adherence to physical activity is one of the most relevant challenges in public health (Dishman, 1988; Matthews et al., 2008) since it is crucial for benefits maintenance. Previous studies have reported that the HIIT appears to be more enjoyable than MIT, since short recovery periods can provide relief from active exercise, in contrast to continuous exercise (Tjønna et al., 2008; Bartlett et al., 2011). A previous systematic review reported that the adherence to HIIT interventions exceeds the 80%. However, in our intervention, adherence was quite similar in both MIT (80.64%) and HIIT (77.78%) protocols. Furthermore, another randomized controlled trial during the COVID-19 outbreak (using home-based resistance training) reported an adherence of 84.8% (with the same percentage of attendance–75%). However, the sample size of this randomized controlled trial was lower than in ours, allocating in the exercise group nine adults (four dropped out) and five in the control group (one dropped out).

This study has some limitations that should be acknowledged. First, the confinement did not allow us to control the intensity through heart rate monitors. Second, results cannot be extrapolated to special populations, since healthy people participated in this study. Moreover, future studies should incorporate physiological outcomes in order to confirm our results. Third, in the present study, gender differences in the effectiveness of the physical exercise, which can affect stress, depression, or anxiety, were not explored. Nevertheless, our study has some strong points that should be also highlighted. In this regard, only one previous article conducted a randomized controlled trial to study the effects of home-based interventions (Vitale et al., 2020), and this is the first that studies the effectiveness of two interventions (HIIT and MIT) on symptoms of depression, anxiety, stress, and resilience. Moreover, the intervention was conducted under an ecological context, with any sports material and associated cost, and therefore anyone could participate. In contrast, other physical exercise alternatives emerged during the COVID-19 home confinement, such as exergames (Viana and De Lira, 2020). However, in contrast with our intervention, the associated cost of these interventions is higher than in home-based physical exercise interventions. Considering all these strong points, this research could be considered as timely and quite relevant since these accessible home-based physical exercise interventions could be used against the negative impacts of COVID-19 on both physical and mental health.

CONCLUSIONS

HIIT and MIT decreased anxiety, stress, and depression as well as increased resilience during the COVID-19 confinement. In addition, the HIIT intervention seemed to be more beneficial to reduce depression than the MIT intervention. Thus, HIIT or MIT home-based sessions should regularly be applied (under professional supervision) in order to maintain the person physically active during the COVID-19 home confinement. This would lead to decrease anxiety, stress, and symptoms of depression as well as to increase resilience. Therefore, results are timely and quite relevant in this situation in which people are isolated and where physical activity has a crucial role in maintaining both mental and physical health.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Extremadura Research Ethics committee (56/2020). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

SV, YB-M, and DC-M conceived and designed the study. YB-M and JS-G assisted with recruitment of participants. JF-G and SV conducted the statistical analysis and interpretation of data. YB-M drafted the manuscript with input from SV, DC-M, JS-G, and JF-G. All authors have read and approved the final manuscript.

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STUDY PROTOCOL
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Comparison Between Conventional Intervention and Non-immersive Virtual Reality in the Rehabilitation of Individuals in an Inpatient Unit for the Treatment of COVID-19: A Study Protocol for a Randomized Controlled Crossover Trial

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Background: The new human coronavirus that leads to COVID-19 (coronavirus disease 2019) has spread rapidly around the world and has a high degree of lethality. In more severe cases, patients remain hospitalized for several days under treatment of the health team. Thus, it is important to develop and use technologies with the aim to strengthen conventional therapy by encouraging movement, physical activity, and improving cardiorespiratory fitness for patients. In this sense, therapies for exposure to virtual reality (VR) are promising and have been shown to be an adequate and equivalent alternative to conventional exercise programs.

Aim: This is a study protocol with the aim of comparing the conventional physical therapy intervention with the use of a non-immersive VR software during COVID-19 hospitalization.

Methods: Fifty patients hospitalized with confirmed diagnosis of COVID-19 will be divided in two groups under physiotherapy treatment using conventional or VR intervention: Group A: participants with COVID-19 will start the first day of the protocol with VR tasks in the morning and then in the second period, in the afternoon, will perform the conventional exercises ($n = 25$) and Group B: participants with COVID-19 will start the first day with conventional exercises in the morning and in the second period, in the afternoon, will perform activity with VR ($n = 25$). All participants will be evaluated with different motor and physiologic scales before and after the treatment to measure improvements.

Conclusion: Considering the importance of benefits from physical activity during hospitalization, VR software shows promise as a potential mechanism for improving physical activity. The results of this study may provide new insights into hospital rehabilitation.

Trial Registration: ClinicalTrials.gov, identifier: NCT04537858. Registered on 01 September 2020.

Keywords: coronavirus, telerehabilitation, virtual reality exposure therapy, hospitals, rehabilitation, autonomic nervous system, physical functional performance

INTRODUCTION

At the end of 2019, the world saw the emergence of a new human coronavirus that was spreading rapidly and with a high degree of lethality (Huang et al., 2020; Singhal, 2020). The virus was called SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), responsible for causing COVID-19 (coronavirus disease 2019) (Baig et al., 2020; Chen et al., 2020; Weston and Frieman, 2020; Zhou et al., 2020).

The majority of people who acquired the virus did not show any significant symptoms (Chen et al., 2020), whereas 15% of people who had the virus developed mild or moderate symptoms, the most common of which were fever (85–90%), cough (65–70%), fatigue (35–40%), dyspnea (15–20%), and myalgia (10–15%) (Guan et al., 2020; Huang et al., 2020; Madabhavi et al., 2020).

Different from existing viruses that cause SARS and Middle East respiratory syndrome (De Wit et al., 2016; Madjid et al., 2020; Paules et al., 2020), COVID-19 symptoms cause early complications such as acute respiratory distress syndrome sepsis and multiple organ failure requiring admission to the intensive care unit (Yang et al., 2020), which might lead to overload of care services in public and private sectors (Sheehy, 2020; Wu and McGoogan, 2020). In addition to the high rate of hospitalization, a major difference from COVID-19 is the average hospitalization period, which is usually 12 days (Guan et al., 2020) in an outpatient setting, and if there is a need for intensive care, this period can be extended to ∼22 days (Yang et al., 2020; Zhou et al., 2020).

Considering the need for hospitalization, the rehabilitation protocol includes multidisciplinary teams, with physiotherapy treatment being recognized as an important intervention. According to Lew et al. (2020), physiotherapy in the treatment of COVID-19 consists mainly of physical care where the patient may have low physical fitness, shortness of breath after exertion, and muscle atrophy (including respiratory muscles, trunk, and limb muscles). It is important to emphasize that hospitalized patients receive physiotherapy treatment at the bedside once a day for those in moderate need, and three times a day for those in high need (Smith et al., 2020). This intervention uses progressive exercises that can be selected so that patients can gradually recover the level of activity observed before the onset of the disease (Zhao et al., 2020).

Thus, innovations using virtual reality (VR) during intervention in outpatient rehabilitation services are important to minimize functional deficits that might otherwise lead to permanent disability (Boldrini et al., 2020; Coraci et al., 2020). Where other VR systems are cost-prohibitive, low-cost VR promotes an important cost-effectiveness to public health service, providing an effective tool to health workers to work as adjunctive to routine with inpatients with less effort in patient handling (Zanaboni et al., 2016; Ford et al., 2018; Shields et al., 2018). Therefore, the use of computational tasks in a virtual environment can be an interesting option (de Freitas et al., 2019; de Moraes et al., 2020; Leal et al., 2020; Stam et al., 2020).

The use of tasks in virtual environments has grown a lot in recent years, showing itself as an adequate alternative and equivalent to conventional exercise programs (Bond et al., 2019; García-Bravo et al., 2019), and the benefits of physical exercise associated with VR have shown a promising impact in improving the patient's self-efficacy for physical training, in addition to providing an engaging environment for the patient (Dias et al., 2019). Moreover, the VR can enable the rehabilitation team to control different variables such as speed, task size, and more important creative tasks to promote motivation (Fernani et al., 2017; Prado et al., 2017; da Silva et al., 2020b).

In addition to improve motor performance and functionality, it has been shown to increase motivation and consequent engagement to rehabilitation. In a recent systematic review of VR and video games for cardiac rehabilitation programs, all publications pointed to improvement of the motivation and engagement to therapy as the main advantage derived from the use of VR rehabilitation; the subjects reported that it was a fun and interactive form of treatment (García-Bravo et al., 2019).

Despite positive existing studies with the use of VR in different respiratory disabilities, such as chronic obstructive pulmonary disease (Mazzoleni et al., 2014; Jung et al., 2020; Rutkowski et al., 2020), exercises training on thoracic hyperkyphosis, and respiratory parameters in young women (Taslimipour et al., 2020), research in a hospital environment is still scarce, and more studies are needed to verify benefits and possible applications.

According to Bond et al. (2019), the requirement of physical exercise inherent to a video game's activities (exergames) is shown to have a promising impact in improving patient self-efficacy for exercise training using digital hardware (e.g., the Nintendo Wii® or the Xbox Kinect®), once interactive VR promotes increased heart rate (HR), rating of perceived exertion (RPE), and physical activity (Bond et al., 2019; García-Bravo et al., 2019). Therefore, patients using exergames rather than conventional exercise routines (e.g., walking, running, or cycling) have been reported to exercise for longer periods, meeting moderate to vigorous physical activity levels, with the perception of "work" being lower or less intense, and more enjoyable, contributing to healthier lifestyle initiatives (Glen et al., 2017; Gomez et al., 2018; Polechoński et al., 2019).

Considering the above deliberations, we have organized a randomized controlled crossover protocol to investigate rehabilitation of patients hospitalized with COVID-19. The aim of this protocol is to find out whether the motor performance, functionality, engagement, motivation, and physiological parameters are different during conventional or virtual intervention. We are interested in comparing conventional cardiovascular and musculoskeletal physical therapy interventions with typical movements and mobilization in different postures such as sitting and standing, using VR software that provides a game in which the participants continually move upper limbs and trunk to finish a motor task proposed by the application. Participants will therefore alternate their rehabilitation intervention (conventional or virtual) during their hospitalization period. Furthermore, we will be using a satisfaction scale to verify the level of engagement in the therapy during the rehabilitation program.

We hypothesize that all participants will show improvement in motor performance, functionality, and physiological parameters independent of the intervention (conventional or virtual environment); however, the use of a virtual task will provide more engagement and motivation. If our hypothesis is proven, it might be the beginning of a technological innovation in cardiorespiratory rehabilitation in hospitals.

METHODS/DESIGN

We registered this trial on ClinicalTrials.gov (NCT04537858). This article has been reported in accordance with the Standard Protocol Items Recommendations for Interventional Trials (SPIRIT) (Chan et al., 2013a,b; **Tables 1**, **2**).

Overview of the Study Design

A randomized controlled crossover protocol will be conducted, and all participants will undertake interventions in non-immersive VR–virtual intervention (with a serious game in web platform) and conventional intervention (with cardiovascular and musculoskeletal conventional physical therapy). All participants will be randomly divided in two groups: Group A will start the first day of the protocol with virtual intervention in the morning (their first rehabilitation session of the day) and the conventional intervention in the afternoon (their second rehabilitation session of the day). Group B will perform the reverse protocol (i.e., starting the first day of the protocol with conventional intervention in the morning and the virtual intervention in the afternoon) in a crossover design, during the hospitalization period (varying from 2 to 8 days according to individual needs). We chose two interventions per day, as it is the protocol of the Hospital of the Federal University of São Paulo (Hospital São Paulo) for inpatients in ambulatory unit.

Recruitment

Fifty participants will be recruited through the Hospital of the Federal University of São Paulo (Hospital São Paulo) located in São Paulo State, Brazil. Those interested in participation will undergo a detailed screening using the eligibility criteria for enrolment in the study. The sample size was calculated using a statistical software (G*Power 3.1.5) on the main outcome measure (i.e., the motor score). This calculation was based on data from five patients (pilot study). The power was 0.80; the α was 0.05, and the effect size was 0.65 (Cohen *d*). The sample estimation indicated that 40 participants would be necessary (i.e., 20 per group), and with an adjustment to allow for a withdrawal rate (20%), we will recruit 50 participants.

Inclusion Criteria

Participants will be included in the study if (1) they are aged between 18 and 90 years; (2) they are diagnosed as having COVID-19 by reverse transcription–polymerase chain reaction, immunoglobulin M, and immunoglobulin G (Corman et al., 2020; Zhong et al., 2020); (3) they are undergoing physical therapy during their hospitalization; and (4) they are able to sign consent form.

Exclusion Criteria

Participants will be excluded if (1) they do not understand the tasks—the understanding of the task will be evaluated through five attempts at each task in VR; (2) they do not want to use VR; (3) they are not in a physical condition to practice a motor task; (4) the use of an intravenous device makes it impossible to move the arms; (5) they have cardiac arrhythmias and an atrioventricular block or cardiac pacemaker; (6) they have congenital anomalies such as congenital heart defects or pulmonary malformations; and (7) they use drugs that interfere with autonomic nervous systems (ANSs), such as antiarrhythmic agents.

Withdrawal Criteria

Participants will be withdrawn from the study if they are not willing to continue.

Randomization

Participants will be randomly allocated to either Group A or Group B with a 1:1 allocation defined by a website (randomization.com). As we will have the participant's characteristics, immediately after the randomization the age and functional capacity (Barthel Index) will be compared between groups. If the groups are not homogeneous, a new randomization will be carried out. This protocol will be repeated until there is no difference between age and Barthel Index among groups (in a maximum of first three attempts at randomization, we always have homogeneous groups). Randomization will be under the control of a blinded investigator who will be the

TABLE 1 | SPIRIT: description of the study protocol, schedule of enrolment, interventions, and assessments.

	Study period										
	Enrolment	**Allocation**	**Post-allocation**							**Close-out**	
Timepoint	**0**	**0**	**t_1** 1 day	**t_2** 2 days	**t_3** 3 days	**t4** 4 days	**t5** 5 days	**t6** 6 days	**t7** 7 days	**t8** 8 days	**t9** 7 days after discharge	**t10** 1 month after discharge
ENROLLMENT												
Eligibility screen	X											
Informed consent	X											
Assessment scales	X											
Allocation		X										
INTERVENTIONS												
Group A												
Group B												
ASSESSMENT SCALES												
Barthel Index	X									X	X	X
Timed Up and Go (TUG)			X							X	X	X
Medical Research Council (MRC)			X							X	X	X
Brunel Mood Scale (BRUMS)			X							X	X	X
Enjoyment Scale (ES)			X	X	X	X	X	X	X	X	X	X
Visual Analogical Satisfaction Scale (VASS)			X	X	X	X	X	X	X	X	X	X
PHYSIOLOGICAL ASSESSMENT												
Heart rate variability (HRV)			X							X	X	X
The Borg Rating of Perceived Exertion (Borg scale)			X	X	X	X	X	X	X	X	X	X
Oxygen saturation (Sao_2)			X	X	X	X	X	X	X	X	X	X
Respiratory rate (RR)			X	X	X	X	X	X	X	X	X	X
Heart rate (HR)			X	X	X	X	X	X	X	X	X	X

only person allowed to manage the electronic security file of the randomization to locate the individuals. The investigator applying the interventions will then be informed about which group the participant was allocated to so they can conduct the protocol in the correct order of interventions.

Assessment Scales

We will use functional capacity, muscle strength, mood, enjoyment, satisfaction scales, and physiological assessment, which will be presented as follows:

Motor Function

For functional capacity, the following tests will be used: Barthel Index, Timed Up and Go (TUG), and Medical Research Council (MRC).

Barthel Index

The Barthel Index is a 10-item instrument measuring functional independence in personal activities of daily living—it reaches a score of 100. The Barthel Index is quick and easy to complete. The scoring instructions used for the Barthel Index have been modified to make the contribution of cognitive problems to functional dependency more explicit. The topics evaluated are as follows: (1) feeding, (2) moving from wheelchair to bed and return, (3) personal toileting (grooming), (4) getting on and off toilet, (5) bathing self, (6) walking on a level surface, (6a) propelling a wheelchair, (7) ascending or descending stairs, (8) dressing and undressing, (9) controlling bowels, and (10) controlling bladder. The Barthel Index has been shown to be appropriate for the assessment of patients' changes over time (Novak et al., 1996; Houlden et al., 2006; Eichhorn-Kissel et al., 2011).

TABLE 2 | Trial characteristics based on WHO Trial Registration Data Set.

Data category	Trial information
Primary registry and trial identifying number	ClinicalTrials.gov, ID: NCT04537858
Date of registration in primary registry	01 September 2020 on
Secondary identifying numbers	Ethics Committee of the Federal University of São Paulo, under the number CAAE: 33244620.5.0000.5505
Source(s) of monetary or material support	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior–Brasil
Primary sponsor	University of São Paulo
Secondary sponsor(s)	NA
Contact for public queries	TDS, CBMM
Contact for scientific queries	TDS, CBMM
Public title	Conventional intervention and non-immersive virtual reality in COVID-19
Scientific title	Comparison Between Benefits of Conventional Intervention and Non-immersive Virtual Reality in the Rehabilitation of Individuals in an Inpatient Unit for the Treatment of COVID-19: A Study Protocol
Country of recruitment	Brazil
Health condition(s) or problem(s) studied	COVID-19
Interventions	Group A: Subjects will start the first day of the protocol with virtual reality intervention and then in the second period will perform the conventional intervention. Group B: Subjects will start the first day with conventional intervention and in the second period will perform activity with virtual reality intervention. Both therapies will be performed on the same day at different times for 10 consecutive days
Key inclusion and exclusion criteria	Inclusion criteria: Agreement to participate in the research from themselves by signing consent form, a clinical and posterior blood analysis of COVID 19 infection, adults with age ranging from x to xx years. Exclusion criteria: Do not understand the tasks; the understanding of the task will be evaluated through five attempts at each task in virtual reality; do not want to use virtual reality task; was not in a physical condition to practice a functional task; use of an intravenous device that makes it impossible to move the arms; cardiac arrhythmias and atrioventricular block; congenital anomalies, such as congenital heart defects, pulmonary malformations; and patients who use drugs that interfere with ANS, such as antiarrhythmic agents
Study type Interventional allocation	Randomized
Masking	Randomization and data analyst
Assignment	Crossover
Primary purpose	Treatment
Date of first enrolment	June 2020
Target sample size	50
Recruitment status	Recruiting
Primary outcome(s)	Functional capacity improvement
Key secondary outcome(s)	HRV improvement

Timed Up and Go

The TUG test is a reliable, cost-effective, safe, and time-efficient way to evaluate overall functional mobility. The TUG may be used to assess and monitor physical activity in younger adults, especially those with physical and mental health risk factors. A sturdy armchair with a back will be placed at the end of a hallway or an area with space to perform the test. A piece of tape will be placed on the floor 3 m away from the front edge of the chair. Patients will be seated in the chair with back against the chair back, arms resting on the armrests, and given instructions on how to complete the task, including walking at a normal (rather than rapid) speed. The TUG will require patients to stand up out of the chair, walk 3 m, turn around, walk back to the chair, and sit down. Patients will be given the following instructions: "Stand up on the word 'go,' walk to the tape, turn around, walk back to the chair, and sit down." The timing of the test will begin at the word "go" and end when the participant is seated. Patients will perform the test one time; if a clear error is made, they will be asked to repeat the TUG. The dependent variable will be the test execution time (Bohannon, 2006; Herman et al., 2011; Kear et al., 2017).

Medical Research Council

This is an instrument adapted to assess muscle strength in critically ill patients. The result is obtained through the evaluation of six movements of upper limbs and lower limbs, and the strength is graded between 0 (plegia) to 5 points (normal strength). The maximum score is 60 points; values of <48 may indicate that the patient has muscle weakness (Craig et al., 2008; Schefold et al., 2020).

Mood, Enjoyment, and Satisfaction Scales

For mood, enjoyment, and satisfaction, the following tests will be used: Brunel Mood Scale (BRUMS), Enjoyment Scale (ES), and Visual Analogical Satisfaction Scale (VASS).

Brunel Mood Scale

This scale was developed to allow a quick measurement of the mood of adults and adolescents. BRUMS contains 24 simple mood indicators, such as feelings of anger, disposition, nervousness, and dissatisfaction that are noticeable by the individual being assessed. The evaluated responds to the scale according to how they feel about such sensations. The score is 5 points (0 = nothing to 4 = extreme). The question format is "How do you feel now," although other forms: "How have you felt this past week, including today" or "How do you normally feel" can be used. BRUMS takes about 1 to 2 min to complete. The 24 indicators of the scale comprise six subscales: anger, confusion, depression, fatigue, tension, and vigor (Rohlfs et al., 2008; Sties et al., 2014).

Enjoyment Scale

An enjoyment scale using smiley faces (0 is "not fun at all," 1 is "boring," 2 is "a bit of fun;" 3 is "fun," and 4 is "great fun") will be applied after the end of the game sequences, as the motivation may be related to the motor proficiency level.

This scale was developed by Jelsma et al. (2014) to evaluate how people feel when interacting with proposed non-immersive VR games. It was used in other studies using different games (Farhat et al., 2016; Smits-Engelsman et al., 2017) and by da Silva et al. (2020a) with the same game used in this study. In the present study, the scale will be applied in the first and last days of the protocol to verify the participant's level of satisfaction with the games presented.

Visual Analogical Satisfaction Scale

The 10-cm VASS assesses the level of satisfaction of the interviewed individuals. Patients will answer the questionnaire and be asked to mark a vertical line on the scale indicating satisfaction with rehabilitation, where zero (0) indicates very dissatisfied, and 10 indicates very satisfied (Brokelman et al., 2012; Voutilainen et al., 2016).

Physiological Assessments

For physiological assessment, the following tests will be used: The Borg Rating of Perceived Exertion (Borg Scale), heart rate variability (HRV), oxygen saturation (SpO_2), respiratory, and HR.

The Borg Rating of Perceived Exertion

The Borg Scale is a tool for monitoring the intensity of physical effort; it is one of the most useful instruments for the evaluation and quantification of the sensations of physical effort, also known as RPE. This is used both in the areas of high-performance sports and physical rehabilitation to monitor the changes caused by physical exercise in the cardiorespiratory, metabolic, and neuromuscular systems (Zamunér et al., 2011; Williams, 2017).

Heart Rate Variability

We will use HRV to analyze ANSs before, during, and after the intervention for recovery assessment. The analysis will follow the guidelines of the (Heart rate variability: standards of measurement, physiological interpretation and clinical use. Task force of the European Society of Cardiology and the North American Society of pacing and electrophysiology, 1996). The strap (for data collection) will be positioned on the participant's chest, and the Polar V800 (Polar Electro, Finland) HR receiver will be positioned next to it. HRV will be recorded after the initial assessments at rest for 20 min. For analysis of HRV data at rest, 1,000 consecutive resting rate intervals will be used (da Silva et al., 2018; Moraes et al., 2019). Heart rate will be recorded beat by beat throughout the protocol by the Polar V800 HR receiver, and resting rate intervals recorded by the monitor will be transferred to the Polar ProTrainer program, which allows HRV visualization and cardiac period extraction in the "txt." file format.

Moderate digital filtering will be performed in the program itself. HRV analysis will be performed using linear (time and frequency domain) that will be analyzed using Kubios HRV® software (Kubios HRV v.1.1 for Windows, Biomedical Signal Analysis Group, Department of Applied Physics, University of Kuopio, Finland) and non-linear methods (Vanderlei et al., 2009).

Oxygen Saturation

Pulse oximetry is widely used for patients who need continuous monitoring of SpO_2. Its main purpose is the early detection of hypoxemia in various situations and the monitoring of perfusion and circulation; monitoring is non-invasive (Diccini et al., 2011). Before starting therapy with VR and conventional therapy, SpO_2 will be measured. At the end of the respective therapies, SpO_2 will be checked again.

Respiratory Rate and Heart Rate

Respiratory rate (RR) and HR will be measured before starting and at the end of both VR and conventional interventions.

Blinding

The statistical analyst will be blinded throughout the treatment; i.e., the statistician will only know that there is a Group A and Group B carrying out the evaluations without information of what the treatment is, so that treatment of data is impartial.

Assessment Protocol

The assessment protocol will have the following sequence. The functional scale (Barthel Index) will be undertaken first to ensure balance in randomization as this is a key variable. This is followed by group randomization process. After that, assessment scales will be undertaken in a separate room (BRUMS, MRC, and TUG) and one physiological assessment (HRV). The assessment part of the protocol will take around 1 h.

Borg Scale, SpO_2, RR, and HR will be evaluated before and after each intervention. At the end of each day, ES and VASS questionnaires will be used to determine the individual's final perception of the intervention.

Intervention

After performing all the tests and questionnaires of the initial evaluation, the individuals will be divided into two groups: Group A: participants with COVID-19 who will start the first day of the protocol with virtual intervention and then in the second period will perform the conventional intervention (n = 25); and Group B: participants with COVID-19 who will start the first day with conventional intervention and in the second period will perform activity with VR intervention (n =

25). After the application of therapies, final evaluations will be carried out. The rehabilitation protocol will be applied during hospitalization, for 2–8 consecutive days, unless they withdraw from the study—the number of days may vary due to length of hospitalization.

Participants will perform the tasks individually in the hospitalization sector, in the presence of the evaluator responsible for providing the intervention and recording the results, considering the patient's general condition. According to the recommendations of the European Respiratory Society, conventional physiotherapy includes (1) mobilization: referring to physical activity sufficient to elicit acute physiological effects that enhance ventilation, central and peripheral perfusion, circulation, muscle metabolism, and alertness and are countermeasures for venous stasis and deep vein thrombosis; and (2) respiratory therapy: to improve global and/or regional ventilation and lung compliance and to reduce airway resistance (Gosselink et al., 2008).

Conventional Intervention

We stipulate a protocol that considers motor physiotherapy conducted for 10 min, which will be performed at the bedside with mobilization exercises to activate the upper and lower limbs, orthostatic training, static and dynamic balance, and walking through the corridor.

Virtual Intervention

During the protocol, the participants will perform tasks in a non-immersive VR environment for 10 min. Thus, we will use the MoveHero game (for details and publication, see Martins et al., 2019) that provides mobilization exercises to activate the upper and lower limbs, orthostatic training, and static and dynamic balance. The software that will be used was developed by the Research Group and Technological Applications in Rehabilitation group from the School of Arts, Sciences, and Humanities of the University of São Paulo and can be accessed at www.movehero.com.br/en.

MoveHero

MoveHero, as presented by Martins et al. (2019), is a game that displays falling spheres in four imaginary columns on the computer screen, with a musical rhythm selected by the researcher. This is also considered a coincident timing task; the action is to react (using the upper limbs) and not let the balls pass the fixed targets. The spheres should only be intercepted when they reach the targets allocated in parallel (at two height levels), two on the left (left position targets A and B) and two on the right of the participant (right position targets C and D), as shown in **Figure 1**. The virtual contact is performed by the avatar of the individual, i.e., a representation of the individual appears on the computer screen. The individuals move their arms and trunk (only if they can move the trunk) in front of the webcam to coincide with the moment the ball touches the target. The individual is positioned at a distance of ~1.5 m from the computer monitor and waits for the balls (which fall randomly on each target) to drop. The avatar's hand should reach the target sphere along with the arrival of the ball, and

FIGURE 1 | Representative design of the MoveHero software performed during treatment intervention, with representation of hits (bottom left figure) with sphere turning into blue with stars, and misses (bottom right figure) with a red X.

the game offers feedback on correctness and error by means of changing the spheres' color (green for correct and a red line for error).

Thus, the participants will play the MoveHero game in a bedside standing or seated position (depending on the patient's capacity), where they have to move their arms and body/trunk to catch the falling spheres. After this motor intervention, the participants will also receive respiratory physiotherapy for 10 min, during which they will perform exercises of respiratory reeducation.

Procedure

Immediately before the beginning of each therapy (virtual intervention or conventional intervention), two assessment scales will be made (BORG Scale, Visual Analog Scale) and four physiological assessments [HRV, SpO_2, RR, and HR]. Group A will start the first day of the protocol with virtual intervention (in the morning) and then in the second period (in the afternoon) will perform the conventional intervention, and Group B will perform the reverse protocol, in a crossover format. It will be applied for up to 8 consecutive days. On the last day, assessment scales will be repeated in a separate room, as well as the physiological assessments. After 7 days and 1 month of hospital discharge, all assessment scales will be undertaken at patients' homes, and the virtual intervention will be applied again (**Figure 2**).

Primary Outcome

We will observe changes in the ANSs after intervention with VR and conventional therapy in inpatients with COVID-19, during hospitalization and after 7 and 30 days of follow-up after hospital discharge.

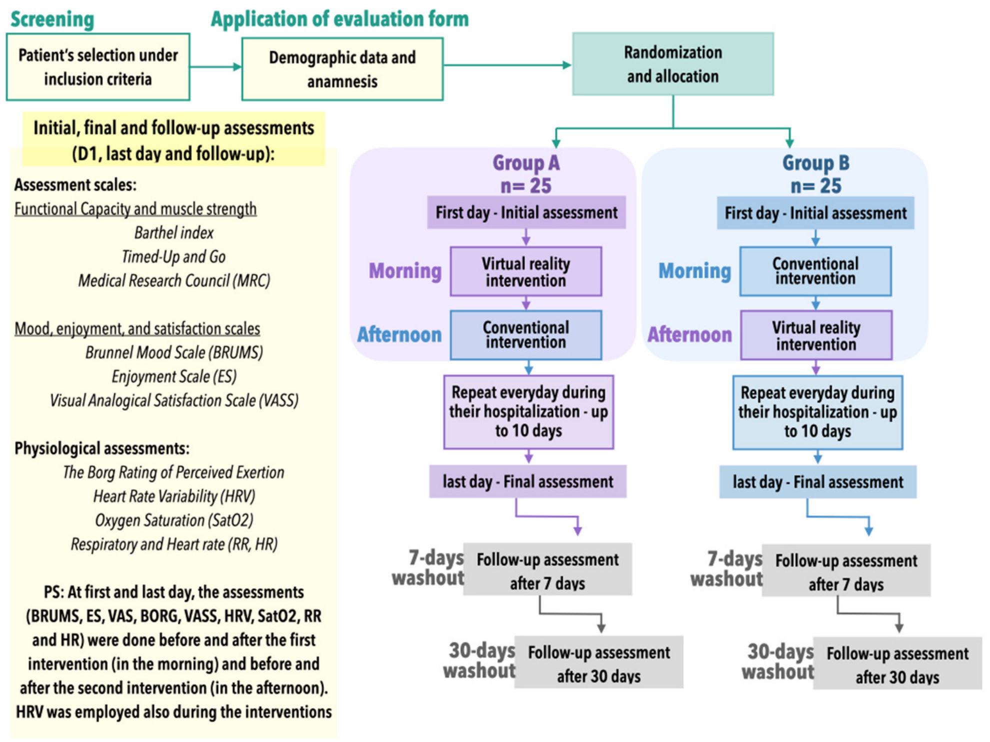

FIGURE 2 | Study design.

Secondary Outcome

We will analyze changes in mood, satisfaction, and enjoyment regarding the interventions, RPE, and functionality in both interventions.

Statistical Analysis

Statistical analysis will be performed using IBM-SPSS (version 26.0, IBM Corp., Armonk, NY, USA). As dependent variables, all HRV indices will be considered, as well as test scores of Barthel Index, TUG, MRC, BRUMS, ES, VASS, Borg Scale, SaO_2, RR, and HR. If the data meet the assumptions of normality, multiple analysis of variance will be used to compare the study groups (virtual group and conventional group) and intragroup comparison (virtual and conventional groups, when comparing the same subject), with least significant difference *post-hoc* test. If the data do not meet the assumptions of normality, the differences between the groups will be analyzed using the Kruskal–Wallis test. Dunn *post-hoc* tests will be performed on each pair of groups, with Dunn–Bonferroni post-test on each pair of groups. The same tests will be applied for $p < 0.05$, which will be considered significant.

DISCUSSION

Rehabilitation was a critical aspect of the healthcare systems during the COVID-19 pandemic; therefore, it is important to prepare new interventions that allow healthcare providers to maximize responses to future rehabilitation challenges (Stein et al., 2020). COVID-19 survivors suffer from reduced lung function, critical illness polyneuropathy and myopathy, cardiorespiratory deconditioning, and impairment in all activities of daily living. Hermann et al. (2020) demonstrated that cardiopulmonary rehabilitation could be performed safely and with beneficial effect to COVID-19 patients, as long as proper safety precautions, close medical management, and supplemental oxygen are available and used if needed.

Moreover, despite studies reporting successful use of the VR in management of different respiratory disabilities (Mazzoleni et al., 2014; Alvarez et al., 2017; Jung et al., 2020; Rutkowski et al., 2020; Taslimipour et al., 2020), lung cancer (Abushakra and Faezipour, 2013), post-thoracotomy lung cancer (Hoffman et al., 2014), and cystic fibrosis (Salonini et al., 2015), the knowledge of the use of this technology in a hospital environment is still scarce. Thus, we organized this study to verify the possibility of using software with VR tasks to encourage physical activity during COVID-19 treatment. Although we hypothesize that all participants will improve in motor, functional, and physiological parameters independent of the intervention (conventional or virtual environment), the use of virtual tasks could provide a more engaging intervention. We can speculate that these results will have a positive influence on rehabilitation programs designed for these patient groups and can be used as an adjunctive for conventional therapy, reducing the suffering of patients during hospitalization. This protocol study therefore aims to answer two important questions:

1. Engagement and motivation: So far, few studies have addressed the motivational and engagement issue within rehabilitation programs (da Silva et al., 2020a). According to Karloh et al. (2020), conventional intervention in rehabilitation following international guidelines does not promote enough motivational changes to ensure engagement and maintenance of physical activity. New technologies (such as platforms and software for rehabilitation) have been suggested as alternatives to improve access and increase capacity of conventional outpatient rehabilitation; however, there has not yet been evidence of a positive impact on behavioral outcomes. Furthermore, an underactive reward system dampens an individual's motivation to engage in activities that are usually experienced as pleasurable. COVID-19 provides the perfect stage for the propagation of demotivation cycle; decreasing engagement, it could also negatively impact mental health (Hagerty and Williams, 2020). Thus, we believe that VR intervention during hospitalization will provide a differentiated form of intervention, positively impacting motivation and engagement in people who are under treatment for COVID-19.
2. Development and use of non-commercial games: A systematic review by Bonnechère et al. (2016) showed that in most cases the introduction of commercial training games for physical rehabilitation offered positive results. However, commercial games are designed for entertainment and are sometimes unsuitable for rehabilitation; there is no possibility of controlling important rehabilitation variables, and it is difficult to adapt the game to the patient necessity (Alankus et al., 2010; Crocetta et al., 2018). An important question is the potential and future use of customized serious games, defined as a game developed for specific target (Leal et al., 2020). Therefore, for the present study, we selected a serious game developed for individuals with physical difficulties to encourage and enhance motivation to engage in physical therapy during hospitalization.

We believe that the results of this study will provide scientific support in the use of VR software for rehabilitation of patients with COVID-19 during their hospitalization.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee of the Federal University of São Paulo, under the number CAAE: 33244620.5.0000.5505. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

TS designed the study, revised the manuscript, performed the statistical analyses, and interpreted the data. PO, JD, AS, CR, and RG collected patient data and drafted the article. ED, MF, ÍM, DS, VB, LA, and HS provided assistance on patient data collection and revised the manuscript. SB and CF revised the manuscript critically for intellectual content. CM coordinated the study, drafted the article, and revised the manuscript critically for intellectual content. All authors read and approved the final manuscript.

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Physical Activity and Psychological Well-Being During the COVID-19 Lockdown: Relationships With Motivational Quality and Nature Contexts

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The COVID-19 pandemic is a global event that has already had substantive negative impacts on psychological well-being. This study investigated the relationship between physical activity (PA) and psychological well-being during a country-wide COVID-19 lockdown in New Zealand. Motivational quality and PA context (nature-based or non-nature-based) were included as potential mediating and moderating variables within this relationship, respectively. Participants completed an online survey assessing psychological well-being, weekly PA levels, and PA during the second and third weeks of the 7 week COVID-19 lockdown period in New Zealand. Data were analysed using Partial Least Squares Structural Equation Modelling. Results showed that PA significantly predicted psychological well-being, with no significant difference evident in psychological well-being dependent on whether PA was nature or non-nature-based. Nature-based PA was a stronger predictor of intrinsic motivation compared to non-nature-based PA, and intrinsic motivation was positively associated with psychological well-being. In contrast, non-nature-based PA was a stronger predictor of introjected regulation compared to nature-based PA, which was negatively associated with psychological well-being. Overall, these findings suggest that (1) weekly PA was associated with increased psychological well-being during the lockdown, and (2) nature-based PA may foster psychological well-being via effects on motivation. The implications for continued participation in PA will be discussed.

Keywords: physical activity, motivation, psychological well-being, nature, COVID-19

INTRODUCTION

On January 30, 2020, the World Health Organisation (WHO) designated the COVID-19 outbreak a pandemic (World Health Organisation, 2020a). In New Zealand (NZ), the government declared a mandatory "Level 4 Lockdown" to control the virus spread, which lasted from March 25 to April 27, 2020. During this time period, residents were urged to stay at home unless undertaking a limited range of "essential" activities, including for certain types of employment (e.g., healthcare), shopping for essential groceries, medical reasons, and outdoor exercise or recreation. Further, people were required to maintain a physical distance of at least 2 metres from others outside their households. The restrictions imposed in the NZ lockdown are similar to those employed internationally.

The inclusion of exercise and recreation as a permissible outdoor activity (albeit in the vicinity of people's homes) was based on the New Zealand government's assertion that "exercise and recreation is an important part of maintaining our health and well-being," with a particular emphasis on exercise being "good for mental health" (New Zealand Government, 2020, para 1). Thus, encouraging outdoor physical activity (PA) formed a part of the government's attempt to mitigate the potential for psychological distress related to COVID-19 events. Indeed, it was predicted that the mental health fallout from COVID-19 would include high levels of psychological distress arising from health concerns, social isolation or relationship friction, and long-term financial insecurity (Anderson, 2020). Research undertaken during the lockdown period in New Zealand (e.g., Every-Palmer et al., 2020) and globally (e.g., Roma et al., 2020; Vindegaard and Benros, 2020) supported these predictions providing evidence of increased depression, anxiety, and psychological distress.

Emphasising PA as a buffer against psychological distress and preserving psychological well-being stems from a robust evidence base, and has been advocated internationally as a way to reduce the negative impacts of the pandemic (World Health Organisation, 2020b). This raised the question of whether being physically active during lockdown influenced psychological well-being.

Psychological well-being is defined as the "personal perception and experience of positive and negative emotional responses and global and domain-specific cognitive evaluations of satisfaction with life" (Proctor, 2014, p. 275). Regular PA has been consistently associated with psychological well-being (Biddle et al., 2003), particularly leisure-time PA (White et al., 2017), as well as reduced psychological distress across the lifespan (e.g., Allison et al., 2005; George et al., 2012). Thus, the extant literature suggests that PA may have been a significant means of maintaining psychological well-being in the disruptive and potentially distressing context of a COVID-19 lockdown (Every-Palmer et al., 2020).

An important factor in whether an individual undertakes (and maintains) PA is the type of motivation that individual has for PA. Within the framework of self-determination theory (SDT; Ryan and Deci, 2017), motivation is described in terms of its quality, ranging from amotivation (a lack of motivation) to controlled and autonomous forms of motivation. In relation to PA, amotivation represents a motivational state wherein an individual sees no value in PA. Thus, they are likely to be either inactive or on the verge of discontinuing PA. Controlled motivation describes undertaking an activity out of obligation, either due to external rewards or punishments (known as *external regulation*) or internalised, self-imposed pressure (known as *introjected regulation*). In relation to PA, controlled motivation manifests when an individual is exercising because they feel they *have to* (e.g., to obtain a certain body image, to please significant others, or for other ego-based reasons; Ryan and Deci, 2017).

In contrast, autonomous motivation refers to an individual experiencing a sense of volition, choice, and self-endorsement when engaging in an activity or behaviour (Deci and Ryan, 2002). This could mean undertaking an activity for its own sake out of enjoyment or love (*intrinsic motivation*), or because the activity aligns with an individual's sense of self (*integrated regulation*) or personally-held values (*identified regulation*). Thus, autonomous motivation for a given behaviour is associated with more "authentic" living in the sense of behaving in line with one's personally chosen values (Deci and Ryan, 2008; Milyavskaya and Koestner, 2011; Hortop et al., 2013). Within the context of PA, autonomous motivation is consistently associated with long-term adherence to PA behaviour, whereas controlled motivation has been associated with higher levels of attrition (Teixeira et al., 2012).

Autonomous motivation is positively associated with psychological well-being while controlled motivation is negatively associated with psychological well-being (Briki, 2016), due to a perceived need to comply with external demands and subsequent feelings of guilt or shame if the behaviour in question is not undertaken (Ryan and Deci, 2017). To the authors' knowledge, the relationship between amotivation and psychological well-being has not been researched. However, because amotivation is characterised by a lack of control over one's own behaviour (Stavrou, 2008), it has been suggested to be associated with poor functioning and depressed symptoms (Briki, 2016) and thus is likely to have a negative relationship with psychological well-being.

During New Zealand's lockdown period, the government encouraged low-risk outdoor PA (New Zealand Government, 2020). This allowed for nature-based PA, defined as "any outdoor area with greenery or other natural features that contrast with the built environment" (Lackey et al., 2019, p. 2), encompassing a wide range of environments including forests, parklands, lakes, wetlands, and beaches. There is growing evidence that nature-based PA can confer additional benefits for psychological well-being beyond those conferred by PA alone. For example, one systematic review identified that nature-based PA provides synergistic psychological benefits beyond those attained from PA in non-natural environments (Thompson Coon et al., 2011). More recently, Eigenschenk et al.'s (2019) review identified a wide range of benefits specifically associated with nature-based PA, including: enhanced general well-being, psychological stability, life satisfaction, emotional intelligence, intellectual flexibility, mindfulness, empathy, self-esteem, self-actualisation, social capital, educational performance, and intrinsic motivation.

The potential influence of nature on motivational quality has also been recognised. Wolsko and Lindberg (2013) posited that spending time in nature ultimately reduces the influence of others on one's self-worth (controlled motivation) and instead cultivates internally-driven motives (autonomous motivation). Indeed, there is growing evidence that nature-based PA is associated with autonomous motivation, most notably in the form of intrinsic motivation (e.g., Gladwell et al., 2013; Eigenschenk et al., 2019) and that nature-based PA is more likely to be associated with autonomous motivation and adherence to PA compared to non-nature-based PA (Fraser et al., 2019).

Thus, there are both suggested and established associations amongst motivational quality, psychological well-being, and PA (in and away from nature). There is scope to explore these relationships during the events of COVID-19 in order to better understand how PA within different contexts may influence psychological well-being under times of psychological distress. During the COVID-19 lockdown, we might expect PA to have at least mitigated the psychological distress that we know was present during this period. In addition, nature-based PA may have conferred psychological benefits above and beyond non-nature-based PA via mechanisms related to motivational quality. We set out to examine the relationships amongst these variables.

Based on the literature reviewed, the aims of the present study were 2-fold. First, to investigate the relationship between PA, motivational quality and psychological well-being during the COVID-19 lockdown. Second, to investigate the potential influence of PA context (nature vs. non-nature based) on motivational quality and psychological well-being.

We had two research questions. During the NZ lockdown period: (1) Was there a relationship between weekly PA and psychological well-being? If so, was this relationship moderated by PA context (nature vs. non-nature)?; (2) Did motivational quality mediate the relationship between weekly PA and psychological well-being? If so, did this mediating role vary by PA context (nature vs. non-nature)? Hypothesised relationships amongst variables can be seen in **Table 1**.

TABLE 1 | Hypothesised relationships amongst variables.

Research question 1	
Hypothesis (H) 1	Weekly PA will positively predict psychological well-being, and this relationship would be significantly stronger in a nature-based PA context compared to a non-nature-based PA context.
Research question 2	
H2	Amotivation will negatively mediate the relationship between weekly PA and psychological well-being.
H3	External regulation will negatively mediate the relationship between weekly PA and psychological well-being.
H4	Introjected regulation will negatively mediate the relationship between weekly PA and psychological well-being.
H5	Identified regulation will positively mediate the relationship between weekly PA and psychological well-being.
H6	Integrated regulation will positively mediate the relationship between weekly PA and psychological well-being.
H7	Intrinsic motivation will positively mediate the relationship between weekly PA and psychological well-being.
H8	The structural relationships among the constructs in the model will be stronger in a nature-based PA context, compared to the non-nature-based PA context.

MATERIALS AND METHODS

Participants and Sampling

Participants were sought across the general NZ population. The inclusion criteria stipulated that participants must be aged 18 years or older and living in NZ for the duration of the lockdown period. Participants were excluded if they had any contraindications (e.g., illness, injury) that prevented PA during the lockdown period. These criteria were assessed via screening questions at the beginning of the survey. A convenience sample was recruited using social media recruitment methods (Akers and Gordon, 2018) and a virtual snowball recruitment technique (Baltar and Brunet, 2012). Study information was shared via Facebook and circulated via email to contacts at large universities and other NZ organisations (e.g., regional and national sports organisations, city councils) for dissemination through their networks. This study comprises part of a larger project investigating determinants and outcomes of PA as a result of the COVID pandemic.

A cross-sectional survey, hosted by the online survey platform Qualtrics, was conducted for 8 days between the second and third weeks (April 8 to April 15, 2020) of NZ's Level 4 lockdown period. The full project survey took an average of 12 min to complete. Ethical approval was obtained prior to data collection from a university ethics committee (redacted for peer review; reference: D20/214). All participants provided online informed consent before completing the survey. The survey elicited 858 responses. Following data cleaning, which omitted cases with too much missing data (<5% missing data for each variable; 99 cases), data from 759 participants were analysed.

Survey Measures

The survey measured weekly PA, nature-based PA, psychological well-being, and motivational quality in relation to PA, using the instruments below.

Weekly PA Levels

The International Physical Activity Questionnaire-Short Form (IPAQ-SF; Craig et al., 2003) is a 7-item measure of self-reported PA, measuring the amount of moderate- and vigorous-intensity PA, walking, and sitting undertaken by participants over the previous 7 days. Example items include: "During the last 7 days, on how many days did you do vigorous activities like heavy lifting, exercise classes, or fast cycling for at least 10 min at a time?" followed by the question: "How much time did you usually spend doing vigorous physical activities on one of those days?" The IPAQ-SF has demonstrated good validity and consistency (e.g., Lee et al., 2011).

Nature-Based PA

Participants were asked if they had the opportunity to be physically active in nature ("Do you currently have the option to be active in or around natural environments?"). Participants responding with "yes" were then asked: "In the past 7 days, have you participated in any nature-based physical activity?".

Psychological Well-Being

The World Health Organisation Well-Being Index (WHO-5; World Health Organisation, 1998) is a self-report measure of subjective psychological well-being, containing five items scored on a Likert-type scale ranging from 0 (at no time) to 5 (all of the time). The item "Thinking about yourself and how you have felt over the last 7 days, to what extent have you felt…" is followed by items that include: "I woke up feeling fresh and rested" and

"I have felt calm and relaxed." The WHO-5 has been shown to have high reliability and validity across many different samples in different countries (Topp et al., 2015).

Motivational Quality

The Behavioural Regulation in Exercise (BREQ-3 PA version; Markland and Tobin, 2004) was used to measure motivation for PA. The BREQ-3 contains 24 items, each scored on a 5-point Likert-type scale from 0 (not true for me) to 4 (very true for me). Example autonomous motivation items include: "I am physically active because I enjoy it" (intrinsic motivation), "It's important to me to be regularly physically active" (identified regulation) and "I consider physical activity as part of my identity" (integrated regulation). Controlled items include: "I feel ashamed when I miss a physical activity session" (introjected regulation) and "I take part in physical activity because my friends/family/partner say I should" (external regulation). The measure also includes a subscale pertaining to a lack of motivation for PA ("I do not see the point in being physically active"). Previous research has shown that the BREQ-3 has high reliability and validity (MacDonald's $\omega = 0.93$) and its six-factor structure has been supported (e.g., Jenkins et al., 2020).

Data Cleaning

For the IPAQ-SF, data screening, cleaning, and coding were undertaken according to Craig et al.'s (2003) detailed guidelines. This included the truncation of data points indicating more than 960 min of PA per week as these are suggested to be outliers (Craig et al., 2003). Very low missing data were present for the items used in the structural model (<5% missing data for each variable), and the Little's Missing Completely at Random test produced a non-significant result, meaning data was missing completely at random. Thus, any missing data was estimated using the Expectation-Maximisation algorithm (Peters and Enders, 2002).

Data Analysis

Partial Least Squares Structural Equation Modelling (PLS-SEM) using SmartPLS (v. 3.2.7) (Ringle et al., 2018) was used for data analysis. PLS-SEM was used over covariance-based SEM (CB-SEM) due to the main objective of this study being the prediction of psychological well-being instead of theory testing and model validation (which is usually the focus of CB-SEM) (Hair et al., 2017). In addition, there was evidence of some non-normality in our data (see **Table 3**, skewness and kurtosis), and PLS-SEM is useful in such situations as it is a non-parametric method that can tolerate mild departures from normality within the data (Hair et al., 2017). Also, PLS-SEM allows issues with regard to sample and sub-sample size limitations to be overcome when dealing with complex models and moderation analysis. Thus, PLS-SEM was used as the model to be estimated was complex relative to sample size, comprising 11 latent constructs with multiple indicators (Haenlein and Kaplan, 2004). In addition, PLS-SEM is more sensitive than CB-SEM in detecting moderator effects given its effectiveness in dealing with measurement error, which also functions to decrease sample size requirements (Lowry and Gaskin, 2014).

Sample Size Adequacy

A priori and *post-hoc* power analyses using G*Power was used to determine the adequacy of the sample size (Faul et al., 2009). Using a suggested minimum R^2 value of 0.10, a statistical power of 95%, and nine predictors (the psychological well-being construct has the largest number of predictors) (Cohen, 1988), the a priori G* Power calculation indicated that a minimum sample size of 211 would be required. In addition, the *post-hoc* G* Power calculation for a minimum R^2 of 0.10, a sample size of 759 (the number of usable responses obtained), and nine predictors indicated that the statistical power achieved using the study's sample size was 1.0, which is well above Cohen's (1988) recommendations, thus, justifying the adequacy of our sample size.

Common Method Bias

Common method bias (CMB) was mitigated through *post-hoc* analysis following Podsakoff et al.'s (2003) recommendations. We applied the marker variable approach using the steps designed for PLS-SEM (Rönkkö and Ylitalo, 2011). Specifically, we estimated the structural model with and without a marker construct as an exogenous variable predicting each construct. Firstly, the correlations between the marker construct and all constructs in the model were very low (correlations ranging between −0.13 and 0.07), and its effect on all constructs were non-significant. Secondly, comparing of results between the structural models, with and without, the marker construct showed no notable differences, and all theorised paths maintained similar path estimates and levels of statistical significance. Thus, the *post-hoc* analysis does not suggest a threat of CMB for this study (Podsakoff et al., 2003; Rönkkö and Ylitalo, 2011).

RESULTS

We first present the descriptive statistics obtained from our sample, followed by the measurement models (the outer model analysis), including internal and indicator reliability, and convergent and discriminant validity of the constructs in our sample. We then describe the relationships amongst the variables in terms of mediation and moderation analysis (inner model analysis) in relation to our research questions and hypotheses.

Descriptive Statistics of the Sample

Participants' mean, and median, age was 43 years (range = 18–81 years, sd = 13.71). They were predominantly employed (90.5%), female (73%), and NZ European (82.9%; 0.9% identified as Māori; 0.6% identified as Chinese; 13.2% identified as Other). Essential workers comprised 13.8% of respondents. Many participants had some form of postgraduate education (46.4%) and approximately half were married (50.2%). Descriptive statistics, including mean scale scores, can be seen in **Table 2**.

Outer Model Analysis: Assessing the Measurement Models

Internal reliability of all constructs was established with Cronbach's α and Composite Reliability values >0.7 (Hair et al., 2017) (see **Table 3**). Indicator reliability for all constructs was

TABLE 2 | Descriptive statistics of the sample.

Variable	Category	*N* (%)
Gender	Male	195 (26.2)
	Female	544 (73.0)
	Gender diverse	3 (0.4)
	Prefer not to say	3 (0.4)
Education	No formal qualification	10 (1.3)
	Less than high school	7 (0.9)
	High school graduate	32 (4.3)
	Some university / tertiary	53 (7.1)
	Certificate or diploma	90 (12.1)
	University undergraduate degree	208 (27.9)
	Postgraduate and above	345 (46.3)
Ethnicity	New Zealand European	574 (82.9)
	Māori	6 (0.9)
	Samoan	1 (0.1)
	Cook Island Māori	2 (0.3)
	Chinese	4 (0.6)
	Indian	2 (0.3)
	Other	91 (13.2)
	Prefer not to say	12 (1.7)
Employment	Yes	674 (90.5)
	No	71 (9.5)
Essential worker	Yes	102 (13.8)
	No	638 (86.2)
Relationship status	Single	140 (21.8)
	Married	381 (50.2)
	Divorced	14 (2.2)
	De facto partnership	94 (14.7)
	Civil partnership	3 (0.5)
	Prefer not to say	9 (1.4)

Age

Mean = 43.04; S.D. = 13.71, Median = 43, Mode = 55, Lowest age = 18, Highest age = 81

Amotivation

Mean = 0.16, S.D. = 0.507

External Regulation

Mean = 0.65, S.D. = 0.938

Introjected Regulation

Mean = 2.14, S.D. = 1.263

Identified Regulation

Mean = 3.35, S.D. = 0.853

Integrated Regulation

Mean = 2.76, S.D. = 1.252

Intrinsic Motivation

Mean = 3.09, S.D. = 0.969

Psychological Well-Being

Mean = 58.06, S.D. = 24.69

established as all indicators had outer loadings >0.6. Convergent validity of all constructs was established as all AVE values >0.5. Discriminant validity of all constructs was established as the confidence intervals for the Heterotrait-Monotrait ratio (HTMT) of the correlations among all latent constructs did not include 1 (Hair et al., 2017).

Inner Model Analysis: Direct, Indirect, and Moderation Analysis

There were no collinearity issues among the predictor constructs with all VIF values <5 (Hair et al., 2017). The results of the direct and indirect effects of the exogenous variables on the endogenous variables are shown in **Table 4**. In terms of the model's predictive relevance, the Stone-Geisser Q^2 values obtained through the blindfolding procedure (omission distance = 7) for the endogenous constructs of amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, intrinsic motivation, nature relatedness, and psychological well-being were >0, supporting the predictive relevance of the model (Hair et al., 2017) (**Table 4**). Finally, due to evidence for differences in motivation across gender (e.g., Lauderdale et al., 2015) and age (e.g., Brunet and Sabiston, 2011), we controlled for these variables in the current analysis. Due to the fact that this was an exploratory study that was focused on isolating the effects of nature-based PA and motivation on the baseline model, other demographic variables (education, ethnicity, employment status, relationship status) were not controlled for within the analysis. Further, there was no theoretical grounding for differences amongst these demographic variables.

The structural model (see **Figure 1**) was cross-validated across the moderating variable of nature-based PA, meaning, whether the respondent had engaged in PA that was nature-based (N = 520) or not (N = 239), through Partial Least Squares Multi Group Analysis (PLS-MGA). Multi group permutation tests were used to assess whether there were significant differences in the path estimates between participants who undertook nature-based PA and those who undertook non-nature-based PA. These between-group differences are described in relation to their associated research questions (see **Table 5**).

Research Question 1: Was There a Relationship Between Weekly PA and Psychological Well-Being? Was This Relationship Moderated by PA Context (Nature vs. Non-nature)?

Weekly PA significantly predicted psychological well-being (β = 0.17, effect size = 0.028, 95% confidence interval (CI) = 0.09–0.25). However, PA context did not moderate this relationship. Thus, hypothesis 1 was partially supported. Relevant results are shown in **Table 4** and **Figure 1**.

Research Question 2: Did Motivational Quality Mediate the Relationship Between Weekly PA and Psychological Well-Being? If So, Did This Mediating Role Vary by PA Context (Nature vs. Non-nature)?

Controlled Forms of Motivation

Results demonstrate that amotivation and external regulation *did not* mediate the relationship between weekly PA and psychological well-being. Thus, hypotheses 2 and 3 were rejected. Results supported hypothesis 4 in showing that introjected regulation negatively mediated the relationship between weekly PA and psychological well-being (indirect path estimate = −0.03,

TABLE 3 | The (outer) structural model.

Latent construct	Indicators	Mean	S.D.	Skew	Kurtosis	Outer loadings	Cronbach's α	Composite reliability	Average	HTMT	R^2	Q^2
Amotivation (AMOT)	AMOT1	0.19	0.545	3.560	14.444	0.823	0.847	0.897	0.685	Does not include 1	0.082	0.054
	AMOT2	0.18	0.533	3.432	12.753	0.852						
	AMOT3	0.15	0.493	4.288	22.236	0.816						
	AMOT4	0.12	0.455	4.604	24.788	0.821						
External regulation (EXT)	EXT1	0.95	1.053	0.821	−0.212	0.866	0.872	0.909	0.715	Does not include 1	0.013	0.007
	EXT2	0.63	0.941	1.447	1.464	0.873						
	EXT3	0.45	0.828	2.039	4.057	0.79						
	EXT4	0.58	0.928	1.639	2.164	0.852						
Introjected regulation (INTRO)	INTRO1	2.73	1.146	−0.593	−0.444	0.835	0.854	0.899	0.691	Does not include 1	0.031	0.018
	INTRO2	1.65	1.270	0.207	−1.011	0.807						
	INTRO3	1.88	1.354	0.088	−1.137	0.828						
	INTRO4	2.31	1.281	−0.262	−0.964	0.855						
Identified regulation (IDENT)	IDENT1	3.47	0.808	−1.509	1.918	0.88	0.848	0.898	0.687	Does not include 1	0.181	0.121
	IDENT2	3.60	0.716	−1.948	4.042	0.811						
	IDENT3	3.55	0.704	−1.569	2.503	0.847						
	IDENT4	2.78	1.184	−0.713	−0.368	0.774						
Integrated regulation (INTEG)	INTEG1	2.93	1.126	−0.859	−0.095	0.801	0.907	0.936	0.785	Does not include 1	0.194	0.151
	INTEG2	2.53	1.400	−0.542	−1.012	0.923						
	INTEG3	2.61	1.381	−0.616	−0.918	0.922						
	INTEG4	2.98	1.102	−0.975	0.245	0.892						
Intrinsic motivation (INTRIN)	INTRIN1	2.85	1.044	−0.720	0.115	0.891	0.938	0.955	0.842	Does not include 1	0.184	0.154
	INTRIN2	3.17	0.919	−1.003	0.659	0.933						
	INTRIN3	3.06	0.984	−0.961	0.616	0.934						
	INTRIN4	3.26	0.930	−1.274	1.342	0.913						
Psychological well–being (PWB)	PWB1	64.90	20.98	−0.832	0.167	0.83	0.859	0.896	0.632	Does not include 1	0.19	0.100
	PWB2	62.48	22.86	−0.642	−0.218	0.796						
	PWB3	52.96	25.51	−0.218	−0.864	0.808						
	PWB4	50.75	28.14	−0.151	−0.967	0.751						
	PWB5	59.21	25.98	−0.242	−0.829	0.787						

TABLE 4 | Inner model analysis (baseline model).

Path estimates of baseline model	Path coefficient	Effect size (f^2)	95% CI
Weekly PA Total→Amotivation	**−0.29**	**0.089**	**−0.34 to −0.24**
Weekly PA Total→External Regulation	**−0.12**	**0.014**	**−0.19 to −0.04**
Weekly PA Total→Introjected Regulation	**0.18**	**0.032**	**0.083–0.258**
Weekly PA Total→Identified Regulation	**0.43**	**0.221**	**0.37–0.48**
Weekly PA Total→Integrated Regulation	**0.44**	**0.241**	**0.38–0.50**
Weekly PA Total→Intrinsic Motivation	**0.43**	**0.225**	**0.38–0.483**
Weekly PA Total→Psychological Well-Being	**0.17**	**0.028**	**0.09–0.25**
Amotivation→Psychological Well-Being	0.06	0.003	−0.03–0.15
External Regulation→Psychological Well-Being	0.01	0	−0.07–0.08
Introjected Regulation→Psychological Well-Being	**−0.17**	**0.03**	**−0.25 to −0.09**
Identified Regulation→Psychological Well-Being	0.09	0.00	−0.061–0.23
Integrated Regulation→Psychological Well-Being	0.10	0.00	−0.04–0.24
Intrinsic Motivation→Psychological Well-Being	**0.14**	**0.01**	**0.01–0.26**
Weekly PA Total→Introjected Regulation→Psychological Well-Being*	**−0.03**	n/a	**−0.05 to −0.01**
Weekly PA Total→Intrinsic Motivation→Psychological Well-Being*	**0.06**	n/a	**0.01–0.12**

For brevity, only the indirect effects that were significant for the baseline model are presented in this table. Significant coefficients in **bold.*

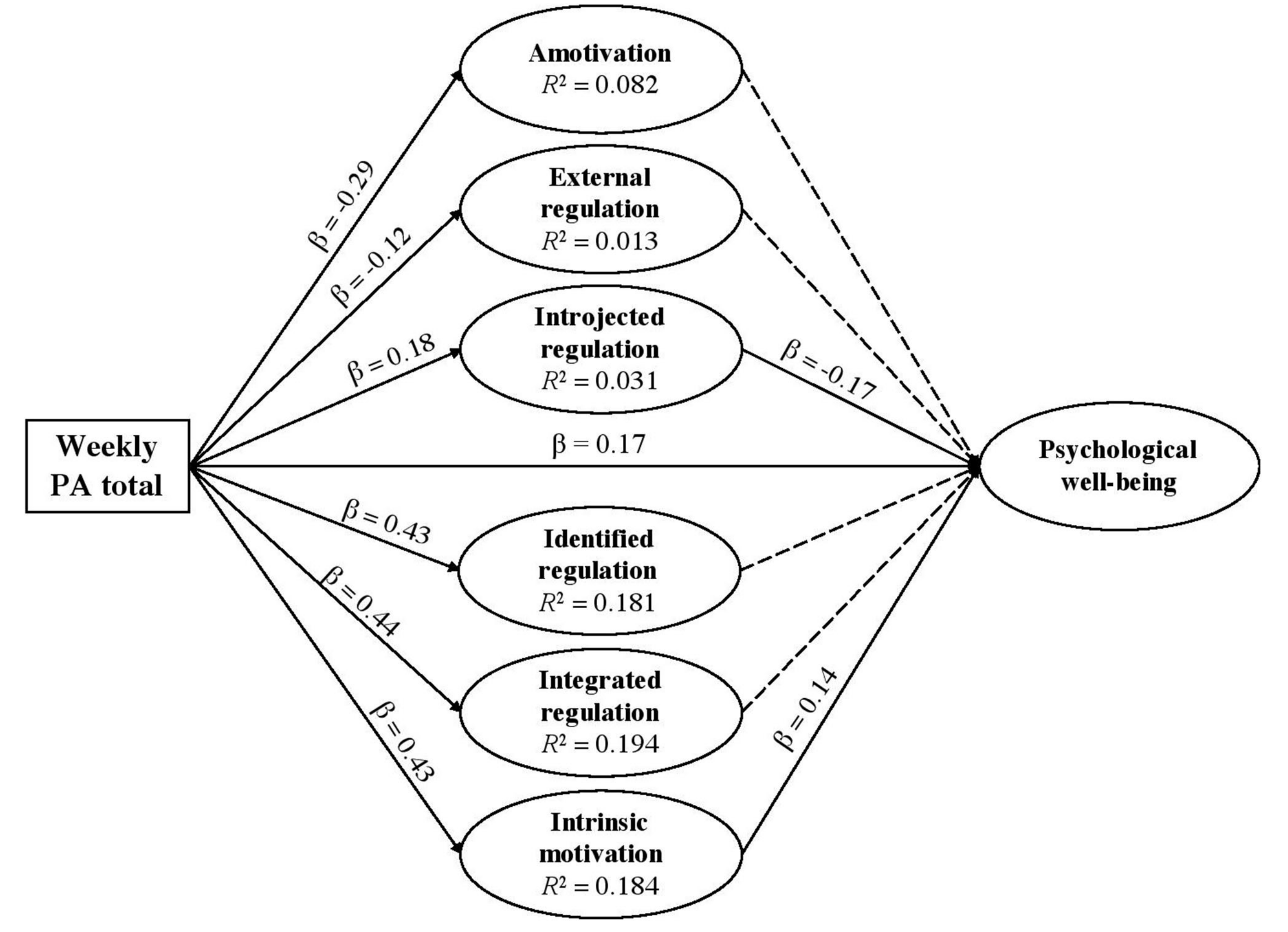

FIGURE 1 | Path coefficients amongst variables. Solid lines represent significant paths. Dashed lines represent non-significant paths.

TABLE 5 | Multi group analysis results.

Path estimate	Path coefficient for non-nature-based PA (N = 239)	Path coefficient for nature-based PA (N = 520)
Weekly PA Total→Amotivation	−0.35***	−0.22***
Weekly PA Total→Identified Regulation	0.53***	0.34***
Weekly PA Total→Introjected Regulation	0.31***	0.10 n.s.
Weekly PA Total→Introjected Regulation→Psychological Well-Being	−0.072**	−0.015 n.s.

***Path estimate significant at $p < 0.01$; ***Path is significant at $p < 0.001$. Only path estimates that were significantly different between the two groups are presented in this table. n.s., non-significant.*

95% CI = −0.05 to −0.01). Relevant results are shown in **Table 4** and **Figure 1**.

Autonomous Forms of Motivation

Results demonstrate that neither identified regulation nor integrated regulation mediated the relationship between weekly PA and psychological well-being. Thus, hypotheses 5 and 6 were rejected. Results supported hypothesis 7 in showing that intrinsic motivation positively mediated the relationship between weekly PA and psychological well-being (indirect path estimate = 0.06; 95% CI = 0.01–0.12). Relevant results are shown in **Table 4** and **Figure 1**.

Moderation of Relationships by Context

Results demonstrate that only in a non-nature-based context did introjected regulation significantly mediate the relationship between weekly PA and psychological well-being. Further, the direct relationships between weekly PA and amotivation, identified regulation, and introjected regulation were significantly stronger within non-nature-based PA (see **Table 5**). There was no other moderating effect of PA context. Thus, hypothesis 8 was partially supported.

DISCUSSION

This study investigated the relationship between PA and psychological well-being during the NZ COVID-19 lockdown period, and whether motivational quality had a mediating role in this relationship. Further, we examined whether PA context (nature or non-nature based) moderated relationships amongst PA, motivational quality, and psychological well-being. As expected, the results indicated that PA was positively associated with psychological well-being. Contrary to predictions, the PA context did not directly influence the relationship between PA and psychological well-being in this sample.We also partially confirmed our hypothesis that motivational quality would mediate the relationship between PA and psychological well-being. Specifically, introjected regulation (a controlled form of motivation) negatively mediated the relationship between PA and psychological well-being, but only in non-nature-based contexts. Intrinsic motivation positively mediated the relationship between weekly PA and psychological well-being, but unexpectedly there was no significant difference between PA contexts.

PA and Psychological Well-Being

These results support the volume of literature showing the important positive relationships between PA and psychological well-being (e.g., Biddle et al., 2003; Pretty et al., 2007; Stubbs et al., 2017). Our study extends this literature by showing that this relationship holds during periods of highly restricted mobility and associated psychological distress due to COVID-19 lockdowns.

The Mediating Role of Motivational Quality

Hypotheses regarding relationships amongst weekly PA, motivational quality, and psychological well-being were partially supported. Contrary to predictions, neither amotivation, external, identified, nor integrated regulations significantly mediated the relationship between PA and psychological well-being. However, intrinsic motivation was a significant positive mediator and introjected a significant negative mediator of the relationship between PA and psychological well-being, reflecting previous research (Briki, 2016). Although we cannot infer causation from these data, this supports the notion that PA may affect psychological well-being via these types of motivation. According to these findings, if an individual was physically active on the basis of ego or guilt, then they were less likely to experience positive psychological well-being. Conversely, if an individual was physically active on the basis of enjoyment or love of the PA activity itself, they were more likely to experience psychological well-being. It should be noted, however, that effect sizes were significant-yet-small, and so we should be cautious when interpreting these results.

The Role of PA Context

The relationships between PA and both amotivation and identified regulation were significantly stronger within non-nature-based contexts, as compared to nature-based contexts. However, again, these significant effect sizes remained small, so we should be circumspect in our interpretations. The finding regarding identified regulation was unexpected, as we predicted that all forms of autonomous motivation would be more likely within nature-based contexts. One potential explanation is that because identified regulation is based on motivation for relatively tangible and valued outcomes (e.g., improved health), individuals may feel those outcomes are more readily achieved, or are more obvious through non-nature-based PA.

As hypothesised, we found that non-nature-based PA predicted introjected regulation to a significantly greater degree than nature-based PA. This is noteworthy as introjected regulation (which is characterised by ego-based motives) negatively predicted psychological well-being. While causality cannot be inferred from our data, these findings align with Wolsko and Lindberg's (2013) hypothesis that ego-based motivations may decrease as a result of being in nature. Thus, future research should directly examine whether natural environments may reduce ego-oriented motivations for PA.

Many of the study findings regarding the role of nature-based contexts were unexpected considering the growing body of literature indicating that nature-based PA benefits psychological well-being in unique and synergistic ways beyond the benefits accrued by non-nature-based PA (Gladwell et al., 2013). Assessing how *often* people engaged in nature-based PA and whether they were active in *both* nature and non-nature-based contexts may have provided important additional data to better understand these relationships. It is possible that either a) people were not accessing nature often enough to generate additional psychological well-being benefits, or b) people sought alternative PA methods that provided comparable psychological well-being benefits. For example, reports indicated a global rise in the popularity of yoga as a form of PA during COVID-19 lockdowns (Merchlinksy, 2020), which is a predominantly indoor practice that is consistently associated with higher levels of psychological well-being (Brinsley et al., 2020). Past studies comparing nature-based and non-nature-based PA have overlooked practices such as yoga, in favour of comparisons between activities such as running and walking. Therefore, future research comparing nature and non-nature-based PA should expand the breadth of activities examined to provide more nuanced information regarding the importance of PA context for psychological well-being.

The finding that PA context did not significantly moderate the relationships amongst PA context, intrinsic motivation and psychological well-being was unexpected, because enjoyment of nature-based PA was one of the more robust findings in the extant literature (e.g., Eigenschenk et al., 2019). The effect of physical distancing requirements during the NZ lockdown may have influenced these results. In NZ, people were asked to maintain a two-metre distance from others at all times. This constant need to ensure physical distance from others may have introduced a novel source of anxiety that is not usually present in nature-based PA, leading to decreased enjoyment in such natural settings. For example, many nature-based walking tracks in NZ are too narrow to maintain a two-metre distance when passing others. In addition, the phenomenon of "exercise shaming" people who were perceived as being too physically active outdoors during lockdown periods may have influenced these findings (e.g., Graham-McLay, 2020). These unique factors may have offset any additional potential positive effects of nature-based PA by shifting people's focus from the natural environment to potential anxiety regarding violations of lockdown restrictions and/or the need to avoid other people, respectively. More research is needed to explore these conjectures as these potential explanations are speculative.

Implications

Considering the main finding that PA was significantly associated with psychological well-being, a primary implication of this research is that PA should be promoted and supported during potentially stressful events, such as lockdowns. From a public health perspective, government policies should encourage and enable a wide range of PA during lockdowns and, where possible, accommodate opportunities for people to engage in nature-based PA. It is also clear that people should not be enticed to engage in PA on the basis of ego- or guilt-based forms of motivation, but rather encouraged to engage in forms of PA that create intrinsic motivation.

The findings also have theoretical implications for SDT in terms of demonstrating significantly different relationships amongst PA and specific types of motivation. In recent years, there has been a trend towards dichotomously grouping motivation into either *autonomous* or *controlled* categories. However, SDT scholars continue to debate whether this is the most appropriate approach to investigating or understanding motivations (e.g., Howard et al., 2020). The current results support a more fine-grained approach to examining motivation, rather than using an autonomous vs. controlled dichotomy. Although, one aspect that we did not consider was the *interaction* between different types of motivation. Individuals rarely have just one motive for undertaking PA and likely experience a mix of reasons. Approaches such as latent profile analyses (e.g., Lindwall et al., 2017) have the potential for greater insights into the relationships amongst motivation, psychological well-being, and PA context.

Limitations and Strengths

The study provided cross-sectional insights into relationships between PA, nature, motivation, and psychological well-being in a unique life situation. However, this uniqueness also represents a limitation, in that the results may not generalise to life situations outside of a pandemic-induced lockdown. We also could not compare our results with pre-pandemic data, as these variables are not routinely collected. In addition, given the cross-sectional design, causal relationships cannot be inferred. Further, as previously mentioned, participants did not report the *amount* of nature-based PA undertaken. Thus, we cannot speculate on the relationships between dose of nature-based PA and motivation or psychological well-being. For instance, participants may have engaged in a single, 20-min bout of nature-based PA during the week, while the rest of their PA may have been non-nature-based. Understanding the extent to which participants engaged in nature-based PA would facilitate more nuanced data analysis and an evaluation of a "dose-response" effect for nature-based PA.

Finally, the obtained sample was not representative of the general NZ population. For example, a high proportion of participants were physically active (81.2% met weekly PA guidelines, compared to 50.8% in the general population; New Zealand Ministry of Health, 2019), and were predominantly highly-educated females. This limits the generalisability of the findings as we cannot assume that they would apply to other populations. Indeed, there may have been a ceiling effect in relation to PA. High PA levels may have reduced variation in the sample, thereby obscuring some of the relationships amongst PA, motivation and psychological well-being.

Future Research

We suggest a number of future research avenues. First, to compare the psychological well-being outcomes of lockdowns that allow outdoor or nature-based PA (e.g., NZ) vs. those that did not (e.g., Spain). It will also be important to examine whether the relationships reported here remain in periods of increased mobility (e.g., under decreased, post-COVID-19 restrictions). For example, we speculated that the absence of a direct positive relationship between nature-based PA and psychological well-being may have been due to potential anxiety experienced when encountering others while engaging in nature-based PA. Future research could examine how these relationships alter once COVID-19 is no longer considered a widespread threat. In addition, longitudinal designs and time-lagged analysis are needed to directly examine potential causal relationships amongst the key variables. There is also a need to further examine the distinct roles of intrinsic motivation and introjected regulation, respectively, in relation to PA in "non-pandemic" circumstances, either cross-sectionally or via intervention designs.

CONCLUSION

During a period of COVID 19 related lockdown restrictions, being physically active benefitted participants' psychological well-being. Ensuring individuals are intrinsically motivated for PA may provide additional benefit to psychological well-being, while individuals who have introjected regulation may experience lower psychological well-being when they exercise in non-nature-based PA contexts. These motivational associations between PA and psychological well-being suggested people may benefit from engaging in nature-based PA during lockdown periods, although more research is required to confirm this conclusion. Given the increasing frequency of pandemics in recent decades and expectations that this trend will continue (Ross et al., 2015), this research provides valuable insights regarding the relationships amongst PA, the context under which it is undertaken, motivational quality and psychological well-being during these periods.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/supplementary material.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Otago Ethics Committee (ref. D20/214). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MJ, EH, SH, KH, and JC conceived the study. MJ, JC, and EH coordinated data collection. MJ, JC, and CL cleaned and analysed the data. MJ led the manuscript writing and all authors contributed to the final submission.

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Changes in Physical Activity Pre-, During and Post-lockdown COVID-19 Restrictions in New Zealand and the Explanatory Role of Daily Hassles

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Covid-19 lockdown restrictions constitute a population-wide “life-change event” disrupting normal daily routines. It was proposed that as a result of these lockdown restrictions, physical activity levels would likely decline. However, it could also be argued that lifestyle disruption may result in the formation of increased physical activity habits. Using a longitudinal design, the purpose of this study was to investigate changes in physical activity of different intensities, across individuals who differed in activity levels prior to lockdown restrictions being imposed, and across three time periods: pre-, during- and post-lockdown. This study also examined the extent to which the experience of daily hassles explained any changes in physical activity. A convenience sample ($N = 759$) recruited through social media, provided data from an online survey administered during weeks 2–3 of a 5-week lockdown and 231 participants provided complete data again 6 weeks post-lockdown (72% female, M age = 43 years). Participants completed the International Physical Activity Questionnaire–Short Form and the Daily Hassles Scale. Results showed that vigorous and moderate intensity PA were significantly lower during- and post-lockdown compared to pre-lockdown in those individuals who had been highly active pre-lockdown. In contrast, for moderately active individuals pre-lockdown, vigorous and moderate intensity PA was significantly higher during-lockdown compared to pre-lockdown, and these increased levels of vigorous PA were maintained post-lockdown. Participants experienced daily hassles due to inner concerns, time pressures, family, and financial concerns to the same extent during- and post-lockdown. Those daily hassles had a small negative (Standardized $\beta = -0.11$; $p < 0.05$) predictive effect on post-lockdown PA. It appears that to understand the effect of COVID-19 restrictions on PA, the activity status of individuals pre-lockdown needs to be taken into account. The daily hassles appeared to play a role in post-lockdown PA behavior, but future research should investigate why these results occurred.

Keywords: behavior change, exercise, psychology, stress, physical activity intensity, COVID-19

INTRODUCTION

In March 2020, the New Zealand (NZ) Government instigated Level 4 lockdown restrictions in response to the World Health Organization (WHO) declared COVID-19 pandemic (World Health Organisation, 2020). These Level 4 lockdown restrictions (henceforth termed "lockdown") urged all New Zealanders (except those classed as essential workers) to stay at home unless undertaking a limited range of "essential" activities (e.g., shopping for groceries, medical reasons) (New Zealand Government, 2020a). Importantly, the NZ government allowed individuals to be physically active in their local neighborhood, imparting to the NZ public the importance of being physically active for health and well-being during this period (New Zealand Government, 2020b). The physiological and psychological benefits (e.g., reductions in depression and anxiety levels) of being physically active are well-recognized (World Health Organization, 2010), and more specific benefits related to the effects of COVID-19 have been proposed (e.g., Matias et al., 2020; Simpson and Katsanis, 2020; Woods et al., 2020). In particular, the COVID-19 pandemic and its associated restrictions have resulted in substantial psychosocial effects, for example increased prevalence of anxiety and stress (Salari et al., 2020), which physical activity (PA) is known to ameliorate (Stubbs et al., 2017). Consequently, researchers have opinionated on the importance of being physically active during the pandemic (Chen et al., 2020; Hudson and Sprow, 2020; Lippi et al., 2020; Ricci et al., 2020; Sallis and Pratt, 2020).

The NZ lockdown constituted a significant lifestyle change for individuals. Many people were either not working or were working from home, plus schools, indoor exercise and recreation facilities were closed, club/community sport was canceled, and outdoor recreation was limited to local neighborhoods. These unprecedented conditions constituted a population-wide "life-change event," defined by the US National Library of Medicine as "those occurrences, including social, psychological and environmental, which require an adjustment or effect a change in an individual's pattern of living" (Engberg et al., 2012, p. 433). Life-change events disrupt a person's daily routine and are a known determinant of physical activity (PA) behavior change (Engberg et al., 2012). This particular life-change event may have facilitated old habits being broken (e.g., patterns of inactivity) and the formation of new habits (e.g., adoption of PA), in part because time-related barriers for PA may be removed. Alternatively, the lockdown restrictions may have decreased normal physical activity levels (e.g., due to exercise facilities being closed, or recreational areas being unavailable) or made people less likely to be physical active (e.g., due to increased childcare demands, or COVID-related anxiety). Consequently, investigating how PA changed in the NZ context as a result of the lockdown provides valuable insights on the ramifications for health-related behavior.

At the outset of the COVID-19 pandemic, researchers suggested PA levels would decline (e.g., Papaioannou et al., 2020). In 2020, studies from different countries (e.g., Belgium, Canada, Greece, USA, Australia) investigated changes in PA behavior as a result of their varied COVID-19 restrictions. Most of these studies used cross-sectional designs with online survey methods, collecting data at one point during lockdown along with retrospective assessment of PA prior to COVID-19 restrictions being implemented. PA behavior was assessed in different ways; for example, with validated self-report measures, non-validated measures or a single item question asking whether PA changed. Summarizing this research, PA was shown to be lower during COVID-19 restrictions compared to before restrictions were put in place (López-Bueno et al., 2020; Mutz and Gerke, 2020; Schnitzer et al., 2020; Stanton et al., 2020). More nuanced analysis has shown that between 24 and 49% of samples had decreased PA levels during restrictions, 21–32% had increased PA levels, and 30.5–44% had no change in PA (Brand et al., 2020; Knell et al., 2020; Mutz and Gerke, 2020; Stanton et al., 2020).

Other research has shown that changes in PA differed as a function of individuals' pre-lockdown PA levels. Meyer et al. (2020) found 32% of their US sample who were active pre-COVID restrictions decreased their PA levels during restrictions, while PA levels remained unchanged for those who were inactive prior to restrictions. Barkley et al. (2020) used tertile splits based on PA scores pre-COVID restrictions from the Godin Leisure-Time Exercise Questionnaire (Godin and Shephard, 1985) to create, low, moderate and high active groups. They found that US university staff and students classified as high active (average of 75.8 METs/week) reduced their PA during the COVID-19 restrictions by 22%; those classed as moderately active (average of 32.5 METs/week) increased their PA by 14%; and those classed as least active (12.9 METs/week) increased their PA by 83%. Also using the Godin questionnaire, Lesser and Nienhuis (2020) found, of the 63% of Canadians classed as inactive pre-COVID restrictions (participating in $<$ 150 min/week of moderate to vigorous PA), 40.5% became less active, and 33% became more active during the restrictions. Of the 37% classed as active pre-COVID restrictions (participating in $\geq$ 150 min/week of moderate to vigorous PA), 22.4% became less active and 40.3% became more active. In Belgium, Constandt et al. (2020) reported that, amongst people classed as "high active" (exercising regularly/at least once a week) prior to COVID-19 restrictions, 36% exercised more, 23% exercised less, and 41% exercised the same during restrictions. Amongst "low active" individuals (exercised non-regularly/less than once a week), 58% exercised more, 7% exercised less, 5% exercised the same, and 30% did not exercise at all.

Given these mixed findings, further investigation of PA behavior in relation to COVID-19 restrictions is warranted, particularly with the use of a validated self-report measure of PA that has been missing in some studies (e.g., Constandt et al., 2020; Meyer et al., 2020; Mutz and Gerke, 2020) and a classification of activity level that corresponds with the WHO PA guidelines. Additionally, research has yet to investigate potential changes in physical activity intensity during COVID-19 restrictions (e.g., vigorous, moderate, walking) and how PA may have changed once lockdown restrictions were eased. NZ provides a unique context in which to study PA after COVID-19 restrictions were lifted because of its success in largely eliminating community transmission which allowed people to return to pre-COVID mobility levels (Wilson et al., 2020).

Research is yet to provide psychological-based explanations for why PA changes have occurred during COVID-19 restrictions (Papaioannou et al., 2020; Sallis et al., 2020). Systematic reviews have shown that, in general, life changes/events have a negative effect on PA participation (Allender et al., 2008; Engberg et al., 2012; Stults-Kolehmainen and Sinha, 2014). However, different life events can have differential effects on PA, with some prompting PA increases (e.g., change in employment status) and others prompting PA decreases (e.g., transition to University, having a child) (see Engberg et al., 2012 for review). Researchers have suggested that, because not everyone responds to life events in the same way, it may not be the particular life event that influences behavior change *per se*, but rather the daily hassles (i.e., stressors) that the event creates in a person's life (Kanner et al., 1981; O'Connor et al., 2009; Uijtdewilligen et al., 2014). For example, DeLongis et al. (1982) showed that a larger percentage of variance in health status was explained by the daily hassles in people's lives resulting from a major life event, rather than stress due to the event itself. Therefore, it may be that the differential effects of COVID-19 restrictions on PA hinges upon the experienced daily hassles created by the event. Indeed, Cheval et al. (2020) suggested a measure of stress should be included in research to examine how it moderates PA change.

Daily hassles have been operationalized as a measure of the everyday stressors (i.e., problems or difficulties that are part of everyday life) that a particular situation causes (O'Connor et al., 2009). The extent of daily hassles has been associated with poorer eating behaviors (O'Connor et al., 2008), lower physical activity (Twisk et al., 1999; Nguyen-Michel et al., 2006) and is predictive of actual stress experienced (Feizi et al., 2012). Nguyen-Michel et al. (2006) found support for their hypothesis that PA would be associated with lower perceived daily hassles, but identified that it was equally plausible that the experience of daily hassles would discourage physical activity participation. In their review of the PA and stress research, Stults-Kolehmainen and Sinha (2014) also found evidence for these bi-directional relationships. Physical activity status may also protect people from experiencing stress as a result of the daily hassles experienced (Feizi et al., 2012). Thus, how active individuals are may influence their response to the daily hassles caused by the COVID-19 restrictions and provide an explanation for PA changes.

The purposes of this study were 2-fold. Firstly, we examined changes in PA from pre-lockdown to PA during-lockdown, and post-lockdown. Specifically, we aimed to examine changes in total PA and PA of different intensities, and compared the PA of individuals who met the WHO PA guidelines pre-lockdown (deemed moderately active), exceeded the PA guidelines (deemed highly active) and who did not meet the guidelines (deemed inactive). We made tentative hypotheses that overall physical activity would decrease during lockdown compared to pre-lockdown, but recover to pre-lockdown levels post-lockdown. We expected highly and moderately active individuals to remain active during- and post-lockdown, and for inactive individuals to increase their PA during- and post-lockdown. The analyses on the changes to PA of different intensities were exploratory. Secondly, we investigated the experience of daily hassles during- and post-lockdown and the extent to which those daily hassles predicted PA during- and post-lockdown. We hypothesized that the experience of daily hassles would be higher during- compared to post-lockdown. We expected that daily hassles would negatively predict PA behavior, but this result would be moderated by the individuals' pre-lockdown PA status.

MATERIALS AND METHODS

Participants and Procedures

A convenience sample of the NZ population was recruited using social media recruitment methods (King et al., 2014) and a virtual snowball recruitment technique (Baltar and Brunet, 2012). Study information with a link to an online survey (hosted on the online survey platform Qualtrics) was shared via Facebook and circulated via email to contacts at NZ universities and other organizations (e.g., regional and national sports organizations, city councils) for dissemination through their networks. The study advertising specifically stated that we wanted to hear from people who were not overly active as well as those who were active in an effort to reduce response bias. Participants were eligible if they were aged 18 years or older and living in NZ for the duration of the lockdown restrictions. Those with any contraindications (e.g., illness, injury) that prevented being physically active during the lockdown restrictions were excluded. These criteria were assessed via screening questions at the beginning of the online survey.

Participants completed the survey at two time points. The first was completed between the second and third weeks of NZ's 5-week lockdown period (April 8 to April 15, 2020; the survey was open for 8 days). We deemed this data point "during-lockdown". Secondly, those participants who completed the first survey and agreed to be contacted again were emailed the link to the follow-up survey. The follow-up survey was sent on June 9th 2020 and was open for completion for 9 days. Participants were sent a reminder 6 days after the first email was sent. This period was 6 weeks after lockdown had ended and was the final week of four where NZ was subject to Level 2 restrictions. Under these restrictions, people could leave home and travel freely, and were asked to adhere to public health measures (e.g., physical distancing, mask wearing on public transport). All gyms, health clubs and swimming pools were open with public health measures in place. Community sport was also allowed but restricted to a maximum of 100 people in a confined space. We deemed this point "post-lockdown". Ethical approval was obtained from the university ethics committee (reference: D20/214). All participants provided online informed consent before completing the survey. This study comprises part of a larger project investigating determinants and outcomes of PA as a result of the COVID-19 lockdown restrictions. The full project survey took an average of 12 min to complete.

The during-lockdown survey elicited 759 responses. Of those 759, 464 agreed to be contacted to complete the post-lockdown survey and 352 surveys were returned. After data cleaning (see **Figure 1**), the final sample for analysis consisted of 231

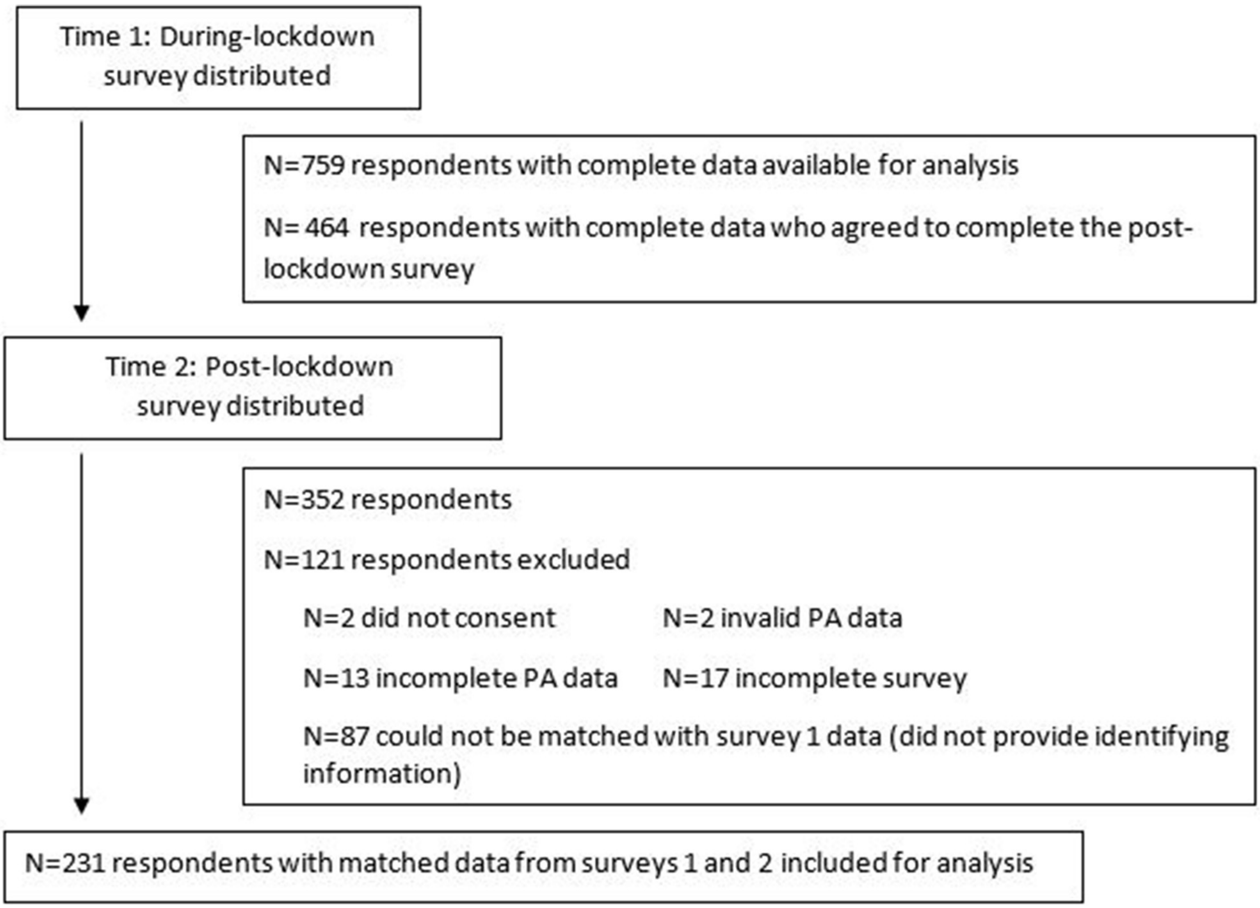

FIGURE 1 | Survey responses during-lockdown (Time 1) and post-lockdown (Time 2).

responses. Detailed participant characteristics of those who responded during-lockdown and the 231 with data from both surveys is shown in **Table 1**. Sample participants ranged in age from 18 to 81 years (mean = 42.91, SD = 13.84), were predominantly female (72.3%), NZ European (82.7%), and with at least a university degree (75.8%). Most were not essential workers (85.3%).

Measures

Physical Activity

The International Physical Activity Questionnaire-Short Form (IPAQ-SF; Craig et al., 2003) is a 7-item measure of self-reported PA, measuring the amount of moderate- and vigorous-intensity PA and walking undertaken by participants over the previous 7 days. Example items include: "During the last 7 days, on how many days did you do vigorous activities like heavy lifting, exercise classes, or fast cycling for at least 10 min at a time?" followed by the question: "How much time did you usually spend doing vigorous physical activities on one of those days?". The IPAQ-SF has demonstrated good validity and consistency (Lee et al., 2011). For the during-lockdown survey participants completed the IPAQ-SF twice. Firstly, they were asked to report their PA from the previous week (during-lockdown). Secondly, they were asked to report their PA from a typical week prior to lockdown. To lessen the risk of recall bias we ensured that the IPAQ-SF was used in the form in which it had been validated and that it incorporated examples of moderate, and vigorous intensity activities (Matthews et al., 2012). In the post-lockdown survey, they were only asked to report their PA from the previous week (during level 2 post-lockdown restrictions).

Data screening, cleaning, and coding were undertaken according to detailed guidelines (IPAQ group, 2014). This included the truncation of data points indicating more than 960 min/week (16 h) as these are suggested to be outliers. Participants were classified as moderately, or highly active, or inactive according to proposed guidelines (IPAQ group, 2014). To be classified as moderately active, participants met one of the following criteria: (a) $\geq$ 3 days of vigorous intensity activity of $\geq$ 20 min per day; (b) $\geq$ 5 days of moderate intensity activity and/or walking of at least 30 min per day; or (c) $\geq$ 5 days of any combination of walking, moderate intensity or vigorous intensity activities achieving $\geq$ 600 MET min/week. The highly active participants achieved $\geq$ 1,500 or $\geq$ 3,000 MET min/week,

TABLE 1 | Participant characteristics.

	Respondents during-lockdown	Respondents with data from during- & post-lockdown
Mean age (SD) years	43 (14)	43 (14)
Gender [n (%)]		
Female	544 (73.0)	167 (72.3)
Male	195 (26.2)	63 (27.3)
Gender diverse	3 (0.4)	1 (0.4)
Prefer not to say	3 (0.4)	0.0
Ethnicity [n (%)]		
NZ European	574 (82.9)	191 (82.7)
Māori	6 (0.9)	2 (0.9)
Samoan	1 (0.1)	0.0
Cook Island Māori	2 (0.3)	0.0
Chinese	4 (0.6)	0.0
Indian	2 (0.3)	1 (0.4)
Other	91 (13.2)	36 (15.6)
Prefer not to say	12 (1.7)	1 (0.4)
Essential worker (N = Yes, %)	102 (13.8)	34 (14.7)

depending on intensity of their PA and the inactive participants did not meet the criteria for moderate or high PA. PA was calculated as weekly total PA MET mins; weekly moderate intensity MET mins, weekly vigorous intensity MET mins and weekly MET mins of walking according to proposed guidelines (IPAQ group, 2014).

Daily Hassles

The Hassles Scale (Kanner et al., 1981) is a 117-item measure of the daily hassles participants experienced in the last 7 days. Participants were instructed to rate the degree to which each hassle item had affected their life in the past seven days (i.e., during-lockdown for the first survey administration, and post-lockdown for the second survey administration). Participants responded by selecting, "This is not a hassle for me" (0), "A somewhat severe hassle" (1), "A moderately severe hassle" (2) or "An extremely severe hassle" (3) for each item. Following Holm and Holroyd (1992), we grouped the daily hassle items according to seven categories: inner concerns (example items: troubling thoughts about one's future, trouble relaxing, concerns about inner conflicts), financial concerns (example items: financial security, concerns about job security, concerns about owing money), time pressures (example items: too many things to do, too many responsibilities, too many interruptions), work hassles (example items: job dissatisfaction, worries about decisions to change jobs), environmental hassles (example items: concerns about news events, crime), family hassles (example items: friends or relatives too far away, problems with one's children, health of a family member) and health hassles (example items: concerns about health in general, use of alcohol, concerns about weight). A severity score for each category was created by summing the item scores.

Data Analysis

To investigate changes in PA intensity from pre- to during- and post-lockdown, in the different activity groups, a factorial repeated measures (PA intensity x time x activity group) ANOVA was conducted. To compare changes in the daily hassles categories between during-lockdown and post-lockdown, a factorial repeated measures ANOVA (daily hassles severity x time) was conducted. The Bonferroni procedure was used for *post-hoc* tests in both ANOVAs. Finally, to examine the extent to which severity of daily hassles predicted total PA during and after the lockdown, and whether any effects were moderated by activity level of participants pre-lockdown (activity group), we conducted two hierarchical multiple regressions–one using during-lockdown data and the second using post-lockdown data. In both analyses, the control variables of pre-lockdown total PA MET mins/week, age, gender, education, ethnicity, whether the respondent was an essential worker, and the number of dependent children were entered into the model first (Model 1). The severity of daily hassles during- or post-lockdown was then entered into the model as the direct predictor of total weekly PA (Model 2). Finally, the interaction between PA group and the extent of daily hassles was entered (Model 3).

RESULTS

Of the 231 people who provided valid PA data pre-, during-, and after-lockdown, 111 were categorized as being highly active pre-lockdown and 120 as moderately active pre-lockdown. Although 32 inactive participants completed the during-lockdown survey, they did not complete the post-lockdown survey.

Change in PA

Highly Active Group (Pre-lockdown)

There was a significant main effect of the lockdown restrictions on total PA [$F_{(2,220)} = 36.88$, $p < 0.001$, partial eta^2 = 0.40]. The follow-up Bonferroni *post-hoc* tests revealed that PA MET mins/week before lockdown were significantly higher than during-lockdown and post-lockdown. There was no significant difference between total PA during-lockdown and post-lockdown (see **Table 2** for mean values).

There was also a significant main effect of PA intensity [$F_{(1.51,166.45)} = 216.61$, $\varepsilon = 0.76$, $p < 0.001$], and an interaction for PA intensity and time [$F_{(3.35,368.57)} = 13.59$, partial eta^2 = 0.11] on total PA MET mins/week. The interaction results showed that lockdown restrictions significantly affected vigorous intensity [$F_{(2,220)} = 30.07$, $p < 0.001$, partial eta^2 = 0.22] and moderate PA [$F_{(2,220)} = 9.87$, $p < 0.001$, partial eta^2 = 0.08], but not walking [$F_{(2,220)} = 1.493$, $p = 0.23$]. The Bonferroni *post-hoc* tests showed that vigorous PA pre-lockdown was significantly higher than during-lockdown and post-lockdown. There was no significant difference between during- and post-lockdown. Moderate PA pre-lockdown was significantly higher than during-lockdown and post-lockdown ($M = 432.51$, SE = 26.57). There was no significant difference between during- and post-lockdown (see **Table 2** for mean values).

Thus, for individuals classed as highly active pre-lockdown, their vigorous and moderate intensity PA levels dropped during

TABLE 2 | Mean (SE) physical activity pre-lockdown, during-lockdown, and post-lockdown.

	Pre-lockdown		During-lockdown		Post-lockdown	
	Highly active	Moderately active	Highly active	Moderately active	Highly active	Moderately active
Total PA (MET mins/week)	2,290 (40)	868 (38)	1,794 (64)	1,218 (66)	1,808 (66)	1,018 (62)
Vigorous intensity (MET mins/week)	1,285 (28)	233 (29)	951 (52)	496 (50)	936 (52)	395 (46)
Moderate intensity (MET mins/week)	543 (24)	253 (21)	419 (27)	289 (26)	433 (27)	244 (24)
Walking (MET mins/week)	462 (18)	382 (20)	424 (20)	434 (19)	439 (20)	379 (21)

lockdown, and remained at this level post-lockdown. While, walking met mins/week stayed the same throughout the three time periods (see **Figure 2**).

Moderately Active Group (Pre-lockdown)

There was a significant time main effect for total PA MET mins/week [$F_{(2,238)} = 14.92$, $p < 0.001$, partial eta$^2 = 0.11$]. The Bonferroni *post-hoc* tests revealed that total PA during-lockdown was significantly higher than pre-lockdown and post-lockdown. Also, post-lockdown PA was significantly higher than pre-lockdown. There was also a significant main effect for PA intensity [$F_{(1.57,\ 187.07)} = 11.74$, $\varepsilon = 0.79$, $p < 0.001$], showing vigorous PA and walking were significantly higher than moderate PA ($M = 261.92$, SE = 17.59). There was no significant difference between vigorous PA and walking.

There was a significant interaction for PA intensity and time [$F_{(3.2,\ 380.96)} = 7.34$, $p < 0.001$, partial eta$^2 = 0.06$]. The results showed that vigorous PA [$F_{(2,\ 238)} = 14.18$, $p < 0.001$, partial eta^2 $= 0.11$], moderate PA [$F_{(1.41,\ 168.21)} = 20.82$, $p < 0.001$, partial eta$^2 = 0.15$] and walking [$F_{(2,\ 238)} = 3.54$, $p \leq 0.03$, partial eta$^2 =$ 0.03] were affected by the lockdown restrictions. The Bonferroni *post-hoc* tests showed that vigorous PA during-lockdown and post-lockdown was significantly higher than pre-lockdown. There was no significant difference between during- and post-lockdown. Moderate PA during-lockdown was significantly higher than pre-lockdown and post-lockdown. There was no significant difference between pre- and post-lockdown. During-lockdown walking was significantly higher than post-lockdown walking. There was no significant difference in walking between pre-lockdown and during- or post-lockdown.

Thus, for individuals classed as moderately active pre-lockdown, their participation in vigorous and moderate intensity PA increased during lockdown compared to before. Post-lockdown, they maintained their vigorous intensity PA, but moderate intensity PA returned to pre-lockdown levels. While walking did not change from pre- to during-lockdown, it reduced from during- to post-lockdown (see **Figure 2**).

Experience of Daily Hassles

There were no significant differences in the severity of each daily hassle category between during- and post-lockdown (See **Figure 3** and **Table 3**). Despite this, the scores show that the predominant daily hassles experienced during- and post-lockdown were inner concerns, time pressures, family hassles, and financial concerns.

Relationship Between Daily Hassles and Physical Activity During-Lockdown

Model 1, with only the control variables as predictors, explained 22% of the variance in PA behavior during-lockdown [$F_{(7,223)} =$ 8.97, $p < 0.0001$]. Model 2, with the extent of daily hassles during-lockdown included as a predictor, explained 22.3% of the variance in PA behavior during-lockdown [$F_{(8,222)} = 7.98$, $p < 0.001$]. This represented a non-significant improvement of 0.3% over Model 1 [R^2 Δ: $F_{(1,222)} = 1.06$, $p < 0.30$]. Model 3, with the interaction term between the extent of daily hassles during lockdown and PA group included as a predictor, did not make any improvements over Model 3 (see **Table 4**).

Relationship Between Daily Hassles and Physical Activity Post-lockdown

Model 1, with the control variables as predictors, explained 48% of the variance in PA behavior post-lockdown [$F_{(8,222)} = 25.65$, $p < 0.001$]. Model 2, with the severity of daily hassles post-lockdown as a predictor, explained 49.1% of the variance in PA behavior [$F_{(9,221)} = 23.72$, $p < 0.001$]. This represented a significant improvement of 1.1% over Model 1 [R^2 Δ: $F_{(1,221)}$ $= 4.77$, $p < 0.05$]. Model 3, which included the interaction term between the severity of daily hassles and PA group as predictors did not make any improvements over Model 3 (see **Table 5**).

These results indicate that post-lockdown there was a small negative association between severity of daily hassles and PA behavior, but there was no association between daily hassles and PA during-lockdown.

DISCUSSION

The first purpose of this study was to examine changes in total PA and PA intensity across pre-lockdown, during-lockdown, and post-lockdown COVID-19 restrictions. We aimed to examine changes in those participants classed as low, highly and moderately active pre-lockdown. The second purpose was to investigate the extent to which the experience of daily hassles influenced any change in PA behavior. Results showed that, for

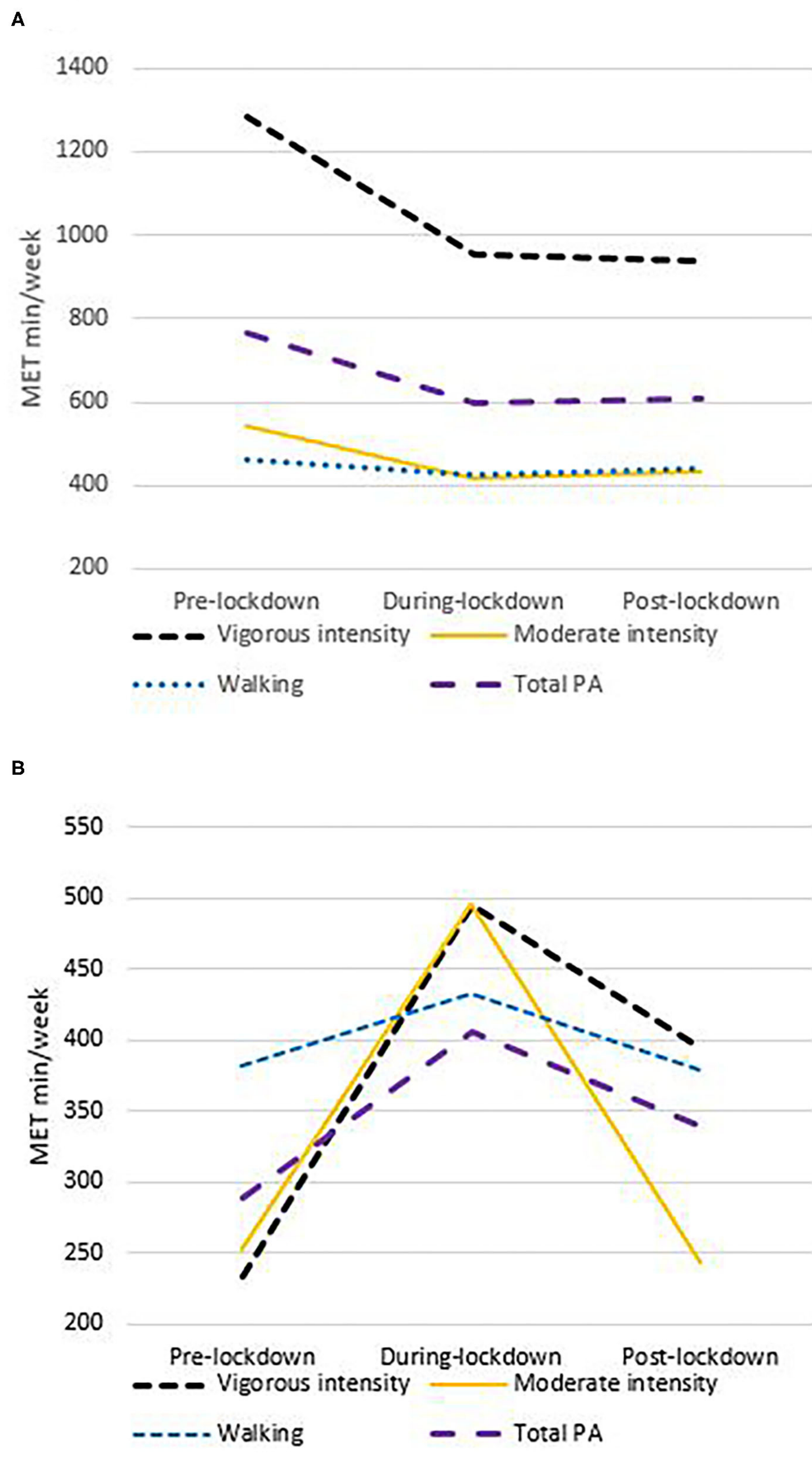

FIGURE 2 | Total PA and vigorous, moderate and walking MET mins/week pre-, during and post-lockdown in highly active **(A)** and moderately active **(B)** participants pre-lockdown.

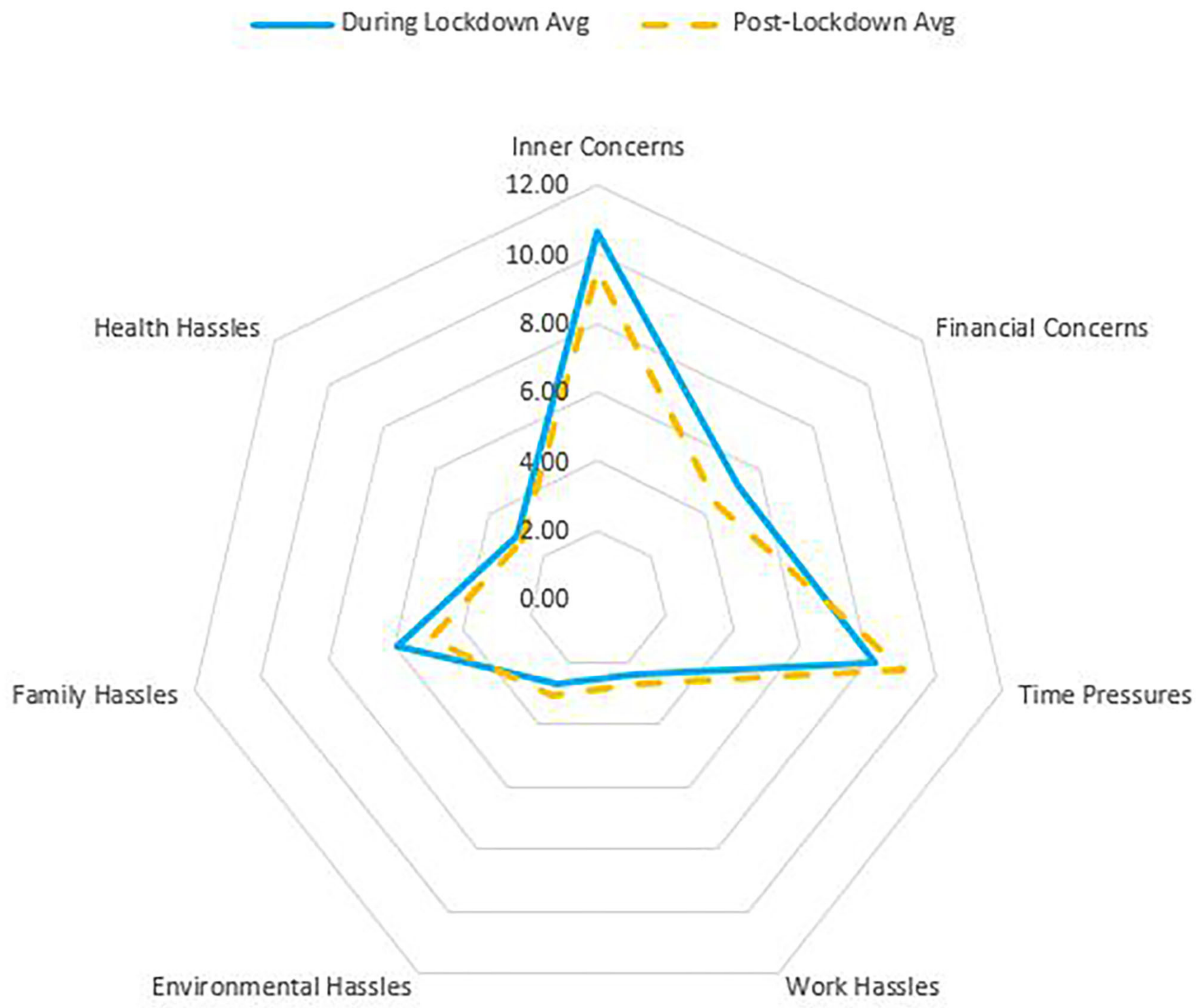

FIGURE 3 | Severity of the daily hassle categories experienced during- and post-lockdown.

TABLE 3 | Mean (SD) severity of daily hassles experienced and percentage of sample experiencing specific hassles during and post-lockdown.

	During lockdown		Post-lockdown	
Daily Hassle category	**Severity**	**% Experiencing hassle**	**Severity**	**% Experiencing hassle**
Inner concerns	10.6 (9.6)	35.5	9.6 (8.9)	31.0
Time pressures	8.2 (7.2)	33.7	9.1 (7.5)	38.1
Family hassles	6.0 (4.5)	27.8	5.0 (4.2)	24.8
Financial concerns	5.2 (7.0)	18.4	4.4 (6.5)	16.7
Health hassles	3.0 (3.4)	19.9	2.8 (3.4)	19.2
Environmental hassles	2.7 (2.9)	18.3	3.1 (3.2)	20.4
Work hassles	2.4 (3.4)	17.6	2.7 (3.4)	20.3

Higher numbers indicate higher severity of daily hassle category.

TABLE 4 | Multiple regression results investigating relationships between daily hassles and PA behavior during-lockdown.

	Model 1				Model 2				Model 3			
	Unstandardized β	Standardized β	Sig.	VIF	Unstandardized β	Standardized β	Sig.	VIF	Unstandardized β	Standardized β	Sig.	VIF
(Constant)	994.34		0.008		1,081.09		0.005		1,081.20		0.006	
Pre-lockdown total weekly PA	0.41	0.44	0.00	1.09	0.40	0.44	0.00	1.10	0.40	0.44	0.00	1.99
Age	−3.14	−0.06	0.34	1.03	−3.25	−0.06	0.32	1.03	−3.25	−0.06	0.33	1.04
Gender	84.56	0.05	0.40	1.05	81.54	0.05	0.42	1.05	81.55	0.05	0.42	1.05
Education	7.45	0.02	0.74	1.03	6.74	0.02	0.77	1.03	6.74	0.02	0.77	1.03
Ethnicity	−23.52	−0.08	0.21	1.03	−23.02	−0.07	0.22	1.03	−23.02	−0.07	0.23	1.05
Essential worker	−46.29	−0.02	0.72	1.02	−47.61	−0.02	0.71	1.03	−47.63	−0.02	0.71	1.03
Children	−32.68	−0.04	0.47	1.04	−33.15	−0.05	0.46	1.04	−33.15	−0.05	0.46	1.04
Extent of daily hassles during lockdown					−1.52	−0.06	0.30	1.01	−1.52	−0.06	0.81	19.07
Extent of daily hassles during lockdown*PA group									0.004	0.05	1.00	19.25

Dependent variable: total weekly PA during lockdown.

TABLE 5 | Multiple regression results investigating relationships between daily hassles and PA behavior post-lockdown.

	Model 1				Model 2				Model 3			
	Unstandardized β	Standardized β	Sig.	VIF	Unstandardized β	Standardized β	Sig.	VIF	Unstandardized β	Standardized β	Sig.	VIF
(Constant)	348.64		0.28		506.71		0.13		496.23		0.15	2.51
Pre-lockdown total weekly PA	0.38	0.39	0.00	1.34	0.38	0.39	0.00	1.34	0.38	0.41	0.00	2.42
During lockdown total weekly PA	0.42	0.40	0.00	1.28	0.41	0.40	0.00	1.29	0.41	0.39	0.00	1.29
Age	1.19	0.02	0.67	1.03	0.22	0.00	0.94	1.06	0.22	0.00	0.94	1.06
Gender	−161.14	−0.09	0.06	1.05	−153.22	−0.09	0.08	1.05	−152.55	−0.09	0.08	1.05
Education	28.72	0.07	0.14	1.03	25.24	0.06	0.19	1.03	25.20	0.06	0.19	1.03
Ethnicity	2.85	0.01	0.86	1.04	6.16	0.02	0.70	1.05	6.62	0.02	0.69	1.10
Essential worker	−107.98	−0.05	0.32	1.03	−99.96	−0.05	0.36	1.03	−100.17	−0.05	0.36	1.03
Children	51.46	0.07	0.18	1.04	47.86	0.06	0.21	1.05	48.01	0.06	0.21	1.05
Extent of daily hassles after lockdown					−2.85	−0.11	0.03	1.05	−2.15	−0.08	0.70	18.73
Extent of daily hassles after lockdown*PA group									−0.30	−0.03	0.90	19.70

Dependent variable: total weekly PA after lockdown.

individuals who were highly active pre-lockdown, vigorous and moderate intensity PA was lower during- and post-lockdown compared to pre-lockdown, while walking behavior did not change. This meant that overall, compared to pre-lockdown, total PA was lower during- and post-lockdown in highly active individuals. Although, it is important to note that, despite PA reducing as a result of lockdown, on average these individuals were still exceeding recommended PA guidelines (World Health Organization, 2010). In comparison, for individuals who were moderately active pre-lockdown, overall PA, vigorous and moderate intensity PA was higher during-lockdown compared to pre-lockdown. Post-lockdown those increases in vigorous intensity PA remained while moderate intensity returned to pre-lockdown levels. Walking behavior was higher during- compared to post-lockdown. The results also showed that the severity of daily hassles was similar during- and post-lockdown. While daily hassles had a small, but significant association with PA behavior after lockdown, there was no association during lockdown.

Our PA results show the importance of analyzing PA data collected during COVID-19 restrictions according to how active people were prior to lockdown because the pattern of change differed between the highly active and moderately active groups. Previous COVID-related research reported decreased vigorous intensity PA (Cheval et al., 2020) and moderate-vigorous intensity PA (Di Sebastiano et al., 2020) during lockdowns, but did not account for changes across groups with different levels of pre-lockdown PA. Research which did account for pre-lockdown activity level found decreases in total PA (Barkley et al., 2020) and vigorous PA (Cheval et al., 2020) in highly active participants during-lockdown. Our results support these findings but also showed lockdown resulted in lower levels of moderate intensity PA than they would normally engage in (i.e., pre-lockdown). Reductions in PA may have been due to highly active individuals being unable to perform their preferred PA as a result of the lockdown restrictions. For example, gyms were closed, sport was canceled and people were confined to exercising close to home, which restricted people from long distance cycling or running. Not being able to do their preferred PA was reported by 45% respondents in our study when they were asked to explain why PA behavior had decreased (data available on request) and has been reported in other research with highly active individuals (e.g., Constandt et al., 2020; Kaur et al., 2020). Additionally, interviews with gym-goers in India, found the closure of gyms and parks resulted in a lack of "fitness motivation" and a need to find alternatives to their usual exercise routines (Kaur et al., 2020). The fact that PA levels of highly active individuals did not revert back to "normal" levels post-lockdown (even though exercise facilities were open and sport had resumed) could be attributed to the formation of new exercise habits during lockdown (Gardner and Rebar, 2019). Our second survey took place 6 weeks after lockdown ended and importantly, took place during the winter months (the pre-lockdown survey was administered during autumn). It may be that it takes longer than 6 weeks for individuals to readjust their behavior back to normal pre-lockdown PA levels or indeed, these highly active individuals have lower PA levels (different PA habits) during the winter months compared to autumn when the pre-lockdown behavior was assessed. Assessing PA again in autumn 2021 with no lockdown restrictions in place will provide data through which to evaluate the return to pre-lockdown PA behavior controlling for seasonal variations. An alternative explanation may be that, COVID-related changes in life situations (e.g., resumption of daily commute to work; changes in workplace or employment status; caregiving for children or family members) from pre- to post-lockdown presented challenges to accumulating the previous large amounts of PA. In support of this explanation, having less time available for PA was reported by 57% of our respondents as an explanation for why their PA changed from during- to post-lockdown. Inevitably, there will be a multitude of interconnected factors that explain PA changes during and after COVID-19 restrictions. Further research, employing qualitative methods, is needed to explore the key factors and interrelationships underpinning the changes.

Participants who were moderately active pre-lockdown increased their vigorous and moderate intensity PA levels during-lockdown, and importantly, maintained vigorous PA post-lockdown. Consequently, total PA was higher post-lockdown compared to pre-lockdown. For moderately active participants, it appears lockdown provided an opportunity to increase the intensity of their pre-lockdown levels of PA. Explanations for these changes are speculative but it is possible that individuals wanted to use the time to "escape" from their homes and individuals knew being physically active was a permitted activity during-lockdown. Indeed, 35% of our participants who increased or maintained their PA levels during lockdown noted that being active "was a good excuse or reason to get outside". Participants may also have wanted to increase their fitness, and so chose to increase at a higher intensity to achieve that. Alternatively, moderately active individuals, compared to highly active individuals, may not have needed access to specialized facilities to significantly increase their PA levels. Being active close to home during-lockdown via simple modes of PA such as running and cycling, or at home using exercise equipment and online exercise videos [which was common during lockdown (Ding et al., 2020)], may have been attractive for these moderately active individuals. Although speculative, post-lockdown, participants may have strengthened their autonomous motivation for PA (participating out of enjoyment, or the personal value attached), as a result of seeing the benefits and value of increasing their PA levels. Autonomous motivation is a strong predictor of PA behavior (Teixeira et al., 2012). Some evidence for this explanation was provided by participants who, in answer to the question "why have you been more active/continued to be active from during- to post-lockdown," reported that it was important for physical and psychological well-being. Other researchers have pointed to the importance of supporting motivation to enable PA behavior change during the pandemic (Hudson and Sprow, 2020; Matias et al., 2020). Given that the majority of research published so far examining PA during COVID-19 restrictions has been quantitative and largely descriptive, the explanations for why PA has changed have not been thoroughly explored, but clearly would be insightful. In particular, future research to understand changes in the different types of motivation people held for PA during the periods of COVID-19 restrictions would be of value.

This study also examined whether daily hassles might help to explain changes in PA behavior. The daily hassles (i.e., stressors) a specific life event creates in a person's life has been shown to influence lifestyle behaviors (Kanner et al., 1981; O'Connor et al., 2009; Uijtdewilligen et al., 2014). We found that inner concerns, time pressures, family hassles and financial concerns were experienced most severely and were endorsed by the greatest proportion of participants both during- and post-lockdown. Contrary to hypotheses, the severity of daily hassles was not associated with PA during-lockdown. However, daily hassles had a small negative (Standardized $\beta = -0.11$) predictive effect on PA post-lockdown, which was not moderated by the participants' pre-lockdown PA status. Previous research has shown daily hassles to explain a similar proportion of variance in unhealthy snacking (Conner et al., 1999; O'Connor et al., 2009), smoking, fruit and vegetable consumption (O'Connor et al., 2009) and physical activity (Nguyen-Michel et al., 2006; O'Connor et al., 2009). While, feelings of worry/stress have been stated as reasons for decreasing engagement in positive health behaviors during lockdown (Knell et al., 2020), and those who reported decreases in PA during lockdown were more likely to report higher levels of stress (Stanton et al., 2020). It is unclear why daily hassles only predicted post-lockdown PA, even though the severity of daily hassles did not change from during- to post-lockdown. It may be that the specific daily hassles encountered post-lockdown, compared to during-lockdown (e.g., returning to work, job insecurity), presented more of a challenge to PA levels. Investigating the relationships between daily hassles and the actual stress that resulted from those hassles may explain these findings.

This study is not without its limitations. We were not able to recruit many low active participants to complete the survey. The during-lockdown survey only garnered 32 responses from participants not meeting the PA guidelines, but they either did not opt to be contacted post-lockdown or did not respond to the post-lockdown survey and so could not be included in the analysis. Therefore, we have no data on how inactive people responded to the COVID-19 restrictions. Additionally, we had a low response rate to our post-lockdown survey which severely reduced our sample size for the longitudinal analysis, this presents a significant limitation. These selection biases have resulted in a sample with a specific demographic profile (predominately of NZ European ethnicity, female and highly educated) thus limiting generalisability of our findings. Our PA data is self-report, and for pre-lockdown behavior is retrospective, which comes with clear limitations in terms of recall bias, but is consistent with the methods of other research and indeed, the only method available under these circumstances. Despite these limitations, a strength of this research is the use of the validated IPAQ-SF as the self-report measure of PA and the longitudinal nature of the data.

In conclusion, contrary to what was predicted at the outset of the COVID-19 restrictions (Papaioannou et al., 2020), PA did not decline during lockdown restrictions in participants who were meeting the WHO PA guidelines prior to lockdown, in fact moderate and vigorous intensity PA increased. For those who were exceeding the guidelines prior to lockdown, PA declined but participation during lockdown was still at a high enough level to benefit health. Post-lockdown, new PA habits had been created (highly active individuals pre-lockdown were participating in less PA compared to pre-lockdown, while moderately active individuals were more active) which may have been driven by changes in life circumstances or recognition of the importance of being physically active under COVID-19 conditions. As expected, participants reported experiencing daily hassles relating to inner concerns, family, time and finances as a result of COVID-19 restrictions, however it was only post-lockdown that these hassles were negatively associated with PA. From a practical perspective, these results suggest that the information disseminated by the NZ government on the importance of remaining active during lockdown was heeded by active New Zealanders. Health promoters should publicize these positive results and encourage people to continue being active. Drawing on our daily hassles results, as New Zealand remains in a post-lockdown period, PA promotion information needs to communicate targeted strategies to overcome the daily hassles identified to provide on-going support for PA behavior. This could include emphasizing that being physically active can help reduce the experience of stress caused by daily hassles (World Health Organization, 2010; Stubbs et al., 2017). Future research should explore the potential explanations for why PA levels of active individuals were protected from the COVID-19 restrictions. Furthermore, different methodologies that specifically target low active individuals are needed to explore potential changes in, and explanations for, their PA behavior.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Otago, Human Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

EH, MJ, and JC coordinated data collection. CL and JC cleaned and analyzed the data. EH led the manuscript writing. All authors contributed to the final submission, conceived the study, and developed the methods.

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Are Emotional and Behavioral Problems of Infants and Children Aged Younger Than 7 Years Related to Screen Time Exposure During the Coronavirus Disease 2019 Confinement? An Exploratory Study in Portugal

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The coronavirus disease 2019 outbreak forced most of the world's population to be confined at home to prevent contagion. Research reveals that one of the consequences of this confinement for children is an increased amount of time spent using screens (television, computers, and mobile devices, etc.) at home. This exploratory study aims to analyze the association between screen time exposure and emotional/behavioral problems of infants and children aged under 7 years, as manifested during the lockdown period in Portugal due to the coronavirus disease 2019 outbreak. The study was controlled for sociodemographic and confinement variables. A sample of 193 parents of children aged from 6 months to 6 years and 12 months, residing in Portugal, completed a survey about the time and manner of use of screen time exposure of their children. Data were derived on circumstances both before and after the confinement; the survey also explored the child's behavioral and emotional adjustment. The findings revealed a modest relationship between children's exposure time to screens and behavioral and emotional problems on children studied. It was also found that parents may play an important role in children's behavioral and emotional adjustment during the confinement period.

Keywords: COVID-19 confinement, children's well-being, screen time, digital media, emotional problems, behavioral problems

INTRODUCTION

Originating in the City of Wuhan (China), in December 2019, the coronavirus disease 2019 (COVID-19) outbreak emerged and quickly disseminated throughout the world. At the end of April, in Portugal, about 24,692 cases were confirmed and 989 deaths reported (Direção_Geral_de_Saúde, 2020a), rising to 42,171 and 1,576, respectively, at the end of June (Direção_Geral_de_Saúde, 2020b). On March 13, the Portuguese government instituted emergency measures forcing the population to be confined in their residences for a long period. This brought several changes to daily routines: schools were closed, and children started to have classes remotely at home; many workers lost their jobs or had to stay at home working remotely. It was the first time in Portuguese history that quarantine was implemented to control a pandemic.

It is known that the psychological impact of quarantining is wide-ranging, substantial, and can be long-lasting (Brooks et al., 2020). Despite limited evidence on the impact of confinement on children's mental health, surveys of students in China showed an increase in anxiety (Cao et al., 2020; Xie et al., 2020) and depression (Xie et al., 2020). Results of a study developed in Italy and Spain to examine the impact of the COVID-19 quarantine on children and adolescents (Orgilés et al., 2020) showed that 85.7% of the parents reported negative changes in their children's emotional state and behaviors. The main symptoms were difficulty in concentrating, boredom, irritability, restlessness, nervousness, and feelings of loneliness; being more uneasy and more worried were also reported by the parents. Over a 1-month lockdown period, parents or caregivers of primary-school-age children reported an increase in their child's emotional, behavioral, and restlessness/attentional difficulties (Pearcey et al., 2020a).

Several factors may contribute to this. The reduction of social interaction and the reduction of outdoor activities (Xie et al., 2020) and even access to outside space (Pearcey et al., 2020b) seem to play an important role. Factors related to the place where the children live, financial stability of parents, concerns about the pandemic situation, or the existence of family members diagnosed with COVID also have an impact on emotional well-being (Cao et al., 2020). Furthermore, children's well-being seems directly related to the level of stress and well-being of parents (Orgilés et al., 2020), which can be influenced by factors related to the economic and family situation, concerns about the severity of the pandemic situation, proximity to infected people and home conditions such as the dimensions of the house or the existence or not of an open-air space (Rodríguez-Rey et al., 2020).

Due to COVID-19, most children in Organization for Economic Cooperation and Development (OECD) countries were more exposed to digital technologies than usual (OECD, 2020). Digital tools take on an important role in providing tools for children, parents, and teachers to continue schooling, facilitate social interactions, and provide recreational activities and psychological and social support from outside. On the other hand, widespread digitalization has its downsides, including increasing exposure to hateful, harmful, or illegal content and cyberbullying (OECD, 2020). In Spain and Italy, during the quarantine, children spent more time using screens (iPads, TVs, mobiles, or computers), slept more hours, and spent less time doing physical activity (Orgilés et al., 2020). This is concerning insofar as there are pieces of evidence that a higher screen-time exposure is correlated with greater sedentary time and lack of physical activity on children, which, in turn, increases the risk of psychological problems (Hamer et al., 2009; Pagani et al., 2010; Page et al., 2010). By itself, confinement leads to a decrease in physical activity, which, in interaction with increased screen-time exposure, may lead children to develop more emotional and behavioral problems.

Studies about the impact of exposure to the new technologies are still controversial. Some research (Radesky et al., 2015) reveals the benefits of children's exposure to digital media with respect to the development of comprehensive and cognitive skills. On the other hand, other studies have found an array of negative outcomes due to children's exposure to media: cognitive and language delays (Zimmerman and Christakis, 2005; Zimmerman et al., 2007), nutritional and physical problems, and aggressiveness (Jordan, 2004). Existing evidence showed a negative association between screen-time and psychological well-being among children and adolescents (Twenge and Campbell, 2018; Zhao et al., 2018).

Despite being described in the literature that there is a decrease in children's well-being during a period of confinement and an increase in the time of exposure to the screens, we have not found any study that intends to test if there is a relationship between screen exposure and behavioral and emotional problems during a confinement situation. Therefore, the main objective of this exploratory study was to analyze the association between screen-time exposure during the lockdown period in Portugal due to the COVID-19 outbreak and the emotional and behavioral problems of infants and children aged younger than 7 years old (while looking for the contribution of sociodemographic and confinement-related variables). Specifically, we aimed to know: the time and conditions of exposure to screens; parents' perception of children's exposure time to screens; conditions related to confinement, considering it as the independent variable when studying its relationship with children's emotional and behavioral state during the confinement period (dependent variable). We hypothesized that higher screen-time exposure during the lockdown would lead children to have higher risks of emotional and behavioral problems. We also hypothesized that confinement conditions (personal situation or home features) might have an influence on children's emotional and behavioral states.

MATERIALS AND METHODS

Participants

To reach the largest number of people, the survey was released online and shared through the personal contacts of the research team, through kindergarten schools and social media groups associated with families and parenting in Portugal. The survey was disseminated in a snowball manner in which participants could reach other participants. We did not control the dissemination within the kindergarten schools. The participants in this study were parents or caregivers (hereafter referred to as "parents") of the children. To participate, parents had to be aged 18 years or older, caring for a 6-month to a 6-year-and-12-month-old child, and self-reporting as being literate in Portuguese. Children were removed from analysis if parents reported developmental disorders. Only one of the parents (mother or father) responded to the questionnaire. All parents were asked to report on a single child; all children involved were in confinement.

In total, 200 participants completed the survey. Of these, two were removed because parents reported on children aged 7 years or older; an additional five participants were removed for reporting developmental disorders (n = 3 autism, n = 1 sensory disorder, and n = 1 genetic disorder). The final sample, then, consisted of a total of 193 participants (all native and living in Portugal, except four participants who were non-native but with a self-reported good understanding of Portuguese). All respondents were parents (fathers n = 14; mothers n = 177), except 2, who were the main legal caregivers. As it was not mandatory to be only fathers or only mothers to answer the questionnaire, there is significantly lower participation of fathers when compared with the mothers. We found pieces of evidence (Grietens et al., 2004; Dave et al., 2008) that there is a high interparental agreement when reporting about problem behaviors in children, so we considered that the responses of both would have the same significance. The sample cannot be considered representative of a larger population.

Procedures and Instruments

Before its dissemination, the survey was previously submitted and approved by the Ethics Review Board of the School of Health of the Polytechnic Institute of Porto. Before answering the questionnaire, all participants agreed to be involved in the study using an online informed consent form. The latter was formulated according to the World Medical Association Helsinki Declaration (2013), which contains the description and purpose of the study; an explanation that the data collected will be used for statistical purposes only; assurances that participation was voluntary; a statement that privacy and confidentiality of all data collected would be protected; and offering advice that the individual could withdraw from the study at any time without prejudice to them.

The survey was open online for about 1 month, from May 6 of 2020 to June 8 of 2020. It took approximately 20 min to be completed and included the following sections:

1. Sociodemographic data of parents and children; and conditions and changes related to confinement: as the personal situation changes [beginning of confinement, number of people living at home, monthly income, loss of job, changes in household income(s), and concerns about the COVID-19 pandemic] and home features (dimensions of the house, having a balcony at home, having a terrace at home, having a small garden, having a large outer space, or having no outer space). Parents' perception about their confinement experience was asked using a five-point Likert-type scale (from "1–Very Negative" to "5–Very positive") as well as their degree of concern about the situation of COVID-19 (from "1–Nothing worried" to "5–Very worried"). It is important to notice that in Portugal, the state of emergency was enacted on March 18 and ended on 2nd May. During this period, the population could only leave their homes to attend to basic needs, such as going shopping for food or going to the pharmacy. Outdoor activities, such as running or bike riding, were allowed, when alone, and solely for short distances. Children could play outdoor for short periods. Schools were closed, and all levels of education shifted to distance learning. On May 18, children younger than 3 years were allowed to go back to nurseries, and children from ages 3 to 6 years went back to kindergarteners after June 1. However, the outdoor restrictions remained.

2. Time and conditions of exposure of children to media and screens, including:

- Exposure time (in hours) to television (TV), computer, videogames, tablet, cellphone, and Internet, before and during the confinement, on weekdays and weekends, in a scale varying from 1 to 9 (1 = none, 2 = less than 1 h, 3 = 1 h, 4 = 2 h, 5 = 3 h, 6 = 4 h, 7 = 5 h, and 8 = more than 5 h). We computed a total score and a score for the difference between total media exposure during and before confinement.
- Parents' perceptions about increased exposure to screens (TV, computer, video games, tablet, and cellphone), during the confinement, on a five-point Likert-type scale (from "1—Strongly Disagree" to "5—Totally Agree"). We computed a total score.
- Parents' behavior while children used devices during the confinement, using a five-point Likert-type scale (1 = never, 2 = rarely, 3 = sometimes, 4 = very often, and 5 = always) on the following: "let children use the devices alone;" "sat close to the children but didn't interact;" "talked with children about what they were doing or viewing;" and "participated with children when using devices."

3. Behavioral and emotional symptoms on children during the confinement period, evaluated using the following scales:

- Baby Pediatric Symptom Checklist (BPSC) (Perrin et al., 2016), for children younger than 18 months.
- Preschool Pediatric Symptom Checklist (PPSC) (Perrin et al., 2016), for children from 18 to 66 months.

These are two components from the Survey of Well-Being of Young Children that assess behavioral and emotional symptoms for children younger than 18 months (BPSC) and from 18 to 66 months (PPSC). For each item on both scales' response options are "Not at All," "Somewhat," and "Very Much." The BPSC has 12 items, divided into three subscales (irritability, inflexibility, and difficulties with routines changings), each with four items. Subscale scores are determined by assigning a "0" for each "Not at All" response, a "1" for each "Somewhat" response, and a "2" for each "Very Much" response and then totaling the results. The range of the BPSC goes from 0 to 24, and any summed score of 3 or more on any of the three subscales indicates that the child is suspected of behavioral changes and needs further evaluation or investigation. The PPSC has 18 items divided into four domains of interest ("Internalizing," "Externalizing," "Attention Problems," and "Parenting Challenges"). Internalizing items reflect the emotional or psychological state of the child, including depressive or anxiety symptoms. Externalizing items are related to the child reactions to other people or stressors, as hostility or aggression. Attention problems items ask about children's ability to sustain focus or persistence in activities. Parenting challenges items reflect issues that parent's face in raising their children. The total score can be assigned as on the BPSC, and a total score of 9 or greater, on a range of 0 to 36, indicates that a child is "at risk" of behavioral changes (Perrin et al., 2016; Moreira et al., 2019). There are two final questions in both surveys about parents' concerns with the child's learning/development and behavior. The Portuguese versions of these scales were used (Moreira et al., 2019).

RESULTS

Descriptive Statistics and Relationship Between Children's Emotional and Behavioral Problems and Age and Sex

The respondents were aged 22 to 50 years (mean = 36.44 *SD* =±4.35), mostly female (92.2%; *n* = 178)), and were the primary caregivers of children aged 6 to 82 months (mean = 42.86 *SD* = ± 20.65), mostly boys (56%, *n* = 108). The caregivers' educational level was high: approximately 40.9% (*n* = 79) had a bachelor's degree, and 35.2% (*n* = 68) had a masters' degree or similar. Before the confinement due to the COVID-19 pandemic, the majority (84.5%, *n* = 163) had a full-time job, 8.8% (*n* = 17) had a part-time job, and 3.6% (*n* = 7) were unemployed. Most children had attended an educational establishment before the period of confinement (81.9%, *n* = 158). Of the parents, 83.9% (*n* = 162) responded to the PPSC test, and the other 16.1% (*n* = 31) responded to the BPSC, so 162 children were in the range of 18 months to 6 years and 12 months old (73 girls and 89 boys), and 31 (12 girls and 19 boys) were between 6 and 18 months old.

The majority of all the participant parents (71%, *n* = 137) agreed that exposure time to TV had increased during the confinement. Approximately 25% of the parents felt that children had increased the time using tablets (*n* = 49) and cellphones (*n* = 46) during the confinement. The majority of the parents (70.5%, *n* = 136) disagreed that exposure time to videogames has increased during the confinement period. Regarding computers, 59.1% (*n* = 114) disagreed that the use of these devices has increased during confinement (**Table 1**).

Independent samples *t*-test showed no differences between boys (*n* = 19) and girls (*n* = 12) ($t = -0.150$; $p = 0.882$) regarding BPSC Total and a trend toward significance regarding PPSC Total ($t = -1.901$; $p = 0.059$), with boys (*n* = 89) showing a higher mean than girls (*n* = 73) (*M* = 7.49; *M* = 5.89, respectively). Pearson's correlation showed no significant correlation between age and child's emotional and/or behavioral problems (**Table 2**).

Relationship Between Children's Emotional and Behavioral Problems and Variables Related to Confinement

For the analysis, we defined as dependent variables the total scores of BPSC and PPSC and used them for each independent

TABLE 1 | Descriptive statistics of parents' perceptions about increasing screen time exposure to children during confinement.

	Television		Videogames		Computer		Tablet		Cellphone	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Totally disagree	26	13.5	136	70.5	114	59.1	93	48.2	82	42.5
Disagree	15	7.8	13	6.7	13	6.7	17	8.8	19	9.8
Don't agree or disagree	15	7.8	18	9.3	16	8.3	15	7.8	17	8.8
Agree	87	45.1	18	9.3	33	17.1	49	25.4	46	23.8
Totally agree	50	25.9	8	4.1	17	8.8	19	9.8	29	15.0
Mean ± *SD*	3.62 ± 1.31		1.70 ± 1.21		2.10 ± 1.47		2.40 ± 1.52		2.59 ± 1.58	

TABLE 2 | Relationship between children's emotional and behavioral problems and age and sex (independent-samples *t*-test).

	BPSC irritability range_0–8	BPSC inflexibility range_0–8	BPSC routines range_0–8	BPSC total range_0–24	
Gender	**Mean ± STD**	**Mean ± STD**	**Mean ± STD**	**Mean ± STD**	
Girls (*n* = 12)	1.17 ± 1.26	2.25 ± 1.54	2.33 ± 2.31	5.75 ± 4.00	
Boys (*n* = 19)	2.11 ± 1.66	1.94 ± 1.47	1.89 ± 1.91	5.95 ± 3.27	
T	−1.669	0.547	0.574	−0.150	
p-value	0.106	0.588	0.570	0.882	
	PPSC internalizing range 0–12	**PPSC externalizing range 0–8**	**PPSC attention problems range 0–6**	**PPSC parenting challenges range 0–10**	**PPSC total range 0–36**
Gender	**Mean ± STD**	**Mean ± STD**	**Mean ± STD**	**Mean ± STD**	**Mean ± STD**
Girls (*n* = 73)	2.29 ± 1.49	0.51 ± 1.11	1.40 ± 1.60	1.70 ± 1.74	5.89 ± 4.61
Boys (*n* = 89)	2.33 ± 1.95	0.89 ± 1.19	1.80 ± 1.79	2.48 ± 2.38	7.49 ± 5.87
T	−0.138	−2.089	−1.486	−2.346	−1.901
p-value	0.891	0.038	0.139	0.020	0.059

TABLE 3 | Relationship between children's emotional state and behavior and factors related to confinement (independent-samples *t*-test).

			Yes Mean ± *SD* (*n*)	No Mean ± *SD* (*n*)	Mean difference	*t*	*p*-value
	Incomeloss	BPSC total	6.25 ± 3.04(16)	5.47 ± 4.02(15)	0.783	0.615	0,544
		PPSC total	6.80 ± 5.65(91)	6.73 ± 5.07(71)	0.070	0.082	0,935
	Balconyat home	BPSC total	5.95 ± 2.94(20)	6.27 ± 4.50(11)	0.623	0.467	0,644
		PPSC total	6.97 ± 5.63(104)	6.41 ± 4.94(58)	−0.557	−0.630	0,530
Home features	Terraceat home	BPSC total	5.50 ± 2.59(6)	5.96 ± 3.74(25)	0.460	0.284	0,779
		PPSC total	6.95 ± 5.56(66)	6.65 ± 5.29(96)	−0.309	−0.357	0,721
	Smallgarden	BPSC total	3.83 ± 2.23(6)	6.36 ± 3.62(25)	2.527	1.627	0,115
		PPSC total	6.98 ± 5.44(50)	6.68 ± 5.39(112)	−0.301	−0.328	0,743
	Largeouter space	BPSC total	5.86 ± 2.97(7)	5.88 ± 3.71(24)	0.018	0.012	0,991
		PPSC total	6.10 ± 4.80(48)	7.05 ± 5.61(114)	0.948	1.023	0,308
	No outerspace	BPSC total	7.20 ± 5.72(5)	5.61 ± 3.02(26)	−1.585	−0.922	0,364
		PPSC total	8.06 ± 7.13(16)	6.63 ± 5.17(146)	−1.432	−1.010	0,314
	Lost job due toCOVID-19	BPSC total	7.00 (1)	5.83 ± 3.56(30)	1.167	0.322	0,750
Personal situation		PPSC total	3.67 ± 3.06(3)	6.83 ± 5.41(159)	−3.163	−1.008	0,315
	Teleworking	BPSC total	5.85 ± 3.92(20)	5.91 ± 2.77(11)	−0.059	−0.44	0,965
		PPSC total	6.65 ± 5.33(96)	6.95 ± 5.50(66)	−0.309	−0.357	0,721

variable related to confinement. Independent-samples *t*-tests were applied to the following independent variables: having a balcony at home, having a terrace at home, having a small garden at home, having a large outer space, having no outer space, parents having lost their job due to COVID-19, and parent teleworking. We used Pearson's correlation between BPSC and PPSC total scores and the following independent variables related to confinement: number of people at home, monthly income, percentage of income loss, square meters of home, parents' perception about confinement experience, concerning about COVID-19, and children's number of days in confinement.

Regarding children from 6 to 18 months, independent-samples *t*-test showed no differences in BPSC between those reporting "yes" or "no" for the following variables related to the confinement condition: income loss, having a balcony at home, having a terrace at home, having a small garden, having a large outer space, having no outer space, parents having lost their job due to COVID-19, and parent teleworking (**Table 3**). There was no significant correlation between BPSC and the variables: number of people at home, monthly income, percent of income loss, house dimension in squared meters during the confinement, parents' worries about COVID-19, and confinement experience. BPSC showed a negative correlation with the child's number of days in confinement ($r = -0.414$, $p = 0.021$).

In the case of older children (from 18 months to 6 years old), independent-samples *t*-test showed no differences in PPSC between those reporting "yes" or "no" for the following variables related to the confinement condition: income loss, having a balcony at home, having a terrace at home, having a small garden, having a large outer space, having no outer space, parents having lost their job due to COVID-19, and parent teleworking (**Table 3**). Pearson's correlation showed a negative correlation between PPSC and the parents' perceptions about the confinement experience ($r = -0.332$; $p = 0.00$; **Table 4**). There was no significant correlation between PPSC and the following variables: number of people at home, monthly income, percent of income loss, house dimension in squared meters during the confinement, parents' worries about COVID-19, confinement experience, and the child's number of days in confinement (**Table 4**).

Relationship Between Children's Emotional and Behavioral Problems and Exposure to Screen-Related Variables

Regarding PPSC domains, PPSC Attention Problems showed positive correlations with total hours of exposure to screens during confinement on weekdays ($r = 0.288$, $p = 0.00$) and total hours of exposure to screens during confinement, on weekends ($r = 0.257$, $p = 0.001$). Parenting Challenges showed positive correlations with total hours of exposure to screens during confinement on weekdays ($r = 0.285$, $p = 0.000$), total hours of exposure to screens during confinement, on weekends ($r = 0.301$, $p = 0.000$), and the difference between total exposure to screens during and before confinement, on weekends ($r = 0.230$, $p = 0.003$). A positive correlation was also found between total hours of exposure to screens during confinement, on weekends ($r = 0.168$, $p = 0.032$) and

TABLE 4 | Correlations between children's emotional state and behavior and factors related to confinement period.

		R	
		BPSC total	**PPSC total**
Home features	Square meters home	0.065	0.023
	Number of people at home	0.250	0.105
	Monthly Income	0.031	−0.094
	% income loss	−0.301	0.184
Personal situation	Perception about confinement experience	−0.092	−0.332**
	Concerns about COVID-19	0.243	−0.44
	Children's number of days in confinement	−0.414*	0.023

*$p < 0.05$.
**$p < 0.01$.

TABLE 5 | Correlations between children's emotional state and behavior and exposure to screens.

	r								
	Children less than 18 months (*n* = 31; 12 girls, 19 boys)				Children + 18 months to 6 years old (*n* = 162; 73 girls, 89 boys)				
	BPSC irritability	BPSC inflexibility	BPSC routines	BPSC total	PPSC internalizing	PPSC externalizing	PPSC attention problems	PPSC parenting challenges	PPSC total
Total hours of exposure to screens during confinement, on weekdays	−0.053	−0.197	0.037	−0.085	0.114	0.132	0.288**	0.285**	0.271**
Total hours of exposure to screens during confinement, on weekends	−0.015	−0.194	0.060	−0.054	0.084	0.168*	0.257**	0.301**	0.266**
Difference between total exposure to screens during and before confinement, on weekdays	−0.027	−0.101	−0, 138	−0.135	0.079	0.035	0.135	0.114	0.121
Difference between total exposure to screens during and before confinement, on weekends	0.112	0.037	−0.028	0.050	0.118	0.216**	0.056	0.230**	0.195*
Parent's perception about the increasing of children screens exposure during confinement	0.209	−0.264	0.220	0.111	0.300**	0.235**	0.218**	0.302**	0.338**
Children use devices alone, during confinement	0.103	0.025	0.094	0.111	0.153	0.161*	0.071	0.091	0.144
Parents sit close to the child while using devices but did not interact, during confinement	−0.288	−0.005	−0.322	−0.319	−0.005	0.058	0.072	0.075	0.064
Parents talk about what children are doing or viewing when using devices, during confinement	0.071	0.100	−0.146	−0.011	–0102	−0.055	0.119	−0.056	−0.029
Parents participate with children when using devices, during confinement	0.018	−0.016	−0.067	−0.038	−0.264**	−0.032	−0.075	−0.136	−0.170*

*$p < 0.05$.
**$p < 0.01$.

the difference between total exposure to screens during and before confinement, on weekends (r = 0.216, p = 0.006) and the PPSC Externalization scale (**Table 5**). We found positive correlations between the results of the PPSC Total and the following variables: total hours of exposure to screens during confinement on weekdays (r = 0.271, p = 0.000) and total hours of exposure to screens during confinement, on weekends (r = 0.266, p = 0.001). We also found a positive correlation between the total PPSC and the difference in the total hours of exposure during and before confinement on weekends (r = 0.195, p = 0.013) (**Table 5**).

Parents' perceptions about the increase of child's media exposure during confinement was correlated to PPSC (r = 0.338, p = 0.00) and with its all domains: Internalization (r = 0.300, p = 0.000), Externalization (r = 0.235, p = 0.003), Attention Problems (r = 0.218, p = 0.005), and Parenting Challenges (r = 0.302, p = 0.000). The attitude of participation of the parents while children are using their devices during confinement was also associated to PPSC Total (r = −0.170, p = 0.030) and PPSC Internalization (r = −0.264, p = 0.001), whereas children using devices alone during confinement showed a positive correlation (r = 0.161, p = 0.041) with PPSC Externalization. All other factors have not shown any correlation with either BPCS Total or PPSC Total (p > 0.05) (**Table 5**).

DISCUSSION AND CONCLUSION

The whole world has been affected by the COVID-19 pandemic and the confinement situation. Being confined, by itself, is an experience that can bring emotional and behavioral changes. The OECD (2020) warns that the stress and uncertainty associated with the COVID-19 outbreak potentially may have significant effects on children's mental health. Furthermore, during the lockdown period, people, including children, were not able to do the amount of physical activity they used to do outdoors, especially if families lived in small apartments with no outer space, which could increase screen-time exposure and deepen psychological problems. In this exploratory study, we wanted to analyze the association between screen-time exposure during the lockdown period in Portugal due to the COVID-19 outbreak and the emotional and behavioral problems of infants and children aged younger than 7-years, with the BPSC and PPSC, while controlling for sociodemographic and confinement variables.

This is important because there is a trend toward increased screen exposure during confinement periods (Orgilés et al., 2020), and there is evidence that confinement is associated with behavior and emotional problems (Pearcey et al., 2020a). Given that there is evidence showing an association between screen-time exposure and behavioral and emotional problems (Özmert et al., 2002; Twenge and Campbell, 2018; Zhao et al., 2018), we hypothesized that greater screen-time exposure during the COVID-19 lockdown would lead children to have higher risks of emotional and behavioral problems. We found significant but weak correlations between these variables.

It should be noted that in our study, for children from 18 months to 6 years and 12 months, attention problems and parent challenges seem to be the most affected by the screen-time exposure. Surprisingly, internalization symptoms were not associated with screening exposure, despite pieces of evidence showing that screen-time exposure is related to reduced emotional regulation and self-control, poor sleep quality, less curiosity, and psychopathology, particularly anxiety and depression (Wu et al., 2015; Twenge and Campbell, 2018). Externalization symptoms were associated with exposure time during the confinement during weekends, which is in line with some reports that found higher aggressive behaviors in children with age-inappropriate viewing and higher duration screen viewing (Özmert et al., 2002; Conners-Burrow et al., 2011).

We did not find any consistent association between screen-time exposure and emotional or behavioral problems of infants aged 6 months to 18 months. Screen time seems to progressively increase with age, and well-being is more affected by screen-time exposure as children get older (Rosen et al., 2014; Twenge and Campbell, 2018). One explanation is that younger children may have spent more time watching age-appropriate TV or videos, whereas older children use more age-inappropriate videos or spend more time online. Another possibility is that older children have a steeper decrease in other fundamental activities when participating in screen activities, such as outdoors and free playtime activities. Some studies revealed that children suffered significant changes in their daily habits during the confinement period, spending more than 3 h using screens and halving the time spent in physical activities (Francisco et al., 2020; Morgül et al., 2020).

Focusing on aspects related to confinement, we hypothesized that confinement conditions could influence children's emotional and behavioral states. Contrary to that and other reports (Cao et al., 2020; Pearcey et al., 2020b; Rodríguez-Rey et al., 2020), house conditions, household, and/or familiar income stability did not seem to have a major impact on the children's well-being on this study. Maybe this is related to the fact that, in Portugal, children could still go outside to practice leisure activities, even if for short periods of time. However, the parents' perceptions of their confinement experience proved to be important in the children's behavior and emotional adjustment showing a bigger correlation to PPSC than screen exposure variables. Thus, when parents have a bad perception about their confinement experience, they tend to report more emotional and behavioral problems in their children from 18 months to 6 years and 12 months. In previous studies, parents who reported a greater impact of COVID-19 also reported higher levels of parental stress, associated with the increased use of harsh parenting and less parent–child relationship closeness and more emotional problems in their children (Chung et al., 2020; Orgilés et al., 2020). Also, we found a negative association between the number of days in confinement and the behavioral and emotional state of younger children (from 6 to 18 months), contrary to the evidence that longer quarantine periods are associated with poorer psychological outcomes (Brooks et al., 2020). This may reinforce the hypothesis that an increased presence of parents may improve emotional and behavioral outcomes in young children.

Moreover, when parents report participating with their children while using devices, there are fewer emotional and behavioral problems, and exteriorization problems increase in children when using devices alone. This supports the importance of co-viewing when children are exposed to screens, as the presence of a co-viewing parent is sufficient to alter children's psychophysiological responses to media content, facilitates the learning process with "scaffolding," and help children understand on-screen content (DeLoache et al., 2010; Council On Communications And Media, 2016; Rasmussen et al., 2017; Gottschalk, 2019). These findings highlight the importance of "doing together" as the gold standard for parents when children use technologies.

This study has several important limitations, including sample size, the lack of data before the confinement, and the bias associated with the subjective indirect measures with self-reporting data. The snowball distribution of the questionnaires proved to be a limitation for the study, as it did not allow to control the size of the sample for the different variables, so we could not equally distribute the groups for the data analysis. We chose to analyze data according to the age ranges defined by the BPSC and the PPSC, which further reinforced the small power sample for data analysis, so results have to be read and understood with careful attention. Also, BPSC and PPSC are screening scales, which may not be refined enough to capture the whole picture of children's emotional or behavioral problems, as it would happen if we were using a fully comprehensive development assessment. Furthermore, most of our measures are subjective, self-reported by parents, and based on estimations. Thus, answers may also be influenced by social desirability bias. We also did not collect data regarding time spent by children in other activities, such as physical or outdoor activities, during the lockdown period due to COVID-19. This would have given valuable data regarding the effect of screen-time exposure during the COVID-19 confinement on lifestyle and fitness at younger ages.

However, showing a negative association between screen time and emotional and behavioral well-being among children during the lockdown period and highlighting the potential role of parents in children's behavioral and emotional adjustment, the results of the study are important so that in future periods of confinement, parents seek to mediate the time and the conditions children are exposed to screens, to minimize their impact.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Review Board of the School of Health of the Polytechnic of Porto. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

RM, SF, and NR: conceptualization, methodology, and writing (review and editing). RM: data collection and original draft. RM and NR: data analysis. All authors have read and agreed to the submitted version of the manuscript.

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ORIGINAL RESEARCH
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Strategies for Coping With Stress in Athletes During the COVID-19 Pandemic and Their Predictors

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The aim of the study was to compare the strategies of coping with stress during the COVID-19 epidemic in athletes involved in Olympic preparations (57 potential Olympians) and students of physical education (54 extramural students), and to determine their depending on the variable gender. The research was conducted in the form of an on-line survey in the period of April 7–28 during the COVID-19 pandemic. Four standard psychological questionnaires were used. Elite athletes and physical education students practicing sports most often dealt with the stress of the COVID-19 pandemic using cognitive and behavioral coping strategies. The sports level depended on the strategies of coping with the stress of the COVID-19 pandemic more strongly than gender. The relationship between the sense of coherence (mainly comprehensibility) and the hope for success treated as a generalized immune resource with coping strategies in the case of the COVID-19 pandemic postulated by Antonovsky was confirmed.

Keywords: pandemic, COVID-19, athletes, coping, stress, Tokyo 2020

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INTRODUCTION

The SARS-CoV-2 coronavirus infectious disease COVID-19 pandemic began on November 17, 2019 in Wuhan city, central China, and on March 11, 2020 was designated a pandemic by the World Health Organization (WHO) (World Health Organization, 2020). By July 8, 2020, over 11.80 million cases of COVID-19 had been reported in 188 countries and territories, including nearly 544,000 deaths and over 6.35 million recoveries (Johns Hopkins University, 2020). From the point of view of the psychology of stress, the pandemic phenomenon can be treated as a stressor. It belongs to the category of stressors affecting large groups of people, such as natural disasters (Lazarus and Cohen, 1977; Lepore and Evans, 1996) and chronic, but not acting continuously (Elliot and Eisdorfer, 1982).

A pandemic is a universal stressor, as it threatens the health and life of all people (Norris et al., 2002). It causes a feeling of helplessness and the loss of a fundamental sense of security, prevents the satisfaction of many basic needs, including protection, stability and the ability to predict one's own future (Bonanno et al., 2007; Shigemura et al., 2020). Athletes are just as vulnerable as the general population to the negative psychological consequences of COVID-19, such as stress, anxiety and depression (Mehrsafar et al., 2020).

On an international scale, measures have been taken to prevent the spread of disease. In 177 countries, schools and universities have been closed at the national or local level, which globally affected nearly 1.27 billion pupils and students (72.4%) (UNESCO, 2020). These actions have made the pandemic a source of additional stress for students, including at the university level. University students had to adapt to the changes resulting from new forms of remote learning, limited access

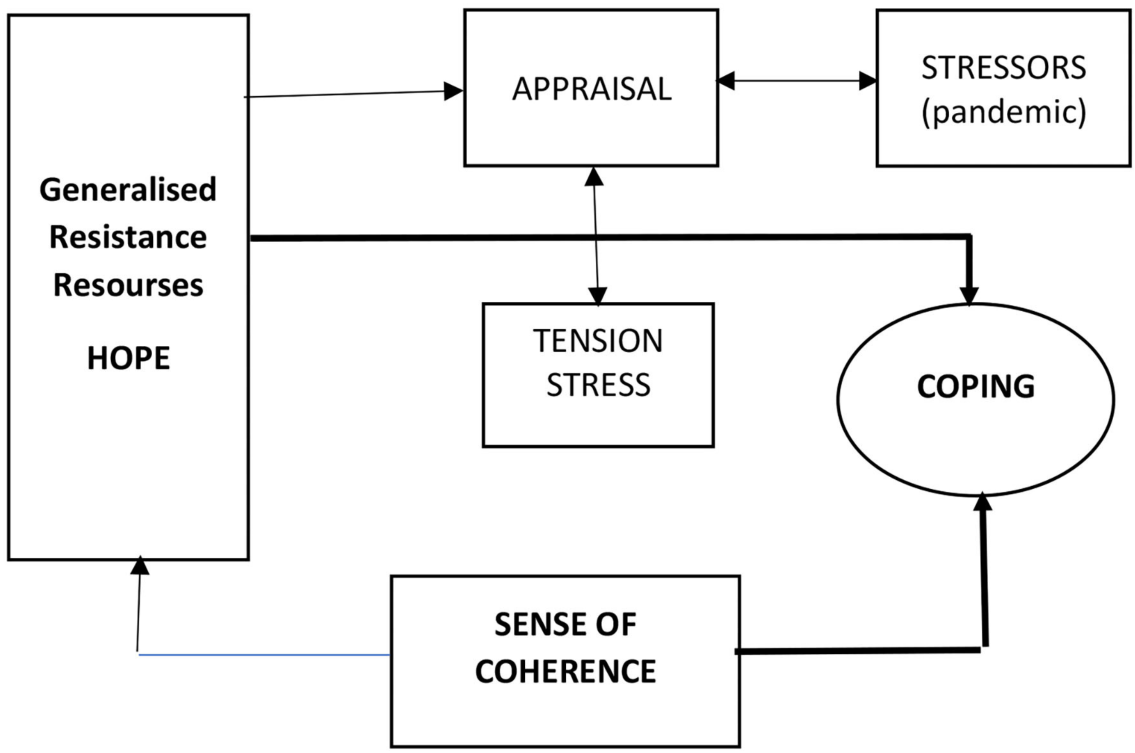

FIGURE 1 | Studied variables in the model of salutogenesis (Antonovsky, 1979).

to information sources and remote obtainment of knowledge. Some of them were deprived of opportunities of earning money, while many were forced to return to their family home (UNESCO, 2020).

The athletes who had to stop their daily organized training almost overnight also experienced additional stress. Closure at home, limitation of previous physical activity, isolation from members of sports teams and the sports community, and lack of social support negatively affected their psychophysical condition (Mehrsafar et al., 2020). In many countries, including Poland, the use of sports facilities has been banned and the activities of sports teams and clubs have been suspended. Athletes, including students of physical education involved in sports activities, were thus confronted with additional stressors resulting from the suspension of organized training (Pillay et al., 2020).

The COVID-19 pandemic caused the greatest disruption to the world sports calendar since World War II. Sporting events have been canceled or postponed worldwide (BBC, 2020; Los Angeles Times, 2020a). On March 24, 2020, the Organizing Committee of the IOC and Tokyo announced that the 2020 Summer Olympic and Paralympic Games would be postponed and would be held no later than summer 2021. For the first time in the history of the modern Olympic Games, their dates have been postponed (BBC Sport, 2020; Los Angeles Times, 2020b). The elite athletes who were preparing for the Olympic Games found themselves in an exceptionally difficult psychological situation. Participation in the Olympic Games is usually the most important event in a sporting career, and an Olympic nomination is a particularly important long-term goal for many athletes. The postponement of the Olympics put into question the participation in this event. This can be expected to increase the stress of the pandemic.

According to Antonovsky (1987), whose salutogenetic concept is the theoretical basis of our research, stressors are the requirements of the environment, for which there are no ready or automated adaptive reactions. They generate states of emotional tension, the content of which, according to the relational approach, will depend on the cognitive assessment of the situation (Lazarus and Folkman, 1984). In the case of assessing the situation as unfavorable (burdensome, exceeding resources, and threatening well-being), the subject experiences a state of stress, which consists of strong, most often negative emotions (fear, anxiety, and anger), less often hope and the accompanying physiological and biochemical changes exceeding the basic level of arousal (Strelau, 2000).

According to Antonovsky (1979) (**Figure 1**), it is not only stressors that determine the health costs of a stress relationship. Generalized immune resources and a sense of coherence are also important. Generalized immune resources are properties of an individual or collective entity that enable them to avoid stressors or (when it is impossible) to cope with the tension they generate (Pasikowski, 2000). They affect how stressors are assessed and how much stress they cause, and how the individual copes with stress (Antonovsky, 1987). One such resource may be hope, understood as the belief that one has the competence to achieve success. This construct, proposed by

Snyder (Snyder et al., 1997, 2000), consists of two related beliefs. The first is the belief that the individual is able to implement the adopted plan (the belief that they can initiate the pursuit of the goal and persevere in it). The second component is the belief in the ability to find solutions, resulting from perceiving oneself as a capable and resourceful person (pathway thoughts, pathways). Hope positively correlates with positive emotions and negatively with negative emotions; it is associated with a smaller number of negative thoughts, greater satisfaction with life and a lower level of depression and anxiety (Łaguna et al., 2005), including in clinical groups (Cui et al., 2020). It buffers the impact of stress on mental well-being (Bernardo et al., 2018). Hope is a positive correlate and predictor of school and academic achievement (Bryce et al., 2019).

According to Antonovsky (1987), we constantly encounter stressors—stimuli to which we do not have a ready, adequate adaptive response—but some of us cope with this experience quite well. In his opinion, effective coping with stress is determined by three factors: the types and levels of stressors, generalized immune resources and a sense of coherence. Generalized immune resources are properties of an individual—or a collective entity—that enable the avoidance of stressors or (when it is impossible) coping with the tension they generate (Pasikowski, 2000).

The ways of coping with stress play a special role in the course of a stress transaction. According to the transactional concept of stress, they are conditioned by the result of the secondary assessment—the ability to cope with stress (Lazarus and Folkman, 1984). They have also been included in the salutogenic model (Antonovsky, 1987).

In accordance with the assumptions of the salutogenetic model, however, the sense of coherence plays a key role in effective coping with stress. Sense of coherence is a global orientation of a person, expressing the degree to which a person has a dominant, persistent but dynamic sense of certainty that: (1) The stimuli flowing in the course of life from the internal and external environment are structured, predictable and explainable; (2) There are resources available to meet the demands of these stimuli; (3) For them, these requirements are a challenge worth the effort and commitment (Antonovsky, 1987). It consists of three components:

1. Comprehensibility—the ability to understand and cognitively evaluate reality as meaningful, information-ordered, coherent, clear and structured;
2. Manageability—the belief of individuals that they have means or resources, both personal and social, allowing them to actively influence the situation; a sense of competence in coping with a stressful situation, resulting from an adequate and realistic assessment of requirements and available resources;
3. Sense of meaningfulness—the conviction that it is worth engaging in challenging situations, related to the sense of meaning and value in one's own life. It plays a special role in shaping the sense of coherence.

The sense of coherence is often referred to as a meta-resource because:

- It influences the primary assessment of the stressor—people with a strong sense of coherence are less likely to assess the stimulus as stressful; they are convinced that they will cope with the situation (Pasikowski, 2000);
- It decides the strength of physiological and emotional reactions under the influence of a stressor (Kaczmarek, 2007);
- It conditions the undertaken remedial actions: people with a strong sense of coherence are more likely to focus on the problem and the available means to change the situation; they choose more appropriate coping strategies, assess the requirements and available resources more realistically, activate them more effectively, make better use of previous experience in coping with stress (Sęk and Pasikowski, 2001);
- It also contributes to the development of other immune resources (Pasikowski, 2000).

Studies have shown a positive relationship between the sense of coherence and various measures of physical health (Eriksson and Lindström, 2005; Hakanen et al., 2007), including a positive mood (Sęk and Pasikowski, 2001) and anxiety, depression, negative emotions, stress intolerance, aggression and self-aggression (Sęk and Pasikowski, 2001; Eriksson and Lindström, 2005, 2007; Hakanen et al., 2007; Langeland et al., 2007). According to Mayer and Thiel (2014), the sense of coherence should be treated as the basic factor determining not only physical and mental health, but also high sports performance in elite athletes. This is confirmed by the results of the study of young Polish (Rutkowska and Wawer, 2012) and Hungarian (Sipos et al., 2015) athletes.

Both the immune resources and the sense of coherence affect how an individual copes with stress. The process of coping with stress consists of strategies—specific cognitive and behavioral efforts—aimed at mastering specific external and internal requirements, assessed by an individual as overburdening or exceeding their resources, undertaken in a specific stress transaction (Wrześniewski, 2000). They depend both on personality traits (e.g., optimism, self-esteem, and emotional reactivity) and individual preferences (including styles of coping with stress), other subjective features (gender, age, and education), the current psychophysical state of the individual, and the stressful situation itself (Strelau, 2000; Wrześniewski, 2000; Sęk and Pasikowski, 2001; Heszen, 2014). The question arises as to how the athletes who prepare for the Olympic Games deal with the stress of the COVID-19 pandemic. Do their preferred strategies differ from those used by physical education students who engage in sports?

The figure shows the salutogenetic model in a synthetic way, highlighting in bold the variables that are of interest in our study.

The aim of the study was to compare the strategies of coping with stress during the COVID-19 epidemic of athletes involved in Olympic preparations and students of physical education, and to determine their depending on the variable gender. Predictor of strategies for coping with stress were also searched for among such explanatory variables as the components of the sense of coherence, hope for success, type of sports activity (elite players—PE students practicing sports) and gender.

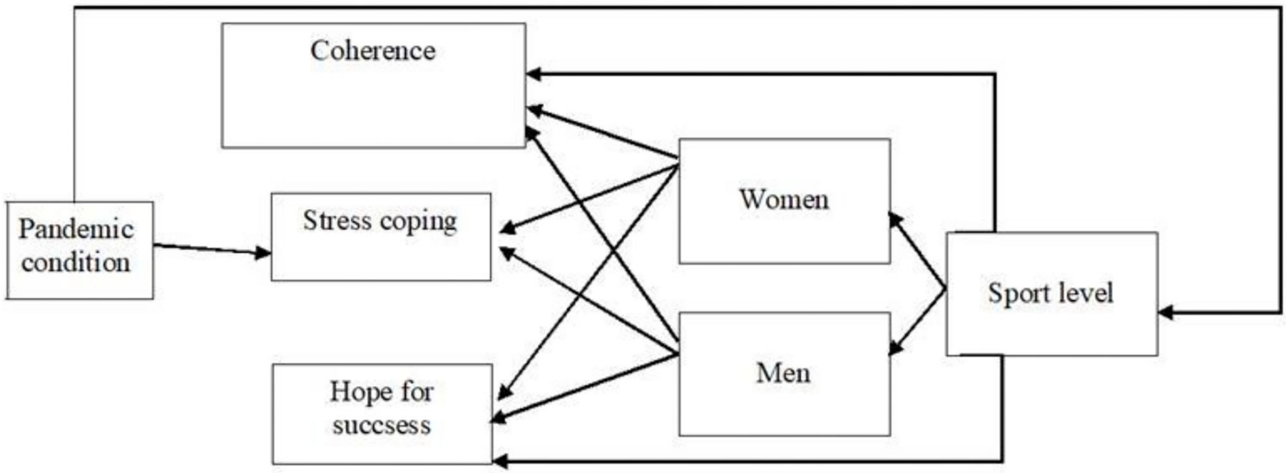

FIGURE 2 | The model presenting the directions of dependencies in the research results.

The psychological situation of athletes were deprived of the possibility of training. The criterion for separating the studied group was played sport (regular physical activity) and above-average physical fitness. The experimental and control groups differ in terms of the level and nature of physical activity, although both groups are characterized by a higher level of these parameters than the general population. For both groups, the reduction in physical activity caused by the pandemic had more severe consequences than for the general population. For students, physical activity was required to complete practical classes at the university, while for athletes, being in shape and preparing for competitions. Moreover, changes to the dates of the Olympic Games increased the level of stress, as they are held once every 4 years and are extremely important sports competitions for each athlete.

There are many reasons to expect men and women to differ in their levels of stress and how they deal with it. Research results indicate that women are significantly more neurotic, perseverative and emotionally reactive, and consequently have a greater tendency to experience stress than men (Grossman and Wood, 1993). On the other hand, as shown by the results of studies on physically active people, physically active women and women practicing sports differ less from men in this respect (Messner, 1988). The unique situation of the pandemic provided an opportunity to see if the typical gender differences would be apparent in a group of physically active people experiencing stress from the pandemic and its consequences (**Figure 2**).

MATERIALS AND METHODS

Test Subjects

The research involved two groups of people practicing sports at different levels. The first group consisted of 57 Polish potential Olympians aged between 18 and 45 (M = 26.61; SD = 5.562), including 29 women (52.7%) and 28 men (49.1%), practicing individual sports disciplines such as athletics, rowing, fencing, shooting, sport climbing, badminton, swimming, modern pentathlon, taekwondo, sailing, wrestling, canoeing, judo, cycling, equestrianism, and weightlifting. Their professional experience ranged from 4 to 25 years (M = 14.59; SD = 5.981). The second group consisted of 54 extramural students of physical education aged 19 to 40 (M = 25.69; SD = 5.908), including 26 women (48.1%) and 28 men (51.9%) who practiced recreational sports. The proportion of men and women in both groups did not differ significantly ($\chi^2 = 0.083$; $p = 0.774$).

Selection for the group was deliberate. The criterion for the inclusion of competitors in the study was to include athletes in Olympic preparation, which meant achieving an Olympic qualification or a good chance of obtaining it in the next year. The group of students was selected from among volunteers systematically undertaking recreational sports activities, in such a way that it was as close as possible to the group of athletes in terms of gender and age.

All subjects were of legal age. The survey was anonymous and voluntary. It was carried out in accordance with the principles of the Code of Ethics of the World Medical Association (Declaration of Helsinki). Manuscript is conformed to the Committee on Publication Ethics (COPE) and the International Committee of Medical Journal Editors (ICMJE) recommendations for ethics, as well as to the general Frontiers article requirements.

Research Procedure

The research was conducted in the form of an on-line survey on the https://www.survio.com/pl platform in the period of April 7–28, 2020 during the COVID-19 pandemic. In Poland, in connection with the regulation of the Council of Ministers of March 31, 2020, the Ministry of Sport introduced a lockdown in participation in sports activities. Throughout the country, the use of outdoor sports facilities, indoor sports facilities (including stadiums, race tracks, swimming pools, gyms and other sports, and recreational facilities) was prohibited and the activities of sports teams and clubs were suspended. The lockdown also applied to the organization of sports events, the activities of athletes and sports referees. This lockdown lasted until May 4,

TABLE 1 | Variables used in the study.

Variable	Variable	Indicator
Stress coping	Dependent	The results of the questionnaire scales
Coherence	Independent	The results of the questionnaire scales
Hope for success	Independent	The results of the questionnaire scales
Physical activity (none)	Independent	Moderate level of activity/very high level of activity
Gender	modifying	Female/Male
Sport level	modifying	Medium/High
Pandemic conditions	Independent	Objective threatening situation

2020. All athletes participated in the study during the period of this lockdown. The average test time was ∼25 min.

Research Tools

Three standard psychological questionnaires were used (**Table 1**). The Stress Management Inventory (Mini COPE) (Carver, 1997) in the Polish adaptation of Juczyński and Ogińska-Bulik (2009) was used to study the coping strategy. It consists of 28 items and measures 14 strategies for coping with stress (two statements for each strategy): active coping, planning, positive re-evaluation, acceptance, sense of humor, turning to religion, seeking emotional support, seeking instrumental support, engaging in other activities, denial, discharging, taking psychoactive substances, ceasing activities, and blaming oneself.

According to Parker and Endler (1994), these strategies can be grouped into three styles:

– task (active counseling, planning, and positive re-evaluation)
– emotional (acceptance, sense of humor, turn to religion, seeking emotional support, and seeking instrumental support)
– avoidance (dealing with something else, denial, unloading, taking psychoactive substances, stopping activities, and blaming oneself).

The respondents give answers on a scale from 0 = almost never to 3 = almost always. In the instructions, the respondents were asked to relate their answers to the current situation—the postponement of the Olympic Games. The Polish language version is characterized by a satisfactory split-half (0.86) and stability. The accuracy of the tool is confirmed by the results of the factor analysis.

The study of the sense of coherence was carried out using the Life Orientation Questionnaire (SOC 29, The Sense of Coherence Questionnaire) by Antonovsky (1987). In the Polish adaptation of Koniarek et al. (1993) it is a tool that allows one to estimate the general level of the sense of coherence, as well as the levels of its three components (i.e., the sense of comprehensibility, the sense of manageability and the sense of meaningfulness). It consists of 29 statements. While responding to them the respondent uses a 7-point Likert scale. The internal consistency of the entire scale is very high.

The Snyder et al. (1991) Hope for Success Questionnaire (KNS) in the Polish adaptation of Łaguna et al. (2005) was used to determine beliefs about the possibility of success. The tool contains two scales: the ability to find solutions and willpower. It also provides a summary indicator of hope for success. The factor structure is in line with the theoretical assumptions. The internal compliance index is estimated between 0.76 and 0.86.

Statistical Analysis

In the first step, the basic descriptive statistics of the investigated quantitative variables were calculated along with the Kolmogorov-Smirnow (K-S) tests, checking the normality of distributions. In the case of the scales of the sense of comprehensibility and manageability, distributions close to the normal distribution were noted. For all other examined variables, the distributions different from the Gaussian distribution were noted. Since the variables did not meet the requirements of the normal distribution, the Mann-Whitney U-test was used to determine differences between the groups. Additional verification of the skewness of the distributions of these variables was done. Because it was in the range of +/− 2, it was decided that it was possible to perform a regression analysis.

The use of the stepwise regression method, this type of analysis was used because it has a mathematical basis. Purely mechanically, it enters the best predictors until none can be incorporated into the model anymore. It allows us to realistically obtain information which of the variables we analyze best allow us to predict the level of the dependent variable.

RESULTS

Strategies for Coping With Stress, Sport Activity, and Gender

Regardless of gender, the surveyed athletes most often applied the strategy of positive re-evaluation, acceptance and planning (**Table 2**). The same was true for male students. For women studying physical education, the third rank was taken by engaging in other activities. The three strategies that are least used by athletes, regardless of gender and male students, are engaging in other activities, taking psychoactive substances, and denial. Female students used the self-blame strategy less than denial.

The nature of sports activity depending on the results more strongly than gender. Men involved in the Olympic preparations reported using the strategy of positive re-evaluation and active coping significantly more often than students, while they were less prone to self-blame and the use of psychoactive substances. Potential female Olympians used the strategy of active coping, positive re-evaluation and acceptance more often than students, while denial was used less often.

There are differences depending on the variable gender only in group of athletes. The competitors included in the Olympic preparations, when compared to their colleagues, showed a greater tendency to seek emotional and instrumental support, to engage in other activities and acceptance.

Predictors of Stress-Coping Strategies

Step regression analyses were performed to determine the factors that would allow prediction of the frequency of using particular coping strategies. The components of the sense of coherence and hope for success, gender, age, and

TABLE 2 | Strategies for coping with stress depending on sports activity and gender.

	AM amateur men	AW amateur women	SM sport men	SW sport women	Comparison			
	M ± SD	M ± SD	M ± SD	M ± SD	AM-SM	AW-SW	AM-AW	SM-SW
Active coping	1.98 ± 0.928	2.14 ± 0.934	1.39 ± 0.966	1.50 ± 0.872	**255.5**[c]	**226.5**[b]	360.5	341
Planning	**2.21 ± 0.726**	**2.29 ± 0.620**	**1.70 ± 1.003**	1.88 ± 0.909	276	284	393	322
Positive re-evaluation	**2.37 ± 0.647**	**2.65 ± 0.519**	**1.73 ± 0.799**	**2.17 ± 0.647**	**207.5**[b]	**218**[b]	296.5	257.5
Acceptance	**2.34 ± 0.667**	**2.65 ± 0.484**	**2.18 ± 0.627**	**2.31 ± 0.618**	326	**251**[c]	**288.5**[c]	324
Sense of humor	1.18 ± 0.710	1.14 ± 0.625	1.34 ± 0.594	1.19 ± 0.788	368	370.5	376.5	319.5
Turning to religion	0.68 ± 0.796	0.57 ± 0.764	0.75 ± 0.822	0.77 ± 1.051	373.5	359	373.5	344
Seeking emotional support	1.46 ± 0.882	2.07 ± 0.842	**1.70 ± 0.809**	1.88 ± 0.840	337.5	325.5	**242.5**[b]	309
Seeking instrumental support	1.11 ± 0.774	1.79 ± 0.861	1.32 ± 0.784	1.385 ± 0.804	346	278	**224**[b]	346
Engaging in other activities	1.07 ± 0.802	1.55 ± 0.880	1.52 ± 0.876	**1.92 ± 0.945**	284	287.5	**283.5**[c]	271.5
Denial	**0.16 ± 0.409**	**0.15 ± 0.465**	**0.43 ± 0.619**	0.60 ± 0.813	307	**252.5**[b]	378.5	330
Discharging	0.91 ± 0.681	1.20 ± 0.677	1.05 ± 0.497	1.31 ± 0.826	331	332	331.5	294.5
Taking psychoactive substances	**0.11 ± 0.416**	**0.33 ± 0.602**	**0.48 ± 0.645**	**0.35 ± 0.505**	**231.5**[a]	348	325.5	324
Ceasing activities	**0.10 ± 0.284**	**0.31 ± 0.618**	**0.30 ± 497**	**0.25 ± 0.381**	317	376.5	325	360
Blaming oneself	0.29 ± 0.584	0.41 ± 0.682	0.54 ± 576	**0.50 ± 0.616**	**260**[b]	336.5	354	338.5

[a]*$p < 0.001$;* [b]*$p < 0.01$;* [c]*$p < 0.05$. Bold values are statistically significant values* $p < 0.05$.

TABLE 3 | Sense of coherence and hope for success, gender, and type of sports activity as predictors of coping strategies.

Strategy	Predictor	Beta	*t, p*	R^2	*F; p*
Active coping	Sense of meaningfulness	0.313	3.615; <0.001	0.199	14.546; <0.001
	Sports activity (A = 1; S = 0)	0.299	3.451; 0.001		
Planning	Strong will	0.516	5.510; <0.001	0.261	13.824; <0.001
	Sports activity (A = 1; S = 0)	0.209	2.445; 0.016		
	Sense of comprehensibility	−0.194	2.056; 0.042		
Positive re-evaluation	Sports activity (A = 1; S = 0)	0.390	4.558; <0.001	0.286	9.749; <0.001
	Gender (M = 1; F = 2)	0.197	2.401; 0.018		
	Strong will	0.231	2.338; 0.021		
	Sense of comprehensibility	−0.335	2.998; 0.003		
	Sense of manageability	0.265	2.287; 0.024		
Acceptance	The ability to find solutions	0.340	3.736; <0.001	0.158	7.804; <0.001
	Sense of comprehensibility	−0.243	2.631; 0.010		
	Sports activity (A = 1; S = 0)	0.212	2.316; 0.023		
Turning to religion	Sense of meaningfulness	0.193	2.049; 0.043	0.029	4.200; 0.043
Seeking emotional support	Strong will	0.312	3.485; 0.001	0.131	9.215; <0.001
	Gender (M = 1; F = 2)	0.202	2.262; 0.026		
Seeking instrumental support	Gender (M = 1; F = 2)	0.223	2.373; 0.019	0.041	5.632; 0.019
Engaging in other activities	Sense of comprehensibility	−0.259	2.859; 0.005	0.105	7.426; 0.001
	Gender (M = 1; F = 2)	0.238	2.627; 0.010		
Denial	Sports activity (A = 1; S = 0)	−0.268	2.953; 0.004	0.110	7.743; 0.001
	Age	−0.213	2.354; 0.020		
Taking psychoactive substances	Sense of comprehensibility	−0.360	4.004; <0.001	0.121	16.035; <0.001
Ceasing activities	Strong will	−0.349	3.875; <0.001	0.114	15.017; <0.001
Blaming oneself	Sense of manageability	−0.282	9.343; 0.003	0.071	9.343; 0.003

type of sports activity were introduced into the equation as explanatory variables. The dependent variables were the strategies of coping with stress. **Table 3** shows the last steps in these analyses. No predictors for the frequency of using the sense of humor and discharge strategies were established.

Among the analyzed strategies of coping with stress, the strongest model was obtained for a positive re-evaluation. Nearly 30% of the use of this strategy can be predicted based on five predictors. Competitors (rather than students), women, people who show strong conviction about having a strong will and a strong sense of manageability, but with a weak sense of comprehensibility, will be more likely to use this strategy.

The obtained model explains to a slightly lesser extent (26%) the frequency of using the planning strategy. All three predictors with the same sign were revealed previously: willpower and type of sports activity (positive predictors) and sense of comprehensibility (negative predictor).

Almost 20% of the willingness to use active coping strategies can be predicted based on the sense of meaningfulness and sports activity. It can be expected that this problem-focused strategy is more likely to be used by athletes and those with a strong sense of meaningfulness.

The variable explained in over 15% is the propensity to use the acceptance strategy. It can be expected that it will be used more often by athletes than students and people with high confidence in the ability to find solutions, but with a low sense of comprehensibility.

In the remaining models, the coefficients of determination had lower values (0.13−0.03). Women seem to be more inclined to seek emotional and instrumental support. The predictor of the use of avoidance strategies (engaging in other activities, taking psychoactive substances) is a poor sense of comprehensibility. People with a weak belief in the ability to initiate an action and its implementation seem to be prone to stopping an action (belief in having a strong will). Students and younger respondents are more likely to use denial.

DISCUSSION

Dealing with stress is of interest to psychologists, as it is the effectiveness of this process that largely determines the health costs of a stress transaction (Antonovsky, 1979). What specific actions people take when faced with stress depends both on the characteristics of the subject and the situation (characteristics of the stressor). A pandemic situation is a strong external stressor affecting the whole society, which can be treated as an extreme event [i.e., one that causes stress for all people experiencing it, regardless of the subjective features and perception of the stressful situation (Heszen, 2014)]. It is beyond the control of the individual and it changes everyday life in a radical way. Otherwise was in the newest study about athletes and pandemic which results showed that chess players significantly decreased physical activity per day while increased chess practice during the confinement period. Amateur players showed a significantly higher level of social alarm than professional and high-performance players. Moreover, professional players showed higher values of extraversion than high-performance players and amateur players. In neuroticism, professional players showed higher values than high-performance players. In addition, the professional players showed higher scores in psychological inflexibility than competitive players (Fuentes-García et al., 2020).

The elite athletes in preparation for the Olympic Games and physical education students practicing sports coping with the stress of the pandemic, regardless of gender, most often used the acceptance strategy. The acceptance strategy is about accepting the situation (recognizing the reality of the stressor) and learning how to live in it without actively trying to change the situation. The mini-COPE questionnaire has no standards for the Polish population. Therefore, we can only refer the results of our study to the values obtained by the authors of the tool adaptation (Juczyński and Ogińska-Bulik, 2009). The acceptance strategy came third in terms of the frequency of use by adult Poles and only seventh for students. Thus, both athletes and PE students, in a pandemic situation, used the acceptance strategy more often than the groups studied by Juczyński and Ogińska-Bulik (2009). Acceptance of the pandemic situation seems to be an appropriate remedial strategy. First, the individual assesses the situation as stressful (exceeding resources) (i.e., he or she is confronted with the fact that it poses a real threat to health and life). Second, he or she is aware of the limited possibilities for active coping. If it is not possible to change the situation, adaptation requires an autoplastic adaptation (i.e., a change in the subject).

The second rank in terms of the frequency of use, regardless of gender and sports activity, was taken by the strategy of positive re-evaluation, which in nationwide surveys came fourth (adults) and fifth (students) (Juczyński and Ogińska-Bulik, 2009). In dealing with the stress of the pandemic, the elite athletes and students of physical education we surveyed more often tried to perceive the situation in a more positive light. In the studies on the mini-COPE factor structure, the strategy of positive re-evaluation was included in the active coping factor. However, it differs from active behavioral coping as it takes place in the cognitive realm. It provides an example of meaning-focused coping (Folkman and Moskowitz, 2006). The results of previous studies confirm that the strategy of positive re-evaluation is associated with a lower intensity of stress, especially when the individual is unable to influence the change of the stressful situation. In the event of the COVID-19 pandemic, the stressful situation is partly out of control. Research on coping strategies during the COVID-19 epidemic shows that coping with stress using positive strategies is a predictor of lower stress levels and mental well-being (Fredrickson and Joiner, 2002).

In the group of athletes involved in the preparations for the Olympic Games, the planning strategy was ranked third, as was the positive reevaluation that made up the active coping factor. Planning is thinking about how to deal with a stressor. It is cognitive in nature and occurs during secondary evaluation. As a result, the individual takes specific, behavioral remedial actions. In nationwide studies, planning was the strategy most often undertaken by adults, slightly less often than active coping and second only to active coping in the case of students (Juczyński and Ogińska-Bulik, 2009). Active coping came fourth among the elite athletes. The research was conducted by us in the second month of the COVID-19 epidemic in Poland, when athletes planned what they would do rather than take specific remedial actions. This hierarchy of coping strategies seems to serve well for adaptation to the stress of a pandemic.

Athletes, regardless of gender, and male students were the least likely to use the cessation strategy (abandonment of efforts to achieve the goal), taking psychoactive substances and denial (active cognitive rejection of the stressful situation). Female students used the self-blame strategy less than denial. All strategies are avoidant in character and are usually considered ineffective. It is also worth noting that the frequency of using all these strategies was lower than in the national studies (Juczyński and Ogińska-Bulik, 2009). Our results show that during the pandemic, elite athletes and students most often used strategies that can be considered effective and aimed at good adaptation to an extreme stressor causing a threat to health and life.

The elite athletes differed from the university students in the frequency of coping strategies. Regardless of their gender, they used more active coping and re-evaluation strategies. Also, in the studies by Nicholls et al. (2007) highly qualified athletes reported more frequent use of problem-focused strategies (planning, blocking and visualization) and greater effectiveness in coping than lower-level athletes.

Confrontation with a stressor, both in the behavioral and cognitive form, is a prerequisite for managing stress in controllable situations (Heszen, 2014). Athletes most often face the stress of sports competition. In this case, they prefer task-oriented strategies (Hofseth, 2016; Litwic-Kaminska and Izdebski, 2016). Athletes researched by Crocker and Graham (1995) also most frequently used problem-focused strategies: effort, planning, and active coping. Research results confirm that problem-focused strategies better serve the level of athletic performance than strategies focused on emotions or avoidance (Folkman, 1992; Nicholls et al., 2012). Problem-focused coping, including active coping, was associated with positive affect and higher self-esteem of athletic performance (Ntoumanis and Biddle, 2000). Athletes deal with non-sport related stressors—such as ending a sports career—in a similar way. They most often use the strategy of acceptance, positive re-evaluation, planning and active coping (Grove et al., 2008).

Athletes accustomed to actively coping with stress (Polman, 2012) probably did not change their preferences, using behavioral and cognitive confrontation strategies effective against stress, including in the face of stress related to the COVID-19 pandemic.

Athletes of both sexes reported the use of the denial strategy less frequently than students. Men practicing sports additionally used psychoactive substances less often and less often blamed themselves. Thus, athletes used problem-focused strategies (both cognitive and behavioral) more often, and avoidance strategies less frequently. Men practicing sports clearly used strategies indicating helplessness in confronting the stress of a pandemic less frequently. These differences are confirmed by the results of the regression analysis. The type of sports activity turned out to be a predictor of the frequency of using the five remedial strategies. Athletes should be expected to be more likely to use active coping strategies (active coping, planning, and positive re-evaluation) and acceptance, while physical education students seem to be more prone to denial.

It is believed (Heszen, 2014) that cognitive and behavioral avoidance strategies are adaptive in uncontrolled situations. In a situation where an athlete has limited ability to change the situation, avoidance strategies may be more effective (Carver et al., 1989). However, they are not widely used by athletes (Nicholls et al., 2009). Is the individual able to control a pandemic situation? They cannot control its course, but they can control their own behavior and reduce the risk of infection. It can therefore be concluded that the coping patterns revealed by the athletes served well for adaptation to the COVID-19 pandemic situation.

There are differences depending on the variable gender in the group of athletes which are more strongly than in the case of students. Competitors included in the Olympic preparations, as compared to their colleagues, reported more frequent searching for emotional and instrumental support, but also using the strategy of engaging in other activities and acceptance. The results of the regression analysis were similar: female gender was found to be a positive predictor of using the strategy of seeking emotional and instrumental support, engaging in other activities and positive re-evaluation. Crocker and Graham (1995) also found that female athletes were more likely to seek emotional support than male athletes. Somewhat different results were obtained by Nicholls et al. (2007)—women practicing sports more often than men applied problem-focused strategies (e.g., planning, communication, and technique-focused coping). The authors themselves note, however, that their results clearly differ from the results of previous studies.

It can be assumed that, at least in part, the differences we identified were due to the greater willingness of women to disclose remedial actions. Moreover, the search for support and help is part of the social role of women. The lower tendency of men to seek or use the available social support in order to cope with stress is explained, among other factors, by fear of being negatively judged (Sirois and Kitner, 2015). Women may also be more likely to engage in surrogate activities and to postpone decision-making and realization over time, due to different patterns of emotional self-regulation (Doyle and Paludi, 1998). Summarizing the results of research on the coping process Lazarus (1993a,b) stated that, contrary to popular beliefs about gender differences in a particular stressful situation, women and men exhibit a very similar coping pattern. Also Crocker and Graham (1995) did not confirm the expected gender differences (more frequent use of problem-focused coping by men) in their study of athletes. Research results are not consistent, so more research is needed on the differences in how women and men deal with various stressors. The aim of Clemente-Suárez et al. (2020) was to analyze the effect of psychological profile, academic schedule, and gender in the perception of personal and professional threat of Olympic and Paralympic athletes facing the 2021 Tokyo Olympiad in the actual COVID-19 crisis. Neuroticism and psychological inflexibility presented the greatest negative feelings for female athletes and the perception that quarantine would negatively affect their sports performance.

The female athletes we surveyed were more similar to the male respondents than female students in terms of the hierarchy of coping strategies. Women who are involved in competitive sports often have features attributed to men. Androgynous people (combining typical male and female characteristics) reveal greater psychological resources, allowing them to deal with stress more effectively (Lipińska-Grobelny and Gorczycka, 2011).

The models turned out to be the strongest in relation to the strategies most often used by athletes and students, which in the research on the adaptation of the tool to Polish conditions were included in the factor of active coping (positive re-evaluation, planning and active coping). The models were somewhat weaker for the strategies constituting the helplessness factor, which were used the least (substance use, stopping action, and self-blame). No predictors for the frequency of using the sense of humor and discharge strategies were established

When analyzing individual explanatory variables, we can observe that the sense of comprehensibility was a negative predictor of using cognitive strategies (planning, positive re-evaluation, and acceptance) and avoidance strategies (engaging in other activities, using psychoactive substances). The low ability to understand and cognitively evaluate reality as meaningful, information-ordered, coherent, clear and structured, therefore, intensifies the use of these strategies. The research involving Polish students (Pasikowski, 2000) also established negative, weak relationships between the sense of comprehensibility and cognitive strategies: logical analysis, cognitive avoidance and acceptance. Perhaps a positive re-evaluation—giving a positive meaning to an event—involves restructuring the problem so that it is easier to assimilate cognitively. Also, creating an action plan allows one to structure the problem situation. People who find the reality unstructured and coherent are more prone to cognitive analysis. Acceptance, in turn, involves recognizing reality as it is, even when it is difficult to "embrace it with the mind." As a result of cognitive reevaluation, cognitive adaptation to threatening events occurs (Schwarzer and Knoll, 2003). It can be assumed that when cognitive strategies are not effective, people with a low sense of comprehensibility use avoidance strategies such as using psychoactive substances or taking care of something else. In Pasikowski's (2000) research, the sense of comprehensibility also negatively correlated with emotional discharge. In our study, however, it did not allow us to predict the frequency of using an emotional strategy.

It can be assumed that when cognitive strategies are ineffective, people with a low sense of comprehensibility use avoidance strategies, such as using psychoactive substances or engaging in other activities. In Pasikowski's research (2000), the sense of comprehensibility was also negatively correlated with emotional discharge. Our study, however, did not allow us to predict the frequency of using an emotional strategy.

The other components of the sense of coherence seem to predict to a lesser extent that the coping strategies of the COVID-19 pandemic will be used by elite athletes and physical education students. The sense of meaningfulness was a positive predictor of active coping (taking active steps toward removing or avoiding the source of stress or mitigating its consequences). To act, one needs a sense of meaningfulness—the conviction that it is worth engaging in challenging situations. This dimension of the sense of coherence was positively correlated with taking actions to solve the problem by Polish students surveyed by Pasikowski (2000).

Interestingly, people with a strong sense of meaningfulness can be expected to turn to religion more often, which can provide emotional support. Perhaps in the case of some of the respondents, faith is strongly related to the sense of meaningfulness and value of their own life. Carver et al. (1989) do not rule out that for deep believers, turning to religion may be a way of actively dealing with the problem. Some researchers use religious (or, more broadly, spiritual) coping (Folkman and Moskowitz, 2004) treated as a separate form of coping with stress. It is especially useful in the face of an uncontrollable source of stress and helps to find meaning in unfavorable events and suffering. This strategy is relatively rarely used by the athletes and students we surveyed; it ranks 10th in the hierarchy, similar to the adult population studied by Juczyński and Ogińska-Bulik (2009).

Dimensions of hope for success were more predictive of coping strategies than sense of manageability (a negative predictor of self-blame and a positive predictor of positive re-evaluation). The belief in having willpower was a positive predictor of active cognitive strategies for planning and positive re-evaluation and seeking emotional support and a negative predictor of disengagement. Contrary to the results of previous studies, the hope for success did not allow prediction of active coping with the stress of the COVID-19 pandemic. In the research of Polish flood victims (Chmielewska and Trzebiński, 2004), the hope for success was associated with taking specific actions (personal involvement in the reconstruction of a house, applying for a bank loan, seeking help from people and institutions). People taking active steps to deal with unemployment were characterized by a stronger hope for success, which allowed the entrepreneurial intention to be anticipated (Łaguna, 2005).

There is, however, a significant difference between experiencing the negative effects of a flood and unemployment (harm/loss situation) and a pandemic (emergency, largely uncontrollable situation).

It is worth noting that the explanatory variables included in the study made it possible to predict the frequency of using remedial strategies to a limited extent; the coefficients of determination ranged from 0.286 to 0.029, and in two cases no predictors were established. The sense of coherence and hope for success, of course, do not exhaust the subject's properties that affect how an individual deals with stress in a specific situation. The research results confirm the role of personality traits in a broad sense, including temperament, beliefs about the world and oneself, and styles of coping with stress (Heszen, 2014).

LIMITATIONS

Our work is obviously not free from limitations. Its weak point is the small number of respondents. It should be remembered, however, that the criterion for inclusion in the research was the respondent athlete's participation in the preparations for the XXXII Olympic Summer Games. We used a universal tool for studying remedial strategies—mini-COPE, adding to the instructions a reference to the pandemic situation. Perhaps it would be more appropriate to use a scale designed to study strategies for coping with catastrophic stressors. However, we did not have such a tool. The lack of standards for mini-COPE in the Polish population made it impossible to precisely interpret the results; they could only be related to the average results of adults and students obtained in the process of adapting the scale to Polish conditions. Based on the salutogenetic model, we focused on the importance of the sense of coherence as a potential factor determining how people deal with stress. Among the many potential immune resources, we chose the hope for success, which we found to be an important construct for athletes striving for success—the Olympic qualification. Of course, this does not exhaust all possible resources. In the online survey, the risk of discouraging participants with too many questions is greater than in the case of auditorium surveys. This forced the limitation of the research tools used and forced us to make a choice.

CONCLUSIONS

1. Elite athletes and physical education students involved in sports most often coped with the stress of the COVID-19 pandemic using active coping strategies at the cognitive and behavioral level.
2. The elite athletes confirmed greater readiness to use them than students of physical education.
3. The strategies for coping with stress caused by the COVID-19 pandemic differ depending on the sport level variable, even more than depending on the gender variable.
4. The relationship of the sense of coherence (mainly the sense of comprehensibility) and hope for success treated as a generalized immune resource with coping strategies in the case of the COVID-19 pandemic postulated by Antonovsky was confirmed.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Senacka Komisja Etyki Badań Naukowych AWF WARSZAWA. The patients/participants provided their written informed consent to participate in this study.

AUTHOR'S NOTE

Regulation - On the establishment of certain restrictions, orders and bans in connection with an epidemic (Journal of Laws, item 566), on the basis of the Act of March 6, 2018 - Law of entrepreneurs and other entities, activities related to sports, entertainment and recreation (included in the Polish Classification of Activities in section 93.0 and in subclass 96.04.Z), access date 15.06.20.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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OPINION
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Psychology, Physical Activity, and Post-pandemic Health: An Embodied Perspective

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INTRODUCTION

The world changed after coronavirus disease 2019 (COVID-19) started spreading. Lockdowns and isolation amount to direct and indirect effects whose consequences are yet to be analyzed more deeply. These social measures affect the health of those who have not been infected (Carter et al., 2020). In this regard, experts and union organizations have recommended home physical activity (PA) (ACSM., 2020). PA can be a protective factor to deal with problems related to the pandemic. By the same token, technological resources and video tutorials are useful tools for PA at home. However, possible collateral effects of their use must be considered as well as the supervision of qualified professionals (Aguirre-Loaiza et al., 2019a; Papaioannou et al., 2020).

Due to the COVID-19 emergency, several states and institutions have closed and followed preventive measures, as suggested by the WHO (Mattioli et al., 2020). Considering that schools generally promote the development of motor skills and knowledge of basic PA for health purposes (e.g., physical education lessons), it is worrying that aspects such as food and sleep schedules have also been negatively impacted since they are directly related to several health problems, including the risk of obesity (Pietrobelli et al., 2020). Some studies indicate that eating and sleeping patterns changed negatively 3 weeks after the confinement started (Pietrobelli et al., 2020).

Academic communities and government agendas face serious post-pandemic challenges. Mainly, they will have to ensure an action plan to promote PA educational strategies for health purposes. Furthermore, this situation represents an opportunity to bring into question the mind–body dichotomy, which can open a space for embodied cognition (EC) and its wide conceptual spectrum to enable research development and applied knowledge of PA. We suggest that future research and its implication should be approached from the standpoint of EC and its possible effects on the cognitive processes associated with PA.

There is increasing evidence in favor of a positive association between PA and cognitive functions. Moderate-to-vigorous intensities are positively related to better memory performance (Berrios Aguayo et al., 2019) and selective attention (Chang et al., 2014). In addition, PA improves cognitive performance in dual tasks involving response inhibition (Joyce et al., 2014). In fact, acute exercise (∼1 h) provides benefits in cognitive processes, e.g., attention, memory, problem solving, language, cognitive flexibility, and inhibitory control (Basso et al., 2015; Basso and Suzuki, 2017).

Neuroscientific experimental designs in animal models have also given clues that contribute to clarify the relationship between PA and cognitive functions. For example, it has been shown in rodents that the protein cathepsin B (CTSB), which is increased with PA, could affect brain tissue, and it has been demonstrated that if these proteins were applied to the progenitor cells of the hippocampus, they could have an impact on its neurogenesis process (Suzuki, 2016).

CONSEQUENCES OF CORONAVIRUS DISEASE 2019 ON PHYSICAL ACTIVITY AND HEALTH

In general terms, COVID-19 has directly affected people's quality of life (Aguirre-Loaiza et al., 2020). Some of the signs and symptoms linked to social confinement are stress, fear, panic attacks, anxiety, and depression (Brooks et al., 2020; Rajkumar, 2020). Negative emotions reduce the quality of sleep (Zhang et al., 2020), and sleep disorders can become risk factors leading to suicidal behaviors (Sher, 2020). Similarly, alterations in PA and eating patterns have compromised people's health (Ammar et al., 2020). Infected patients have more serious respiratory complications when there is a high correlation between obesity and other illnesses (Petrilli et al., 2020).

PA has been affected by the social isolation measures that have been implemented. Some results point out that 1 week before the pandemic started, PA had an average duration of 540 min per week, but during the pandemic, it reduced to 105 min per week (Xiang et al., 2020). Likewise, there is PA reduction in students, while sedentary activities, calorie consumption, and exposure to electronic devices have increased (Arévalo et al., 2020; Rundle et al., 2020). As a whole, these factors represent a risk to develop main non-communicable diseases. Although guidelines have been suggested for children and adolescent PA (Radom-Aizik, 2020) and for their return to school environments (Chen et al., 2020), the near future might be discouraging due to a likely new wave of obesity and psychopathology cases. Consequently, scientific and government strategies must promote PA to alleviate several of the difficulties caused by COVID-19 (Zhu, 2020) and child obesity (King et al., 2020).

EMBODIED COGNITION AND PHYSICAL ACTIVITY

Every day more evidence of the positive impact of PA in cognitive development is found (Mandolesi et al., 2018; Aguirre-Loaiza et al., 2019a; Doherty and Forés Miravalles, 2019; Erickson et al., 2019), which not only helps to the consolidation of knowledge on this area but also offers promising perspectives for multifactorial studies involving young students. Nevertheless, theoretical underpinnings have emphasized the mind–body dichotomy. EC proposes an inseparable relation of cognitive processes and body interactions, which creates a causal dependency on mental events that derive on body actions in a specific environment (Kiverstein, 2018).

The basic tenets of EC suggest that cognitive functions depend on their use and interaction with the environment (Shapiro and Spaulding, 2019). For example, children's play is an important event for the application of EC.

Although theories of cognitive development differ between innate and learned, there is a large part of them that support the link between perceptual, cognitive, and action skills. It is through the sensory-motor experience, that is, in contact with the world and objects, that babies build a representation of concepts about their physical environment and the objects that are present there (Gibbs, 2005).

In adults, coordination activities constitute a rich interaction between body and the environment. In both cases, action–perception patterns lead to adaptive coupling patterns (Cappuccio, 2019). Sensory experiences that arise when the body moves are responsible for building the foundations of learning through action and perception (Moreau and Tomporowski, 2019). In this representational scheme, cognitive functions (e.g., control, anticipation, perceptual discrimination, memory, and linguistic representations) are not stored in the brain, but they are functions modeled through the interaction with the environment (Cappuccio, 2019).

Currently, the notion that athletic performance might aid the understanding of the mind has been praised (Shapiro and Spaulding, 2019). Following this trend, PA and sport in general offer several possibilities to recognize that cognitive functions do not stand apart from the body. EC introduced new ways of understanding human and social interaction (Cappucio, 2019; Shapiro and Spaulding, 2019). Processes involving the body and its surroundings contribute to modeling the basic forms of cognition (sensory-motor, affective, and adapative) as well as the higher ones (inferential, linguistic, and representational) (Cappuccio, 2019). Consequently, it is possible to abandon the dualistic conception existing between cognition and PA. Neuronal processes have been reported to be healthier and more efficient after PA, leading to a regulation of the negative effects of stress on brain neurotrophic factors (Moreau and Tomporowski, 2019), which mediate many of the benefits that PA has on cognition.

The aforementioned is supported by enactive and extended theories. The former proposes that cognitive capacities arise from the adaptive interaction between subjects and their ecological environment (Cappuccio, 2019), whereas the latter suggests that the mind is integrated to its environment and that the environment is responsible for the representations that the mind has of its surroundings and their constant change. Likewise, body actions and the ecological environment in which subjects act can be foundational elements of a cognitive process (Kiverstein, 2018).

On the other hand, the integration of knowledge through motor actions has become increasingly important for learning processes. As an example, one recent study compared 2 learning groups: a sedentary one and another of embodied PA practice. The study showed positive results for the embodied group (Schmidt et al., 2019). The motivational aspects that an embodied approach entails have their roots in the embodiment thesis that hold cognition and affection as inseparable. Here, affective patterns are foundational to perception, action, and behavior (Kirchhoff, 2018). Learning environments are appropriate contexts in which PA and its cognitive benefits are promoted (Aguirre-Loaiza et al., 2019b). Therefore, the commitment and participation of school students should increase.

This can explain the role that PA has in cell generation since, in order to survive, neurons must come into contact, and this process improves when PA is interlinked with learning (Moreau and Tomporowski, 2019). We have illustrated situations that involve coordination and play processes, but yoga has also showed how to integrate EC (Rashedi and Schonert-Reichl, 2019). Additionally, dancing can also be promising for any population group. The synchronization of movement and music, the memorization of step sequences, and the interaction with the surroundings improve cognitive and physical functions through perception, execution, memory, and motor skills (Borhan et al., 2018). Thus, through EC, a theoretical framework for the integration of PA for health purposes and people's welfare can be justified.

Additionally, since clinical neuropsychology discovered through mirror neurons the relationship between language and the motor system, it was possible to explore neurodegenerative diseases in which the motor system and language are involved (Cardona, 2017), as well as processes of anticipation and comprehension (Amoruso et al., 2014).

FUTURE RESEARCH OPPORTUNITIES AND COURSES OF ACTION

PA is essential to maintain a stable health. By keeping an adequate physical condition, cognitive, and physical processes can be improved. Games and dancing are alternatives that can be considered for children. Meanwhile, coordination or dual activities that use the body are to be implemented.

Future research can be projected in two purposes: (a) to understand the interaction between PA and EC and its health and educational implications. It can be useful, in the midst of the COVID-19 contingency, to approach PA and EC alternatives as theoretical and methodological proposals, mainly in anticipation of post-pandemic psychopathology cases (Wade et al., 2020). (b) To reveal the role of athletic performance on cognitive functions. Here, sports psychology has a potential course of action to be explored (Cappuccio, 2019).

The experience of a pandemic and its economic, social, and health consequences suggest that measures based on scientific evidence are taken for granted, such as the impact of physical education on school children and their extracurricular life as well as the motivation to continue healthy lifestyle practices (Evans and Davies, 2010). In general, the challenge of future research is demanding, and it is a matter of furthering the understanding of the link between body and cognition in the face of which educational institutions, families, and government agendas must strive to offer such opportunities.

In regard to short-term action—and considering that after the COVID-19 pandemic educational contexts will highly depend on virtual tools and that, therefore, this will result in sedentary behavior—educational policies should look for ways to integrate the body activities to subjects such as mathematics, biology, and others. However, educational contexts should also make health care a priority using EC schemes starting from early ages.

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HA-L, AM-B, JC, and SO contributed in writing, reviewing, and editing of the manuscript. All authors contributed to the article and approved the submitted version.

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Relationship Between Acute Stress Responses and Quality of Life in Chinese Health Care Workers During the COVID-19 Outbreak

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This study aimed to determine the relationship between acute stress and quality of life and explore their influencing factors on health care workers. A descriptive cross-sectional study was conducted, and a sample of 525 health care workers was recruited from 15 hospitals through a convenient sampling method. Participants completed an online self-report questionnaire to assess their acute stress and quality of life. Descriptive and multiple linear regression statistics were used for this analysis. The results regarding acute stress responses varied significantly among the differences in marital status, physical activity, work status, perceived risk of contracting COVID-19, and the expected duration of the pandemic. Moreover, a younger age, lack of physical activity, being a front-line medical staff, and higher acute stress scores indicated a worse quality of life. Healthcare workers' acute stress was negatively correlated with their quality of life. Therefore, the authorities should pay special attention to health care workers' mental health and provide them with timely protection during the pandemic.

Keywords: acute stress, coronavirus, health care workers, quality of life, China

INTRODUCTION

The coronavirus disease 2019 (COVID-19), an acute respiratory disease caused by β-coronavirus, has spread worldwide since it first appeared in Wuhan, China, in December 2019 (Paules et al., 2020). As of June 26, 2020, more than 9.2 million confirmed cases and 470,000 deaths have been reported worldwide, including 85,119 confirmed cases and 4,647 deaths in China (World Health Organization, 2020). The World Health Organization (WHO) officially declared the COVID-19 pandemic a public health emergency of international concern on January 30, 2020, marking the third pandemic of coronavirus in the 21st century (Mahase, 2020).

To control the COVID-19 pandemic swiftly, health care workers throughout China actively participated in medical treatment, disease prevention, and logistics support. However, due to the shortage of personal protective materials in the early stages, the persistence of the disease, and the highly contagious nature of the COVID-19 virus, health care workers were at risk of being infected with COVID-19 (Van Doremalen et al., 2020). Previous studies have showed a link between chronic work-related stress among healthcare workers and post-traumatic stress disorder (Laposa et al., 2003; Robertson and Perry, 2010). Meanwhile, long work hours and high-pressure environments increase the physical and psychological stress among medical staff, leading to anxiety, depression, and, at worst, suicide (Goyal et al., 2020).

Quality of life (QoL) refers to an individual's self-perception of goals, expectations, standards, and concerns in the context of different cultures and value systems (Kuyken et al., 1995). Traumatic life events have various psychological and physiological consequences, affecting an individual's well-being and QoL (Garfin et al., 2018). For example, adults who experienced an earthquake exhibit acute stress symptoms, psychological distress, and maladaptive behaviors (Dorahy et al., 2016). Correspondingly, some studies reported that Ebola survivors suffered from various physical and mental sequelae (James et al., 2019). Most existing studies have focused on the victims of COVID-19. Furthermore, several studies have explored the mental health and QoL of health care workers during the outbreak. In their systematic review, de Pablo et al. (2020) summarized that 62.5% of health care workers reported general health concerns during the outbreak of SARS, MERS-CoV, and COVID-19. Adverse psychological responses such as high levels of anxiety, depression, and post-traumatic stress disorders may occur among front-line medical staff who are in direct contact with the COVID-19 patients (Chersich et al., 2020; Nochaiwong et al., 2020). Moreover, recent studies have demonstrated that the outbreak of COVID-19 had a significant impact on QoL of health care workers (Huang et al., 2020; Suryavanshi et al., 2020).

In facing this international health emergency, researchers strongly advise that everyone pay special attention to health care workers' mental health and support them during the COVID-19 outbreak (Xiang et al., 2020). Acute stress responses usually occur in the first month after a traumatic event, accompanied by dissociative, re-experiencing, avoidance, and hyperarousal symptoms (Garfin et al., 2015). A study from Toronto demonstrated that health care workers who had been in contact with SARS patients reported a severe acute trauma response (Maunder et al., 2004). Front-line medical staff may report more severe psychological symptoms and worse QoL (An et al., 2020). Pietrzak et al. (2012) found that police who were older and widowed or divorced were more likely to suffer from post-traumatic stress disorder after experiencing traumatic events. In addition, several recent studies have proved that regular physical activity can lead to positive behavioral changes, strengthen the immune system, and reduce negative psychological impacts (Alsalhe et al., 2020; Jiménez-Pavón et al., 2020; Slimani et al., 2020). Although theoretical and empirical evidence suggested that there might be a strong link between acute stress and general health outcomes, acute post-traumatic stress responses have not been well studied in health care workers (Holman et al., 2014; Jeronimus et al., 2019). It is imperative to assess the acute stress responses after a traumatic event to predict long-term health consequences (Dai et al., 2018). Accordingly, it is equally important to investigate the physical and mental health of health care workers during the COVID-19 outbreak. The purpose of our study is as follows: (1) to determine the status of acute stress and QoL in health care workers, (2) to explore the relationship between acute stress and QoL, and (3) to evaluate the influencing factors of acute stress and QoL.

MATERIALS AND METHODS

Sample

Calculations were performed using G-Power statistical software (G*Power Version 3.1.9.7), and the recommended sample size was 280. The inclusion criteria of the study were as follows: (a) people who obtained a certificate of professional qualification, (b) staff on duty in hospitals during the COVID-19 pandemic, (c) and people who volunteer to participate in the research and sign the informed consent form. In total, 525 participants from 15 hospitals were recruited using a convenient sampling method. The participants were divided into three categories according to their occupation: (1) doctors; (2) nurses; (3) auxiliary staff, including technical executives (pharmacists, therapists, dieticians, and so others). Frontline medical staff were defined as individuals who had direct contact with confirmed or suspected cases through diagnosis, treatment, nursing, nosocomial infection control, case sample collection, and pathogen detection. Otherwise, they were classified as non-frontline medical staff.

Instruments

Demographic Characteristics

All participants were required to complete a demographic questionnaire, including gender, age, marital status, occupation, professional title, education level, disease, physical activity level, and work status. Physical activity was defined as aerobic exercise that lasted for at least 30 min per session and was categorized into never, low (1–2 times per week), moderate (3–5 times per week), and high (6 or more times per week).

Participants were invited to answer questions related to COVID-19. They were required to give an honest response to the following questions: a) What is the current pandemic situation in your area? b) Have you been to Wuhan (in the last month)? c) What is your current infection status regarding COVID-19? d) What do you think are your chances of being infected with COVID-19? e) How long do you think the pandemic will last?

Acute Stress Response

Acute stress response was measured by the Stanford Acute Stress Reaction Questionnaire (SASRQ); it is a valid research instrument with good reported internal reliability (0.80–0.95) and test-retest reliability (0.69) (Cardeña et al., 2000). Participants were invited to fill out the Chinese version of SASRQ to report whether they had experienced acute stress related to COVID-19. The SASRQ is a 30-item questionnaire that rates acute reactions to trauma on a 5-point Likert scale. It includes four different subscales and three additional questions about the traumatic event, which refers to COVID-19 in our study. The questionnaire consists of the following: dissociative reactions (10 items), re-experiencing of trauma (6 items), avoidance (6 items), hyperarousal (6 items), and impairment in social functioning (2 items). The symptoms are considered positive if a score above three is obtained on at least one item of each subscale (Roberge et al., 2010). A total score (range 0–150) is calculated through the sum of each item, with higher scores implying more serious acute stress.

Quality of Life

The Chinese version of the World Health Organization Quality of Life Questionnaire (WHOQoL-BREF) demonstrated good reliability (0.76–0.90) and validity (0.72–0.82); it was used to assess the QoL of hospital employees in this study. This 26-item instrument, rated on a 5-point Likert scale (range 1–5), consists of two questions on general health and four domains: physical health (7 items), psychological well-being (6 items), social relationships (3 items), and environment (8 items). The total score ranges from 26 to 130, with higher scores reflecting a better QoL.

Procedure

A non-probabilistic and convenience sampling method was conducted. Potential respondents were recruited exclusively through online methods (QQ, Wechat, E-mail, etc.) and were sent the questionnaire link. To reduce the risk of infection during the COVID-19 pandemic, all participants were invited to complete an online self-report questionnaire anonymously by clicking the survey link or scanning the Quick Response code.

Experimental Design

A cross-sectional descriptive correlational design was conducted on health care workers to assess their acute stress response and QoL during COVID-19. Before recruitment commenced, the study was designed following the Helsinki principles and approved by the Local Ethics Committee of Qianfoshan Hospital Affiliated with Shandong University (2020S517). All respondents provided informed consent (completed online) to participate in the research (10 February to 17 February, 2020). This study is reported as per the STROBE checklist.

Statistical Analyses

Descriptive statistics were generated for all variables. The continuous demographic data included mean and standard deviation (SD), whereas frequencies and percentages were used to summarize the categorical variables. For each variable, Kolmogorov-Smirnov's test was utilized to inspect the normality, and Levene's test was performed to determine the homogeneity of variance. The independent-samples t-test (or Mann–Whitney U-tests) and the one-way analysis of variance (or Welch's test) were used to evaluate the differences in continuous variables. The *post hoc* test was performed with Bonferroni correction or Dunnet T3 test, depending on the homogeneity of variance test. Criteria for entry into the multiple linear regression included variables with $p \leq 0.10$ in univariate analysis (Kang et al., 2015). Subsequently, the bivariate Pearson's correlation analysis was utilized to determine the correlation between acute stress and QoL. Stepwise multiple regression analysis was used to identify which variables influenced acute stress response and QoL. All statistical analyses were two-sided, and a p-value less than 0.05 was defined as statistically significant. All original data were input and calculated by the IBM SPSS ver. 23.0 for Windows (IBM Corporation, Chicago, IL, United States).

RESULTS

Sample Characteristics and Distribution of SASRQ and QoL

Among 525 volunteers, 502 completed the questionnaire, of which 47 were excluded because of missing or implausible data. Finally, 455 individuals were included in this study, with a response rate of 95.6% and an effective rate of 86.6%. Sample characteristics of participants, SASRQ, and QoL scores are summarized in **Table 1**. More than half of the respondents were under 35 years old (64.0%) and had received undergraduate education or above (94.7%). Of the total, 251 (55.2%) thought that the outbreak was under control, 292 (64.2%) believed the pandemic would last more than two months, and 408 (89.7%) thought they were at risk of contracting COVID-19. Regarding the participants' scores for SASRQ, among the 455 volunteers (356 women) who enrolled in the study, nearly half (48.8%) experienced dissociative reactions; 26.6% reported symptoms of trauma re-experience; 22.6% exhibited avoidance symptoms; 42.4% experienced hyperarousal, and 31.9% suffered from maladaptive behaviors. The mean scores on SASRQ and QoL were 25.88 (SD = 21.84) and 65.60 (SD = 12.60), respectively.

In the univariate analysis, the acute stress response levels varied significantly among differences in marital status ($F = 4.062$, $p = 0.018$) and physical activity ($F = 5.457$, $p = 0.002$). Acute stress was significantly higher in people who were divorced/widowed and those who were not physically active. The statistical differences in the degrees of acute stress were intimately tied to the perceived risk of contracting COVID-19 ($F = 12.698$, $p < 0.001$) and perceived pandemic status ($F = 4.306$, $p = 0.014$). Participants who perceived a medium or high risk of contracting COVID-19 and perceived an upward trend in the pandemic's infection rate showed higher scores in SASRQ. Similarly, the front-line medical staff ($t = 5.307$, $p < 0.001$) and people who had been to Wuhan in the last month ($t = 2.941$, $p = 0.003$) were significantly more likely to exhibit acute stress.

Regarding QoL, there was a significant difference in physical activity ($F = 8.072$, $p < 0.001$), work status ($t = -6.009$, $p < 0.001$), and the perceived risk of contracting COVID-19 ($F = 10.477$, $p < 0.001$). The front-line medical staff was more likely to report a worse QoL. Participants who were regularly physically active and those who perceived themselves to be at no or low risk of contracting COVID-19 showed higher QoL scores (**Table 1**).

Correlations Among SASRQ and QoL

As shown in **Table 2**, the study participants' acute stress response negatively correlated with QoL ($r = -0.611$, $p < 0.001$). Furthermore, the five dimensions of SASRQ significantly and negatively correlated with all QoL dimensions, which exhibited a strong negative association ($r < -0.60$) between acute stress and QoL in health care workers (all $p < 0.001$).

TABLE 1 | Univariate analysis of acute stress and quality of life with demographic (n = 455).

Variables	*n* (%)	Acute stress response			Quality of life		
		Mean ± SD	*t/F*	*p* (*post hoc*)	Mean ± SD	*t/F*	*p* (*post hoc*)
Gender	−0.913	0.362		0.588	0.557		
Male	99 (21.8)	24.11 ± 23.34			66.26 ± 12.66		
Female	356 (78.2)	26.38 ± 21.41			65.42 ± 12.59		
Age (years)			1.197	0.303		2.406	0.091
≤ 35	291 (64.0)	25.58 ± 21.09			64.65 ± 12.56		
35–60	154 (33.8)	27.07 ± 23.67			67.19 ± 12.50		
>60	10 (2.2)	16.40 ± 8.82			68.85 ± 13.46		
Marital status			4.062	0.018		0.393	0.675
Divorced/Widowed[a]	7 (1.5)	27.86 ± 10.53		a > b, $p = 0.016^{\dagger}$	61.53 ± 7.21		
Married[b]	267 (58.7)	22.40 ± 1.37		a > c, $p = 0.007^{\dagger}$	65.56 ± 12.12		
Single[c]	181 (39.8)	20.35 ± 1.51			65.82 ± 13.45		
Occupation			0.456	0.634		1.305	0.272
Nurse	229 (50.3)	25.42 ± 21.80			66.33 ± 12.99		
Doctor	162 (35.6)	25.57 ± 21.66			65.41 ± 12.64		
Auxiliary staff	64 (14.1)	28.30 ± 22.60			63.48 ± 10.87		
Professional title			0.053	0.949		1.683	0.187
Primary	282 (62)	25.62 ± 21.08			64.78 ± 12.63		
Intermediate	112 (24.6)	26.26 ± 23.30			67.27 ± 12.27		
Senior	61 (13.4)	26.39 ± 22.86			66.33 ± 12.88		
Educational level			1.334	0.264		1.326	0.266
Associate degree or below	24 (5.3)	24.96 ± 17.97			68.24 ± 12.23		
Bachelor's degree	212 (46.6)	27.67 ± 23.06			64.69 ± 13.19		
Master's degree or above	219 (48.1)	24.26 ± 20.94			66.19 ± 12.02		
Chronic disease history			−1.624	0.105		0.416	0.677
Yes	14 (3.1)	16.57 ± 22.73			66.98 ± 11.82		
No	441 (96.9)	26.18 ± 21.77			65.56 ± 12.63		
Physical activity			5.457	0.002			
Never[a]	313 (68.8)	28.28 ± 22.78		a > c, $p = 0.029^{\ddagger}$	63.71 ± 12.41	8.072	< 0.001
1–2 times/week[b]	68 (14.9)	21.16 ± 20.68			69.01 ± 11.41		b > a, $p = 0.001^{\dagger}$
3–5 times/week[c]	60 (13.2)	21.07 ± 16.67			70.58 ± 11.79		c > a, $p < 0.001^{\dagger}$
6 times or more/week[d]	14 (3.1)	15.79 ± 16.11			70.05 ± 16.19		
Front-line medical staff			5.307	<0.001		−6.009	<0.001
Yes	164 (36)	33.61 ± 25.91			61.05 ± 11.56		
No	291 (64)	21.53 ± 17.79			68.17 ± 12.45		
Perceived pandemic status			4.306	0.014		1.027	0.381
Under control[a]	251 (55.2)	22.94 ± 19.19		c > a, $p = 0.028^{\ddagger}$	66.36 ± 12.32		
Prevail peak[b]	35 (7.7)	31.43 ± 25.25			66.16 ± 11.06		
Upward trend[c]	90 (19.8)	31.41 ± 25.52			63.75 ± 14.11		
Indetermination[d]	79 (17.4)	26.49 ± 22.30			65.05 ± 12.27		
Have been to Wuhan (in the last month)			2.941	0.003		−1.459	0.145
Yes	14 (3.1)	42.64 ± 25.33			60.77 ± 11.31		
No	441 (96.9)	25.35 ± 21.54			65.76 ± 12.62		
Infection status of COVID-19			1.606	0.206		0.355	0.723
Infected	0 (0)	0			0		
Quarantine	6 (1.3)	14.67 ± 5.85			67.42 ± 7.01		
Uninfected	449 (98.7)	26.03 ± 21.94			65.58 ± 12.66		
Perceived risk of contracting COVID-19			12.698	<0.001		10.477	<0.001
Norisk[a]	47 (10.3)	15.75 ± 18.41		c > a, $p < 0.001^{\ddagger}$	71.11 ± 12.55		a > c, $p < 0.001^{\dagger}$
Low risk[b]	272 (59.8)	23.06 ± 18.71		c > b, $p < 0.001^{\ddagger}$	66.81 ± 12.76		a > d, $p < 0.001^{\dagger}$

(Continued)

TABLE 1 | Continued

Variables	*n* (%)	Acute stress response			Quality of life		
		Mean ± SD	*t/F*	*p* (*post hoc*)	Mean ± SD	*t/F*	*p* (*post hoc*)
Medium risk[c]	124 (27.3)	34.15 ± 25.67		d > a, $p = 0.005$‡	61.78 ± 1 0.98		b > c, $p < 0.001$†
High risk[d]	12 (2.6)	44.25 ± 22.23		d > b, $p < 0.042$‡	56.17 ± 10.40		b > d, $p = 0.003$†
Expected duration of the pandemic			5.173	0.072		1.014	0.386
1–2 months[a]	163 (35.8)	23.32 ± 19.09			66.55 ± 12.27		
2–3 months[b]	253 (55.6)	26.01 ± 21.35			65.07 ± 12.41		
3–6 months[c]	33 (7.3)	32.49 ± 30.76			66.18 ± 14.91		
≥6 months[d]	6 (1.3)	53.83 ± 32.15			59.08 ± 15.66		

SD, standard deviation; COVID-19, coronavirus disease 2019.
†p-value of Bonferroni correction.
‡p-value of Dunnet T3 test.
The variables such as physical activity, perceived pandemic status, perceived risk of contracting COVID-19 and expected duration of the pandemic were divided into four categories: a, b, c, and d, respectively. Marital status was divided into three categories: a, b, and c.

TABLE 2 | Correlation between acute stress response and quality of life.

Variables	Total score of QoL scale	Physical health	Psychological health	Social relationships	Environment
Total score of SASRQ	−0.611**	−0.586**	−0.546**	−0.417**	−0.549**
Dissociation	−0.571**	−0.540**	−0.522**	−0.394**	−0.503**
Re-experiencing of trauma	−0.529**	−0.519**	−0.450**	−0.354**	−0.493**
Avoidance	−0.492**	−0.475**	−0.452**	−0.315**	−0.447**
Hyperarousal	−0.624**	−0.599**	−0.554**	−0.441**	−0.545**
Impairment in functioning	−0.414**	−0.391**	−0.354**	−0.287**	−0.390**

QoL scale, quality of life scale; SASRQ, Stanford Acute stress Reaction Questionnaire.
***p < 0.001 (2-tailed), based on Pearson's correlation test.*

Factors Influencing Acute Stress and Quality of Life

Stepwise multiple linear regression analysis was conducted to determine the factors that influenced acute stress and overall QoL. Seven variables, which were significant in univariate analysis, were gradually included in the regression model based on the seven hierarchical steps. Finally, all explanatory variables were incorporated into our regression model and summarized in **Table 3**. With respects to multivariate linear regression analysis, **Table 3** revealed the following: marital status (single: $\beta = -0.424$, $p = 0.017$; married: $\beta = -0.443$, $p = 0.012$); physical activity (3–5 times/week: $\beta = -0.094$, $p = 0.035$); front-line medical staff ($\beta = -0.182$, $p < 0.001$); perceived risk of contracting COVID-19 (high risk: $\beta = 0.130$, $p = 0.010$; medium risk: $\beta = 0.276$, $p < 0.001$); and the expected duration of the pandemic (≥6 months: $\beta = 0.095$, $p = 0.035$) collectively accounted for 15.5% of the variance of SASRQ ($R^2 = 0.184$, adjusted $R^2 = 0.155$). Since the variables in the regression analysis explain only a small part of the variance, it also indicates that there may be other important predictive variables that have not been included, such as pre-existing mental and physical conditions or pre-existing levels of acute stress and QoL. Therefore, further research is needed.

The dependent variable was computed as QoL. Acute stress response and four significant variables derived from univariate analysis were tested as independent variables. There were four explanatory variables in the final regression model after five hierarchical steps. **Table 4** shows the results of the final multiple linear regression model. In our study, falling between 35 and 60 years of age ($\beta = 0.143$, $p < 0.001$), physically active 3–5 times per week ($\beta = -0.109$, $p = 0.004$), being a front-line medical staff member ($\beta = 0.137$, $p < 0.001$), and the total score of SASRQ ($\beta = -0.545$, $p < 0.001$) collectively accounted for 41.2% of the variance of QoL ($R^2 = 0.425$, adjusted $R^2 = 0.412$). Additionally, acute stress response accounted for most of the variance ($\Delta R^2 = 0.373$, adjusted $\Delta R^2 = 0.372$) (**Table 4**).

DISCUSSION

This study aimed to determine the relationship between acute stress and QoL and explore the influencing factors on health care workers during the outbreak of COVID-19. Our study presented that marital status, physical activity, work status, perceived risk of contracting COVID-19, and the expected duration of the pandemic were significantly associated with the acute stress of health care workers. Furthermore, age, physical activity, work status, and acute stress responses significantly affected the QoL of health care workers.

In the multiple linear regression analysis, results indicated that widowed individuals or those who experienced divorce reported more serious acute stress responses. As a traumatic event, divorce or loss of spouse is commonly accompanied by numerous negative consequences and psychological distress.

Pérez et al. (2017) observed that people who had experienced negative life events were more likely to be affected by a major traumatic event, showing higher levels of anxiety, depression and post-traumatic stress. Consistent with previous studies (Rosenbaum et al., 2015; Oppizzi and Umberger, 2018), our findings suggested that engagement with moderate physical activity could alleviate the acute stress response. As an auxiliary means to usual care, physical activity has been proven to improve the health conditions caused by PTSD (Rosenbaum et al., 2015; Oppizzi and Umberger, 2018). In a study conducted in New York, Shechter et al. (2020) found that more than half of medical staff reported acute stress since the outbreak of COVID-19, and the most common coping style was physical activity. Based on the above findings, moderate and regular physical activity can help to deal with the psychological problems associated with COVID-19 quarantine.

Our findings suggested that the front-line medical staff exhibited greater levels of acute stress. Wang et al. (2020) highlighted that acute stress disorder is a prominent psychological problem for front-line health professionals. Working on the front-line is an independent risk factor for negative emotions (Lai et al., 2020). Zhou et al. (2020) showed that workload was associated with psychological disturbances in frontline medical staff. However, health care workers with a larger workload are less likely to participate in the survey and are more likely to receive psychological intervention, which may lead to the underestimation of acute stress (Cole et al., 2009; Zhou et al., 2020). Furthermore, the degree of perceived risk regarding contracting COVID-19 was associated with the level of acute stress response. Lin et al. (2007) reported that a medical staff's self-perceived risk of infection caused by SARS could lead to severe PTSD. A study from Australia showed that the perceived risk of contracting COVID-19 was

TABLE 3 | Multiple linear regression analysis of the influencing factors of acute stress response.

Variables	Unstandardized coefficients (B)	Std. error (SE)	Standardized coefficients (β)	*t*	*p*
Marital status					
Divorced/Widowed	Reference				
Married	−19.608	7.791	−0.443	−2.517	0.012*
Single	−18.905	7.898	−0.424	−2.394	0.017*
Physical activity					
Never	Reference				
1–2 times/week	−5.024	2.791	−0.080	−1.800	0.073
3–5 times/week	−5.911	2.795	−0.094	−2.115	0.035*
6 or more times/week	−9.367	5.528	−0.074	−1.695	0.091
Front-line medical staff					
No	Reference				
Yes	−8.275	2.144	−0.182	−3.859	< 0.001**
Have been to Wuhan (in the last month)					
No	Reference				
Yes	−10.774	5.982	−0.085	−1.801	0.072
Perceived pandemic status					
Under control	Reference				
Prevail peak	3.038	4.022	0.037	0.755	0.451
Upward trend	3.430	2.623	0.063	1.308	0.192
Indetermination	0.546	2.670	0.009	0.205	0.838
Perceived risk of contracting COVID-19					
No risk	Reference				
Low risk	6.359	3.244	0.143	1.960	0.051
Medium risk	13.530	3.561	0.276	3.799	< 0.001**
High risk	17.693	6.804	0.130	2.600	0.010*
Expected duration of the pandemic					
1–2 months	Reference				
2–3 months	0.004	2.104	0.000	0.002	0.998
3–6 months	6.119	3.992	0.073	1.533	0.126
≥6 months	18.096	8.547	0.095	2.117	0.035*
R^2	0.184				
Adjusted R^2	0.155				

COVID-19, coronavirus disease 2019.
$^{*}p < 0.05$; $^{**}p < 0.001$.

associated with acute mental health responses (Newby et al., 2020). The high perceived risk not only causes significant psychological distress and intense fear in individuals, but also prompts them to adopt protective measures (Lee et al., 2020; McCloskey and Heymann, 2020). We also demonstrated that a long expectation of disease duration might increase acute stress. Previous studies showed that prolonged exposure to traumatic events usually indicated detrimental effects (Garfin et al., 2015). When faced with emergencies, exposure to continuous, unpredictable threats, and overestimation of negative effects can lead to intense anticipatory anxiety (Grupe and Nitschke, 2013). Meanwhile, the excessive psychological expectation of potential negative stimuli is an important source of stress responses such as anxiety and hopelessness (Simmons et al., 2011). Our findings indicate that effective interventions are necessary to promote health care workers' mental health. Moderate physical activity and targeted psychological interventions may be practicable.

In our model, factors affecting the QoL of individuals included age (36–60), being a front-line medical staff, physical activity (3–5 times per week), and the extent of acute stress response. Older participants (ages between 35 and 60) had a higher QoL than younger participants (age $\leq$ 35). Our conclusion is consistent with an air crash observation, which found that older individuals reported a smaller increase in negative effects caused by the MH17 crash than younger participants (Jeronimus et al., 2019). One possible explanation might be that older medical staff have more experience, professional skills, sophisticated coping strategies to deal with risks and crises, and pay less attention to negative information (Piotrkowska et al., 2019). In the current study, people engaged in moderate physical activity reported higher QoL levels than those who never exercised. Our findings are partly consistent with Slimani et al. (2020), who reported that moderate physical activity was positively correlated with all domains of QoL. Similarly, the WHO recommends at least 150 min of moderate exercise per week to improve QoL during the outbreak of COVID-19.

This study also highlighted that the QoL of front-line medical staff was worse than those who were not in direct contact with patients. All health and safety personnel are shown to be at high risk; notably, Lai et al. (2020) showed that the more severe symptoms of depression, anxiety, and insomnia were reported by front-line workers. Moreover, heavy protective equipment and N95 masks make it difficult to breathe and communicate. Prolonged exposure to the virus and the possible risk of infection could increase work-related and psychological stress. Furthermore, front-line medical staff is more likely to encounter patients dying from COVID-19. Research showed that the disposal of corpses results in negative psychological reactions and a poor QoL, which was the case in a sample of earthquake rescuers (Hsiao et al., 2019).

Furthermore, the multiple linear regression analysis showed that the most prominent potential risk factor was acute

TABLE 4 | Multiple linear regression analysis of the influencing factors of quality of life.

Variables	Unstandardized coefficients (B)	Std. error (SE)	Standardized coefficients (β)	*t*	*p*
Age (years)					
≤35	Reference				
36–60	3.814	1.001	0.143	3.812	< 0.001**
>60	−0.693	3.179	−0.008	−0.218	0.828
Physical activity					
Never	Reference				
1–2 times/week	2.436	1.342	0.067	1.816	0.070
3–5 times/week	3.935	1.357	0.109	2.900	0.004*
6 or more times/week	1.449	2.691	0.020	0.539	0.590
Front-line medical staff					
No	Reference				
Yes	3.601	1.036	0.137	3.476	0.001*
Perceived risk of contracting COVID-19					
No risk	Reference				
Low risk	−1.553	1.545	−0.061	−1.006	0.315
Medium risk	−2.589	1.722	−0.092	−1.504	0.133
High risk	−3.071	3.250	−0.039	−0.945	0.345
Acute stress response (SASRQ)	−0.315	0.022	−0.545	−14.007	< 0.001**
R^2	0.425				
Adjusted R^2	0.412				

COVID-19, coronavirus disease 2019; SASRQ, Stanford Acute stress Reaction Questionnaire. Explained variance of acute stress response: $\Delta R^2 = 0.373$, Adjusted $\Delta R^2 = 0.372$.
$^*p < 0.05$; $^{**}p < 0.001$.

stress responses, which contributed 37.2% of the variance, while the remaining two factors only represented 4.0% of the variation on QoL. Our findings, along with previous conclusions, indicated that acute stress response was associated with QoL. A study on front-line health professionals during the outbreak of COVID-19 showed that acute stress response led to serious emotional distress and chest pain (Wang et al., 2020). Chaudhury et al. (2015) demonstrated that a history of acute stress increased individuals' susceptibility to depression by changing molecular activity in the brain. Lefebvre et al. (2020) illustrated an inverse correlation between acute stress and QoL in samples of victims of violent crime and added the evidence that health-related QoL to remain stable within 12 months. Another study emphasized that a serious onset of acute stress was significantly related to depressive disorders and anxiety symptoms; often manifesting a year later for the first time (Bryant et al., 2012). Recurrent, acute stressors can increase the risk of hypertension by activating the stress-mediating autonomic nervous system (Gerin et al., 2012). Continuous fear stimuli are likely to cause abnormal neurocircuitry patterns, resulting in various physiological damages (Olff et al., 2019). In other words, acute stress not only affects the short-term QoL but also threatens long-term health-related outcomes. It is, therefore, imperative to reinforce the awareness of and intervention on the acute stress of health care workers during the duration of the COVID-19 pandemic.

Generally speaking, our research may provide some ideas toward formulating protective measures for health care workers engaged in the COVID-19 pandemic. We recommend that hospital managers pay close attention to the mental health of health care workers, especially front-line medical staff. Professional psychological counseling services and an adequate supply of personal protective equipment are needed to ensure the safety of these health care providers (Banerjee, 2020).

Limitations

First, all respondents were asked to consider experiences with COVID-19 as a specific stressful event and review the extent to which the epidemic has interfered with their mental health and daily lives – thereby minimizing the effects of pre-existing stress and QoL on the results. Furthermore, due to the sudden outbreak of the COVID-19 pandemic in China, we only conducted a cross-sectional survey and could not assess the psychological status at a baseline. Further longitudinal studies, with an extended follow up, will be needed to determine the causality between the acute stress response and QoL. Second, an online investigation was conducted as everyone was required to be quarantined. Hence, our sample was not based on random selection from all hospital staff. The use of convenience sampling meant that health care workers who were under extreme stress or an extremely high workload would be less likely to participate in the survey, causing selection bias and an underestimation of acute stress and QoL. A more representative sample will be needed to generalize our research results. Lastly, our study is limited to a self-reported questionnaire, which does not include objective data or clinical diagnoses.

CONCLUSION

This study displayed health care workers' acute stress responses and QoL during the outbreak of the COVID-19 pandemic. Factors such as marital status, physical activity, work status, perceived risk of contracting COVID-19, and the expected duration of the pandemic were significantly associated with increased acute stress responses. In addition, younger individuals, lack of physical activity, front-line medical staff, and higher acute stress scores indicated a worse QoL. It is imperative that the physical and mental health of health care workers are improved, to help combat the COVID-19 pandemic. Our findings can help health practitioners and authorities to identify high-risk individuals and provide them with appropriate intervention and timely protection.

DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: The dataset presented in this article involves 15 hospitals and the participants of this study did not consent to their data being shared. Requests to access these datasets should be directed to CX, abc181818123@163.com.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Local Ethics Committee of Qianfoshan Hospital Affiliated with Shandong University (2020S517). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

LZ, RJ, YJ, ML, and RW: study design, data collection, and analysis plan. LZ, RJ, and CX: manuscript writing and revisions for important intellectual content. All authors: statistical analysis and final versions of the manuscript.

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Individual, Sociodemographic, and Environmental Factors Related to Physical Activity During the Spring 2020 COVID-19 Lockdown

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Background: Research has shown important between-individual variations in physical activity (PA) during the COVID-19 lockdown.

Objectives: The objectives of this is study are to examine the individual, sociodemographic, and environmental factors related to PA during the spring 2020 COVID-19 lockdown in France and to explore the mediating and moderating role of intention and self-efficacy toward PA in the relationships between sociodemographic/environmental variables and PA.

Design: In this cross-sectional study, participants living in France ($N = 386$) completed an online survey between March 30 and April 10, 2020.

Method: Minutes per week of moderate-to-vigorous PA during the lockdown; usual physical activity before the lockdown; and psychological (e.g., intention, self-efficacy, and autonomous and controlled motivation), sociodemographic (gender, age, and number of children), and environmental (habitat surface area and type of housing) factors were measured in the survey. Multiple linear regressions were used to investigate the role of these predictors on PA. Intention and self-efficacy were also examined as moderators and mediators of the association between sociodemographic/environmental factors and PA.

Results: Usual physical activity before the COVID-19 lockdown, intention toward PA, habitat surface area, and controlled motivation significantly predicted PA during the lockdown. No mediating effects of intention or self-efficacy were found. Intention significantly moderated the association between gender and PA and the association between part-time work and PA.

Conclusions: PA during the COVID-19 lockdown was mainly predicted by individual factors and notably usual PA. These results highlight the important role of habits in a highly changing context.

Keywords: physical activity, COVID-19 pandemic, psychology, context, exercise

INTRODUCTION

COVID-19 represents one of the most important sanitary crises in the last decades. Beyond the effects of COVID-19 on physical health, the disease may also have side effects on mental health, due to the strategies most countries have adopted for restraining contagion (e.g., lockdowns and closure of restaurants, schools, and public places) and other related events (e.g., overload media exposure of COVID-19, Garfin et al., 2020). In France for example, the government has implemented a national lockdown from 17th March to 11th May, 2020. People were authorized to go out of their home only for necessity reasons (work, medical check-up, purchases of necessities, or physical activity for <1 h per day and <1 km from home) and with a signed certificate. In the work domain, the lockdown has generated important differences between workers. While teleworking became the rule for most companies, workers who were unable to work (e.g., hotel industry and construction) were either placed in partial unemployment (and continued receiving around 85% of their salaries) or lost their jobs in the case of precarious contracts (e.g., interim workers and nannies).

To limit the side effects of these restrictive measures, the WHO (2020), researchers (Chen et al., 2020), and local and national governments published a series of recommendations so that people could remain sufficiently physically active (i.e., by giving advices about how to maintain physical activity during the lockdown). Indeed, regular physical activity is known as an important source of physical health (e.g., benefits for the immune system, Nieman and Wentz, 2019) and mental well-being (e.g., reduced depression and anxiety symptoms, Rebar et al., 2015). For example, being physically active has been associated with greater well-being during the spring 2020 COVID-19 lockdown (Green et al., 2020; Lesser and Nienhuis, 2020; Qin et al., 2020; Schuch et al., 2020; Ginoux et al., 2021). In contrast, physical inactivity and sedentary behaviors have been associated with increased stress and anxiety (Meyer et al., 2020).

Despite WHO recommendations and the potential benefits of physical activity during COVID-19 lockdown, a reduction of physical activity from 7 to 38% in European countries has been observed during the week of March 22 (FitBit, 2020). Although some activities (e.g., walking for commuting) have decreased while other activities (e.g., working out indoors) have increased (Cheval et al., 2020; Garmin, 2020), a recent literature review of 41 articles indicates that physical activity has globally decreased during lockdown worldwide (Caputo and Reichert, 2020). However, this review also indicates significant between-individual variations in the impact of lockdown on physical activity: while some people managed to remain sufficiently active during lockdown, others were mostly inactive. It is therefore essential to identify the factors of physical activity during this period in order to better adapt physical activity recommendations during physical and social isolation.

The sociocognitive approach has been dominant to examine factors of physical activity (for a review, see Rhodes et al., 2019). Sociocognitive theories (e.g., Theory of Planned Behavior, Ajzen, 1991; Health Belief Model, Rosenstock, 1974) consider that behavior depends on reasoned cognitions: people act when they have formed the intention to do so, which emerges when they believe they are capable to perform the behavior (e.g., self-efficacy), and that the behavior has consequences that are more positive than negative (e.g., perceived benefits and risks). Another prominent approach is the self-determination theory (Ryan and Deci, 2017), which considers behavior to depend on motivations that are either internal to the individual—when behavior is the result of a personal choice and act of volition (i.e., autonomous motivation)—or external to the individual—when behavior results from perceived internal or external pressure (i.e., controlled motivation).

Although psychological theories are useful to explain engagement in physical activity, they have mostly focused on psychological factors and have omitted the role of external ones. Yet, there is evidence that sociodemographic and environmental factors also substantially predict physical activity. For example, research in different countries showed a tendency of women to be less physically active than men (for a review, see Guthold et al., 2018). Other research has shown an inverse association between age and physical activity, with younger people being more physically active than older people (e.g., Bauman et al., 2012). Moreover, physical activity has been associated with employment status and family type, with people working in full-time jobs and having children being less physically active (e.g., Rhodes et al., 2014; Borodulin et al., 2016). Past research has also shown that people in higher socioeconomic positions might be more active during leisure time than people in lower socioeconomic ones (Gidlow et al., 2006; Beenackers et al., 2012) and have more home equipment for leisure-time physical activity (Cerin and Leslie, 2008). In contrast, people in lower socioeconomic positions seem to be more active during work (Beenackers et al., 2012).

Other studies have identified environmental factors on physical activity, including walkability, housing type, access to open spaces/recreation facilities, aesthetic variables (e.g., places evaluated as attractive), and mixed land use (coexistence of shops, residences, and other buildings in the same neighborhood/zone) (for a review, see Durand et al., 2011; Bauman et al., 2012).

In sum, it is necessary to consider not only psychological factors but also external ones to better understand physical activity participation. This integrative approach is particularly relevant in the context of the COVID-19 crisis, which has caused sudden changes in people's work, family, and living environment.

Based on the aforementioned literature, we investigated individual-level factors, including psychological (i.e., intention, self-efficacy, autonomous, and controlled motivation, as well as factors that may be particularly relevant in this sanitary crisis situation, such as perceived risks of being contaminated, perceived stress, and vitality) and behavioral (i.e., usual physical activity before the lockdown) factors, as well as sociodemographic (i.e., age, gender, education, employment, household, and socioeconomic status) and environmental (i.e., type of housing, habitat surface areas, region's degree of COVID-19 contamination, access to sports equipment, and the media exposure) factors.

A recent study conducted at the same time as the present research suggests that individual-level factors predict more physical activity than environmental ones (Rhodes et al., 2020). This study indeed observed that the main predictors of physical activity during lockdown were exercise identity and extraversion. Only one environmental factor, sports equipment at home, significantly predicted physical activity. The present study also examined this question and went a step further, by investigating how individual and external factors articulate with each other. Several studies suggest that external variables (e.g., sociodemographic and environmental) may influence behavior through the mediating role of social cognitions (e.g., intention and self-efficacy) (Cerin and Leslie, 2008; Sniehotta et al., 2013; Hagger and Hamilton, 2020). In contrast, other studies (e.g., Sniehotta et al., 2013; Schüz et al., 2019) suggest that sociocognitive constructs interact with sociodemographic/environmental variables to predict physical activity. For instance, Sniehotta et al. (2013) showed that the relationships between social cognitions and physical activity were stronger for individuals with better physical health and lower levels of socioeconomic deprivation. Moreover, Schüz et al. (2019) observed that more educated people presented a stronger relationship between intention and physical activity.

To investigate the relationships between individual and external factors and moderate-to-vigorous physical activity during the COVID-19 lockdown, we adopted the same model comparison approach as in Sniehotta et al. (2013), by investigating the three following competing hypotheses:

Hypothesis 1. Sociodemographic (i.e., age, gender, number of children, employment status, and educational attainment), environmental (i.e., type of housing, habitat surface area, access to sports equipment, and media exposure), and individual (e.g., usual physical activity before COVID-19 lockdown, intention, self-efficacy, autonomous motivation, controlled motivation, subjective vitality, stress, and perceived risks of getting COVID-19) variables predict physical activity during the COVID-19 lockdown independently from each other.

Hypothesis 2. The relationships between environmental/sociodemographic variables and physical activity during the lockdown are mediated by intention and self-efficacy.

Hypothesis 3. The relationships between environmental/sociodemographic variables and physical activity during the lockdown are moderated by intention and self-efficacy.

MATERIALS AND METHODS

Participants and Procedure

An *a priori* power analysis conducted using G. Power 3.1.9.4 (Faul et al., 2007; Erdfelder et al., 2009) indicated that 308 participants were needed, considering 47 predictors (21 single predictors and 26 interactions), an R^2 of 0.40 (based on similar research, Sniehotta et al., 2013), and 90% power. Participants aged 18 and over and residing in France were recruited to answer an online survey (about 20 min). Recruitment was done using social media (i.e., Facebook and Twitter) and by word of mouth. To encourage participation, our research laboratory committed to donating 0.50€ to bioclinical research on COVID-19 for each completely fulfilled questionnaire. The survey was available between March 30 (2 weeks after the French government announced the lockdown) and April 10, 2020.

Three-hundred-and-eighty-six people (65.54% women; M_{age} = 33.09, SD = 13.18) completed the survey, after reading and signing an online informed consent form.

Measures

Physical activity during lockdown was assessed based on the International Physical Activity Questionnaire (IPAQ, Craig et al., 2003), which was adapted to better reflect the extraordinary circumstances of COVID-19 lockdown. Participants reported the time in minutes on different physical activity categories. These categories were chosen based on a recent opinion article about how to maintain physical activity levels during COVID-19 (Chen et al., 2020). Participants were also asked to add the time spent doing any other physical activities and, in this case, to define these activities. We then classified each activity into moderate-to-vigorous physical activity when it was superior or equal to 3 METS (metabolic equivalent task, which is the amount of energy that is used during an activity) using the compendium of physical activities of Ainsworth et al. (2011).

Usual physical activity before the lockdown was assessed using the Saltin–Grimby Physical Activity Questionnaire (Grimby et al., 2015).

Intention to do physical activity was assessed using one item from Godin (2012), and self-efficacy related to physical activity was assessed using one item (Schwarzer et al., 2015). Autonomous and controlled motivation toward physical activity was assessed using a short version of the “motivation scale toward health-oriented physical activity” (Boiché et al., 2019). The eight items reflected four motivational regulations: intrinsic, identified, introjected, and external regulations. Intrinsic and identified regulations were averaged to obtain autonomous motivation, and introjected and external regulations were averaged to obtain controlled motivation (Brunet et al., 2015). Autonomous motivation showed good reliability ($\alpha = 0.89$). However, because controlled motivation did not show good reliability ($\alpha = 0.55$), we decided to remove one item. Reliability after removing this item was acceptable ($\alpha = 0.61$). Subjective vitality was assessed using the Subjective Vitality Scale (Ryan and Frederick, 1997), showing good reliability ($\alpha = 0.90$), and perceived stress was assessed using a French translation of the short form of Perceived Stress Scale (PSS-4, Warttig et al., 2013), showing good reliability ($\alpha = 0.81$). Finally, the perceived risks of getting coronavirus were assessed using perceived susceptibility and perceived severity scales. Perceived susceptibility of getting coronavirus disease was adapted from a scale related to the susceptibility of getting influenza infection (Nexøe et al., 1999). This scale did not show good reliability ($\alpha = 0.48$). Therefore, we decided not to include it in our analyses. Perceived severity of coronavirus disease was assessed and adapted from perceived severity scale of getting influenza infection (Nexøe et al., 1999). Reliability was good for this scale ($\alpha = 0.77$).

Media exposure was assessed to gather information about the extent to which the search of information has or has not increased since the start of lockdown. Four items measured four different sources of information (e.g., television, Internet, social networks, and press). Reliability was acceptable for this scale ($\alpha = 0.64$) (more details of the scales in **Supplementary Material**).

Sociodemographic information included age, gender, number of children, employment status (full-time work, partial-time work, partial unemployment, or no job), educational attainment, type of housing (housing with access to green areas or terrace and housing without access to green areas or terrace), habitat surface area, region's degree of contamination (regions most affected by coronavirus were classified as red, regions less affected as yellow, and the regions the least affected as green), and access to sports equipment at home (yes or no).

Analytical Procedures

Moderate-to-vigorous physical activity (MVPA) did not have a normal distribution, and squared root transformation was applied to approximate a normal curve. Once MVPA was transformed, skewness and kurtosis were examined to check for normality.

All hypotheses were tested using multiple linear regressions in R version 3.6.0. The "Lm" function was used to test the first and second hypotheses, and "olsrr" package (Hebbali, 2020) was used to do stepwise regression analyses (Hypothesis 3). Dummy variables were created for the categorical variables (gender, employment status, type of housing, and access to sports equipment at home).

Hypothesis 1 was tested using hierarchical regression analyses. In the first step, all the sociodemographic and environmental variables were included as predictors. In the second step, individual variables (intention, self-efficacy, autonomous motivation, controlled motivation, subjective vitality, perceived stress, perceived severity of COVID-19, and usual physical activity before lockdown) were additionally included following the methodology used by Sniehotta et al. (2013). Finally, both models were compared using chi-square difference tests to decide which model better explained behavior.

Hypothesis 2 was investigated using mediation analysis following recommendations of Yzerbyt et al. (2018), which showed that the joint significance test has a better balance of type I error and statistical power, compared to other approaches such as the bias-corrected bootstrap method. Intention and self-efficacy were tested as mediators between all other variables (environmental, sociodemographic, and individual) and physical activity. In the first step, we tested whether sociodemographic, environmental, and individual variables (except intention and self-efficacy that were tested as hypothesized mediators) predicted physical activity. In the second step, we tested whether sociodemographic, environmental, and individual (except the hypothesized mediators) variables predicted each of the hypothesized mediators (intention and self-efficacy). In the third step, we tested whether each mediator predicted physical activity when controlling for sociodemographic, environmental, and individual variables. According to the joint significance method, an indirect effect is claimed when regression coefficients in the second and third steps are significant.

Hypothesis 3 was tested using stepwise forward regression analyses. Stepwise forward regression is a method that selects and retains predictors based on mathematical criteria (e.g., Akaike information criterion), the final model containing the best predictors of the outcome and the best fitting indices (Field et al., 2012). In the first step, we centered all predictors using subtract mean to avoid multicollinearity problems (e.g., Shieh, 2011; Iacobucci et al., 2016). In the second step, physical activity was regressed on all sociodemographic, environmental, and individual variables. In the third step, interactions between sociodemographic and environmental variables, on the one hand, and intention and self-efficacy, on the other hand, were included. Finally, significant interactions were decomposed into simple slope analyses and Johnson-Newman plots using the package "interactions" (Long, 2019). To simplify these analyses, all the variables were scaled using the scale function in R (this function subtracts the mean and divides each value by the standard deviation).

After testing each hypothesis, we followed recommendations to assess the independence of residuals (using Durbin–Watson test), normal distribution of residuals (using bar plot and q–q plot), and non-multicollinearity (using VIF function in "car" package, Fox and Weisberg, 2019).

RESULTS

Descriptive Statistics

The sample population reported performing an average of 368 min of moderate-to-vigorous physical activity (MVPA) per week (SD = 251.12). The means, standard deviations, and the description of our variables are presented in **Table 1**. Correlations between variables are displayed in **Supplementary Material**.

Did Sociodemographic/Environmental and Individual Factors Independently Predict Physical Activity (Hypothesis 1)?

Hierarchical multiple linear regression analyses were performed to test Hypothesis 1 (see **Table 2**). The first model including all sociodemographic and environmental variables was significant [$F_{(12, 354)} = 4.27$, $p < 0.001$], with an R^2 of 0.13. Gender ($\beta = 0.11^{*}$, $p = 0.040$), habitat surface area ($\beta = 0.13^{*}$, $p = 0.035$), and not having access to sports equipment at home ($\beta = -0.24^{***}$, $p < 0.001$) were significantly associated with physical activity.

The second model, which included individual variables in addition to sociodemographic/environmental ones, was significant [$F_{(20, 330)} = 10.95$, $p < 0.001$] with an R^2 of 0.40. Usual physical activity before the lockdown ($\beta = 0.32^{***}$, $p < 0.001$), intention ($\beta = 0.24^{***}$, $p < 0.001$), habitat surface area ($\beta = 0.11^{*}$, $p = 0.037$), and controlled motivation ($\beta = -0.09^{*}$, $p = 0.048$) were significantly associated with physical activity during COVID-19 lockdown. Durbin–Watson test (Durbin and Watson, 1971) (Durbin–Watson$_{\text{Model 1}} = 1.84$, Durbin–Watson$_{\text{Model 2}} = 1.97$), quantile–quantile plot (available in **Supplementary Material**), as well as VIF tests (Mansfield and Helms, 1982) (average VIF$_{\text{Model 1}} = 1.18$, average VIF$_{\text{Model 2}} = 1.24$) suggested that residuals were normally distributed and not

TABLE 1 | Means, standard deviations, and description of variables.

Variable	Mean (95% CI)	SD	Range/unity of measure
Dependent variable			
PA during COVID-19 lockdown	368 (342.74, 393.34)	251.12	Minutes per week
Sociodemographic and environmental Variables			
Gender	65.54% women and 34.46% men		
Age	33.09 (31.76, 34.41)	13.18	
Region classified by color (green zones are the least affected by COVID-19, red zones are the most affected zones)	63% people living in yellow zones, 19.2% people living in green zones, and 17.9% people in red zones		
Educational attainment	6.04 (5.92, 6.16)	1.20	0–7
Employment status	45.08% full-time job, 32.9% no work, 12.7% part-time job, and 9.3% partial unemployment		
Type of housing	68.65% access to green spaces/balcony and 31.35 % without access to green spaces/balcony		
Habitat surface area	99.41 (94.37, 104.45)	49.88	Square meters
Number of Children	0.55 (0.46, 0.64)	0.91	
Media exposure	5.52 (5.35, 5.68)	1.65	1–10
Access to sports equipment at home	69.69% access to sports equipment and 32.9% without access to sports equipment		
Psychological and individual variables			
Intention	5.60 (5.43, 5.77)	1.67	1–7
Self-efficacy	5.27 (5.1, 5.45)	1.76	1–7
Autonomous motivation	5.62 (5.5, 5.74)	1.20	1–7
Controlled motivation	1.84 (1.76, 1.93)	0.87	1–7
Subjective vitality	4.31 (4.18, 4.44)	1.30	1–7
Perceived stress	3.60 (3.55, 3.66)	0.55	1–7
Perceived severity of getting COVID	2.9 (2.74, 3.04)	1.48	1–7
Usual physical activity before lockdown	3.03 (2.94, 3.12)	0.90	1–4

N = 387. PA, physical activity; CI, confidence interval; SD, standard deviation. Values between parentheses represent confidence intervals.

autocorrelated (i.e., Durbin–Watson values should be between 1.5 and 2.5; Field et al., 2012 and VIF values should not be bigger than 10; Field et al., 2012). Finally, the chi-squared tests showed that the second model (the extended one) better explained physical activity than the first model.

Did Psychological Factors (Intention and Self-Efficacy) Mediate the Association Between Sociodemographic/ Environmental Factors and Physical Activity (Hypothesis 2)?

The first multiple regression of the mediation analysis (see **Table 3**, model 3) tested whether sociodemographic/environmental and individual variables (excluding intention and self-efficacy) predicted physical activity. This regression was significant [$F_{(18, 332)} = 9.19$, $p < 0.001$] with an R^2 of 0.33. Usual physical activity before the lockdown ($\beta = 0.38^{***}$, $p < 0.001$), subjective vitality ($\beta = 0.15^{**}$, $p = 0.003$), autonomous motivation ($\beta = 0.13^{*}$, $p = 0.015$), and controlled motivation ($\beta = -0.10^{*}$, $p = 0.042$) were significant predictors. Durbin–Watson$_{\text{Model 3}} = 1.95$ and average VIF$_{\text{Model 3}} = 1.18$.

Second, in model 3.1 (**Table 3**), intention was regressed on the same predictors used in model 3. The regression was significant [$F_{(18, 334)} = 5.97$, $p < 0.001$] with an R^2 of 0.24. Autonomous motivation ($\beta = 0.33^{***}$, $p < 0.001$), usual physical activity before lockdown ($\beta = 0.17^{**}$, $p = 0.004$), subjective vitality ($\beta = 0.14^{*}$, $p = 0.011$), and perceived stress ($\beta = -0.10^{*}$, $p = 0.041$) were significantly associated with intention to do physical activity. Durbin–Watson$_{\text{Model 3.1}} = 2.01$ and average VIF$_{\text{Model 3.1}} = 1.18$.

In model 3.2 (**Table 3**), self-efficacy was regressed on the same predictors. This model was significant [$F_{(18, 334)} = 9.52$, $p < 0.001$] with an R^2 of 0.34. Subjective vitality ($\beta = 0.30^{***}$, $p < 0.001$), autonomous motivation ($\beta = 0.29^{***}$, $p < 0.001$), and usual physical activity before lockdown ($\beta = 0.19^{**}$, $p = 0.001$) were significantly related to self-efficacy to do physical activity. Durbin–Watson$_{\text{Model 3.2}} = 2.06$ and average VIF$_{\text{Model 3.2}} = 1.19$.

We decided to stop the mediation analyses at this stage because there was no sociodemographic or environmental factor that was significantly associated to both physical activity and one of the potential mediators (intention or self-efficacy).

Did Psychological Factors (Intention and Self-Efficacy) Interact With Sociodemographic/Environmental Factors in the Prediction of Physical Activity (Hypothesis 3)?

Given the high number of predictors when adding interactive terms, a stepwise forward multiple regression analysis was performed to test Hypothesis 3. The final model is detailed in **Table 4**. This model was significant [$F_{(29, 321)} = 8.64$, $p < 0.001$]

TABLE 2 | Hierarchical regression models testing the independent contribution of sociodemographic, environmental, and individual variables to physical activity during COVID-19 lockdown (Hypothesis 1).

	Model 1				Model 2			
	b	**SE *b***	***β***	***p***	***b***	**SE *b***	***β***	***P***
Constant	**15.84*** **	2.90		**<0.001**	−5.67	3.86		0.14
	(10.13, 21.54)				(−13.27, 1.93)			
Gender	**1.57***	0.76	**0.11***	**0.040**	0.27	0.67	0.02	0.688
	(0.08, 3.06)				(−1.05, 1.59)			
Age	−0.01	0.03	−0.02	0.669	−0.001	0.03	−0.002	0.967
	(−0.07, 0.04)				(−0.05, 0.05)			
Region degree of contamination	0.49	0.58	0.04	0.397	0.46	0.49	0.04	0.348
	(−0.65, 1.62)				(−0.50, 1.41)			
Educational attainment	0.03	0.35	0.01	0.937	0.27	0.30	0.05	0.361
	(−0.67, 0.72)				(−0.31, 0.86)			
Part-time job	−0.48	1.18	−0.02	0.686	−0.10	1.01	−0.01	0.919
	(−2.79, 1.84)				(−2.09, 1.88)			
Partial unemployment	0.51	1.27	0.02	0.686	0.15	1.10	0.01	0.891
	(−1.99, 3.02)				(−2.01, 2.32)			
No job	1.33	0.97	0.09	0.170	1.33	0.82	0.09	0.105
	(−0.57, 3.23)				(−0.28, 2.94)			
Housing without access to green areas/terrace	−0.15	0.87	−0.01	0.863	1.14	0.75	0.08	0.130
	(−1.87, 1.57)				(−0.34, 2.62)			
Habitat surface area	**0.02***	0.01	**0.13***	**0.034**	**0.02***	0.01	**0.11***	**0.037**
	(0.001, 0.04)				(0.001, 0.03)			
Number of children	−0.59	0.41	−0.08	0.157	−0.33	0.36	−0.04	0.358
	(−1.40, 0.23)				(−1.03, 0.37)			
No access to sports equipment	**−3.68*** **	0.78	**−0.24*** **	**<0.001**	−0.90	0.71	−0.06	0.203
	(−5.21, −2.15)				(−2.30, 0.49)			
Media exposure	0.02	0.21	0.01	0.917	0.31^{t}	0.18	0.07^{t}	0.092
	(−0.40, 0.44)				(−0.05, 0.67)			
Intention					**0.99*** **	0.26	**0.24*** **	**<0.001**
					(0.47, 1.51)			
Self-efficacy					0.36	0.27	0.09	0.174
					(−0.16, 0.86)			
Autonomous motivation					0.17	0.31	0.03	0.595
					(−0.45, 0.79)			
Controlled motivation					**−0.72***	0.36	**−0.09***	**0.048**
					(−1.44, −0.01)			
Subjective vitality					0.50^{t}	0.27	0.09^{t}	0.068
					(−0.04, 1.04)			
Perceived stress					0.35	0.58	0.03	0.545
					(−0.79, 1.48)			
Perceived severity					−0.22	0.21	−0.05	0.299
					(−0.63, 0.20)			
Usual physical activity before lockdown					**2.49*** **	0.43	**0.32*** **	**<0.001**
					(1.66, 3.33)			
R^2	**0.13**				**0.40**			
Adjusted R^2	**0.10**				**0.36**			

*$N_{Model\ 1} = 367$, $N_{Model\ 2} = 351$. Dependent variable is minutes of moderate-to-vigorous physical activity per week transformed in squared root. Women were used as reference dummy group; results in this table are displayed for men. b, raw coefficient; SE b, standard error of betas, β, standardized betas. $^{t}p < 0.10$, *$p < 0.05$, ***$p < 0.001$. Values between parentheses represent confidence intervals. Bold values are significant ($p < 0.05$).*

TABLE 3 | Hierarchical regression models testing the mediating role of intention and self-efficacy in the association between sociodemographic/environmental variables and physical activity during COVID-19 lockdown (Hypothesis 2).

	Model 3				Model 3.1				Model 3.2			
	β	SE *b*	*β*	*p*	*b*	SE *b*	*β*	*p*	*β*	SE *b*	*β*	*p*
Constant	−2.34 (−10.23, 5.55)	4.01		0.560	**2.76**** (0.78, 4.74)	1.01		**0.007****	1.44 (−0.53, 3.42)	1.00		0.151
Gender	0.15 (−1.23, 1.54)	0.71	0.01	0.827	−0.10 (−0.45, 0.25)	0.18	−0.03	0.573	−0.03 (−0.37, 0.32)	0.18	−0.01	0.887
Age	−0.01 (−0.07, 0.04)	0.03	−0.02	0.683	−0.01 (−0.02, 0.01)	0.01	−0.07	0.188	−0.00 (−0.02, 0.01)	0.01	−0.03	0.583
Region degree of contamination	0.53 (−0.48, 1.54)	0.51	0.05	0.300	0.05 (−0.21, 0.30)	0.13	0.02	0.712	0.07 (−0.18, 0.33)	0.13	0.03	0.565
Educational attainment	0.30 (−0.32, 0.92)	0.31	0.05	0.342	0.03 (−0.12, 0.19)	0.08	0.03	0.658	−0.04 (−0.19, 0.12)	0.08	−0.03	0.619
Part-time job	0.11 (−1.98, 2.19)	1.06	−0.01	0.919	0.21 (−0.31, 0.73)	0.26	0.04	0.435	0.10 (−0.28, 0.86)	0.26	0.02	0.702
Partial unemployment	0.14 (−2.13, 2.41)	1.15	0.01	0.904	−0.12 (−0.69, 0.45)	0.29	−0.02	0.676	0.29 (−0.28, 0.57)	0.29	0.05	0.319
No job	1.26 (−0.43, 2.95)	0.86	0.09	0.142	−0.13 (−0.56, 0.29)	0.22	−0.04	0.539	0.15 (−0.28, 0.57)	0.21	0.04	0.499
Housing without access to green areas/terrace	1.14 (−0.41, 2.69)	0.79	0.08	0.148	0.03 (−0.36, 0.43)	0.20	0.01	0.863	−0.07 (−0.46, 0.32)	0.20	−0.02	0.717
Habitat surface area	0.01^{t} (−0.002, 0.03)	0.01	0.10^{t}	0.090	−0.002 (−0.01, 0.002)	0.002	−0.06	0.291	0.00 (−0.00, 0.00)	0.00	−0.01	0.934
Number of children	−0.46 (−1.19, 0.28)	0.37	−0.06	0.220	−0.10 (−0.28, 0.09)	0.09	−0.05	0.309	−0.12 (−0.30, 0.07)	0.09	−0.06	0.209
No access to sports equipment	−0.99 (−2.45, 0.48)	0.74	−0.07	0.186	−0.07 (−0.44, 0.30)	0.19	−0.02	0.709	−0.04 (−0.41, 0.32)	0.19	−0.01	0.813
Media exposure	0.29 (−0.09, 0.67)	0.19	0.07	0.134	−0.02 (−0.11, 0.08)	0.05	−0.02	0.732	0.01 (−0.09, 0.10)	0.05	0.01	0.913
Autonomous motivation	**0.76*** (0.15, 1.38)	0.31	**0.13***	**0.015**	**0.45***** (0.29, 0.60)	0.08	**0.33*****	**<0.001**	**0.41***** (0.26, 0.57)	0.08	**0.29*****	**<0.001**
Controlled motivation	**−0.77*** (−1.52, −0.03)	0.38	**−0.10***	**0.042**	0.01 (−0.18, 0.20)	0.10	0.01	0.901	−0.16^{t} (−0.35, 0.03)	0.10	−0.08^{t}	0.095
Subjective vitality	**0.82**** (0.28, 1.36)	0.27	**0.15****	**0.003**	**0.18*** (0.04, 0.31)	0.07	**0.14***	**0.011**	**0.41***** (0.27, 0.54)	0.07	**0.30*****	**<0.001**
Perceived stress	−0.07 (−1.25, 1.11)	0.60	−0.01	0.912	**−0.31*** (−0.61, −0.01)	0.15	**−0.10***	**0.041**	−0.27^{t} (−0.56, 0.03)	0.15	−0.08^{t}	0.077
Perceived severity	−0.14 (−0.57, 0.29)	0.22	−0.03	0.527	0.06 (−0.05, 0.17)	0.06	0.05	0.296	0.06 (−0.05, 0.17)	0.06	0.05	0.292
Usual physical activity before lockdown	**2.94***** (2.07, 3.80)	0.44	**0.38*****	**<0.001**	**0.32**** (0.10, 0.54)	0.11	**0.17****	**0.004**	**0.36**** (0.15, 0.58)	0.11	**0.19****	**0.001**
R^2	**0.33**				**0.24**				**0.34**			
Adjusted *R^2*	**0.30**				**0.20**				**0.30**			

$N_{Model\ 3} = 351$, $N_{Model\ 3.1} = 353$, $N_{Model\ 3.2} = 353$. In model 3, dependent variable is minutes of moderate-to-vigorous physical activity per week transformed in squared root. In model 3.1, dependent variable is intention, and in model 3.2, dependent variable is self-efficacy. Women were used as reference dummy group; results in this table are displayed for men. b, raw coefficient; SE b, standard error of betas, β, standardized betas. $^{t}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Values between parentheses represent confidence intervals. Bold values are significant ($p < 0.05$).

TABLE 4 | Stepwise regression model testing interaction effects between intention, self-efficacy, and sociodemographic/environmental variables on physical activity during COVID-19 lockdown (Hypothesis 3).

	Model 4			
	b	**SE *b***	***β***	***P***
Constant	**17.46*** (16.21, 18.70)**	0.63		**<0.001**
Usual physical activity before lockdown	**2.20***** (1.36, 3.04)	0.43	**0.28*****	**<0.001**
Self-efficacy	0.14 (−0.48, 0.76)	0.31	0.04	0.652
Habit surface area	0.02^t (0.00, 0.03)	0.01	0.10t	0.053
Controlled motivation	**−0.85*** (−1.52, −0.11)	0.36	**−0.11***	**0.020**
Subjective vitality	0.47^t (−0.07, 1.01)	0.27	0.09^t	0.085
Part-time job	0.19 (−1.79, 2.16)	1.00	−0.01	0.852
Partial unemployment	0.28 (−1.86, 2.43)	1.09	0.01	0.794
No job	1.26 (−0.34, 2.85)	0.81	0.09	0.122
Media exposure	**0.40*** (0.04, 0.76)	0.18	**0.10***	**0.031**
Gender	0.23 (−1.07, 1.54)	0.66	0.02	0.725
Region degree of contamination	0.28 (−0.67, 1.24)	0.48	0.03	0.561
Number of children	−0.44 (−1.13, 0.26)	0.35	−0.06	0.215
Perceived severity	-0.36^t (−0.78, 0.06)	0.21	-0.08^t	0.096
No access to sports equipment	−0.97 (−2.36, 0.42)	0.71	−0.06	0.172
Age	0.01 (−0.04, 0.06)	0.03	0.02	0.762
Housing without access to green areas/terrace	0.97 (−0.50, 2.44)	0.75	0.07	0.194
Educational attainment	−0.34 (−0.94, 0.25)	0.30	0.06	0.257
Perceived stress	0.46 (−0.67, 1.59)	0.58	0.04	0.422
Autonomous motivation	0.25 (−0.36, 0.87)	0.31	0.04	0.421
Intention	**0.85*** (0.12, 1.58)	0.37	**0.20***	**0.022**
Gender × intention	**0.80*** (0.03, 1.57)	0.39	**0.12***	**0.041**
Age × intention	−0.02 (−0.05, 0.01)	0.01	−0.07	0.128
Housing without access to green areas/terrace × self-efficacy	0.70^t (−0.05, 1.45)	0.38	0.10^t	0.067
Number of children × self-efficacy	0.36^t (−0.02, 0.74)	0.19	0.09^t	0.066
Region degree of contamination × intention	0.52^t (−0.06, 1.10)	0.30	0.08^t	0.080
Educational attainment × self-efficacy	0.25 (−0.05, 0.54)	0.15	0.08	0.010
Part-time job × intention	**−1.34*** (−2.63, −0.05)	0.66	**−0.10***	**0.042**
Partial unemployment × intention	−0.51 (−1.78, 0.75)	0.64	−0.04	0.425
No job × intention	0.14 (−0.70, 0.98)	0.43	0.02	0.744
***R*²**	**0.44**			
Adjusted *R*²	**0.39**			

N = 351. In model 4, dependent variable is minutes of moderate-to-vigorous physical activity per week transformed in squared root; all predictors were mean centered. b, raw coefficient, SE b, standard error of betas, β, standardized betas. $^t p < 0.10$, $^* p < 0.05$, $^{***} p < 0.001$. Values between parentheses represent confidence intervals. Bold values are significant (p < 0.05).

with an R^2 of 0.44. Usual physical activity before the lockdown ($\beta = 0.28^{***}$, $p < 0.001$), intention ($\beta = 0.20^*$, $p = 0.022$), media exposure ($\beta = 0.10^*$, $p = 0.031$), and controlled motivation ($\beta = -0.11^*$, $p = 0.020$) were significantly related to physical activity.

Concerning the moderating role of self-efficacy and intention, the interaction between gender and intention ($\beta = 0.12^*$, $p = 0.041$) and the interaction between people having a part-time job and intention ($\beta = -0.10^*$, $p = 0.042$) were significantly related to physical activity.

Durbin–Watson test [Durbin and Watson, 1971; Durbin–$\text{Watson}_{\text{Model 4}} = 2.00$, quantile–quantile plot (displayed in **Supplementary Material**)] as well as VIF tests (average $\text{VIF}_{\text{Model 4}} = 1.35$) suggested that residuals were normally distributed and not autocorrelated.

To simplify simple slopes analyses interpretations, all independent variables were scaled before analyses. All the Johnson Neyman plots are displayed in **Supplementary Material**. We then decomposed gender × intention and partial-time job × intention interactions using "Interactions" package (Long, 2019) (details of the interactions are displayed in **Supplementary Table 2**). Intention significantly

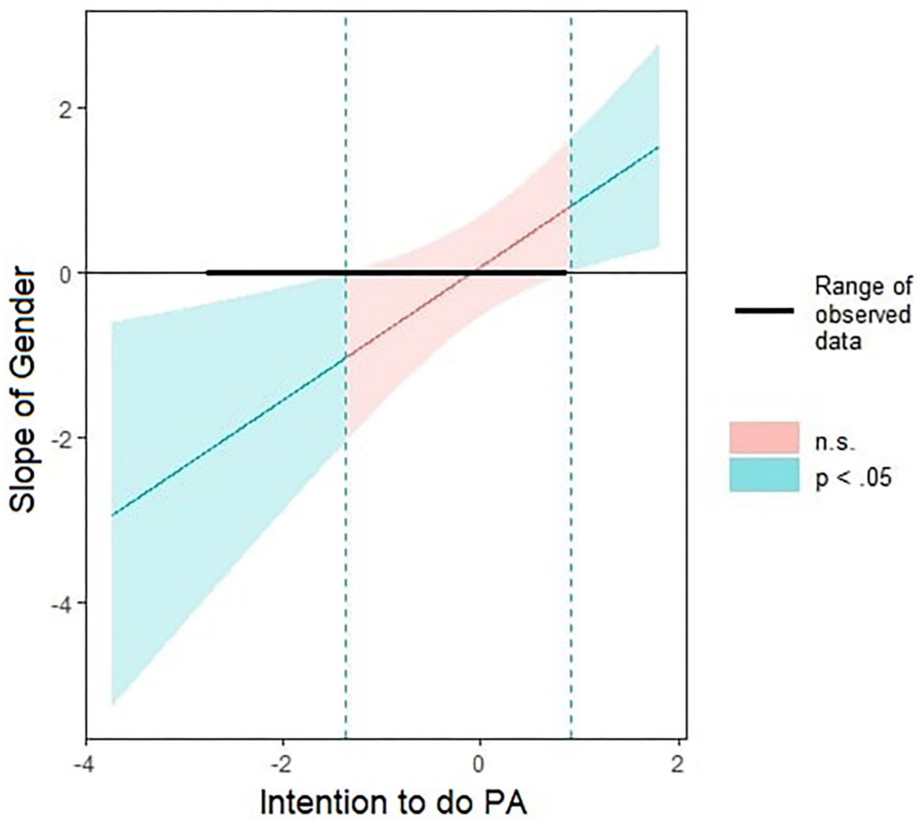

FIGURE 1 | Johnson-Neyman plot of the Interaction Gender x Intention on physical activity. In the x label, Intention standard deviations (SD). In the y level, slope of Gender. Green areas represent significant ($p < 0.05$) slopes, and orange areas represent non-significant slopes. The tick line represents the range of observed data.

moderated the association between gender and physical activity (**Figure 1**). This association was significant when intention was lower or equal to SD = −1.37. In other words, women were more physically active than men when intention was low. Moreover, intention significantly moderated the association between partial-time job and physical activity (**Figure 2**). This association was significant when intention was inferior to SD = −1.22. In other words, participants with partial-time jobs were less physically active than participants with full-time jobs, but again, only when intention was low.

DISCUSSION

Main Findings

Results provide partial support to the hypothesis that individual, sociodemographic, and environmental factors independently predict physical activity (H1). More particularly, we observed a significant role of only one environmental variable (habitat surface area). In contrast, three individual-level variables (usual physical activity, intention, and controlled motivation) significantly predicted physical activity. In other words, people were less physically active when they were little physically active before the COVID-19 lockdown, when they had low intention to be physically active, when they had a high controlled motivation, and when they lived in a small housing.

In contrast, our findings do not provide support to the hypothesis that intention and self-efficacy mediate the association between sociodemographic/environmental factors and physical activity, which contradicts previous studies (Sniehotta et al., 2013; Hagger and Hamilton, 2020). This may be due to the lack of statistical power to carry out mediation analyses.

Finally, intention moderated the association between some sociodemographic variables (i.e., gender and partial-time job) and physical activity, providing some support to H3. More particularly, when intention was low, women and participants with full-time jobs were more physically active than men and participants with partial-time jobs.

Comparison With Other Studies

The main contribution of this study is to show that individual factors predicted physical activity more than environmental and sociodemographic ones during lockdown, corroborating the results of Rhodes et al. (2020). Although the lockdown has caused sudden changes in people's work, family, and living environment, usual physical activity before the lockdown remained a major predictor of physical activity during this period. This suggests

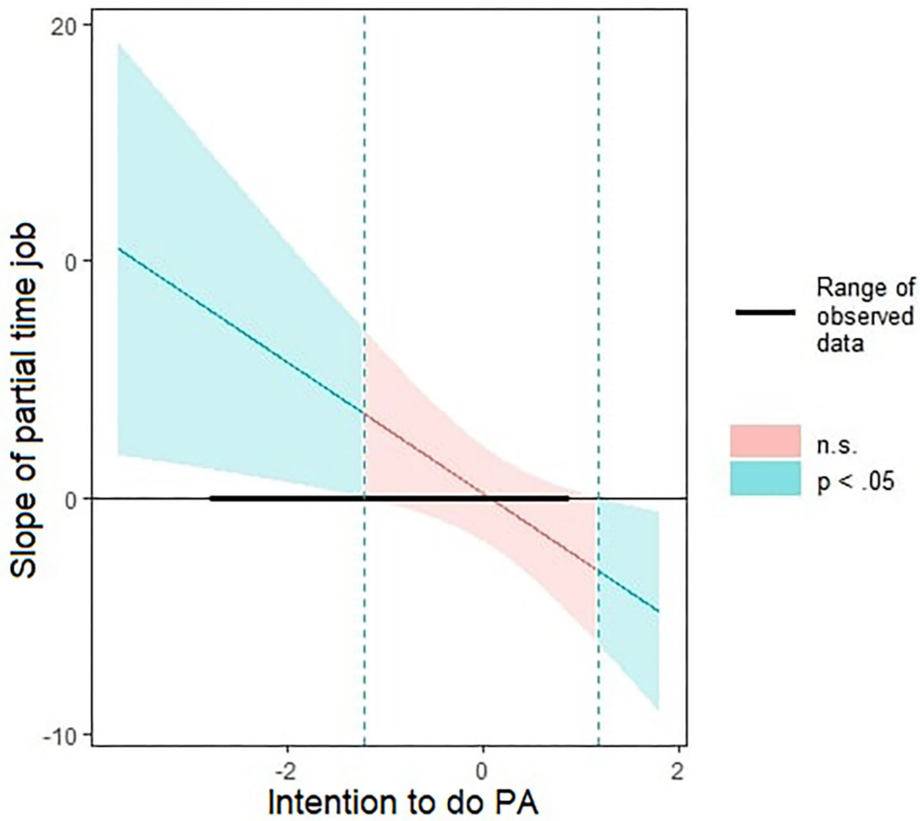

FIGURE 2 | Johnson-Neyman plot of the Interaction Part-time job x Intention on physical activity. In the x label, Intention standard deviations (SD). In the y level, slope of Partial-time job. Green areas represent significant ($p < 0.05$) slopes, and orange areas represent non-significant slopes. The tick line represents the range of observed data.

the importance of habits in order to maintain regular physical activity in a suddenly changing environment. Whereas one could have expected external factors to be particularly important in this situation, only one environmental factor (i.e., habitat surface area) significantly predicted physical activity.

At first glance, these results may seem contradictory with several studies showing that the diminution of physical activity during lockdown mostly affected people who were usually physically active (Barkley et al., 2020; Bourdas and Zacharakis, 2020; Castañeda-Babarro et al., 2020; Maltagliati et al., 2020; Meyer et al., 2020; Martínez-de-Quel et al., 2021). Instead, we believe our results nicely complements this line of research. While the lockdown may have negatively affected the evolution of physical activity mostly in usually active individuals, the present study indicates that these individuals were still more active than usually inactive individuals (see also Maltagliati et al., 2020). This suggests that although past physical activity did not completely prevent the damaging impact of lockdown on physical activity, it still had a protective role during lockdown.

The predictive role of intention was in line with past research (e.g., Hagger et al., 2002). In contrast, the lack of significant association between autonomous motivation and physical activity (Teixeira et al., 2012) as well as the association between self-efficacy and physical activity (Hagger et al., 2002) were less expected.

Furthermore, the role of habitat surface area is less studied in the physical activity literature. Some research in leisure-time sitting (Saidj et al., 2015) showed that people living in smaller surfaces tended to spend more hours in a leisure-time sitting. Moreover, habitat surface and characteristics of housing might be an indirect measure of socioeconomic status (Juhn et al., 2011). If we link smaller surfaces with lower socioeconomic status and bigger surfaces with higher socioeconomic status, this could explain our results, as socioeconomic status is related with physical activity (e.g., Ford et al., 1991; Gidlow et al., 2006; Cerin and Leslie, 2008; Beenackers et al., 2012).

Contrary to past research (Cerin and Leslie, 2008; Sniehotta et al., 2013; Hagger and Hamilton, 2020), sociodemographic and environmental effects were not mediated by intention and self-efficacy. COVID-19 has provoked negative impacts on health, employment, and economy in most countries. Nevertheless, recent studies reveal negative impacts are greater for those with lower socioeconomic status (Chung et al., 2020), suggesting that social, health, and economic inequalities are exacerbated due to the epidemic (van Dorn et al., 2020). It seems plausible that the extraordinary challenges of the COVID-19 have revealed a direct association between sociodemographic/environmental and physical activity rather than an association mediated by intention and self-efficacy.

Finally, previous studies have shown that intention and self-efficacy moderate physical activity behaviors (Sniehotta et al., 2013; Schüz et al., 2019; Hagger and Hamilton, 2020); therefore, intention toward physical activity might moderate the effects of sociodemographic and environmental variables on physical activity. For instance, gender and intention toward physical activity have been shown to affect physical activity behaviors in previous work (for a review, see Rhodes and Dickau, 2013).

Limitations

Measuring physical activity using self-reports was the main limitation of this study, as past research has shown an overestimation of the amount of physical activity when using self-reported physical activity (Dyrstad et al., 2014). In addition, while some methods of power analysis suggest that our study is sufficiently powered to detect mediation (e.g., Schoemann et al., 2017), our methods suggest instead that our study might be insufficiently powered to detected mediation (e.g., Fritz and MacKinnon, 2007). Accordingly, results of our mediation analyses should be interpreted with precaution and need to be replicated in future studies before concluding on the mediating role of intention and self-efficacy in the relationships between sociodemographic/environmental variables and physical activity. Furthermore, because the participants were recruited through social media, our sample was overeducated (i.e., individuals holding a diploma of more than 2 years in France, representing between 14 and 36% of the population; INSEE, 2019) and had fewer children than the average French person (i.e., 0.5 in our sample against the birth rate of 1.87; INSEE, 2019). As such, our results should be interpreted with caution as they are limited to this particular population, which may limit the generalization of our results. In addition, while we observed that individual and environmental/sociodemographic variables independently predicted physical activity, fully disentangling their role is difficult. Indeed, it is possible that usual exercise is determined by sociodemographic (e.g., gender and social status) and environmental factors. As such, some of the environmental/sociodemographic effects may have been partialled out by the inclusion of usual physical activity in the model. Finally, the cross-sectional nature of our study does not allow us to establish causal links. Further longitudinal research during and after the lockdown might allow having more insights about the barriers and levers to physical activity, as well as the mediation and moderation effects of psychological variables.

Practical Implications

In terms of practical implications, identification of the sociodemographic, environmental, and individual factors of physical activity patterns and levels could benefit physical activity promotion programs. Most countries have implemented two or more lockdowns since the beginning of the pandemic, and the health situation seems to be far from over. Consequently, the promotion of healthy behaviors during lockdowns are critical to preserve mental and physical health, especially for people who have been impacted by unemployment and the economic crisis provoked by the COVID-19 pandemic. Future research should focus on understanding how the health behaviors of individuals from different socioeconomic backgrounds are affected by containment measures in order to better adapt intervention programs.

Broadly speaking, understanding how different levels of factors (i.e., individual, environmental, and sociodemographic) affect physical activity and other health behaviors might give us clues to address social inequalities in physical activity and health (e.g., Hunter et al., 2015). This could be done by targeting either individual-level factors or environmental-level ones. For example, developing intention to be physically active or autonomous forms of motivation for physical activity seems crucial during lockdowns. This may be done by fostering positive attitudes toward physical activity at the individual level or by implementing policies that enable secure, accessible, and child-friendly outdoor places (e.g., public parks) for people living in small and crowded housings. In summary, these findings provide some evidence for the importance of considering multi-level barriers and levers to healthy behavior.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: https://osf.io/f9c6b/.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by CERGA Univ. Grenoble Alpes. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CT-E analyzed and interpreted the data under the supervision of CF and ACh. CT-E and ACh drafted the manuscript and the remaining authors provided critical revisions. All authors developed the study concept, contributed to the study design and data collection, and approved the final version of this manuscript for submission.

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SUPPLEMENTARY MATERIAL

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"Oh, My God! My Season Is Over!" COVID-19 and Regulation of the Psychological Response in Spanish High-Performance Athletes

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Background: In an unprecedented situation of interruption of the sporting dynamics, the world of sport is going through a series of adaptations necessary to continue functioning despite coronavirus disease 2019 (COVID-19). More than ever, athletes are facing a different challenge, a source of discomfort and uncertainty, and one that absolutely alters not only sports calendars, but also trajectories, progressions, and approaches to sports life. Therefore, it is necessary to identify the levels of psychological vulnerability that may have been generated in the athletes, because of the coexistence with dysfunctional responses during the COVID-19 experience, and which directly influence the decrease of their mental health.

Methods: With a descriptive and transversal design, the study aims to identify the state of the dysfunctional psychological response of a sample of Spanish athletes ($N = 284$). The DASS-21 (Depression, Anxiety, and Stress Scale), Toronto-20 (alexithymia), and Distress Tolerance Scale questionnaires were administered to a sample of high-level Spanish athletes in Olympic programs.

Results: The results suggest that the analyzed athletes indicate high levels of dysfunctional response (e.g., anxiety, stress, depression, and alexithymia) when their tolerance is low. In addition, the variables show less relational strength, when the capacity of tolerance to distress is worse and age is lower. At the same time, the greater the anxiety and uncertainty are, leading to more catastrophic and negative thoughts, the younger the athletes are.

Conclusions: It is clear that both age and tolerance to distress are considered adequate protective factors for psychological vulnerability in general and for associated dysfunctional responses in particular. Moreover, the psychological resources offered by more experienced athletes are also a guarantee of protection against negativity and catastrophism.

Keywords: distress tolerance, anxiety, depression, athletes, COVID-19

INTRODUCTION

Emotional stability in athletes is extremely necessary. They need to focus their efforts on clear, concrete, and planned objectives. Temporarily, athletes find in competitions possibilities to measure themselves and their opponents. The lack of all these details in an athlete's life, even with their constant orientation toward sporting challenges, increases psychological processes that lead to uncertainties, directly influencing their personal health and professional dedication. In the situation of the global pandemic by the coronavirus disease 2019 (COVID-19), the psychological resources of the athletes have been questioned; added and multiplied pressure is created that involves experiencing it in a traumatic way in the present and with possible repercussions in the future. Professional sports have been one of the most punished contexts, where all the possibilities of competing have disappeared (UEFA Soccer CUP, World Championships in all modalities, Tour of France and Giro of Italy, or JJOO have been canceled).

Generally, the experiences of high-performance athletes (e.g., sporting demands, constant challenges) require a great emotional and psychosocial stability, which strengthens them in constant competitive experiences (e.g., managing successes, resilience, accepting failures) (Cece et al., 2019), but the unexpected coexistence with an unknown disease without treatment, the inability to determine the psychosocial and economic repercussions, and the uncertainty of how to deal with the virus are all excessively traumatic situations, which turned them into a very high-risk population that will require a functional response and ready and in the best possible conditions for the future (Costa et al., 2020).

Préville et al. (1995) described the psychological distress syndrome as a combination of five factors (depression, anxiety, anger, cognitive problems, and somatization), understood as second-order factors, which also reflect the non-specific coexistence of differential distress symptoms in all these factors. Other researchers have defined it as a process of breakdown (Frank, 1973) or psychological suffering (Vélez et al., 2013; Den Hartogh, 2017), describing both somatic complaints and psychological symptoms. Furthermore, the most recent reports have demonstrated the relevance of latent but ambiguous psychophysiological symptoms, reflecting possible links with the presence of physiological and emotional disturbances (Haeberlein et al., 2020), including alexithymia as a major health risk factor (Davydov, 2017).

Distress tolerance is considered to be the perceived ability to endure negative emotional and distressing internal states caused by some type of stressor (Simons and Gaher, 2005; Bardeen and Fergus, 2016) (see **Figure 1**). It influences and is altered by a variety of psychological processes involved in cognition (e.g., attention distortions, rumination), emotional responses (e.g., emotional lability) (Honkalampi et al., 2018), physical responses (e.g., digestive distress, sleep disturbances), or social responses (e.g., perceived social support, isolation) (Drapeau et al., 2012). Thus, people with low distress tolerance perceive distress as unbearable, unacceptable, and uncontrollable, and to be overly reactive to stress and distress (Sandín et al., 2017).

This study is important for investigating individual differences that impacts an athlete's well-being. This makes necessary to identify the levels of psychological vulnerability in athletes that may be generated by living together with dysfunctional responses during and after the COVID-19 experience, directly associated with the decrease in mental health. In the same way that Mannes et al. (2019) mention how athletes feel and suffer intense unrest when the inevitable sporting withdrawal (e.g., due to age, injury) occurs, in this "forced withdrawal" the response is much more unspecific and contradictory.

Issues such as the intensity, frequency, and duration of these processes will influence athletes to develop a lower tolerance to distress (Zvolensky et al., 2010), protecting their defensive resources to cope effectively with anxiety, stress, or depression (Cheung and Yip, 2015) if this tolerance is high (Boffa et al., 2018). Sporting experience is another important issue, as high-performance athletes are used to performing under pressure, and in the face of the paralysis and uncertainty generated by the pandemic, many of their psychological strengths have been put to the test.

Both situational factors and individual differences exert their influence on the perception of negative stress (Turner et al., 2019a) or in the absence of words to express one's emotions and difficulty recognizing one's own emotions and feelings along with the inability to express them to others (e.g., alexithymia) (Eccles et al., 2011), highlighting studies that associate it with the motivational orientation of mastery transmitted by coaches and peers, in the face of perceived lack of capacity (Pensgaard and Roberts, 2000), high sport pressure (Roberts and Woodman, 2017), or vital risk (Woodman et al., 2008). Similarly, cognitive–behavioral (e.g., negative thoughts, irrational beliefs) arguments have served to describe the distress response to contextual influence through the mediation of cognitive response (Nixdorf et al., 2013; Turner et al., 2019b).

Studies that have sought to explain the connections between depressive responses in sports populations have described major events in sports life (e.g., injuries, failures) (Frank et al., 2015; Putukian, 2016), self-esteem (Armstrong and Oomen-Early, 2009), and, of course, anxiety (Gorczynski et al., 2017). In addition, it has been reported that athletes show lower indicators of depression than non-athletes (Brand et al., 2013), which appears more in female athletes (Wolanin et al., 2016) and young athletes (Junge and Feddermann-Demont, 2016). Similarly, while anxiety is one of the most studied variables in the psychological interpretation of the athlete, it has been associated with perceptions of distress through the influence of perfectionist beliefs (Madigan et al., 2017), rumination (Grossbard et al., 2009), or self-regulation (Steiner et al., 2010).

A significant connection between depressive symptomatology and distress has been understood (Reardon et al., 2019), as well as negative coping (Madigan et al., 2018), rumination (Walton et al., 2020), or catastrophism (Rice et al., 2016) in "regular" sport situations. Under the COVID-19 pandemics, this relationship is more evident. Undoubtedly, the pandemic has changed many athletes' behaviors. Recent studies have provided evidence of this relationship. See, for example, the appearance of gambling problems (Håkansson et al., 2020), social distancing,

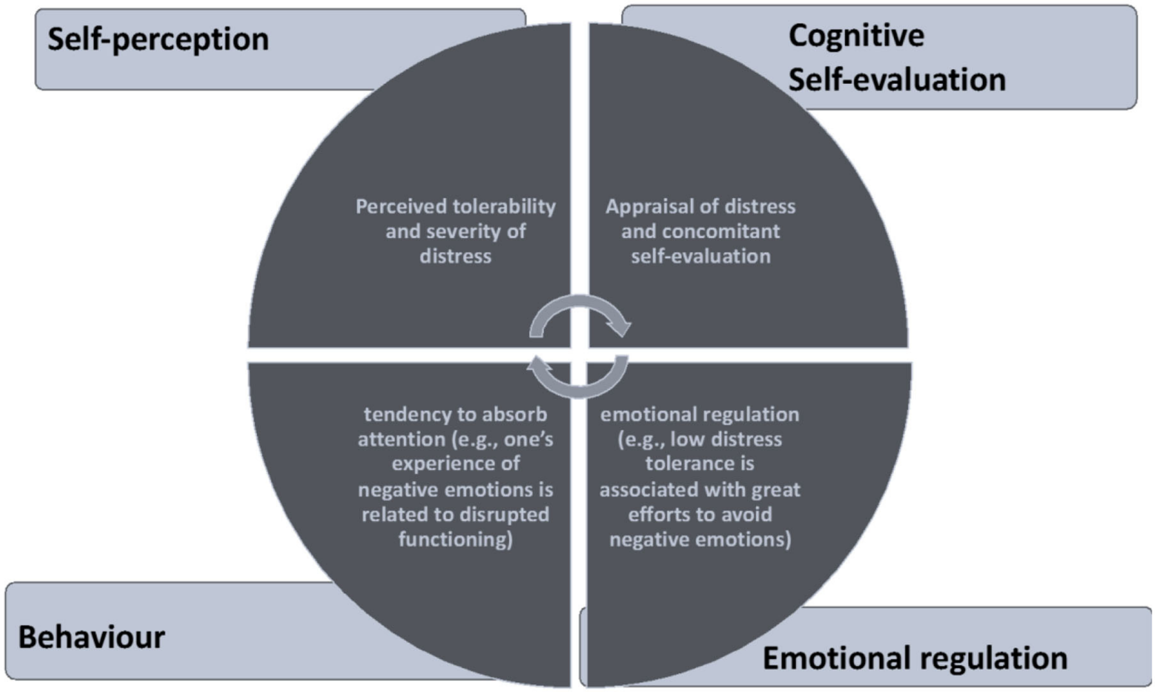

FIGURE 1 | Distress tolerance model (Simons and Gaher, 2005).

and loneliness (Graupensperger et al., 2020; Senişik et al., 2020) or adaptations in mental health (Yousfi et al., 2020).

Therefore, the aims of this study are (1) to describe how athletes are coping with the situation in COVID-19, regarding their cognitive and emotional response; we expect to find significant levels of indicators of dysfunctional psychological response (anxiety, stress, depression, alexithymia, and distress); and (2) to study participants' distress tolerance and its relationship with emotional vulnerability (high anxiety, stress, and depression). We expect that athletes showing higher distress tolerance will report lower scores in stress, alexithymia, anxiety, and depression.

METHODS

Sample and Procedure

We chose a transversal and non-randomized design to assess anxiety, stress, and depression (vulnerability factors in psychological health) in a sample of Spanish athletes ($N = 284$). The average age was 24.26 (SD = 6.83) years, of which 78.3% were men and 21.7% were women. The range of sport experience was from 9 to 22 years [mean = 15.02 (SD = 4.86) years]. Different professionals (belonging to professionals' leagues), Olympians (competing in the summer and winter Olympic Games), and athletes from other sports (**Table 1**) were represented. From March to June 2020, athletes were contacted both at their workplaces and in person to conduct this research. Participants completed an online Google forms questionnaire we developed. All participants completed a consent form approved by the Ethics Committee of the University of Granada (ID: 1494/2020). Participants were required to read, accept, and sign it voluntarily.

Measures

Dysfunctional Psychological Response

The Spanish version of the questionnaire Depression, Anxiety and Stress Scale (DASS-21) (Daza et al., 2002) was used to measure emotional distress in three subcategories: stress, anxiety, and depression. Self-report with 21 items (seven for each category) was based on a score of four points: (0) "not applied to me at all" to (3) "applied to me a lot." The higher the score, the more severe the indicator is. Global score demonstrated a good internal consistency ($\alpha = 0.87$), as well as good depression ($\alpha = 0.84$), anxiety ($\alpha = 0.86$), and stress ($\alpha = 0.80$) scores.

Tolerance to Distress

Stress Tolerance Scale was administered in its Spanish version (ETD; Sandín et al., 2017). It is a 15-item self-report designed to assess the degree to which individuals experience and cope with psychological distress, on a 5-point scale [(1) "strongly agree" to (5) "strongly disagree"]. Consistency was high ($\alpha = 0.86$). The higher the score was, the more resources participants showed for managing distress responses.

Alexithymia

We used the Toronto Scale of Alexithymia in its Spanish adaptation (TAS-20; Páez et al., 1999) to measure inability to control and recognize emotions. The 20 items in the questionnaire are scored using a Likert scale from (1) "strongly disagree" to (5) "strongly agree," The score obtained is considered alexithymic if the person obtains a score equal to or greater than 61. We obtained an adequate consistency level ($\alpha = 0.84$).

Data Analysis

We used the IBM SPSS Statistics 25 software to run the statistical analyses. We calculated descriptive measures (tendency and Kolmogorov–Smirnov) of stress, anxiety, depression, distress, and alexithymia. We also calculated the internal consistency (Cronbach α and Cohen d) of stress, anxiety, depression, distress, and alexithymia. We performed t tests to study the mean differences of stress, anxiety, depression, distress, and alexithymia between professionals, Olympians and other sports athletes. Showing the linearity relationships between stress, anxiety, depression, distress, and alexithymia, we calculated bidirectional correlations (Pearson). Finally, a multiple regression analysis was performed. Distress tolerance was the dependent variable, and stress, anxiety, depression, and alexithymia were the predictors (5.000 bootstrap resamples to establish the significance < 0.05).

TABLE 1 | Descriptive data on statistical variables.

***N* = 284**	**Range**	**%**
Age (years)	18–31	
Gender		
Male	222	78.3
Female	62	21.7
Sport experience (years)	9–22	
Sport modalities		
Olympic sports (athletism, swimming, combat sports, cyclist,…)	96	33.8
Professional sports (soccer, basketball, handball, tennis,…)	134	47.1
Other sports (running, billiard, chess,…)	54	20.1
Competition level		
Under 23	159	56.0
Senior	125	44.0
	Range	**Mean (SD)**
Anxiety	0–21	15.73 (3.61)
Depression	0–21	13.15 (3.11)
Stress	0–21	16.38 (3.04)
Alexithymia	20–100	49.37 (12.13)
Distress	15–75	54.02 (4.62)

RESULTS

The descriptive data indicate that the scores on dysfunctional psychological response of the selected sample were above the normal average scores for each variable (**Table 1**). Only alexithymia and depression showed levels around the mean.

Relationships of the dysfunctional response were analyzed through the calculation of the partial correlations among distress and all other variables, controlling the effect of the remaining ones. In addition to the "zero order" correlation and the partial correlation of each of the predictor variables with distress, the semipartial correlation was calculated (**Table 2**). All the correlations were positive and significant. Correlations between distress and anxiety and between distress and stress were the highest.

Linear and differential relationships (**Table 3**) between the variables studied showed that as the participants increase in age, depression, anxiety, alexithymia, and stress scores decreased significantly, both when the tolerance to distress was low and high. Likewise, Distress Tolerance showed positive and significant relationships with depression, anxiety, alexithymia, and stress, being stronger when tolerance distress was low. In addition, significant differences in the levels of anxiety, depression, stress, and alexithymia were shown, mainly when tolerance to distress was low.

Predictive analysis (**Table 4**) revealed different significant relationships about dysfunctional response, depending on whether tolerance to distress was high or low [depression ($F_{(4, 279)} = 67.34$, $p < 0.01$), anxiety ($F_{(4, 279)} = 70.16$, $p < 0.01$), stress ($F_{(4, 279)} = 68.03$, $p < 0.00$)] or low [depression ($F_{(4, 279)} = 69.68$, $p < 0.01$), anxiety ($F_{(4, 279)} = 71.56$, $p < 0.00$), stress ($F_{(4, 279)} = 68.36$), and alexithymia ($F_{(4, 279)} = 67.12$, $p < 0.01$)]. More specifically, predictive relationships were stronger for dysfunctional response when tolerance to distress was lower.

DISCUSSION

Results suggest that the athletes analyzed indicate lower levels of dysfunctional response (e.g., anxiety, stress, alexithymia, and depression) when their distress tolerance is higher. The more resources athletes show to withstand the distress, the weaker the appearance of anxiety, depression, and alexithymia is.

The first aim was to describe how athletes have perceived their cognitive and emotional response to the situation created by the COVID-19 pandemic. When facing a stressor, individuals experience an alteration of their psychophysiological activation level. This effect happens before the person is

TABLE 2 | Partial correlations between distress and anxiety, stress, depression, and alexithymia, controlling the effects of variables ($n = 284$).

	Anxiety		**Depression**		**Stress**		**Alexithymia**	
	Partial	**Semipartial**	**Partial**	**Semipartial**	**Partial**	**Semipartial**	**Partial**	**Semipartial**
Distress tolerance	0.436**	0.378**	0.245**	0.203**	0.346**	0.278**	0.304**	0.285**

TABLE 3 | Differential and linear relations, according distress tolerance levels.

$N = 284$	Range	d	Low distress tolerance						High distress tolerance					
			Mean (SD)	1	2	3	4	5	Mean (SD)	1	2	3	4	5
Sport experience	9–22	0.75	7.41 (7.25)	–					16.78 (6.04)	–	−0.71**	−0.59**	−0.76**	−0.59*
Anxiety	0–21	0.79	14.03 (2.96)	−0.74**	(0.85)[a]				11.42 (2.75)[c]		(0.86)[a]	0.43**	0.47*	0.49
Depression	0–21	0.83	16.24 (3.71)	−0.54*	0.76**	(0.82)[a]			10.07 (3.38)[b]			(0.81)[a]	0.39*	0.31*
Stress	0–21	0.85	17.06 (2.95)	−0.61**	0.74**	0.76**	(0.83)[a]		13.70 (2.80)[b]				(0.84)[a]	0.34*
Alexithymia	20–100	0.86	59.91 (14.51)	−0.48*	0.68*	0.74**	0.58**	(0.88)[a]	38.84 (7.31)[c]					(0.86)[a]

$^*p < 0.05$; $^{**}p < 0.01$; [a]Cronbach α; means differences (Student t); [b]$p < 0.01$; [c]$p < 0.05$; d: Cohen reliabilty.

TABLE 4 | Regression analysis over anxiety, depression stress, and alexithymia, according distress tolerance levels.

Low distress tolerance				High distress tolerance			
VD: DEPRESSION							
$R^2 = 63.7\%$ ($p < 0.00$)	β	t	p	**$R^2 = 61.2\%$ ($p < 0.00$)**	β	t	p
(Constant)		0.54	0.48	(Constant)		0.52	0.42
Sport experience	−0.66	−3.01	0.02*	Sport experience	− 0.57	−2.82	0.26
Alexithymia	0.61	2.67	0.02*	Alexithymia	0.39	2.27	0.26
Anxiety	0.75	6.92	0.00**	Anxiety	0.68	6.41	0.00**
Stress	0.58	4.82	0.00**	Stress	0.46	4.71	0.00**
VD: ANXIETY							
$R^2 = 63.1\%$ ($p < 0.00$)	β	t	p	**$R^2 = 56.68\%$ ($p < 0.00$)**	β	t	p
(Constant)		−2.08	0.21	(Constant)		−2.34	0.19
Sport experience	−0.12	−2.50	0.03**	Sport experience	−0.39	−2.52	0.21
Alexithymia	0.43	2.14	0.01*	Alexithymia	0.27	2.05	0.21
Depression	0.49	4.98	0.00**	Depression	0.21	4.37	0.02*
Stress	0.47	5.36	0.00**	Stress	0.32	5.86	0.01*
VD: STRESS							
$R^2 = 58.3\%$ ($p < 0.00$)	β	t	p	**$R^2 = 55.6\%$ ($p < 0.00$)**	β	t	p
(Constant)		−3.82	0.27	(Constant)		−3.49	0.24
Sport experience	−0.26	−3.73	0.00**	Sport experience	−0.56	−4.01	0.31
Alexithymia	0.24	−2.76	0.02*	Alexithymia	0.49	1.23	0.56
Depression	0.37	4.93	0.00**	Depression	0.66	5.83	0.02*
Anxiety	0.53	6.26	0.00**	Anxiety	0.64	5.35	0.01*
VD: ALEXITHYMIA							
$R^2 = 58.3\%$ ($p < 0.00$)	β	t	p	**$R^2 = 62.7\%$ ($p < 0.00$)**	β	t	p
(Constant)		−03.64	0.34	(Constant)		−2.43	0.24
Sport experience	−0.17	−2.76	0.00**	Sport experience	−0.62	−1.62	0.12
Anxiety	0.37	2.61	0.02*	Anxiety	0.65	1.44	0.03*
Depression	0.61	3.47	0.00**	Depression	0.48	4.37	0.01*
Stress	0.52	6.15	0.00**	Stress	0.69	6.42	0.02*

$^*p < 0.05$; $^{**}p < 0.01$. VD, dependent variable.

aware of the impact that the stressful situation has had on them (Chalmers et al., 2014). As in many other professional areas, being exposed to stressful sources for a prolonged and uncertain period of time triggers dysfunctional responses in sportsmen and sportswomen, which may involve an important risk of suffering psychological alterations or disorders (di Fronso et al., 2020).

Competitions cancelation, moving away from going to the locker room, and frequent training stoppage due to team mates or coaches positives in COVID are common issues sportsmen and sportswomen face right now (Arnold et al., 2018). Athletes experience uncertainty not only about competition and their sport career, but also about their personal lives (Schinke et al., 2020).

Another purpose of the present study was to establish relationships on how the tolerance distress is a psychological resource that protects from emotional vulnerability (high anxiety, alexithymia, stress, and depression). As stated in the hypothesis, athletes who report higher indicators of distress tolerance report a lower score for a dysfunctional psychological response such as stress, alexithymia, anxiety, and depression (Simons and Gaher, 2005).

Because of the constant presence of stressful events in sports, sportsmen should be used to deal with them and the positive and negative emotions that are frequently attached to sport competitions and practices (Laborde et al., 2016). However, this may not be the case. In fact, according to our data, an unusual situation such as the one we are living with, the COVID pandemic, generates a significant source of stress that accumulates to the regular level of stress sport performance involves. Athletes who do not have an adequate capacity to adapt and to cope with the high stress level may feel an increase in their stress level perception (Sukys et al., 2019).

Increased acceptance, risk-taking, self-regulation, and positive coping become possible transdiagnostic markers of psychological distress (Rice et al., 2020). Hence the important relevance of building on their sporting abilities, psychological resources that promote self-regulation, resilient resources, and adequate emotional coping that allow the appearance of a high tolerance to distress (Donohue et al., 2018).

However, our study has some limitations. Results may be influenced by the sample chose. Their competitive level (e.g., used to traveling, competing), the cultural heterogeneity of each sport (e.g., indoor sports, open spaces), or other personal circumstances of the athletes (e.g., being away from family or their usual training places) may have influenced the results. Even taking into account the difficulties of data collection (e.g., confined athletes and researchers), the size of the sample can be discussed, making it difficult to generalize the results obtained to other groups of athletes (e.g., team sports, individual sports,…). Therefore, we expect to replicate the study with more homogeneous samples (e.g., gender, age) and other performance levels (e.g., team competition level). Counting with the study transversal nature, it only allows the adjustment of the model in a certain period of time, which, although opportune, circumscribes the understanding of the causal process of the results to very similar situations. However, these results allow us to suggest future studies, both transversal studies that allow us to contrast the data obtained from similar samples (e.g., other countries, other types of athletes, by gender) and longitudinal studies that allow us to advance in the knowledge of the repercussions that the COVID-19 situation is generating in populations of athletes.

In addition, it is proposed to add cognitive and emotional variables (e.g., resilience, coping, motivation,…) to complete these results in the next research proposals. In this way, it will be possible to analyze the cognitive, emotional, and temperamental connections and their links, through new explanatory proposals or models that will make it possible to describe more precisely the functional and adaptive response of athletes to critical situations that affect their sporting life (e.g., sporting withdrawal, long-term injuries).

CONCLUSIONS

The effective implementation of psychological health interventions, before and during crisis situations, is a unique opportunity for the functional to assess vulnerability versus empowerment. The supervision of studies in this line will provide medium- and long-term evidence of the response and psychosocial health in athletes, essential for the proper development of preventive measures and the anticipation of psychiatric and psychological care, as well as with the promotion and training of personal skills (e.g., specific training, mental training) to manage and preserve it.

Failure is an experience we may be facing every day. And it is not alien to anyone; we all have failures. The important thing here is to have sufficient reason to get up and either continue our efforts toward achieving the objectives, or reformulate them, or postpone them, or offer them a new time frame. The idea of failure is very much related to the figure of a loser. However, athletes who faced more failures used to be better prepared mentally, physically and technically to face their sport competitions. Fear of failure is one of the worst feelings that an athlete can experience, as when faced with the magnification of the situation that has occurred, the emotional reaction (e.g., shame, fear of social criticism, guilt) paralyzes him, leading him to respond in an altered, dysfunctional way that, in most cases, leads to a high suffering.

Teaching athletes to analyze the function of their negative emotions will bring them kindness (being kind, supportive, understanding themselves in times of pain in the face of self-judgment), feeling "human" (recognizing that failing and being imperfect is part of the human condition in the face of isolation) and empathic self-awareness (a balanced awareness of negative thoughts and emotions in the face of over identification).

Self-pity has the capacity to make us anticipate positive feelings in a more stable way than self-esteem (Leary et al., 2007; Neff and Vonk, 2009). The ability to forgive ourselves and be empathetic to ourselves (Sherman, 2014) helps us to stop comparing ourselves so much with others and to reduce our inner rumination or anger.

Despite the paucity of studies on samples of high-performance athletes, the detection of how similar responses are occurring in other countries and cultures will allow a general comparison of how athletes are coping with the global COVID-19 situation. While everyone hopes that this pandemic will not last long, similar situations in the future could mean the manifestation of behaviors and responses already experienced. Improved psychological resources to train and strengthen tolerance to dysfunctional responses (e.g., reframing challenges, self-regulating emotions, assuming other social roles) will generate a better management of athletes' desperate situations, preparing them not to maximize their discomfort about the development of their present and future sport.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the data taken and recorded for this study are kept under the strictest care of the confidentiality of our institution and collaborating institutions. If you wish to review or use them, the authors must be expressly requested, under specific arguments, to obtain the relevant approvals. Requests to access the datasets should be directed to jgonzalez@ugr.es.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Granada. ID: 1494/2020. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JG-H: introduction, methodology design, and analyses. MT-G, AY, and AN-L: translate, discussion, and conclusions. CL-M: methodology and analyses. All authors contributed to the article and approved the submitted version.

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Depression and Anxiety Among Quarantined People, Community Workers, Medical Staff, and General Population in the Early Stage of COVID-19 Epidemic

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Background: We described the prevalence of anxiety and depression related to COVID-19 pandemic among different types of population and examined their potential risk factors.

Methods: A cross-sectional survey was conducted to collect demographic characteristics, exposure histories, and many other concerns about COVID-19. The Zung's self-rating anxiety scale (SAS) and self-rating depression scale (SDS), followed by a four-step multiple logistic regression analysis was performed to identify factors associated with mental health outcomes.

Results: Out of 3,303 participants, the quarantined people (40.9%), community workstation staffs-policemen-volunteers (CPV) (36.4%) and general public (30.7%) reported higher percentages of depression than the general medical staff (18.4%). Moreover, the quarantined people (19.1%) also showed higher prevalence of anxiety than the general public (9.1%) and the general medical staff (7.8%). The quarantined people had the highest risk of anxiety and depression, whereas the self-rated health was negatively associated with the risks of anxiety and depression. Younger age group (18 to 30 years) showed higher risks of anxiety (OR = 6.22, 95% CI = 2.89–13.38, $p < 0.001$) and depression (OR = 3.69, 95% CI = 2.40–5.69, $p < 0.001$). People who had exposure history or contact from Hubei province after December 1, 2019 (OR = 1.57, 95% CI = 1.07–2.30, $p < 0.001$), had family or friends engaged in front-line health care work (OR = 1.47, 95% CI = 1.02–2.14, $p < 0.001$), had confirmed case nearby (OR = 2.44, 95% CI = 1.43–4.18, $p < 0.001$) were all more likely to suffer from anxiety. Moreover, the negligence (OR = 1.85, 95% CI = 1.37–2.51, $p < 0.001$) or overindulgence (OR = 1.45, 95% CI = 1.03–2.04, $p < 0.001$) toward the epidemic information was associated with a higher risk of depression and anxiety.

Conclusions: Our findings show that the CPV and quarantined people were most at-risk population. We have identified that the young people, people with exposure histories and negligence or overindulgence toward epidemic information are in grave need of attention.

Keywords: depression, anxiety, COVID-19, epidemic information dissemination, risk factors

INTRODUCTION

The coronavirus disease 2019 (COVID-19) emerged as a global pandemic, and by February 23, 2021, there has been over 111 million confirmed cases and 2,470,772 deaths in 223 countries around the world. By February 23, 2021, the National Health Commission of China reported 101,726 confirmed cases, with 4,842 deaths (WHO, 2021).

At the early stages of the COVID-19 epidemic, the China government rapidly implemented a series of non-medical interventional strategies to contain the disease. As an emergency containment approach, a lockdown was imposed on Wuhan on January 23, and the protocol for the community prevention and control measures for COVID-19 was released on January 25 (Nhc.gov., 2020b). The government initiated the first-level emergency response in all the 31 provinces, municipalities, and autonomous regions covering over 1.3 billion people on January 29, 2020 (Xiang et al., 2020). Facing this critical situation, all Chinese people have done their best to fight the epidemic. Many health care workers from different parts of the country were recruited and volunteered to be on the front-line and were directly engaged in the diagnosis, treatment, and care of patients with COVID-19. The community workstation, police, volunteer and community health service centers formed a Trinity Joint Prevention and Control Group to trace and quarantine all close contacts. During quarantine, the community workstation staffs, policemen, and volunteers (CPV) were responsible for managing and ensuring their daily necessities and tracks. The community health service center's medical staffs were also responsible for managing their physical and mental health. Apart from this, the general public stayed at home and socially isolated themselves to prevent spreading the infection and getting infected.

Given the high prevalence and with the rapidly increasing numbers of confirmed cases and deaths, negative emotions were spreading under this grim situation. A large number of people have been experiencing psychological problems, including anxiety, depression and stress (Kang et al., 2020; Liem et al., 2020; Xiang et al., 2020; Yang et al., 2020). Overwhelming workload, inadequate protective equipment and family concern have contributed to the mental burden of health care workers and CPV. Furthermore, this epidemic has seen entire cities in China effectively placed under lockdown with travel restrictions and mass quarantine. Separations from family and friends, the loss of freedom, and boredom have created dramatic psychological effects among citizens. Previous studies have reported a profound and wide range of psychological distress such as anxiety and depression impact on people at the individual, community, and international levels during outbreaks of SARS (Wu et al., 2009), pandemic influenza A(H1N1) (Rubin et al., 2009), and influenza A (H7N9) (Wang et al., 2014). More importantly, those people who were under quarantine because of contact with confirmed cases of SARS have reported various negative emotions during the quarantine period such as fear, sadness, anxiety and depression (Reynolds et al., 2008). Therefore, it is tempting to assume that a psychological interventional approach is urgently needed for all affected persons, including patients, health care workers, close contacts, as well as the general public.

The National Health Commission of China on January 26, 2020 issued its guideline for emergency psychological crisis intervention for people affected by COVID-19, which emphasized the need for mental health teams to deliver mental health support to patients and health care workers (Nhc.gov., 2020c). In addition, the guideline for psychological assistance hotline during the COVID-19 epidemic was released on February 7 (Nhc.gov., 2020a). In spite of imposing all these guidelines on psychological interventional strategies, studies have shown that many of the front-line health care workers involved in COVID-19 treatment and care were experiencing psychological burden, including depression, anxiety, insomnia, and distress (Lai et al., 2020). However, the exact distribution of various mental-health-problems among different groups of population is still unknown. Besides, there is no clear-cut information on the psychological impact and mental health of the persons on quarantine during the peak of the COVID-19 epidemic.

Therefore, the aim of this current study was to describe the prevalence and distribution of two major psychological problems- anxiety and depression among different groups of population, and analyzed the potential risk factors associated with these symptoms. In particular, this study will compare the differences in psychological problems between the people on quarantine and other types of population during COVID-19 epidemic. This may help government agencies and psychological experts in safeguarding the psychological well-being of people in the face of COVID-19 epidemic expansion in the world.

METHODS

Study Design and Participants

This study is a cross-sectional survey conducted using an anonymous online questionnaire from March 5, 2020 to March 19, 2020. We employed a widely used "Sojump" platform (www.sojump.com) to generate a link to the survey questionnaire, which was distributed via WeChat (social networking software). Participants included members of the public in China with a WeChat account and aged 18 years or above. Those confirmed as COVID-19 cases, asymptomatic infections or suspected cases were excluded from the study.

The questionnaire consisted five parts, including demographic characteristics, COVID-19 epidemic-exposure histories, concerns toward the COVID-19 epidemic, the Zung's self-rating anxiety scale (SAS) and self-rating depression scale (SDS) for evaluating psychological symptoms, which took about 15 min to complete. An online written informed consent before the survey was designed to ask whether participants would like to participate. It included the aims, contents, risks and benefits of participating in this study. If they answered "yes," the survey would begin. Otherwise, the survey was terminated. A participant was restricted to access only once for a single device.

Ethics

This study has been approved by the Ethics Committee of the Eighth Affiliated Hospital, Sun Yat-sen University (No. 2020-001-02).

MEASUREMENTS

Mental-Health-Problems (Outcomes)

The Chinese versions of the Zung's self-rating anxiety scale (SAS) and self-rating depression scale (SDS) were used to assess the severity of anxiety symptoms and depressive symptoms (Biggs et al., 1978; Dunstan et al., 2017; Dunstan and Scott, 2019, 2020). The SAS and the SDS covered both psychological and somatic symptoms. Participants were asked to give their responses to the questions based on their experiences and feelings during the last week. Both these scaling measures contain 20 items measured using a four-point Likert scale (1 = none, or a little of the time, 2 = some of the time, 3 = good part of the time, 4 = most, or all of the time). The raw scores range from 20 to 80 and was transformed to a standardized total score ranged from 25 to 100. A score of 50 or greater represents a reasonable cut-off point for identifying cases of anxiety and depression. Previous studies have shown that both the SAS and SDS have good internal consistency with a Cronbach's alpha of 0.83 (Dunstan and Scott, 2020) and 0.81 (Tanaka-Matsumi and Kameoka, 1986), respectively. This study has also demonstrated good internal consistency (SAS: Cronbach's alpha = 0.827; SDS: Cronbach's alpha = 0.898) and construct validity (SAS: Kaiser–Meyer–Olkin (KMO) value = 0.915; SDS: Kaiser–Meyer–Olkin (KMO) value = 0.945).

Covariates

We collected demographic and clinical information from individuals belonging to different groups which was classified as general medical staffs, general public, front-line health care workers, CPV and quarantined people. Those directly engaged in clinical activities of diagnosing, treating, or providing nursing care to suspects with elevated temperature or confirmed cases were defined as front-line health care workers (HCWs). Demographic characteristics were collected including sex age, marital status, education level, living status and self-rated health. Self-rated health was measured using a 5-point Likert scale (1 = very good, 2 = good, 3 = general, 4 = poor, 5 = very poor). Exposure histories included: (1) exposure in Hubei province or had contacts with people from Hubei province after December 1, 2019, (2) had families or close friends engaged in front-line health care work, (3) had confirmed cases nearby. We asked participants' self-reported concern about the COVID-19 epidemic using the 5-point Likert scale ranged from 1 (not at all) to 5 (very much), and daily hours spent in attention to epidemic information.

Statistics Analysis

Data analysis was performed using SPSS statistical software version 25.0 (IBM SPSS Statistics, New York, United States). All tests were two-tailed, with a significance level of $p < 0.05$. The categorical variables were shown as frequency and proportion (%). The Chi-square test was used to compare the demographic characteristics and different mental health statuses. A power calculation was conducted. A sample size of 3,303 can achieve 0.99 and 0.97 power to detect the difference of depression and anxiety between five groups of participants (general public, general medical staffs, front-line healthcare workers, CPV and quarantined people) using a 4 degrees of freedom Chi-Square test with a significance level of 0.05.

We conducted a four-step multiple logistic regression modeling in the following reasons. In step 1, the types of population were included in the model to evaluate the independent effects on anxiety and depression. In step 2, we added demographic variables into the model considering the difference of demographic characteristics between different types of population. In step 3, exposure history variables were added into the model considering the potential association between exposure history and mental-health-problems. In step 4, we included variables related to participants' concerns toward the epidemic into the model to explore the relationship of these variables with mental-health-problems.

RESULTS

Demographic Characteristics

In total, 3,436 participants took part in the study, 3,303 participants from 34 provinces, autonomous regions and municipalities completed the survey. There have not confirmed as COVID-19 cases, asymptomatic infections and suspected cases in these participants. Of the eligible participants, 255 (7.7%) were general medical staffs, 2,413 (73.1%) general public, 204 (6.2%) front-line health care workers, 316 (9.6%) community workstation staffs-policemen-volunteers (CPV), and 115 (3.5%) quarantined people. The average age of the participants was 35.77 ± 12.45 (range 18–85). The majority of participants were female (59.2%), married (62.0%), and (64.7%) had attained a college or above educational level (**Table 1**).

Anxiety and Depression

The prevalence of anxiety (19.1%) and depression (40.9%) was the highest among quarantined people, followed by CPV (anxiety: 13.9%; depression: 36.4%), and the general public (anxiety: 9.1%; depression: 30.7%). The lowest prevalence of both anxiety and depression was among the general medical staff (anxiety: 7.8%; depression: 18.4%). The prevalence of anxiety

TABLE 1 | Demographic characteristics of participants.

Variable	Total (*N*, %)	General public (*N*, %)	General medical staffs (*N*, %)	Front-line health care workers (*N*, %)	CPV (*N*, %)	Quarantined people (*N*, %)	χ^2	*P*-value
Overall	3,303 (100.0)	2,413 (73.1)	255 (7.7)	204 (6.2)	316 (9.6)	115 (3.5)		
Gender							89.24	<0.001
Male	1,346 (40.8)	1,006 (41.7)	59 (23.1)	53 (26.0)	182 (57.6)	46 (40.0)		
Female	1,957 (59.2)	1,407 (58.3)	196 (76.9)	151 (74.0)	134 (42.4)	69 (60.0)		
Age							66.42	<0.001
18–30	1,456 (44.1)	1,089 (45.1)	96 (37.6)	75 (36.8)	150 (47.5)	46 (40.0)		
31–40	981 (29.7)	661 (27.4)	106 (41.6)	86 (42.2)	91 (28.8)	37 (32.2)		
41–50	484 (14.7)	343 (14.2)	40 (15.7)	30 (14.7)	52 (16.5)	19 (16.5)		
51–60	206 (6.2)	168 (7.0)	6 (2.4)	11 (5.4)	16 (5.1)	5 (4.3)		
>60	176 (5.3)	152 (6.3)	7 (2.7)	2 (1.0)	7 (2.2)	8 (7.0)		
Marital status							18.89	0.001
Single/divorced/widowed	1,255 (38.0)	948 (39.3)	70 (27.5)	64 (31.4)	130 (41.1)	43 (37.4)		
Married	2,048 (62.0)	1,465 (60.7)	185 (72.5)	140 (68.6)	186 (58.9)	72 (62.6)		
Education							188.50	<0.001
High school or below	1,167 (35.3)	977 (40.5)	16 (6.3)	23 (11.3)	94 (29.7)	57 (49.6)		
College or above	2,136 (64.7)	1,436 (59.5)	239 (93.7)	181 (88.7)	222 (70.3)	58 (50.4)		
Living status							35.24	<0.001
Alone	358 (10.8)	232 (9.6)	31 (12.2)	30 (14.7)	50 (15.8)	15 (13.0)		
Live with family member	2,733 (82.7)	2,049 (84.9)	204 (80.0)	157 (77.0)	232 (73.4)	91 (79.1)		
Live with friend	212 (6.4)	132 (5.5)	20 (7.8)	17 (8.3)	34 (10.8)	9 (7.8)		
Self-rated health							15.99	0.043
Excellent	2,646 (80.1)	1,923 (79.7)	207 (81.2)	162 (79.4)	262 (82.9)	92 (80.0)		
Very good	504 (15.3)	371 (15.4)	45 (17.6)	36 (17.6)	38 (12.0)	14 (12.2)		
Good/general/poor	153 (4.6)	119 (4.9)	3 (1.2)	6 (2.9)	16 (5.1)	9 (7.8)		
Hubei exposed after December 1, 2019							89.97	<0.001
No	3,043 (92.1)	2,270 (94.1)	232 (91.0)	159 (77.9)	289 (91.5)	93 (80.9)		
Yes	260 (7.9)	143 (5.9)	23 (9.0)	45 (22.1)	27 (8.5)	22 (19.1)		
Family or friends engaged in front-line health care work							202.26	<0.001
No	2,996 (90.7)	2,273 (94.2)	204 (80.0)	139 (68.1)	272 (86.1)	108 (93.9)		
Yes	307 (9.3)	140 (5.8)	51 (20.0)	65 (31.9)	44 (13.9)	7 (6.1)		
Confirmed cases nearby							29.83	<0.001
No	3,215 (97.3)	2,371 (98.3)	245 (96.1)	188 (92.2)	302 (95.6)	109 (94.8)		
Yes	88 (2.7)	42 (1.7)	10 (3.9)	16 (7.8)	14 (4.4)	6 (5.2)		
Cared about the COVID-19 epidemic							7.99	0.092
Non-care	204 (6.2)	163 (6.8)	10 (3.9)	6 (2.9)	20 (6.3)	5 (4.3)		
Care	3,099 (93.8)	2,250 (93.2)	245 (96.1)	198 (97.1)	296 (93.7)	110 (95.7)		
Daily attention to epidemic information (hour)							54.66	<0.001
<1	1,700 (51.5)	1,323 (54.8)	118 (46.3)	77 (37.7)	131 (41.5)	51 (44.3)		
1–3	1,157 (35.0)	802 (33.2)	102 (40.0)	81 (39.7)	132 (41.8)	40 (34.8)		
>3	446 (13.5)	288 (11.9)	35 (13.7)	46 (22.5)	53 (16.8)	24 (20.9)		
Anxiety[#]							21.66	<0.001
No	2,970 (89.9)	2,193 (90.9)	235 (92.2)	177 (86.8)	272 (86.1)	93 (80.9)		
Yes	333 (10.1)	220 (9.1)[b]	20 (7.8)[a]	27 (13.2)	44 (13.9)	22 (19.1)[ab]		
Depression[#]							29.49	<0.001
No	2,298 (69.6)	1,673 (79.3)	208 (81.6)	148 (72.5)	201 (63.6)	68 (59.1)		
Yes	1,005 (30.4)	740 (30.7)[c]	47 (18.4)[c]	56 (27.5)	115 (36.4)[c]	47 (40.9)[c]		

[#] *Multiple comparison of anxiety and depression of five type in participants, using Bonferroni-corrected P-value (0.05/10 = 0.005).*
[a] *General medical staffs VS Quarantined people, $p < 0.005$;*
[b] *General public VS Quarantined people, $p < 0.005$;*
[c] *General medical staffs VS General public, CPV, Quarantined people, $p < 0.005$.*

and depression among front-line HCWs were 13.2 and 27.5%, respectively (**Table 1**).

Analysis of Factors Associated With Anxiety and Depression

Quarantined people were consistently at higher risks than general medical staffs to suffer from anxiety (Model 1: OR = 2.78, 95% CI = 1.45–5.33; Model 2: OR = 2.36, 95% CI = 1.20–4.66; Model 3: OR = 2.39, 95% CI = 1.20–4.75; Model 4: OR = 2.33, 95% CI = 1.17–4.65) (**Table 2**) and depression (Model 1: OR = 3.06, 95% CI = 1.88–4.98; Model 2: OR = 2.49, 95% CI = 1.50–4.13; Model 3: OR = 2.57, 95% CI = 1.54–4.28; Model 4: OR = 2.52, 95% CI = 1.51–4.21) (**Table 3**). Besides, CPV were also at a higher risk than general medical staffs to suffer from anxiety (OR = 1.90, 95% CI = 1.09–3.32) and depression (OR = 2.13, 95% CI = 1.42–3.21), and the general public (OR = 1.70, 95% CI = 1.20–2.41) were also more likely to suffer from depression than the general medical staff.

Self-rated health was negatively associated with the risks of anxiety (OR = 2.5, 95% CI = 2.06–3.04) and depression (OR = 1.73, 95% CI = 1.49–2.02). People at younger ages were more likely to have risks of anxiety and depression compared with people older than 60, the odds ratios of anxiety for people at 18–30, 31–40, 41–50, 51–60 years old were 6.78 (95% CI = 3.16–14.53), 4.62 (95% CI = 2.17–9.85), 4.16 (95% CI = 1.92–9.04), and 2.89 (95% CI = 1.22–6.84), respectively. Similarly, the odds ratios of depression were 3.90 (95% CI = 2.53–6.01), 2.47 (95% CI = 1.62–3.78), and 1.80 (95% CI = 1.15–2.80) for people at 18–30, 31–40, 41–50 years old than those older than 60. In addition, educational level and living status were associated with anxiety and depression.

All groups of individuals who had exposure history in Hubei province or had close contact with people from Hubei province after December 1, 2019 (OR = 1.58, 95% CI = 1.08–2.32), had family or friends engaged in front-line health care work (OR = 1.51, 95% CI = 1.04–2.18), had confirmed case nearby (OR = 2.42, 95% CI = 1.42–4.13) were more likely to suffer from anxiety compared with those groups without any of these exposure histories. Similarly, it was also noticed that the group where individual living near the confirmed cases have reported a higher risk of depression (OR = 2.37, 95% CI = 1.50–3.76) compared to all other groups.

Notably, groups with individuals who spent more time and attention on epidemic information were more likely to show anxiety symptoms (>3 vs. <1 h: OR = 1.45, 95% CI = 1.03–2.04), while those who were less concerned about epidemic information (OR = 1.85, 95% CI = 1.37–2.51) were more likely to suffer from depression.

DISCUSSION

The COVID-19 outbreak has disrupted the normal lives of individuals, and the worldwide rapid increase of infected cases has created a sense of uncertainty, depression, and anxiety. Mental health status of individuals engaged in front-line emergency public health events is of vital importance and utmost concern. Our study firstly reported the prevalence of anxiety and depression among general public (9.1, 30.7%), general medical staff (7.8, 18.4%), front-line health care workers (13.2, 27.5%), CPV (13.9, 36.4%), and quarantined people (19.1, 40.9%). The high prevalence of anxiety and depression was noticed among the CPV and quarantined people which may attract more concern and further actions.

The latest studies showed that during the initial stage of the COVID-19 epidemic in China (from January 29, 2020 to February 3, 2020), the prevalence of anxiety and depression of the general public and front-line health care workers were (28.8, 16.5%) and (44.6, 50.4%) (Lai et al., 2020; Wang et al., 2020). During the 2009 H1N1 pandemic more than half of health care workers reported moderately high anxiety and subsequent psychological distress (Goulia et al., 2010). Compared with these previously reported data, our study found a lower prevalence of anxiety among general public and front-line health care workers, which may be related to the improvement of diagnosis and treatment technology, the increasing availability of protective materials and the decreasing number of newly confirmed cases. Additionally, we also found that the prevalence of anxiety and depression in general medical staffs were lower than that of general public, indicating that the proper knowledge about prevention of disease can effectively reduce the occurrence of anxiety and depression.

The general public and front-line health care workers, however, are not the only ones at risk for psychological problems during this pandemic. Undoubtedly, during the lockdown and travel restrictions imposed during this epidemic outbreak, the CPV played a vital role in the prevention and control measures. Compared with the health care workers, the individuals in this group had faced more unknown sources of infections. Due to the high rate of spread of infection and the requirement of emergency critical care facilities for COVID-19, CPV were required to be on call 24 h per day to promptly investigate any suspicious person to be put under quarantine facilities. Unfortunately, the over workload, uncertainty of infection, uncooperative, and discrimination of community residents may all have extensively contributed to the mental burden of these CPV group of individuals (Ni et al., 2020).

Previous studies have identified that quarantine measures and travel restrictions can cause psychological distress and disorder such as anxiety and depression (DiGiovanni et al., 2004; Desclaux et al., 2017). Moreover, those quarantined for more than 10 days showed significantly higher psychological problems (Hawryluck et al., 2004). According to a previous study during the SARS outbreak, 28.9% of quarantined people had reported depression symptoms (Ko et al., 2006). Our finding was consistent with these study reports and highly supported that quarantine is an important factor which cause anxiety (OR = 2.33, 95% CI = 1.17–4.65) and depression (OR = 2.52, 95% CI = 1.51–4.21) among individuals. Previous studies have also showed that the upset of daily routine and reduced social and physical contact with others may often lead to boredom, frustration, and depression (Reynolds et al., 2008; Wilken et al., 2017). Moreover, progression of anxiety and depression experienced in the early stages of natural disaster can evolve into long-term

TABLE 2 | Multiple logistic regression analysis of factors associated with anxiety.

	Model 1[a]	Model 2	Model 3	Model 4
Pseudo R^2	1.2%	8.3%	9.8%	10.7%
ΔPseudo R^2	–	7.1%	1.5%	0.9%
Chi-square[b]	19.237	134.486	158.401	164.76
P-value	0.001	<0.001	<0.001	<0.001
Step 1: Participants' type				
General medical staff	Reference	Reference	Reference	Reference
General public	1.18 (0.73, 1.90)	0.97 (0.59, 1.60)	1.09 (0.66, 1.80)	1.09 (0.66, 1.80)
Front-line health care worker	1.79 (0.97, 3.30)	1.67 (0.90, 3.11)	1.41 (0.75, 2.67)	1.37 (0.72, 2.59)
CPV	1.90 (1.09, 3.32)*	1.50 (0.84, 2.67)	1.53 (0.86, 2.75)	1.51 (0.84, 2.70)
Quarantined people	2.78 (1.45, 5.33)**	2.36 (1.20, 4.66)*	2.39 (1.20, 4.75)*	2.33 (1.17, 4.65)*
Step 2: Demographic				
Gender				
Male	–	1.38 (1.08, 1.76)**	1.35 (1.06, 1.72)*	1.34 (1.05, 1.71)*
Female	–	Reference	Reference	Reference
Age				
18–30	–	6.78 (3.16, 14.53)***	6.17 (2.87, 13.24)***	6.22 (2.89, 13.38)***
31–40	–	4.62 (2.17, 9.85)***	4.22 (1.98, 9.00)***	4.27 (2.00, 9.13)***
41–50	–	4.16 (1.92, 9.04)***	3.92 (1.81, 8.50)**	3.93 (1.81, 8.52)**
51–60	–	2.89 (1.22, 6.840)*	2.70 (1.14, 6.40)*	2.66 (1.12, 6.30)*
>60		Reference	Reference	Reference
Marital status				
Single/divorced/widowed	–	Reference	Reference	Reference
Married	–	1.00 (0.74, 1.35)	1.02 (0.75, 1.38)	1.01 (0.74, 1.37)
Education				
High school or below	–	Reference	Reference	Reference
College or above	–	0.75 (0.58, 0.96)*	0.73 (0.57, 0.94)*	0.74 (0.57, 0.95)*
Living status				
Alone	–	Reference	Reference	Reference
Live with family member	–	0.78 (0.55, 1.11)	0.80 (0.56, 1.13)	0.81 (0.57, 1.16)
Live with friend	–	0.43 (0.23, 0.80)**	0.44 (0.23, 0.82)*	0.46 (0.24, 0.85)*
Self-rated health		2.50 (2.06, 3.04)***	2.44 (2.00, 2.96)***	2.43 (2.00, 2.96)***
Step 3: Exposure history				
Hubei province exposed after December 1, 2019				
No	–	–	Reference	Reference
Yes	–	–	1.58 (1.08, 2.32)*	1.57 (1.07, 2.30)*
Family or close friends engaged in front-line medical work				
No	–	–	Reference	Reference
Yes	–	–	1.51 (1.04, 2.18)*	1.47 (1.02, 2.14)*
Confirmed cases nearby				
No	–	–	Reference	Reference
Yes	–	–	2.42 (1.42, 4.13)**	2.44 (1.43, 4.18)**
Step 4: Concern to the epidemic				
Care for the information				
Non-care	–	–	–	1.44(0.93, 2.23)
Care	–	–	–	Reference
Daily attention to the information				
<1	–	–	–	Reference
1–3	–	–	–	1.12 (0.86, 1.47)
>3	–	–	–	1.45 (1.03, 2.04)*

[a]*Model 1–unadjusted; Model 2–adjusted for demographics; Model 3–adjusted for demographics and epidemic-exposure variables; Model 4–adjusted for demographics, epidemic-exposure variables and epidemic-concern variables.*
[b]*Chi-square for changes in −2LnL.*
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

TABLE 3 | Multiple logistic regression analysis of factors associated with depression.

	Model 1[a]	Model 2	Model 3	Model 4
Pseudo R^2	1.3%	8.0%	8.8%	10.5%
ΔPseudo R^2	–	6.7%	0.8%	1.7%
Chi-square[b]	30.746	192.977	212.33	230.315
P-value	<0.001	<0.001	<0.001	<0.001
Step 1: Participants' type				
General medical staff	Reference	Reference	Reference	Reference
General public	1.96 (1.41, 2.72)***	1.63 (1.16, 2.29)**	1.74 (1.23, 2.46)**	1.70 (1.20, 2.41)**
Front-line health care worker	1.68 (1.08, 2.60)*	1.60 (1.02, 2.51)*	1.50 (0.95, 2.37)	1.50 (0.95, 2.37)
CPV	2.53 (1.71, 3.74)***	2.12 (1.41, 3.17)***	2.17 (1.44, 3.26)***	2.13 (1.42, 3.21)***
Quarantined people	3.06 (1.88, 4.98)***	2.49 (1.50, 4.13)***	2.57 (1.54, 4.28)***	2.52 (1.51, 4.21)***
Step 2: Demographic				
Gender				
Male	–	1.13 (0.97, 1.33)	1.13 (0.96, 1.32)	1.12 (0.96, 1.32)
Female	–	Reference	Reference	Reference
Age				
18–30	–	3.90 (2.53, 6.01)***	3.77 (2.44, 5.80)***	3.69 (2.40, 5.69)***
31–40	–	2.47 (1.62, 3.78)***	2.42 (1.58, 3.70)***	2.37 (1.55, 3.62)***
41–50	–	1.80 (1.15, 2.80)*	1.75 (1.12, 2.72)*	1.73 (1.11, 2.70)*
51–60	–	1.46 (0.88, 2.41)	1.42 (0.86, 2.34)	1.40 (0.84, 2.31)
>60		Reference	Reference	Reference
Marital status				
Single/divorced/widowed	–	Reference	Reference	Reference
Married	–	1.09 (0.89, 1.34)	1.09 (0.89, 1.34)	1.11 (0.90, 1.36)
Education				
High school or below	–	Reference	Reference	Reference
College or above	–	0.56 (0.50, 0.69)***	0.58 (0.49, 0.68)***	0.58 (0.49, 0.68)***
Living status				
Alone	–	Reference	Reference	Reference
Live with family member	–	0.61 (0.48, 0.78)***	0.62 (0.49, 0.80)***	0.64 (0.50, 0.82)***
Live with friend	–	0.47 (0.32, 0.68)***	0.48 (0.33, 0.70)***	0.51 (0.35, 0.74)***
Self-rated health		1.73 (1.49, 2.02)***	1.71 (1.47, 2.00)***	1.70 (1.46, 1.98)***
Step 3: Exposure history				
Hubei province exposed after December 1, 2019				
No	–	–	Reference	Reference
Yes	–	–	1.04 (0.78, 1.39)	1.02 (0.76, 1.37)
Family or close friends engaged in front-line medical work				
No	–	–	Reference	Reference
Yes	–	–	1.28 (0.98, 1.68)	1.26 (0.96, 1.66)
Confirmed cases nearby				
No	–	–	Reference	Reference
Yes	–	–	2.37 (1.50, 3.76)***	2.38 (1.50, 3.77)***
Step 4: Concern to the epidemic				
Care the information				
Non-care	–	–	–	1.85 (1.37, 2.51)***
Care	–	–	–	Reference
Daily attention to the information				
<1	–	–	–	Reference
1–3	–	–	–	0.96 (0.81, 1.15)
>3	–	–	–	1.17 (0.92, 1.48)

[a]*Model 1–unadjusted; Model 2–adjusted for demographics; Model 3–adjusted for demographics and epidemic-exposure variables; Model 4–adjusted for demographics, epidemic-exposure variables and epidemic-concern variables.*
[b]*Chi-square for changes in −2LnL.*
**p < 0.05; **p < 0.01; ***p < 0.001.*

post-traumatic stress disorder if not intervened at an early stage (Adams et al., 2006). Therefore, symptoms of anxiety and depression should be recognized earlier and appropriate intervention needs to be implemented immediately for the improvement of symptoms.

Of note, those individuals belonging to the group of 18–30 years of age category have reported the highest risk of anxiety and depression. This is substantiated by the fact that the psychological distress among the general population is generally found to peak around middle age (Taylor et al., 2008). The study findings would suggest that young people were particularly vulnerable and were coping less well with the consequences of this epidemic. The early stage of COVID-19 epidemic saw rapid changes in daily routines, with students moving following University closures and attending classes remotely, and for other young adults, transitioning to remote work or experiencing loss of work. These suspensions of classes, economic and employment hardships may put young people at greater risk for mental health challenges (Liu et al., 2020; Rachel Conrad et al., 2020). Besides, compared with middle-aged and elderly people, younger individuals prefer to participate in more social activities including outdoor gatherings and parties. Due to the dire need to control the spread of this epidemic, one major recommendation from health organizations was to implement social distancing procedures, which involves minimizing social and physical contact between people (WHO, 2020), making it impossible for young people participate in various social activities, which might have increased the risk of psychological problems. Young people who engaged in social distancing reported greater anxiety and depressive symptoms (Oosterhoff et al., 2020). From the general perspective of mental and physical health of younger people, it is interesting to consider the long-term consequences and potential burden of the disease.

Interestingly, we have noticed that imprudence toward the epidemic information and guide lines of prevention have increased the risk of depression, but, overindulgence and consciousness about the epidemic information for more than 3 h per day have significantly increased the risk of anxiety. As lot of misconceptions and false information regarding the epidemic outbreak are spreading around in society, most of the individuals prefer not to pay close attention to the information circulated about COVID-19. This depression might be exacerbated by the inadequate information participants often reported to be receiving from public health officials, and may confuse them about the nature of risk factors they faced (Rubin et al., 2016). However, it is also highly recommended to be over-conscious and spend a lot of time to care about the epidemic information. Moreover, too much of mixed information may lead to a difficult situation for people in finding trustworthy sources of information and may even cause harm to people's physical and mental health (Cuan-Baltazar et al., 2020). Disinformation and falsified reports about the COVID-19 have bombarded the social media and stoked unfounded fears among many netizens (Xinhuanet, 2020).

These findings implicated the government need pay more attention to mental health among CPV and quarantined people while combating with the COVID-19. In addition, it would be worthwhile to provide online or smart phone-based psycho education about the COVID-19, promote mental wellness and initiate psychological intervention (Sidi, 2020). It is noteworthy that the interventions should be implemented to help people to limit the time they spend on social media and to obtain accurate information related to the epidemic of the COVID-19 from authoritative and authentic resource to prevent psychological problems (Woon et al., 2020).

LIMITATION

This study has several limitations. First, this is a cross-sectional study, so it is difficult to accurately elucidate causal relationships. It would be ideal to conduct a prospective study on the same group of participants in future to explore the possible long-term effects of quarantine. Second, because the survey was conducted online, we could not explain the questionnaires to the respondents completely, hence a possibility of respondent bias affecting the results. Finally, although the pseudo R^2 of this study was very small, we have noticed that incorporating the depression or anxiety into the model have significantly increased the pseudo R^2 (38.0, 30.4%). However, the focus of this study is not to explore the relationship between anxiety and depression, we hope to discover other important factors that may impact the anxiety or depression during the COVID-19 epidemic in China.

CONCLUSION

Our findings show that the CPV and quarantined people were most at-risk population. We have identified that the young people, people with exposure histories and negligence or overindulgence toward epidemic information are in grave need of attention.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by this study has been approved by the Ethics Committee of the Eighth Affiliated Hospital, Sun Yat-sen University (No. 2020-001-02). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

XL, XZ, and HL were responsible for draft writing and conceived the idea of the study. XL and XZ analyzed the data and wrote the final manuscript. XL, HL, WY, and HY were co-principal investigators designed and implemented this study. XZ and HL supervised and checked the analyses. All authors contributed to the collection of data, read, and agreed to the published version of the manuscript.

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The Effect of Persuasive Messages in Promoting Home-Based Physical Activity During COVID-19 Pandemic

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We tested the plausibility of a persuasion model to understand the effects of messages framed in terms of gain, non-loss, loss, and non-gain, and related to the physical, mental and social consequences of doing physical activity at home during the lockdown restrictions. 272 Italian participants responded to a questionnaire on their attitude and intention at Time 1, frequency of past behavior, and self-efficacy related to exercising at home. Then, participants were randomly assigned to four different message conditions: (a) gain messages focused on the positive outcomes associated with doing physical activity at home; (b) non-loss messages focused on the avoided negative outcomes associated with doing physical activity at home; (d) loss messages focused on the negative outcomes associated with not doing physical activity at home; (c) non-gain messages focused on the missed positive outcomes associated with not doing physical activity at home. After reading the messages, participants answered a series of questions regarding their perception of threat and fear, their evaluation of the messages, and their attitude and intention toward exercising at home at Time 2. Using multigroup structural equation modeling, we compared message conditions, and tested whether the effects of the messages on attitude and intention at Time 2 were mediated by message-induced threat, message-induced fear, and message evaluation. Results showed that the perception of the messages as not threatening was the key point to activate a positive evaluation of the recommendation. The highest persuasive effect was observed in the case of the non-loss frame, which did not threaten the receivers, triggered a moderated fear and, in turn, activated a positive evaluation of the recommendation, as well as higher attitude and intention to do home-based physical activity at Time 2. Overall, these results advance our comprehension of the effects of message framing on receivers' attitudes and intentions toward home-based physical activity.

Keywords: message frame, home-based physical activity, COVID-19, lockdown, exercising at home, psychosocial

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INTRODUCTION

The Coronavirus (Covid-19) appeared in December 2019 in China (Wuhan) and the infection rapidly spread throughout the world. Three months later, Covid-19 became a worldwide pandemic with more than 1,728,878 cases confirmed on December 07th, 2020 and 60,078 deaths in Italy (Coronavirus Statistiques, 2020). At the beginning of the pandemic, Italy was one of the most seriously affected countries and, on March 08th, 2020, the Italian Government implemented extraordinary measures to limit viral transmission, including social and physical distancing measures, lockdown of industry, school, and overall social life. Although these measures have proven to be the best option to reduce the rapid spread of infections, this has produced collateral effects on other dimensions, determining a radical change in the lifestyle of the Italian population (Cancello et al., 2020; Cavallo et al., 2020; Odone et al., 2020).

Requiring a large-scale behavior change, the COVID-19 pandemic has raised the importance to apply the insights from psycho-social and behavioral sciences to promote people's adherence to the recommendations of epidemiologists and public health experts. In particular, this event has highlighted the relevance of the use of persuasive communication to educate people around preventive health behaviors. Evidence for the effectiveness of persuasive messages to promote health behaviors has been built over the last decades (e.g., Gallagher and Updegraff, 2012), but it has also received confirmation during the COVID-19 pandemic. Many scholars have shown that persuasive messages can facilitate policy-makers to promote prevention behaviors during a global public health crisis, and have confirmed the importance of finding efficient messages, as an easy and potentially scalable public intervention (e.g., Bilancini et al., 2020; Capraro and Barcelo, 2020; Heffner et al., 2020; Jordan et al., 2020; Lunn et al., 2020; Søraa et al., 2020). However, there do not seem to be any studies specifying how to formulate persuasive messages to promote home-based physical activity during the lockdown, even if one of the major changes regarded a reduction in the level of physical activity and sport, due to the closure of gyms, stadiums, pools, dance and fitness studios, physiotherapy centers, parks, and playgrounds (Serafini et al., 2020).

During the COVID-19 pandemic, many health communication practitioners designed persuasive messages to reduce the negative effects of the imposed restrictions on physical and mental health, such as the unhealthy consequences of sedentary behavior. For this reason, the evaluation of how persuasive messages impact on people' behavior appears as more necessary than ever. Even if health communication campaigns are often effective at changing individuals' behaviors (Anker et al., 2016), in some cases they can also have a "boomerang effect" that results in receivers adopting behaviors opposite to the health recommendation (Byrne and Hart, 2009). This counterproductive effect may be generated when receivers perceive health messages as too fearful or threatening.

To overcome this possible counterproductive effect of health communication, in the present study we aimed at clarifying the role of threat and fear induced by messages promoting home-based physical activity during the COVID-19 outbreak. We specifically tested whether differently framed messages can differently involve receivers both cognitively and emotionally, thus influencing their attitude and intention toward home-based physical activity. Generally, health guidelines recommend that all adults should engage in at least 150–300 min a week of moderate-intensity exercise (Piercy et al., 2018) and this recommendation was even more valid during the quarantine for at least two reasons. First, regular exercise may reduce the risk of acute respiratory distress syndrome, a major cause of death in patients COVID-19 (University of Virginia Health System, 2020). Second, regular exercise is associated with emotional resilience to stress (Childs and de Wit, 2014), one of the positive psychological responses observed during times of pandemics (Taylor et al., 2020). However, physical activity guidelines alone are unlikely to increase physical activity levels of the population (Milton et al., 2020). Appropriate and effective communication is key to maximizing the impact of such guidelines. In the present study, we tested whether differently framed messages can differently involve receivers both cognitively and emotionally, influencing their attitude and intention toward indoor home-based physical activity.

Message Framing

Under given conditions, persuasive messages stimulate attitude change, and consequent change in intention and behavior regarding physical activity (e.g., Ajzen, 1991; Eagly and Chaiken, 1993; Petty and Cacioppo, 2012; Petty and Briñol, 2015). Research has shown that the persuasive effect depends, at least in part, on how message recommendations are framed (Davis, 1995; Chong and Druckman, 2007; Spence and Pidgeon, 2010). For example, recommendation messages can differ as to their valence frame, that is, their stress on either the positive or the negative consequences of a given behavior (e.g., Rothman et al., 2006). While a positively framed message presents the positive outcomes associated with the implementation of the recommended behavior, a negatively framed message presents the negative outcomes associated with not performing the recommended behavior.

Existing evidence suggests that positively framed messages regarding various outcomes of physical activity are more effective than negatively framed messages (e.g., Jones et al., 2003; Kozak et al., 2013; for a review: Williamson et al., 2020). For example, found that gain-framed messages were more effective in increasing participants' action planning regarding physical activity. Similarly, van't Riet et al. (2010) showed that gain-framed messages were more persuasive than loss-framed messages in advocating physical activity.

Messages can be framed not only as regards their gain or loss valence, but also as regards a further level of framing, namely, the *outcome sensitivities level* of message framing (Cesario et al., 2013). According to this framing level, gain-framed messages can be further diversified in messages focused on actual *gain*, when they describe the presence of positive outcomes (e.g., ≪If you eat well, you will improve your health≫), and messages focused on *non-loss*, when they focus on the absence of negative outcomes (e.g., ≪If you eat well, you will avoid damaging your health≫). Likewise, loss-framed messages can be further diversified in messages focused on actual *loss*, when they emphasize the presence of negative outcomes (e.g., ≪If you eat badly, you will damage your health≫) and messages focused on *non-gain*, when they focus on the absence of positive outcomes (e.g., ≪If you eat badly, you will miss the opportunity to improve your health≫).

The different effects of gain, non-loss, non-gain and loss messages have been studied in communication advocating different types of healthy behavior (e.g., Dijkstra et al., 2011; Carfora et al., 2020). For example, Carfora et al. (2021)

considered the aforementioned four types of messages to promote healthy eating and showed that they induce different message evaluations, which in turn influences attitude and intention, via a cognitive or emotional elaboration. Besides, Carfora et al. (2020) showed that gain and non-loss messages activate an integrated emotional and cognitive processing of the health recommendation, while loss and non-gain messages mainly activate emotional shortcuts toward attitude and intention. Finally, the differential influence of these four message frames on attitude and intention has been shown to vary according to some baseline psychosocial features, such as self-efficacy (e.g., Di Massimo et al., 2019; Carfora et al., 2020).

To the best of our knowledge, so far research on the promotion of physical activity has ignored the distinction among gain, non-loss, non-gain, and loss message framing. For example, Strachan et al. (2020) compared the effects of gain- and loss-framed messages to promote physical activity, including non-loss outcomes in the gain-framed messages (e.g., reduced risk of diseases, less anxiety) and non-gain outcomes in the loss-framed messages (e.g., decreased attractiveness through reduced muscle tone). To move further in the comprehension of the factors that may underly the different effectiveness of the four types of messages, in the present study we submitted these messages to different groups of participants and explored the reactions receivers have when they are exposed to these messages. We aimed to assess the cognitive and emotional mechanisms underlying message influence on attitude and intention toward increased home-based physical activity, as well as possible differences in the role played by these mechanisms according to the message type. Below, the cognitive and emotional mechanisms investigated in the study are discussed in detail.

Message-Induced Threat

The basic premise of persuasion models is that attitude and intention changes depend upon the likelihood that a persuasive issue or argument will be positively evaluated by the receiver (Petty and Cacioppo, 1986; Eagly and Chaiken, 1993). Message evaluation has a direct effect on receivers' attitude and intention toward the behavior recommended in the message (e.g., Cauberghe et al., 2009; Fernando et al., 2016), and this effect has been demonstrated also when the recommended behavior regards physical activity (Jones et al., 2003). In the present study, we moved from the assumption that the effect of message framing on attitude and intention would at least partially depend on how differently framed messages would be evaluated.

One of the aspects influencing the evaluation of a health recommendation message is the extent to which receivers perceive the message as threatening. According to psychological reactance theory, when individuals feel that someone or something is pressuring them to accept a certain view or attitude that limit their freedom, they activate psychological reactance to restore the lost freedom (Brehm and Brehm, 1981). Since recommendation messages in health communication aim to shape, reinforce, or change attitudes and behaviors, this attempt can be therefore perceived as a threat to freedom (Shen, 2015). As regards physical activity, receivers may perceive a message recommending it as threatening. Thus, they may not process it accurately and instead respond defensively (Liberman and Chaiken, 1992), for example downplaying its recommendation (Falk et al., 2015; Howe and Krosnick, 2017). According to self-affirmation theory (Steele, 1988; Sherman and Cohen, 2006), people may react defensively to threatening messages because they seek to maintain self-integrity, i.e., a perception of being capable of controlling important outcomes. When self-integrity is threatened, people seek to protect or restore it, often rejecting or denigrating threatening information (Cohen and Sherman, 2014). Thus, exposure to physical activity messages may threaten the self-integrity of individuals (McQueen and Klein, 2006; Jessop et al., 2014). In this threatened state, the ability to process a message recommending increased physical activity may be compromised because people, in order to maintain self-integrity, may question or reject the validity of the recommendation, or direct attention away from it (Sherman, 2013; Strachan et al., 2020). However, so far, no research has analyzed how perceived threat after exposure to differently framed messages recommending physical activity may negatively influence receivers' attitudes and intentions.

Message-Induced Fear

Receivers' processing and evaluation of health recommendation messages is also influenced by affective responses triggered by messages themselves (e.g., Gross and D'ambrosio, 2004; Dillard and Nabi, 2006; Peters et al., 2006; Kühne et al., 2015). This is also the case when the recommendation message regards physical activity (Michalovic et al., 2018), and fear is one of the emotions that is more likely to influence the evaluation and the effect of a health recommendation message. There is overwhelming evidence of a positive fear–persuasion relationship (e.g., King and Reid, 1990; LaTour and Rotfeld, 1997; Dillard and Anderson, 2004). Messages evoking fear lead people to rely on systematic processing, which in turn stimulates many issue-relevant thoughts, and thus a positive message evaluation (e.g., Meijnders et al., 2001; Slater et al., 2002; Meyers-Levy and Maheswaran, 2004). Consistently, a long history of research has led to the general conclusion that messages inducing fear are more effective than those that do not (for a meta-analysis, see De Hoog et al., 2007), and the investigated effects include attitude and intention change toward a variety of health-related behaviors (for a meta-analysis, see Tannenbaum et al., 2015). Once said that, some research has also shown that messages inducing fear can be counterproductive. Fear can induce people to enact defensive strategies to reduce the potential emotional distress associated with the message. These strategies can include directing attention away from the message, reinterpreting or disregarding it (Witte, 1992; Ruiter et al., 2001). In the case of differently framed messages recommending increased physical activity, the different frames are likely to trigger different levels of fear in the receivers. However, we lack empirical evidence of whether and how far this is the case, as well as of related effects on attitude and intention.

Starting from the above, in the present study we examined whether and how far physical activity recommendations framed as gain, non-loss, non-gain, or loss (i.e., varying according to the outcome sensitivities level of message framing) would be perceived as threatening or induce fear. We also examined whether perceived threat or fear would have an impact on message evaluation toward home-based physical activity. Self-efficacy, frequency of past behavior and habit to exercise regularly have found to be some of the main predictors of physical activity, in general and also during the lockdown due to the COVID-19 pandemic (Carriedo et al., 2020; Rhodes et al., 2020), in addition to attitude and intention (Kaushal and Srivastava, 2020). Consistently, in the present research we tested the effects of differently framed messages not only on message evaluation, but also on attitude and intention toward home-based physical activity. Finally, we controlled for the independent effects of self-efficacy and frequency of past behavior regarding physical activity before the pandemic.

The Present Study

Based on the above literature on the influence of perceived threat and fear on the evaluation of recommendation messages, in the present study we proposed and tested a theoretical model to understand receivers' reactions to gain, non-loss, non-gain and loss messages focused on home-based physical activity. We first measured attitude and intention We examined whether perceived *threat* or *fear* would have an impact on message evaluation, and thus would influence attitude and intention toward home-based physical activity at Time 2 differently, in the case of a recommendation framed as *gain, non-loss, non-gain or loss*.

Given that literature on threat and fear triggered by the four different message frames is scarce, we did not make specific hypotheses about the various relationships among the study variables, but only a series of research questions.

Research Question 1, RQ1: To what extent does message-induced *threat* influence message evaluation, attitude and intention regarding home-based activity at Time 2 in the four different message conditions?

Research Question 2, RQ2: To what extent does message-induced *fear* influence message evaluation, attitude and intention regarding home-based activity at Time 2 in the four different message conditions?

Research Question 3, RQ3: How far *attitude and intention at Time 1, frequency of past behavior and self-efficacy* influence message evaluation, attitude and intention at Time 2 regarding home-based activity in the four different message conditions?

METHOD

Procedure and Participants

In April 2020, a sample of Italian citizens was invited to participate in a university study on public communication. Participants were recruited by students of the Department of Psychology of the Catholic University of the Sacred Heart (Italy), and received an email with a link to an online survey developed through the Qualtrics platform. Through the online survey, participants:

- completed the first part of a questionnaire measuring the psychological antecedents of home-based physical activity (Time 1);
- were then automatically and randomly assigned to four different conditions (gain, non-loss, non-gain, and loss messages) and were invited to read an infographic reporting a series of messages on the physical and psychological consequences of exercising at home;
- after reading the messages, were required to fill in the second part of the questionnaire (Time 2).

The initial sample was made of $N = 280$ participants. Participants who did not fully or accurately complete the questionnaire were then excluded ($N = 8$). So, the final sample consisted of 272 participants (126 males, 142 females, 4 other; mean age = 42.97, $SD = 14.98$, age range = 18–70), distributed in the four message conditions as follows: gain message condition $N = 70$; non-loss message condition $N = 67$; non-gain message condition $N = 67$; loss message condition $N = 68$.

Pre-test Measures

At the beginning of the questionnaire, participants provided their informed consent and read the following statement: "We are interested in understanding what drives people to do physical exercises at home in the absence of alternatives (i.e., in the impossibility of accessing parks, gyms and open spaces). By physical activity at home we mean, for example: bodyweight workout, such as stretching, aerobics, push-ups, and abs; walking for at least 30 min (6,000 steps per day); training with weights and machines, such as stationary bikes and treadmills." After that, participants responded to a series of questions aimed at measuring their frequency of past behavior, attitude and intention toward home-based physical activity, and self-efficacy.

Frequency of past behavior related to physical activity was measured with 2 items regarding how often participants engaged in physical activity away from home and at home before the lockdown restrictions: "Before this period of restrictions, on average how many times a week did you engage in moderate or intense physical activity outdoor - e.g., fast walking, climbing stairs, cycling, swimming, going to the gym, going for a run etc.?"; "Before this period of restrictions, on average how many times a week did you exercise at home?." Answers were given on a seven-point Likert scale, from never (1) to every day (7). Higher scores indicated a higher frequency of physical activity before the lockdown restrictions.

Intention at Time 1 toward doing home-based physical activity was assessed with 3 items on a seven-point Likert scale [completely disagree (1) – completely agree (7)] (e.g., "I intend to do physical exercises at home regularly in the next month"; Clark and Bassett, 2014). Higher scores indicated a greater intention to exercise at home at Time 1.

Attitude at Time 1 toward home-based physical activity was measured using 5 items on a semantic differential scale ranging from "1" to "7" (e.g., "I believe that doing physical exercises at home regularly is… useless – useful"; Caso et al., 2020). Higher values indicated a more positive attitude toward exercising at home at Time 1.

Self-efficacy related to regular physical activity was measured using 6 items on a seven-point Likert scale [completely disagree (1) – completely agree(7)] (e.g., "If I wanted, I would be able to do the physical activity regularly when I am feeling tired"; Bandura, 1977). Higher values indicated a more positive self-efficacy toward exercising at home.

Message Intervention

After completing the first questionnaire, all participants were invited to read one infographic including 6 messages (∼14 words each) describing the physical, mental and social consequences of doing physical activity at home, and formulated in prefactual terms (i.e., "If only…"; see Carfora et al., 2019; Bertolotti et al., 2020). Participants read different messages according to the experimental condition to which they had been randomly assigned. Participants in the *gain message condition* read messages on the positive outcomes associated with doing home-based physical activity (e.g., "If you do physical activity at home, you will improve your fitness."). Participants in the *non-loss message condition* read messages informing about how doing home-based physical activity relates to preventing negative outcomes (e.g., "If you do physical activity at home, you will avoid worsening your fitness."). Participants in the *non-gain message condition* read messages emphasizing how doing home-based physical activity is related to missing out positive consequences (e.g., "If you do not do physical activity at home, you will lose the chance to improve your fitness."). Finally, participants in the *loss message condition* read messages on the negative outcomes of not doing home-based physical activity (e.g., "If you do not do physical activity at home, you will worsen your fitness."). The full list of messages is reported in Appendix 1 in **Supplementary Material**.

Post-test Measures

After reading the messages, participants completed the second part of the questionnaire, which measured the dimensions described below.

Message-induced fear was measured with five items pertaining to the degree to which reading messages had made participants feel fearful (e.g., "To what extent reading these messages made you feel scared?"; adapted from Brown and Smith, 2007). Answers were given on a 7-point Likert scale, from (1) "not at all" to (7) "completely." Higher values indicated higher fear after reading the messages.

Message-induced threat was measured with four items related to how much reading messages had made participants feel their freedom threatened (e.g., "The messages have tried to pressure me"; adapted from Shen, 2015). Answers were given on a 7-point Likert scale, from (1) "strongly disagree" to (7) "strongly agree." Higher values indicated higher perceived threat.

Message evaluation was measured with three items asking participants to state how involved they had been in the messages (e.g., "Messages were very interesting"; adapted from Godinho et al., 2016). Answers were given on a 7-point Likert scale, from (1) "strongly disagree" to (7) strongly agree." Higher values indicated a more positive evaluation of the messages.

Finally, we again measured receivers' attitude and intention toward home-based physical activity at Time 2 after message exposure, using the same scale and items used at Time 1.

At the end of the second part of the questionnaire, participants reported their age and gender.

Data Analysis

As a first step of our analysis, we assessed the variance inflation factor (VIF) to compute multicollinearity. The VIF results, which are below threshold value of 5.0, indicate that collinearity issues among the study variables is absent (Hair et al., 2016).

Then, we used confirmatory factor analysis to verify the measurement model. To verify the internal consistency among the measurement items for each variable, we used composite reliability. We also tested convergent and discriminant validities among our variables.

The adequacy of fit of the measurement and structural models were estimated using a chi-square test and recommended incremental goodness-of-fit indices: the root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker-Lewis Index (TLI). A nonsignificant chi-square test indicates that the model fits the data well (Iacobucci, 2010). RMSEA value of 0.05 or less indicates a good fit and values up to 0.10 represent errors that approximate those expected in the population (Iacobucci, 2010). Finally, CFI and TLI cut-off values of at least 0.90 are generally considered to represent an acceptable fit (Iacobucci, 2010).

After confirming the adequacy of fit of our structural model, we used it as a base model to test the invariance of the relationship between study variables across groups. We first applied a *multi-group Structural Equation Modeling (SEM)* to observe the relationships among study variables in each group. We then constrained the main significant paths of each group to be equal in the other groups, while we left the other path coefficients free to vary across groups. By disconfirming the equality (or invariance) of the main significant paths, we would be able to establish that the diverse messages read by participants moderated the relationship among the psychological antecedents of home-based physical activity, the reactions to the messages, and attitude and intention regarding home-based physical activity at Time 2. We evaluated the null hypothesis of the equalities of such paths across message groups through a Wald test.

RESULTS

Preliminary Analyses

Table 1 shows means, standard deviations, composite reliability and average variance extracted (AVE) of each study variable, plus standard loadings of each item employed to measure the variable. **Table 2** reports the estimates relevant to convergent and discriminant validity.

The VIF results for each dependent variable were below threshold value of 5.0 (message-induced threat = 1.00; message-induced fear = 1.03; message evaluation = 1.30; attitude at Time 2 = 2.80; intention at Time 2 = 4.13). This result indicated that collinearity issues among the study variables were absent from this study.

Confirmatory factor analysis showed that the measurement model fit the data satisfactorily ($\chi^2_{(2)} = 3.58$, $p = 0.17$; RMSEA = 0.05, CFI = 0.99, TLI = 0.97, SRMR = 0.02). Results revealed that all the composite reliability values were greater than the minimum threshold of 0.60 (Bagozzi and Yi, 1988), ranging from 0.76–0.98. Thus, the reliability of the measurement

TABLE 1 | Results of the confirmatory factor analysis.

Construct	Mean	Standard deviation	Items	Standard loadings	Composite reliability	AVE
Frequency of Past Behavior (PB)	3.51	1.43	PB1	0.68	0.76	0.61
			PB2	0.35		
Intention at Time 1 (INT_T1)	5.15	1.75	INT_T1_1	0.94	0.98	0.94
			INT_ T1_2	0.98		
			INT_ T1_3	0.95		
Attitude at Time 1 (ATT_T1)	5.58	1.63	ATT_T1_1	0.71	0.96	0.82
			ATT_T2_2	0.92		
			ATT_T2_3	0.91		
			ATT_T2_4	0.90		
			ATT_T2_5	0.90		
Self-Efficacy (SE)	3.97	1.57	EFF1	0.70	0.93	0.72
			EFF2	0.83		
			EFF3	0.82		
			EFF4	0.82		
			EFF5	0.86		
Message-Induced Fear (MIF)	1.21	0.43	MIF1	0.71	0.91	0.68
			MIF2	0.75		
			MIF3	0.88		
			MIF4	0.87		
			MIF5	0.70		
Message-Induced Threat (MIT)	2.50	1.28	MIT1	0.71	0.92	0.75
			MIT2	0.86		
			MIT3	0.90		
			MIT4	0.82		
Message Evaluation (ME)	4.92	1.17	ME1	0.92	0.97	0.78
			ME2	0.78		
			ME3	0.75		
Attitude at Time 2 (ATT_T2)	5.79	1.52	ATT_T2_1	0.68	0.95	0.79
			ATT_T2_2	0.94		
			ATT_T2_3	0.91		
			ATT_T2_4	0.93		
			ATT_T2_5	0.85		
Intention at Time 2 (INT_T2)	5.17	1.70	INT_T2_1	0.96	0.97	0.96
			INT_T2_2	0.98		
			INT_T2_3	0.95		

TABLE 2 | Convergent and discriminant validity.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Frequency of past behavior	**0.67**	0.30*	0.06	0.31*	0.17*	−0.05	−0.02	0.14*	0.29*
2. Intention at Time 1		**0.94**	0.38*	0.50*	−0.00	−0.06	0.26*	0.39*	0.84*
3. Attitude at Time 1			**0.82**	0.29*	−0.14*	−0.01	0.18*	0.76*	0.35*
4. Self-efficacy				**0.72**	−0.10	−0.04	0.25*	0.37*	0.52*
5. Message-induced fear					**0.68**	0.21*	0.07	−0.08	0.02
6. Message-induced threat						**0.75**	−0.31*	−0.11	−0.10*
7. Message evaluation							**0.78**	0.34*	0.37*
8. Attitude at Time 2								**0.79**	0.48*
9. Intention at Time 2									**0.96**

The values in the diagonal row (bold) are the average variance extracted by each latent construct. The numbers above diagonal are the correlation coefficients between the constructs.
**p <0.001.*

model was confirmed. The standardized item loadings of all observed variables on their corresponding latent constructs varied from 0.68–0.98 (**Table 1**), except for one of the two items measuring frequency of past behavior. Thus, standardized item loadings were mainly significant. The AVE from latent constructs ranged from 0.61 to 0.96. Therefore, all AVE values were above the recommended threshold of.50 (Anderson and Gerbing, 1988). These findings showed that all measurement items presented a high convergent validity. Discriminant validity was also confirmed, because all AVEs were higher than squared correlations between latent constructs (Fornell and Larcker, 1981). Finally, we confirmed the adequacy of fit of our structural model ($\chi^2_{(524)} = 1018.51$, $p = 0.001$; RMSEA = 0.03, CFI = 0.94, TLI = 0.94, SRMR = 0.05).

Main Analyses

Multi-Group SEM Model

In the main analyses, we used the tested model to disconfirm the null hypothesis of the invariance of the relationships among the study variables across groups. We did so by computing a multi-group SEM model with the message groups. The goodness-of-fit statistics for the model were acceptable. The chi-square test was not significant ($\chi^2 = 13.78$, $df = 8$, $p = 0.09$) and also the other indices pointed to an acceptable fit (*RMSEA* = 0.10; *CFI* = 0.99; *TLI* = 0.90; χ^2 gain message group = 3.34; χ^2 loss message group = 7.20; χ^2 non-gain message group = 0.01; χ^2 non-loss message group = 3.22), indicating that dataset had overall a good model fit.

We then analyzed the parameter estimates of the model in the four message conditions (gain, non-loss, non-gain, loss). All parameter estimates are reported in Appendix 3 in **Supplementary Material**. Below, we will consider the predictors of all dependent variables related to our three main research questions, namely, how message-induced threat predicted message evaluation, attitude and intention (RQ1), how message-induced fear predicted message evaluation, attitude and intention at Time 2 (RQ2), and how the psychological antecedents of home-based activity influenced message evaluation, attitude and intention at Time 2 (RQ3).

As showed in **Figure 1**, when participants were exposed to *gain messages* the perception that the messages were not threatening increased the positive evaluation of the messages ($\beta = -0.25$; $p = 0.04$), as well as the intention to do home-based physical activity at Time 2 ($\beta = -0.17$; $p = 0.05$). Message-induced fear did not predict message evaluation, attitude at Time 2, or intention at Time 2, but a high level of self-efficacy reduced the perception of the gain messages as being fearful ($\beta = -0.24$; $p = 0.05$). Positive attitude at Time 1 had a direct effect on positive attitude at Time 2 ($\beta = 0.88$; $p = 0.001$), and in turn attitude at Time 2 determined a higher intention to exercise at home at Time 2 ($\beta = 0.25$; $p = 0.05$). Actually, the effect of attitude at Time 1 on intention at Time 2 was fully mediated by attitude at Time 2 (*Ind. = 0.22*; $p = 0.05$). When participants had higher intention to do physical activity before message exposure they also gave a more positive evaluation of the gain messages ($\beta = -0.22$; $p = 0.05$) and had higher intention at Time 2 ($\beta = 0.81$ $p = 0.05$). To sum up, these results showed that gain messages had an impact on intention at Time 2 mainly because this message frame was not perceived as threatening. Moreover, there was an increase in intention at Time 2 especially when participants had a positive attitude toward home-based physical activity both at Time 1 and Time 2.

In the case of participants exposed to *non-loss messages* (**Figure 2**), the perception of the messages as not threatening predicted a positive message evaluation ($\beta = -0.32$; $p = 0.001$), which in turn influenced attitude at Time 2 ($\beta = 0.43$; $p = 0.001$) and then intention at Time 2 ($\beta = 0.30$; $p = 0.001$). Positive message evaluation also had a direct effect on intention at Time 2 ($\beta = 0.30$; $p = 0.001$). Consistently, mediation analyses confirmed that the negative impact of threat on intention at Time 2 was fully mediated by the participants' positive evaluation of the messages (*Ind.* = −0.11; $p = 0.01$) and by the effect of this positive evaluation on attitude at Time 2 (*Ind.* = −0.05; $p = 0.03$). Moreover, in this group message-induced fear increased a positive message evaluation ($\beta = 0.20$; $p = 0.05$), which in turn marginally increased attitude at Time 2 and then intention at Time 2 (*Ind.* = −0.06; $p = 0.10$). As to the other antecedents of physical activity, a higher level of self-efficacy predicted both a more positive message evaluation ($\beta = 0.31$; $p = 0.001$) and a higher attitude at Time 2 ($\beta = 0.17$; $p = 0.05$). Moreover, mediation results showed that receivers' with higher self-efficacy had higher intention to exercise at home at Time 2 thanks to the effect of a more positive message evaluation (*Ind. = 0.13*; $p = 0.01$) on their attitude at Time 2 (*Ind. = 0.06*; $p = 0.02$). Attitude at Time 1 had a direct effect on participants' attitude at Time 2 ($\beta = 0.52$; $p = 0.001$) and an indirect effect on intention at Time 2 that was fully mediated by attitude at Time 2 (*Ind. = 0.16*; $p = 0.05$). In addition, intention at Time 1 ($\beta = 0.43$; $p = 0.001$) and frequency of past behavior ($\beta = 0.14$; $p = 0.03$) determined receivers' intention to do home-based physical activity at Time 2. To sum up, these results showed that non-loss messages were effective in increasing intention at Time 2 when the messages were perceived as not threatening, but triggered some fear, especially when participants had a high self-efficacy.

In the case of participants exposed to *non-gain messages* (**Figure 3**), a higher perception that the messages were not threatening determined a more positive message evaluation ($\beta = -0.54$; $p = 0.001$), and mediation analyses showed that there was also an indirect effect of message-induced threat on attitude at Time 2 through message evaluation (*Ind.* = −0.09; $p = 0.03$). As in the case of non-loss messages, also in the case of non-gain messages a higher perception that the messages were fearful increased the positive evaluation of the messages ($\beta = 0.25$; $p = 0.001$) and the impact of message-induced fear on attitude at Time 2 was mediated by message evaluation (*Ind. = 0.09*; $p = 0.05$). A more positive evaluation of the messages increased attitude at Time 2 ($\beta = 0.16$; $p = 0.02$), which in turn marginally influenced intention at Time 2 ($\beta = 0.21$; $p = 0.10$). As to the influence of baseline variables, a higher attitude at Time 1 influenced their attitude at Time 2 ($\beta = 0.80$; $p = 0.001$), strongly decreased perceived message-induced threat ($\beta = -0.34$; $p = 0.001$), and increased a positive message evaluation ($\beta = 0.20$; $p = 0.03$). This chain was also marginally confirmed by a mediation

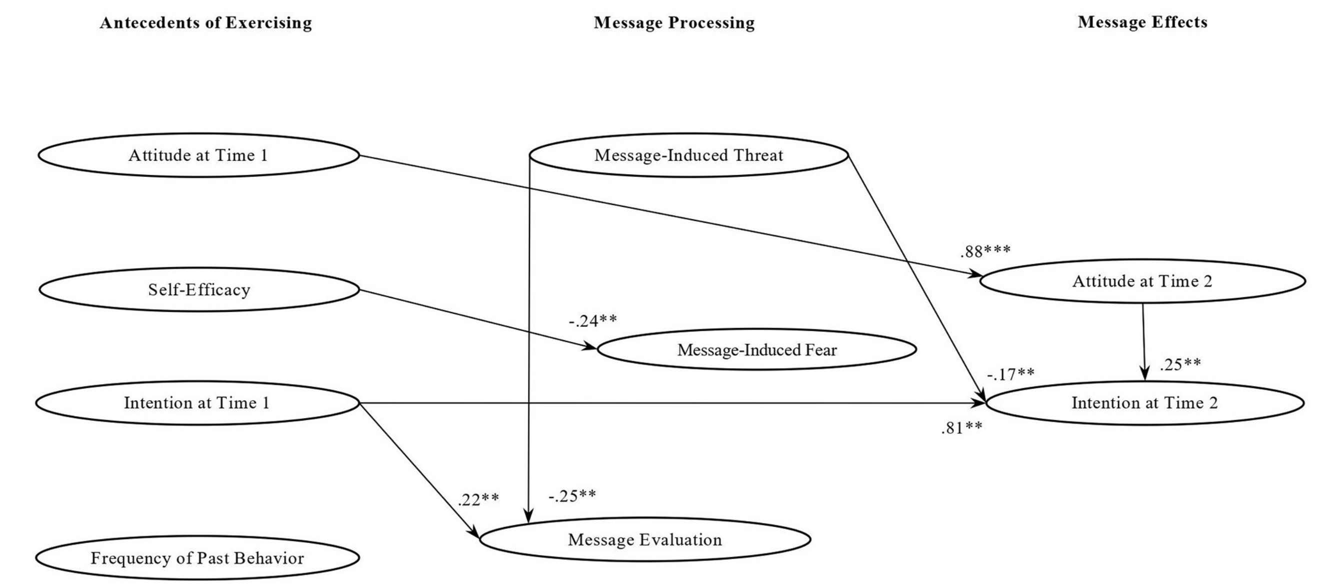

FIGURE 1 | Standardized factor loadings of the relationships among study variables in the gain message group. **$p < 0.05$; ***$p < 0.001$.

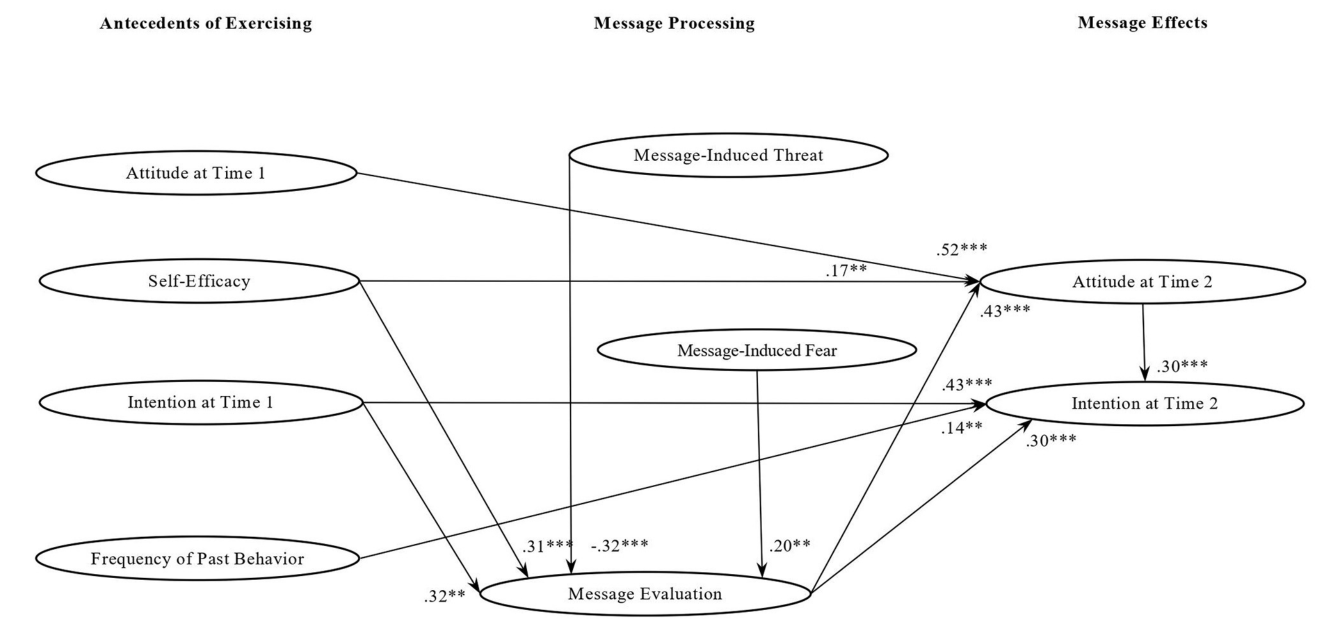

FIGURE 2 | Standardized factor loadings of the relationships among study variables in the non-loss message group. **$p < 0.05$; ***$p < 0.001$.

analysis (*Ind.* = 0.03; p = 0.10). In turn, a higher level of intention at Time 1 influenced intention at Time 2 ($\beta = 0.83$; $p = 0.001$), but it also increased message-induced fear ($\beta = 0.32$; $p = 0.001$). However, the indirect impact of intention at Time 1 on attitude at Time 2 through message-induced fear was only marginally confirmed ($\beta = 0.04$; $p = 0.08$). To sum up, these findings indicated that in the case of non-gain messages the impact of message processing on attitude and intention at Time 2 was rather limited. Intention at Time 2 was only marginally predicted by attitude at Time 2, which in turn was only marginally influenced by message evaluation.

Finally, in the case of participants exposed to *loss messages* (**Figure 4**), message-induced threat had a marginal effect both on message evaluation ($\beta = -0.22$; $p = 0.07$) and intention at Time 2 ($\beta = -0.11$; $p = 0.08$). As to message-induced fear, it stimulated a positive message evaluation ($\beta = 0.25$; $p = 0.04$). A more positive evaluation of the messages increased attitude at Time 2 ($\beta = 0.16$; $p = 0.05$), which in turn influenced intention to do physical

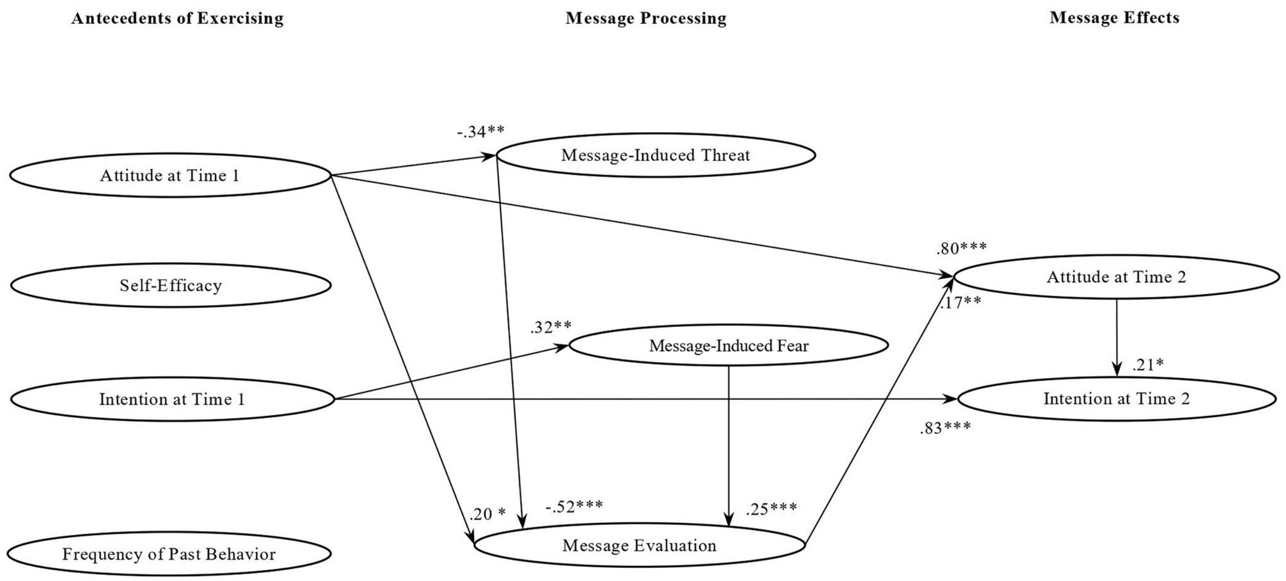

FIGURE 3 | Standardized factor loadings of the relationships among study variables in the non-gain message group. *$p < 0.10$; **$p < 0.05$; ***$p < 0.001$.

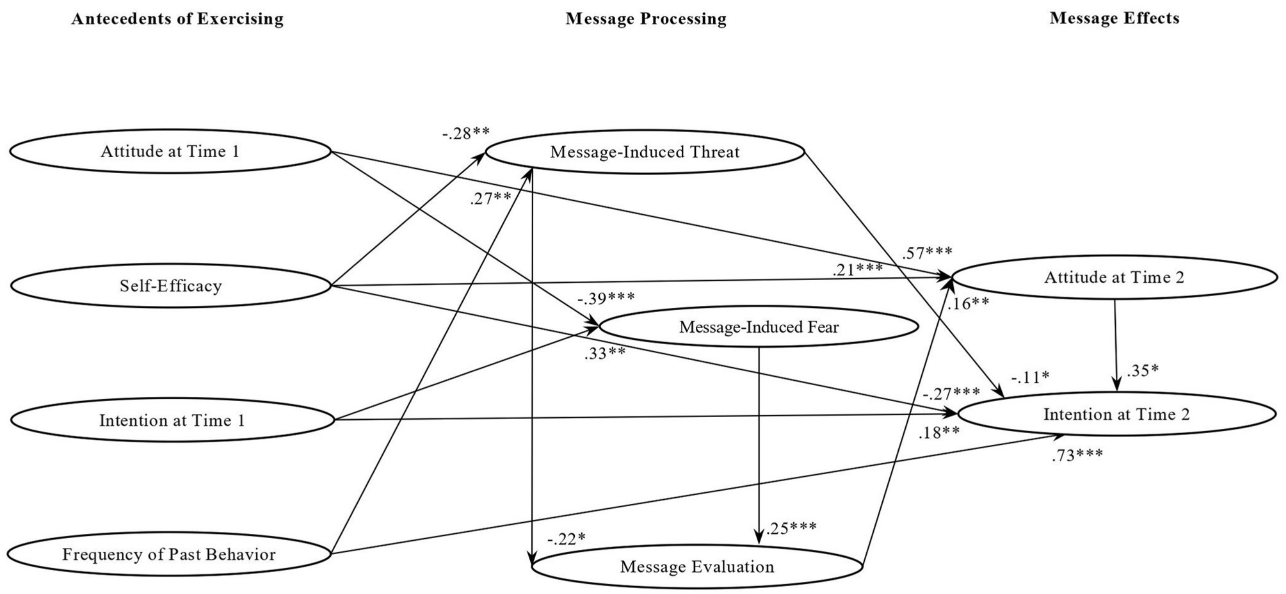

FIGURE 4 | Standardized factor loadings of the relationships among study variables in the loss message group. *$p < 0.10$; **$p < 0.05$; ***$p < 0.001$.

activity at home at Time 2 ($\beta = 0.35$; $p = 0.001$). In this message group, positive attitude at Time 1 ($\beta = 0.57$; $p = 0.001$) increased attitude at Time 2 and had an indirect effect on intention at Time 2 through attitude at Time 2 (*Ind. = 0.20*; $p = 0.001$). However, loss messages were counterproductive for people with a high level of positive attitude at Time 1, who did not perceive the messages as fearful ($\beta = -0.39$; $p = 0.001$) and showed a lower intention at Time 2 after reading these messages ($\beta = -0.27$; $p = 0.001$). A higher intention at Time 1 predicted both a higher intention at Time 2 ($\beta = 0.73$; $p = 0.001$) and a higher message-induced fear ($\beta = 0.33$; $p = 0.001$). Instead, participants with high self-efficacy perceived the loss messages as less threatening ($\beta = -0.28$; $p = 0.05$) and had a more positive attitude at Time 2($\beta = 0.21$; $p = 0.04$) and intention ($\beta = 0.18$; $p = 0.02$) toward home-based physical activity. Self-efficacy had also a positive indirect effect on intention at Time 2 via attitude at Time 2 (*Ind. = 0.07*; $p = 0.05$). Regarding the role of the frequency of past behavior, people with high frequency of past behavior perceived messages as more threatening ($\beta = 0.27$; $p = 0.03$). However, there was not a significant mediation effect from frequency of past behavior to intention at Time 2. To sum up, the perception and the consequences of loss messages were differently affected by the baseline antecedents of physical activity. If a high level of self-efficacy increased their persuasiveness, a high level of attitude at Time 1 and frequency of past behavior decreased it.

Determination of Invariant Paths in the Multigroup SEM Model

To disconfirm the null hypothesis of the invariance of the main significant paths among study variables across groups, we then used the Wald test. **Table 3** reports all the Wald tests for each comparison.

Compared to the other message conditions, only in the gain message condition perceiving the messages as not threatening directly increased intention at Time 2 to do home-based physical activity (**Table 3**, a). Instead, in the non-loss message condition receivers perceiving the messages as not threatening evaluated them more positively, as increased their attitude and intention at Time 2 more as compared to receivers in the other message conditions (**Table 3**, b). Moreover, only in the case of the non-loss messages, when receivers perceived themselves as being able to exercise regularly (self-efficacy), they evaluated the messages positively and thus increased intention at Time 2 (**Table 3**, c). Finally, the self-efficacy-attitude at Time 2-intention at Time 2 chain (**Table 3**, e), and the self-efficacy-message evaluation-attitude at Time 2-intention at Time 2 chain (**Table 3**, f) were invariant across all message groups.

The pattern from message-induced fear to message evaluation was invariant across groups (**Table 3**, g). In addition, Wald tests showed that when receivers perceived the non-gain messages as not threatening, they had more positive evaluation and then more attitude at Time 2, compared to receivers in the gain message (**Table 3**, h). Wald tests also showed that these higher effect of non-gain message as compared to gain message on attitude at Time 2, via a lower message-induced threat, was even more accentuated when receivers had a high attitude at Time 1 (**Table 3**, i). Finally, both in the non-loss and non-gain message groups, an effect of message-induced fear on intention at Time 2 through message evaluation and attitude at Time 2 emerged. Wald tests showed that this mediation path was stronger in the non-gain message group than in the non-loss message group (**Table 3**, d). This result confirmed a high impact of the perception of fear on receivers' message elaboration when exposed to the gain messages.

DISCUSSION

First of all, our findings confirmed that message-induced threat and fear have an important role in determining the effects of recommendation messages in the context of the promotion of home-based physical activity. Results showed that the persuasiveness of the *gain-framed messages* is based on their being perceived as *not* threatening, so that this perception increases intention to do home-based physical activity at Time 2. This suggests that the major strength of gain-framed messages is their positive valence, which does not stimulate a sense of threat in receivers. In the elaboration of gain-framed messages, message-induced fear plays no significant role, and this absence may be counterproductive, given that messages evoking fear lead people to rely on systematic processing, which in turn stimulates many issue-relevant thoughts, including a positive evaluation of the message (e.g., Meijnders et al., 2001; Slater et al., 2002; Meyers-Levy and Maheswaran, 2004). In consideration of the above, gain-framed messages seem to have an immediate effect because the absence of a threat induces a greater intention to exercise. This effect, however, is not based on systematic processing and belief change (favored by message-induced fear) and is therefore likely to be short-term.

Non-loss-framed messages are also perceived as not threatening. However, in this case such perception stimulates a positive evaluation of the message which, in turn, influences attitude and intention at Time 2. Besides, unlike gain-framed messages, non-loss-framed messages stimulate a link from the perception of fear to attitude and intention at Time 2 through a positive message evaluation. This effect can be attributed to loss aversion, the most considered cause of the persuasive effect of the loss frame (O'Keefe, 2012). Loss aversion is a phenomenon related to the fact that people generally prefer to avoid losses rather than obtain gains. In the case of the non-loss frame, the effect of message-induced fear is marginal, and this suggests that this frame does not induce excessive fear, which may lead people to enact defensive strategies to reduce the potential emotional distress associated with the messages (Witte, 1992; Ruiter et al., 2001). Lack of threat and some presence of fear are likely to have contributed to the clear link among message evaluation, attitude and intention at Time 2 observed in receivers exposed to non-loss-framed messages. This strength of the non-loss frame could lie in the fact that it combines the positive aspects of both gain and loss frames. Like the gain frame, the non-loss frame produces a low perceived threat to freedom (Cho and Sands, 2011), that may reduce the psychological reactance. At the same time, proposing the avoidance of negative outcomes, the non-loss frame directs the attention to the possible negative consequences of one's behavior and triggers some fear. Relying on a negative bias, the acquisition of negative information requires greater information processing than does positive information (Rozin and Royzman, 2001). Thus, people tend to think and reason more about non-loss- than gain-framed messages. A greater elaboration may then induce a greater attitude and intention change.

As in the case of gain- and non-loss-framed messages, also in the case of *non-gain-framed messages* the absence of message-induced threat is fundamental for the positive evaluation of the message. However, the positive evaluation of non-gain-framed messages also depends on their perception as fearful, which in turn influences attitude at Time 2 via a higher message evaluation. These effects trigged by message processing do not extend to intention at Time 2, however, and the absence of a strong attitude-intention link could compromise the likelihood of an actual behavioral change. This can be because a recommendation based on missing the chance to obtain positive outcomes may be rather difficult to understand.

TABLE 3 | Results of the comparisons of the main significant paths among message groups.

	Gain vs. non-loss messages	Gain vs. non-gain messages	Gain vs. loss messages	Non-loss vs. non-gain messages	Non-loss vs. loss messages	Non-gain vs. loss messages
a. Message-Induced Threat → Intention at Time 2	$\chi^2_{(1)} = 5.08$ $p = 0.02$	$\chi^2{}_{(1)} = 6.03$ $p = 0.01$	$\chi^2_{(1)} = 10.07$ $p = 0.001$	/	/	/
b. Message-Induced Threat → Message Evaluation → Attitude at Time 2→ Intention at Time 2	$\chi^2_{(1)} = 9.11$ $p = 0.002$	/	/	/	$\chi^2_{(1)} = 4.54$ $p = 0.03$	/
c. Self-Efficacy→ Message Evaluation → Intention at Time 2	$\chi^2_{(1)} = 5.09$ $p = 0.02$	/	/	$\chi^2_{(1)} = 6.15$ $p = 0.01$	$\chi^2_{(1)} = 6.89$ $p = 0.01$	/
d. Message-Induced Fear → Message Evaluation → Attitude at Time 2 → Intention at Time 2	$\chi^2_{(1)} = 2.79$ $p = 0.09$	/	/	$\chi^2_{(1)} = 1.77$ $p = 0.18$	$\chi^2_{(1)} = 2.79$ $p = 0.09$	/
e. Self-Efficacy→ Attitude at Time 2 → Intention at Time 2	$\chi^2_{(1)} = 1.99$ $p = 0.16$	/	$\chi^2_{(1)} = 2.79$ $p = 0.05$	$\chi^2_{(1)} = 2.51$ $p = 0.11$	$\chi^2_{(1)} = 0.21$ $p = 0.64$	$\chi^2_{(1)} = 3.26$ $p = 0.05$
f. Self-Efficacy→ Message Evaluation → Attitude at Time 2 → Intention at Time 2	$\chi^2_{(1)} = 0.77$ $p = 0.38$	/	/	$\chi^2_{(1)} = 1.65$ $p = 0.19$	$\chi^2_{(1)} = 3.50$ $p = 0.05$	/
g. Message-Induced Fear → Message Evaluation	$\chi^2_{(1)} = 1.04$ $p = 0.31$	$\chi^2_{(1)} = 2.21$ $p = 0.14$	/	$\chi^2_{(1)} = 0.38$ $p = 0.53$	$\chi^2_{(1)} = 0.04$ $p = 0.84$	$\chi^2_{(1)} = 0.75$ $p = 0.39$
h. Message-Induced Threat → Message Evaluation → Attitude at Time 2	/	$\chi^2_{(1)} = 4.25$ $p = 0.03$	/	$\chi^2_{(1)} = 0.46$ $p = 0.50$	/	$\chi^2_{(1)} = 1.88$ $p = 0.17$
i. Attitude at Time 1→ Message-Induced Threat → Message Evaluation → Attitude at Time 2	/	$\chi^2_{(1)} = 5.30$ $p = 0.02$	/	$\chi^2_{(1)} = 5.06$ $p = 0.02$	/	$\chi^2_{(1)} = 3.64$ $p = 0.05$
j. Frequency of Past Behavior→ Message-Induced Threat	/	/	$\chi^2_{(1)} = 0.93$ $p = 0.33$	/	$\chi^2_{(1)} = 4.65$ $p = 0.03$	$\chi^2_{(1)} = 3.39$ $p = 0.05$

Thus, in this case the elaboration of the recommendation could exceeds the receivers' processing capacity, which in turn would create an information overload that reduces the quality of the decision.

Finally, the perception of *loss-framed messages* as threatening or fearful does not directly influence message evaluation, attitude and intention at Time 2. Actually, the persuasiveness of loss-framed messages is strongly influenced by the level of self-efficacy of the receivers. When they have high self-efficacy, they have greater attitude at Time 2, and then intention at Time 2. In the case of non-loss-framed messages, these receivers have also a more positive evaluation of the messages. This suggests that both loss- and non-loss-framed messages may be more suitable for those who perceive a high capacity of exercising regularly. These findings confirm the role of self-efficacy in influencing message effects, already established by research on framing effects in other types of recommendation messages (e.g., Bertolotti et al., 2020). Specifically, past studies showed that people who feel that they have the necessary skills to perform message recommendations are more motivated to accept a loss frame and more inclined to change their behavior accordingly (Cauberghe et al., 2009; Riet et al., 2010; Tudoran et al., 2012). Conversely, people who feel they are not able to deal with the requests tend to activate defense mechanisms that lead them to reject the threatening loss message. In the present study, we reported a first evidence that self-efficacy is also an important predictor of how people elaborate non-loss-framed messages.

Our research has several limitations. First, our sample was small and restricted to Italian people, thus the data may not be generalized to other countries. Second, our research design lacked a measure for assessing future behavior and did not include a measure of the volume or amount of past physical activity. Third, we cannot exclude the risk of self-selection bias, as participants were invited for a study on public communication. Finally, participants were exposed only once to short messages on physical activity outcomes, thus we were able to assess only small and short-term effects. Messages delivered over a longer time span and with repeated exposure (e.g., Caso and Carfora, 2017; Carfora et al., 2018) could yield larger and long-term effects on recipients' attitudes and intentions. In sum, future research should carefully retest our results on the mechanisms involved in processing messages on physical activity formulated with different frames, sending messages over a longer period. Once said that, the results of the present study can have some useful implications regarding how to select message framing in their communication to promote home-based physical activity in the case of future outbreaks or in other eventualities that require physical exercise at home, such as in the case of rehabilitation programs.

CONCLUSION

To sum up, in the present study we validated a model explaining how messages differing according to the outcome sensitivities level of message framing (i.e., gain, non-loss, non-gain and loss messages; Cesario et al., 2013), influence receivers' evaluation of the messages, as well as attitude and intention toward home-based physical activity at Time 2. Our results respond to the need of theoretical advancement in the area of the underlying mechanisms elicited by message framing and show the plausibility of a model including both threat and fear elicited by message exposure. The present study showed that a low perception of threat to freedom strongly contributed to the persuasive effect of the gain and non-loss messages. Moreover, the non-loss messages induced a marginal fear, which may have led participants to systematically process the recommendation but not to enact defensive strategies to reduce a to high emotional distress (Witte, 1992; Ruiter et al., 2001). Instead, when reading loss and non-gain messages, receivers' reactions were more determined by self-efficacy, ending up with reduced persuasive power.

In conclusion, our study introduced and tested an inclusive reference model to explain the effects of message frames based on the presence/absence of positive/negative outcomes of expected behavior and aimed at changing the attitude and intention of the receivers at Time 2. It will be up to future research to further investigate the possibility of applying this model to messages aimed at modifying attitudes and intentions other than the one investigated here, as well as verifying if and how the differences in the mechanisms studied here also depend on individual differences among receivers.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics committee of the Department of Psychology - Catholic University of the Sacred Heart - Milan. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.644050/full#supplementary-material

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Educational and Social Exergaming: A Perspective on Physical, Social, and Educational Benefits and Pitfalls of Exergaming at Home During the COVID-19 Pandemic and Afterwards

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Physical inactivity and coronavirus disease 2019 (COVID-19) signify two pandemics with negative physical, mental, and economic consequences. Younger and older people have not reached the recommended physical activity level for years. Societal restrictions due to COVID-19 additionally reduce opportunities for physical activity, and they increase social isolation. Here, we outline how playing exergames with others (social exergaming) at home could foster physical and mental health and promote communication and discussions on exergaming. Accordingly, we highlight the educational and social benefits of exergaming at home and delineate the concept of Educational and Social Exergaming (EASE). We outline specific benefits and pitfalls of exergaming regarding its physical and nonphysical effects, including educational values of discussing exergaming experiences and related topics. Moreover, we discuss the relevance of practical guidelines for educational and social exergaming at home as well as prospects for future research. Overall, educational and social exergaming could alleviate several detrimental effects of both pandemics on the health and well-being of people of all ages.

Keywords: COVID-19, exergaming, physical activity, social gaming, social learning, media education, home exercising

INTRODUCTION

Physical activity and exercising can promote health and well-being for people of all ages, but worldwide, recommended levels of physical activity are not reached by about 80% of adolescents (Guthold et al., 2020) and by almost 30% of adults (Guthold et al., 2018). This problem is exacerbated by restrictions on daily life and on physical activity associated with the coronavirus disease 2019 (COVID-19) pandemic (López-Bueno et al., 2020; Rhodes et al., 2020; Santos et al., 2021). Positive associations were found between physical activity and participation in community sports, access to sports and recreational facilities, and time outdoors (Sterdt et al., 2014). However, pandemic restrictions reduce health benefits that sport club activities (Kokko et al., 2019) and leisure-time physical activity (Saint-Maurice et al., 2019) could generate. Importantly, lower levels of physical activity may also be more likely to lead to social isolation (Herbolsheimer et al., 2018; Werneck et al., 2019). Overall, physical inactivity and COVID-19 signify two different but partly intertwined pandemics with negative physical, mental, and economic consequences that must be alleviated (Ding et al., 2016; Hall et al., 2020).

Active video gaming (exergaming) appears to be a suitable option to stay physically active at home, for instance, with balance training, dancing, boxing, and tennis (Street et al., 2017). Several exergames mean one-time investments, can be used with available devices (e.g., smartphones and an internet-connected screen), and provide social connections to many players (e.g., gaming communities, Goodman et al., 2018). Developers of exergames can quickly adapt to changes such as the current pandemic (cf. Laato et al., 2020). Nevertheless, there are also long-lasting exergame series, for instance, dance exergames that can be played on different consoles or only with a smartphone and a display device (e.g., Ubisoft, 2021a,b). Hence, the gaming market is constantly changing, and new applications and technical devices may also emerge from innovative research.

Not surprisingly, exergaming has also been suggested as one promising way of home exercising during the current pandemic (e.g., Chtourou et al., 2020). Previous research also outlined several strengths and limitations of using exergames by people of all ages (Stanmore et al., 2017; Kappen et al., 2019; O'Loughlin et al., 2020). However, in contrast to scientific studies using controlled exergaming settings, the realization of exergaming at home leaves much room for success and failure. The present conceptual work, hence, outlines a detailed perspective on potential benefits and pitfalls.

THE MEANING AND VALUE OF EDUCATIONAL AND SOCIAL EXERGAMING AT HOME

Playing exergames with others (social exergaming) can be realized locally within a household or online via the internet. Social exergaming can not only foster physical activity but also provide social support and create valuable opportunities to communicate with others (Marker and Staiano, 2015). Indeed, social interactions are a key element of physical activity (Best et al., 2017) and some video games (Rogers, 2017). Hence, social exergaming might help to counteract negative nonphysical impacts of pandemic restrictions, such as social isolation (Bentlage et al., 2020) or anxiety (Viana and de Lira, 2020). Moreover, the value of exergames for physical education is apparent (e.g., Ennis, 2013; Vaghetti et al., 2018), yet we highlight that exergaming experiences can foster more general media competences that have been widely neglected so far in the context of exergames. Hence, social exergaming can foster physical and mental health, and it provides experiences being worth to be reflected from an educational perspective, forming the concept of *Educational and Social Exergaming (EASE)* (see **Figure 1**). Accordingly, we outline how physical, social, and educational aspects can contribute to a successful and satisfying exergaming experience at home and how these aspects are interrelated.

Physical Effects of Exergaming at Home

Physical effects of exergaming include (neuro-)plasticity and motor learning that take place via (neuro-)biological, physiological, and other mechanisms (e.g., Sigrist et al., 2013; Voss et al., 2013; Lubans et al., 2016). As summarized by **Table 1**, exergaming can unfold several positive and negative effects on the physical dimension. Importantly, meta-analytic results indicate that exergaming can lead to substantially higher physical activity than sedentary behavior (Santos et al., 2021). In addition, strong correlations between exergaming and increases in energy expenditure were reported in several studies (Sween et al., 2014). During a pandemic, exergames can assist in establishing or maintaining structured and regular activity routines in (small) home environments (Chtourou et al., 2020). Exergaming can also complement or even (temporarily) substitute other physical activities (Street et al., 2017) and support therapeutic and rehabilitative procedures in home environments (Ambrosino et al., 2020). However, a meta-analysis focusing on home and lab environments (Oliveira et al., 2020) revealed that exergaming was better in reducing the body mass index but not in increasing physical activity levels in young people, compared to minimal interventions, such as education, sedentary video gaming, or waiting. These effects were similar at short term (<3 months) and intermediate term (3–12 months). In their review, Baranowski et al. (2014) also reported mixed results regarding the effect of exergaming interventions on physical activity; the authors highlighted that interventions could be more effective if they include instructions or are embedded in a

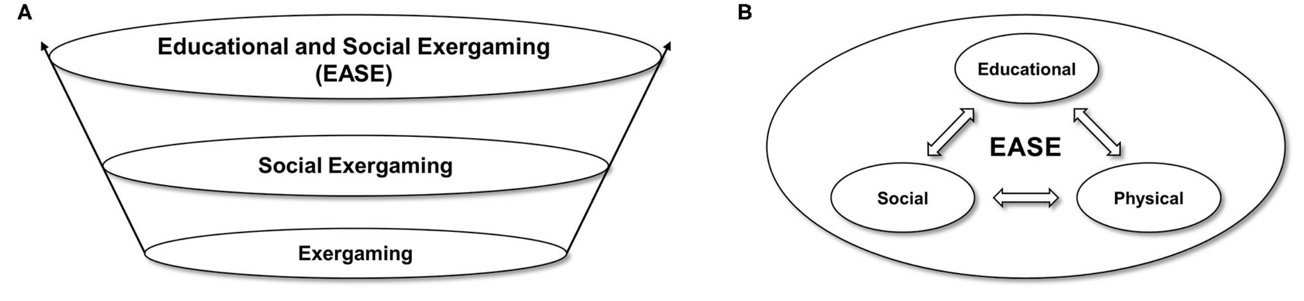

FIGURE 1 | Educational and Social Exergaming (EASE). **(A)** The pure physical dimension, which is addressed by exergaming by definition, is supplemented by the social dimension of social exergaming and by an educational dimension, forming three levels. The highest level is represented by EASE. However, the vertical transitions between the model's levels are fluid rather than categorical. **(B)** The physical, social, and educational dimensions of EASE are strongly interrelated.

TABLE 1 | Potential benefits and pitfalls of educational and social exergaming at home.

	Potential benefits: Exergaming…	**Potential pitfalls: Exergaming…**
Physical effects of exergaming at home	…stimulates adequate and sufficient physical activity and energy expenditure	…promotes inappropriate and insufficient physical activity and energy expenditure
	…establishes or maintains structured and regular activity routines in (small) home environments	…takes place in unstructured and erratic ways (e.g., since no instructions are provided)
	…complements or even (temporarily) substitutes other physical activities	…is an ineffective complementation or substitution of other physical activities
	…supports therapeutic and rehabilitative procedures in home environments	…does not (appropriately) consider specific needs of users
	…is enjoyable and motivates to engage in physical activity	…does not motivate for physical activity due to suboptimal procedures and features
	…includes real-time and informative (formative) feedback on users' performance	…does not include adequate, preferred, or professional feedback
	…allows to engage in physical activity at a customizable training intensity	…results in unhealthy exercising due to inappropriate training intensity
	…allows to assess the goal attainment level and includes (summative) feedback	…is aimless (e.g., no learning objectives and no specific goals are provided prior to exergaming)
Nonphysical effects of social exergaming at home	…in competitive and/or cooperative modes elicits effects on a motivational, emotional, and cognitive level that foster physical activity (e.g., higher self-efficacy and physical effort)	…in competitive and/or cooperative modes elicits effects on a motivational, emotional, and cognitive level that hamper physical activity or cause undesirable side effects (e.g., physical aggression)
	…is motivating with suitable teammates or opponents due to higher perceived relatedness	…does not promote relatedness; there is even a risk of social exclusion in competition modes
	…means a social family activity that fosters family satisfaction and family closeness	…is inadequately integrated into daily life; competition modes might stress family harmony
	…provides motivating and feasible challenges that improve (perceived) competences	…provides frustrating and unfeasible challenges that counteract competence acquisition
	…is motivating, as there is an appropriate level of voluntariness and choice (high autonomy)	…is not motivating because it is forced or because it offers little control (low autonomy)
	…is motivating since it offers new experiences (high novelty).	…is not motivating since it is monotonous (low novelty).
	…is motivating due to social support from family, friends, and (significant) others	…lacks (adequate) social support so that exergaming might not be initiated or retained
Educational values of discussing exergaming and related topics at home	…provides shared and discussable experiences (e.g., physical and nonphysical effects)	…provides experiences that are not shared or not considered worthy to be discussed
	…facilitates discussing media-driven topics (e.g., exergames' features, ubiquity of technology)	…is used but media-driven topics are not (adequately) discussed (e.g., due to insufficient knowledge about media)
	…facilitates discussing education-driven topics (e.g., digital competences, mediation styles)	…is used but education-driven topics are not (adequately) discussed (e.g., due to insufficient digital competences)
	…facilitates discussing health-related topics (e.g., loneliness, behavioral addictions)	…is used but health-related topics are not (adequately) discussed (e.g., due to insufficient health-related knowledge)
	…offers opportunities for (intergenerational) communication that can alleviate loneliness and social anxiety and allow learning with others	…offers little or no opportunity for communication; discussing results in conflicts with others or the termination of exergaming

structured program. Besides methodological issues questioning some of the previously reported results, effective exergaming regarding the physical domain, hence, seems to depend on several moderating factors.

Exergaming may be preferred over other physical activities due to its game-oriented characteristics. Enjoyment is commonly experienced during video gaming (Ryan et al., 2006), and it is the key to motivate for physical activity (Lewis et al., 2016; Best et al., 2017). Therefore, procedures and features that enhance enjoyment in exergames are important and heavily discussed, such as aesthetical aspects, game mechanics, and story elements (e.g., Mellecker et al., 2013; Baranowski et al., 2014). An effective promotion of physical activity also requires real-time and informative (formative) feedback about users' performance, a customizable training intensity, and an assessment of and (summative) feedback on the goal attainment level (cf. Sigrist et al., 2013). Importantly, users' preference for a specific feedback type may contradict its objective effectiveness (Greinacher et al., 2020). In general, feedback is essential for motor learning (Sigrist et al., 2013; Wulf, 2013), also because the variability that humans show in their movements seems to be important for motor learning (Dhawale et al., 2017). In addition, positive effects on body composition and physical activity may disappear given no learning objectives and no specific goals prior to exergaming (Gao et al., 2020). Moreover, several nonphysical processes can affect physical activity specifically when it comes to social exergaming.

Nonphysical Effects of Social Exergaming at Home

Exergaming can elicit several nonphysical (psychological) effects on the motivational, emotional, and cognitive level in clinical and nonclinical populations (for reviews, see Joronen et al., 2017; Lee et al., 2017; Stanmore et al., 2017; Santos et al., 2021). Prominent theoretical accounts to explain psychological effects and correlates of social exergaming include self-determination theory, social cognitive theory, theory of planned behavior, and social identity theory (e.g., Nasuti and Rhodes, 2013; Marker and Staiano, 2015). Here, we emphasize potential benefits and pitfalls that can be attributed to the social dimension of exergaming (see **Table 1**).

Social exergaming principally means to play against (competitively) and/or with (cooperatively) other players. Compared to exergaming alone, competitive exergaming against peers was found to reduce perceived exertion and to increase affective outcomes of children and adolescents (Lisón et al., 2015). Moreover, competitive exergaming could increase physical effort or even aggression when exergames contain violent behavior (Marker and Staiano, 2015). Cooperative exergaming can foster motivation, game continuance, and self-efficacy as well as increase prosocial behaviors, for instance, when parents play with their children (Marker and Staiano, 2015). Exergames also allow for cooperative competitions: In a school environment, students in sixth grade danced in groups and competed against each other. The students reported not only high dance and game enjoyment across 4 weeks but also considerable group cohesion in terms of social attraction to group members (Rüth and Kaspar, 2020). Given these results, social exergaming seems recommendable over exergaming alone in some cases, yet more social factors come into play.

Relatedness (to engage with others) is a basic human need besides competence (to perceive skill increase) and autonomy (to endorse activities oneself) in terms of self-determination theory (Standage and Ryan, 2020). First, users can experience higher social relatedness when playing exergames online with peers compared to playing against a computer opponent (Kooiman and Sheehan, 2015). However, in competition modes, there is a general risk of social exclusion processes as indicated by research on (minimal) group membership (cf. Lelieveld et al., 2020). In turn, exergaming experiences can be more motivating and satisfactory given suitable teammates or opponents (cf. Chan et al., 2019). Relatedly, families that video gamed together reported better family satisfaction and closer relationships within the family (Wang et al., 2018). Second, perceived competence was found to be lower when exergaming compared to exercising (Osorio et al., 2012). In general, task difficulty should be adapted to players' skill level and competences as well as their individual learning curve (Kiili, 2005; Hardy et al., 2015). Third, children who were offered a high level of autonomy in terms of a free choice to play exergames or sedentary video game alternatives played both types of games for a similar amount of time (Lam et al., 2011). Notably, social exergaming could also satisfy a (fourth) basic need for novelty (Vansteenkiste et al., 2020). While offering new experiences had a positive indirect effect on the intention to be physically active via autonomous motivation in school-aged students (Fernández-Espínola et al., 2020), playing with other players can result in new experiences. However, novelty effects (a rapid decline from an initially high level of appeal or usage) might also lead to an overestimation of exergames' (long-term) effects. Overall, the fulfillment of basic human needs fosters motivation, well-being, and personal growth.

Social exergaming can be further enriched via social support, which means that people exchange various kinds of social resources to improve their mental well-being (cf. Zimet et al., 1988). Examples of social support include emotional support (e.g., parents who care for their children) or exchange of information (e.g., friends who give advice). For children and adolescents, social support of parents, friends, and significant others was found to positively correlate with physical activity (Sterdt et al., 2014), whereas meta-analytic results indicate small effects of parental support on physical activity (Yao and Rhodes, 2015). Still, more recently, parental support for physical activity was found to be a key predictor of their children's physical activity (Best et al., 2017). Social support from family members also seems to specifically benefit older adults' physical activity (Smith et al., 2017). In families, parents can support the initiation of exergaming, and siblings can support adherence (Baranowski et al., 2014). Previous research also reported positive associations between social support from friends and physical activity (Hamilton et al., 2017; Scarapicchia et al., 2017). Nonetheless, further research on social support during exergaming is needed (Gao et al., 2020). Conversations about exergaming could also provide social support and needs support, for instance, of relatedness by showing authentic interest in a person (Standage and Ryan, 2020). Consequently, social exergaming has the potential to help people cope with pandemic restrictions on social contacts.

Educational Values of Discussing Exergaming and Related Topics at Home

Communication can alleviate loneliness and social anxiety (Bonetti et al., 2010; Chipps et al., 2017). With limited access to formal education (UNESCO, 2021), particularly children and adolescents more likely feel lonely without participation in physical education (Pinto et al., 2019). We argue that exergaming provides valuable opportunities to reflect on the meanings of media as environments (media-driven) and the promotion of critical thinking and digital skills (education-driven), which is important to people of all ages (Rasi et al., 2019). Therefore, EASE at home could provide educational values through discussions that can also promote media competences (see **Table 1**). We present four possible (intertwined) directions for joint discussions at home.

First, players' shared exergaming experiences (e.g., successes or failures) and related physical and nonphysical effects could serve as obvious conversation starters. Players could reflect on their physical activity, including motor and cognitive skills, values of physical activity, and motivational and social aspects (Corbin, 2016). Even before exergaming, parents could explain their children what it means to participate in competitive vs. cooperative exergaming. Discussing game experiences offers opportunities to practice media criticism, and this process can be supported by parents or teachers (Rüth and Kaspar, 2021).

Second, media-driven topics include understanding the exergames' features such as the motion sensors, which are often readily accessible in the form of visual, performance-based feedback. This could also facilitate a visual approach to complex topics such as the ubiquity of technology and the associated generation, measurement, and surveillance of data in daily life (Mascheroni, 2020).

Third, education-driven topics include diverse aspects of media education that require standards (Blumberg et al., 2019) and prioritization (Fedorov et al., 2016). Still, available frameworks allow examinations of key digital competence areas at different proficiency levels (Carretero et al., 2017). Further, parents usually regulate how their children use video games (ESA, 2020). Accordingly, mediation styles, such as restrictive use (limited time or content) or co-use (playing together) (Lorenz and Kapella, 2020), could be discussed (e.g., why parents allow exergaming and restrict sedentary video gaming).

Fourth, video games and digital technology are prevalent in peoples' daily lives, even more so during COVID-19 pandemic restrictions (GWI, 2020; Newzoo, 2020). Relatedly, excessive sedentary screen time can hamper physical and mental health (Twenge and Campbell, 2018; Engberg et al., 2019), and excessive online communication can increase loneliness (Boursier et al., 2020). Therefore, potential unhealthy consequences could be discussed and related to exergaming, including addictions regarding video gaming (Paulus et al., 2018; WHO, 2020a) and the internet (Venkatesh et al., 2019; Dong et al., 2020).

Overall, many more directions are conceivable, but who is talking to whom at all? Communicators can be of different ages and include (grand)parents and their (grand)children, siblings, friends, and players from online communities. When older people play with younger people, it could also improve intergenerational communication (Costa and Veloso, 2016) and decrease social anxiety in older people (Xu et al., 2016). Moreover, communicators could increase their interpersonal competences, such as providing emotional support, and thereby reduce their stress and loneliness (Segrin, 2019). Communicators can influence each other and learn from each other cooperatively (cf. Butera and Buchs, 2019). While teacher-led discussions can support students to reflect on video game experiences in formal school teaching (Rüth and Kaspar, 2021), question catalogs and interview guidelines could facilitate and structure communications in informal learning environments at home. That said, care should be taken to balance exergaming with serious discussions so that players enjoy and engage in exergaming also in the long run.

DISCUSSION

After outlining several *potential* benefits and pitfalls related to the concept of EASE, we now turn to its feasibility. Exergaming interventions should provide appropriate levels of physical activity, enjoyment, and adherence but low additional costs (LeBlanc et al., 2013). First, one needs to select and use exergames appropriately (considering exercise frequency, intensity, timing, type, and context) to promote health benefits and to avoid negative effects on the immune system (Lubans et al., 2016; Chtourou et al., 2020). Existing guidelines for physical activity (e.g., Dwyer et al., 2020; WHO, 2020b) or for the parental control of video game use (e.g., ESRB, 2021; ISFE, 2021) can provide some orientation. Second, people could adhere to exergaming if it satisfies their basic needs. Techniques such as self-monitoring, self-reinforcement, or motivational interviewing can also promote long-term play (cf. Hardcastle et al., 2015). Third, additional costs include time, budget, and adverse events. For instance, integrating game-like elements into common activities (e.g., rewards, such as points or badges for rope skipping, Fang et al., 2019) has low additional costs and provides new experiences, even if suitable exergames are not available or affordable. Overall, recommendations depend on several situational factors.

EASE at home may benefit from structured programs and professional guidance. Therapeutic and rehabilitative applications would even require professional support (Ambrosino et al., 2020). Online video communication allows coaches to provide professional feedback (cf. Chtourou et al., 2020) and to improve physical activity and weight-related outcomes (Staiano et al., 2018). Supportive parent–child communication can also alleviate negative effects of children's digital technology use on their life satisfaction (Boniel-Nissim et al., 2015) and their risk of becoming a victim of cyberbullying (Buelga et al., 2017). Moreover, child abuse potential was found to be higher when parents were more stressed due to feelings of anxiety and depression related to COVID-19 but lower when parents provided parental support (Brown et al., 2020). Nevertheless, a successful promotion of exergaming and physical activity at home is needed (cf. Ainsworth and Ananian, 2020; Williamson et al., 2020). Taken together, structured programs and professional guidance could be important cornerstones for effective implementations of EASE, yet more high-quality evidence on EASE is needed.

There is a lack of research on exergaming in home environments, and the fidelity of interventions should be ensured (Gao et al., 2020). Moreover, heterogeneity in the exergaming literature complicates generalizability and comparability of evidence and hampers theoretical and practical progress (O'Loughlin et al., 2020). While heterogeneity partly relies on situational factors, some convergence could result from evaluating sound theoretical frameworks such as self-determination theory (Standage and Ryan, 2020). Several suggestions for future research on exergaming (e.g., Straker et al., 2015; Baranowski et al., 2016; O'Loughlin et al., 2020) and general guidelines for media-based interventions (cf. Rüth and Kaspar, 2017) should also be considered when investigating home environments. In the **Supplementary Material**, we outline some avenues for future research on EASE regarding research approaches, measurement of dependent variables, and effects of exergaming elements. In the long term, databases might help to converge evidence across contexts and to determine at-risk groups (cf. Ayllón et al., 2020), in accordance with respective laws on data protection and appropriate ethical standards. Overall, we recommend the development and use of evidence-based guidelines for (investigations of) exergaming at home.

To conclude, EASE can alleviate detrimental effects of pandemic restrictions on physical and mental health and foster media competences in home environments. While the COVID-19 pandemic has severe consequences on daily lives and physical activity, its end will not put an end to the pandemic of physical inactivity. Therefore, this work is not limited to the current COVID-19 restrictions.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

MR and KK conceptualized the manuscript. MR drafted and revised the manuscript. KK revised the manuscript. All authors contributed to the article and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.644036/full#supplementary-material

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Physical Activity, Boredom and Fear of COVID-19 Among Adolescents in Germany

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Background: The effectiveness of physical activity (PA) as an intervention against anxiety disorders and depression is undeniable in clinical psychology. Therefore, the question arose whether these effects also occur when a fear stimulus, like the COVID-19 pandemic, affects otherwise healthy adolescents. Boredom is closely linked to symptoms of fear and anxiety, but the connection between PA, boredom and fear is partly unclear.

Methods: A cross-sectional online study was conducted that involved 122 students. Participants were 13–19 years old (M_{age} = 15.83, SD = 1.73). The survey was available online from April 27th to May 3rd, 2020. At this time, schools in Germany had already been closed for 6 weeks. A self-report questionnaire was used to measure physical activity, boredom, and fear of COVID-19. A multiple linear regression model was conducted.

Results: The reported fear of COVID-19 significantly correlates with total PA, quantity of strenuous PA, and boredom. Furthermore, a significant regression equation was found. The variables boredom, PA, and age contribute significantly to predicting the fear of COVID-19 [$R^2 = 0.127$, $F(3,118) = 6.876$, $p < 0.000$], among adolescents.

Conclusion: Our results indicate that there is an association between PA, boredom and the quarantine experience of adolescents. Students who were physically more active, especially with strenuous intensity, did not feel bored and showed less fear of COVID-19.

Keywords: physical activity, physical exercise, boredom, fear, anxiety, COVID-19, adolescents

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INTRODUCTION

On January 30th the World Health Organization (WHO) classified the Coronavirus as a "public health emergency of international concern" (World Health Organization, 2020c), p1. On March 11th, the WHO said that COVID-19 "can be characterized as a pandemic" (World Health Organization, 2020a), p1. As a reaction to the exacerbating situation and the WHO's warnings, many countries decided to introduce public life restrictions. On March 22nd, 21.463 cases of

COVID-19 were counted in Germany by the WHO. The German government, therefore, decided to introduce a contact lock for more than two persons and several restrictions to the public life, such as a minimum distance of 1.5 m between people in public spaces and the closure of public facilities, like kindergartens and schools (World Health Organization, 2020b). On April 28th, the German society had been living with the corona safeguard measures for 6 weeks. It is difficult, to describe the dynamic development of the pandemic accurately, but it may give an idea of how much stress the pandemic has caused for a significant number of individuals. Not surprisingly, researchers found that many people report an increased feeling of fear in quarantine (Reynolds et al., 2007). Previous studies have shown that even a few-day period of isolation can cause severe consequences to society, such as post-traumatic stress symptoms, anger, and the fear of infection (Brooks et al., 2020). Moreover, boredom, frustration and separation from others are included in the serious consequences of isolation as well and they should not be underestimated (Cava et al., 2005). Students seem to be particularly sensitive to the effects of a pandemic, as they are mainly active in institutional structures (e.g., schools, clubs) and do not have experience in self-organizing their days, which leads to extended sedentary activities (Brazendale et al., 2017). Additionally, quarantine and school cancelation inevitably lead to a reduction of physical activity (Amatriain-Fernández et al., 2020b). In the time of the lockdown students did not have guided physical education lessons or organized free-time activities anymore, playgrounds and outdoor sports facilities were forbidden to be used, and many young people were not allowed to spend time outside their home due to their parent's fear of them contracting the virus.

Since this research is investigating physical activity and in order to avoid confusion of terms, the difference between physical activity (PA) and physical exercise (PE) should be clarified (Budde et al., 2016a). PA is defined as any bodily movement produced by the contraction of skeletal muscles that significantly boosts the calorie consumption compared to resting energy expenditure (American College of Sports Medicine, Riebe et al., 2018). PE can be defined as one subcategory of PA and mainly differs from PA in its planned and structured execution, and the objective to improve or maintain one's physical fitness domains (Caspersen et al., 1985). PE is always included in the category of PA, however, the conception of PA is wider than PE (Wegner et al., 2020). Our study aimed to measure (total) PA within 1 week, including easy walking, leisure activities, and PE. The German "national recommendation for exercise and physical activity promotion" recommends 90 min of daily moderate to vigorous PA to adolescents from 12 to 18 years (Pfeifer et al., 2016). Due to the current situation, it can be assumed that most people were unable to accomplish this amount of PA.

The terms fear and anxiety are deliberately used synonymously by some scientists. However, many research results suggest that fear and anxiety differ and are two distinct emotions (Sylvers et al., 2011). According to McNaughton and Corr (2004), fear is present when actively leaving a dangerous situation (active avoidance), and anxiety operates when a dangerous situation is entered or approached (passive avoidance). In this study a fear questionnaire originally developed to measure the fear of Severe Acute Respiratory Syndrome (SARS) was used, since no fear questionnaire for COVID-19 was available at the time of the data collection (Ho et al., 2005). The questionnaire contains items on the active fear of the virus (fear that I will be infected) and items on the underlying mood in an epidemic situation (SARS makes me feel that life is threatening). Thus, it does not seem possible to speak of a very selective recording of fear in the questionnaire used, as both active and passive avoidance behavior are measured.

We chose adolescent students as the sample of interest, since they were unable to follow their daily routine during the lockdown, which could make them extraordinarily vulnerable to this situation (Dubey et al., 2020). The main idea of this study was to investigate the effects of PA on the fear during the COVID-19-pandemic. Since research has shown that boredom and symptoms of anxiety are connected (Lee and Zelman, 2019), we decided to also collect data of boredom to further investigate the connection between PA, boredom, and fear of COVID-19 (FOC-19). In terms of PA studies have shown that participation in sports contributes to a greater well-being of adolescents (McMahon et al., 2016). In contrast, physical inactivity is significantly related to symptoms of anxiety and depression (Bélair et al., 2018). Therefore, we hypothesized that participants with higher PA scores would have less fear, higher boredom scores would correlate with higher FOC-19 scores, and that higher PA scores would also indicate lower boredom scores.

MATERIALS AND METHODS

Participants

The study involved 122 students [69 females (56.6%), 53 males (43.4%)], ages range from 13 to 19 (M_{age} = 15.83, SD = 1.73). All of the participants attended a school in the German federal states Hamburg or Schleswig-Holstein. Participants, who have attended a vocational school and accept vocational training, have been excluded from the study.

Ethics

All participants (or their legal guardian) provided their written informed consent to participate in this study and have been informed about data protection and use at the start of the questionnaire. They were also informed that they could withdraw from the study at any time without consequences. The study was approved by the Ethics Commission of the MSH Medical School Hamburg (Germany) and conducted in accordance with the Declaration of Helsinki (World Medical Association, 2018).

Measures and Procedures

For our cross-sectional survey, economic measuring instruments were sought as far as possible to enable students to participate in the survey quickly. Attention was paid to ensure that the instruments are low-threshold and easy to understand for adolescents with all kinds of educational background. The WHO defines adolescence as the phase from 10 to 19 years of age (World Health Organization, 2019). In our study, adolescents from 13 to 19 years of age were included for the statistical analysis. The present data were collected online. Test subjects were only offered to participate via a link provided by teachers and social media platforms. The survey was available online from April 27th to May 3rd. At the time of data collection, schools in Hamburg and Schleswig-Holstein had already been closed for 6 weeks. There was a ban on contact for more than two people and an order to keep a minimum distance of 1.5 m to other people. An additional obligation to wear mouth-nose covers was introduced in both federal states on April 27th.

Physical Activity

Physical activity was measured using the "Godin-Shephard Leisure-Time Physical Activity Questionnaire" (Godin and Shephard, 1985). The GSLTPAQ originally consisted of one item (During a typical 7-day period how many times on the average do you do the following kinds of exercise for more than 15 min during your free time?) and three response categories (strenuous, moderate, mild intensity). The total volume of PA is calculated by metabolic equivalents (METs). The frequency of PA is multiplied by the factor of the PA intensity level, which is three for mild, six for moderate, and nine for strenuous intensities. As mentioned above, German schools were closed for 6 weeks at the time of the data collection. Therefore, the item of the GSLTPAQ was changed to "During a 7-day period how many times on the average do you do the following kinds of activities for more than 15 min?" and thus, the total PA of the students was recorded. Also, the GSLTPAQ is particularly well suited to our intent, because it does not require high-level self-reporting skills (Godin, 2011).

FOC-19: (= 0.718)

FOC-19 was measured using the "SARS Fear Scale." Ho et al. (2005) developed the questionnaire for the Severe Acute Respiratory Syndrome (SARS) discovered in China in 2002 and used it to survey 179 healthcare workers. Based on the sample, the researchers conducted a factor analysis for the items and recommended nine of the 18 items for the further use of the scale. To meet this study's purpose, six out of nine items were selected, as three of the items were specifically intended for health care workers. Example items include "COVID-19 makes me fear that I will be infected" (factor infection) and "COVID-19 makes me feel that life is threatening" (factor insecurity). Participants responded on a 4-point Likert scale. Answers included "1 = definitely false," "2 = somewhat false," "3 = somewhat true," and "4 = definitely true."

Boredom: (= 0.779)

To measure "state Boredom," the short form of the "Multidimensional State Boredom Scale" (MSBS-8; Hunter et al., 2016) was chosen. The MSBS was initially published by Fahlman et al. (2011) and consisted of 28 items. The short form is reduced to eight items. The MSBS-8 is an appropriate tool to differentiate between "bored" and "not bored" (Hunter et al., 2016), p246. Compared to other test instruments, the MSBS was designed to measure the current state of boredom and not the boredom proneness. Participants responded to the items on a 7-point Likert scale ranging from "1 = strongly disagree" to "7 = strongly agree."

Covariates

Age, gender, and the federal state of the attended school were collected as demographic covariates.

Data Analysis

The analysis of the data was performed by using IBM SPSS Statistics 25. The collected data was checked for completeness, exclusion criteria was applied, and the data was checked for outliers. Also, the significance level was set at $p < 0.05$.

Statistical Analyses

First, the total scores for our three main variables (PA, FOC-19, Boredom) were calculated. The endogenous variable in the regression model was the FOC-19 score. Possible predictors were the overall PA value, the total boredom value, the age, gender and the federal state where the school is located (Hamburg or Schleswig-Holstein). When selecting the regression model, the information criterion according to Akaike (AIC) was used. The model shown in **Table 2** has the lowest AIC and will be used for the further study. The Breusch–Pagan test provides no indication of heteroscedasticity, the RESET test does not indicate any incorrect specifications.

RESULTS

Descriptive Statistics

Table 1 presents: means, standard deviations, minima and maxima, as well as Pearson correlation coefficients of the variables. The reported FOC-19 significantly correlates with total PA ($r = -0.214$, $p = 0.017$), quantity of strenuous PA ($r = -0.325$, $p < 0.001$), and boredom ($r = 0.305$, $p < 0.001$). Also, of the six FOC-19 items, the item "COVID-19 makes me worry if my family will be infected" has the highest average value with a mean of 3.13 ($SD = 1.01$). "COVID-19 makes me feel very unsafe about myself," has the lowest average value, with a mean of 1.92 ($SD = 0.93$).

Multiple Regression

Table 2 shows the linear multiple regression model that was calculated to predict FOC-19 based on PA, boredom, and age. A significant regression equation was found [$F(3,118) = 6.876$, $p < 0.000$], with an adjusted R^2 of 0.127. The standardized beta values of PA (= −0.198, $p = 0.0223$) and boredom (= 0.291, $p \leq 0.001$) were significant. The beta value of the variable age was not significant (= −0.140, $p = 0.101$).

Participants predicted FOC-19 is equal to 15.575 – 0.028 (PA) + 0.127 (Boredom) – 0.310 (Age). If PA decreases by one unit, the FOC-19 increases by an average of 0.028 units. If boredom increases by one unit, the FOC-19 increases by an average of 0.127 units, and the FOC-19 decreases by an average of 0.310 units with increasing age (years). The three independent variables explain 12.7% of the variance in the dependent variable FOC-19. According to Cohen (1992), this corresponds to a weak to medium size effect.

TABLE 1 | Descriptive statistics and correlation matrix.

***N* = 122**	**FOC-19**	**MSBS-8**	**GSLTPAQ**	**Strenuous**	**Moderate**	**Mild**
FOC-19	1					
MSBS-8	0.305**	1				
GSLTPAQ *(Total)*	−0.214*	−0.083	1			
Strenuous	−0.325**	−0.211*	0.824**	1		
Moderate	0.058	0.120	0.618**	0.132	1	
Mild	0.016	0.098	0.561**	0.120	0.512**	1
Mean	13.426	33.893	53.868	2.93	3.08	4.04
SD	3.835	8.813	26.707	2.198	2.011	2.494
Minimum	6	8	3	0	0	0
Maximum	23	53	119	10	7	10

**Correlation is significant at the $p < 0.05$ level (2-tailed); **correlation is significant at the $p < 0.01$ level (2-tailed); FOC-19, Fear of COVID-19; MSBS-8, Boredom; GSLTPAQ, Physical Activity; SD, Standard Deviation.*

TABLE 2 | Coefficients and R^2 for the regression model; dependent variable fear of COVID-19.

Variables	**Unstandardized**	**Std. error**	**Standardized (Beta)**	***t***	**Sig.**
Constant	15.575	3.358		4.638	0.000
GSLTPAQ	−0.028*	0.012	−0.198	−2.315	0.022
MSBS-8	0.127***	0.037	0.291	3.413	0.001
Age	−0.310	0.188	−0.140	−1.648	0.102
R^2	0.149				
adj. R^2	0.127				
F (df = 3, 121)	6.876***				

**Significant at $p < 0.05$ level; ***significant at the $p < 0.001$ level; GSLTPAQ, Physical Activity; MSBS-8, Boredom.*

DISCUSSION

Higher rates of symptoms of anxiety (6.33–50.9%), depression (14.6–48.3%), post-traumatic stress disorder (7–53.8%), psychological distress (34.43–38%), and stress (8.1–81.9%) were reported by the general population of several countries of the world during the current COVID-19 pandemic (Xiong et al., 2020). According to these authors, to have a younger age, to be a student, and to be frequently exposed to social media/news concerning COVID-19, are, among others, risk factors for suffering any mental problem. Among all of the population groups, adolescents fit the previously mentioned prerequisites, which situates them as a vulnerable group for having a mental problem triggered by the current pandemic.

The present study aimed to investigate the association between PA, boredom, and fear during the COVID-19 pandemic. We have used the naturally occurring circumstances as an opportunity to investigate the mode of action of the variables. The effectiveness of PA (especially PE) as an intervention against anxiety disorders and depression for adolescents and adults, is undeniable in clinical psychology (Ströhle, 2008; Anderson and Shivakumar, 2013; Wegner et al., 2014, 2020; De Souza Moura et al., 2015). Therefore, the question arose whether these effects also take place when a fear stimulus affects otherwise healthy adolescents. The construct boredom was additionally selected because previous research has shown that children and adolescents, in particular, perceive boredom as a severe consequence of isolation (Cava et al., 2005; Brooks et al., 2020).

It was assumed that more bored adolescents have more FOC-19. At the same time, we hypothesized that PA and boredom correlate negatively. However, our study results suggest that the correlation between boredom and PA is small and not significant. Nevertheless, there is a significant positive correlation between boredom and FOC-19; students who have reported more boredom have also reported greater fear of the virus and its consequences. Also, as predicted, there is a significant correlation between PA and FOC-19; students who were physically more active have reported less fear of the virus. Especially the amount of strenuous PA per week shows a significant correlation with the FOC-19, which is in line with the results that exercise intensity matters (Budde et al., 2016b; Gronwald et al., 2018). Also, looking at the individual item scores, the fear of an infection in the family is particularly striking. In addition, the multiple regression model's calculations have shown that the variables boredom, PA, and Age contribute significantly to predicting the FOC-19.

There are only a few studies that have researched PA during a pandemic, but these show similar results to ours. Maugeri et al. (2020) reported that a reduction of PA during the time of pandemic is associated with poorer mental well-being. In another study on PA and mental health during the COVID-19 pandemic, researchers showed that participants with more PA got higher mental health scores, and participants who became more active during the pandemic had lower anxiety scores

(Lesser and Nienhuis, 2020). Besides, it was shown that chronic (regularly conducted) PE shows positive effects on the immune system and can improve the immune response to virus or bacteria (Amatriain-Fernández et al., 2020a). There are various theories of the effectiveness of PA (Wegner et al., 2020). Among others, it is believed that PE induces neuromodulation processes, which can "enhance an individual's capacity to respond to new demands" (Budde et al., 2020), p2.

In the past, boredom had mainly been identified in qualitative studies. As far as we know, only one study related to state boredom has been published during the COVID-19 pandemic. In their study on adults, Chao et al. (2020) found that state boredom is significantly related to anxiety, stress, and depression, which is in accordance with the data presented here. Still, it should be noted that the researchers did not measure virus-related anxiety, but rather general anxiety symptoms. However, a large number of statements show that, boredom, frustration, and loneliness are perceived as severe consequences of isolation (Ahmed et al., 2020; Kumar and Nayar, 2020; Wang et al., 2020; Xiang et al., 2020).

Our results suggest that adolescents who show both of the indications; less physically active and more bored (during quarantine), show a greater fear of the virus.

According to research data, these effects can decrease with age. Youths are extraordinarily vulnerable to environmental changes, and the foundation for a healthy life must be established for children from 0 to 18 years old (Clark et al., 2020). Thus, clear strategies must be designed to stabilize the conditions that have been thrown off balance in the crisis. For example, measures to maintain (a health contributing amount of) PA could be implemented through schools, and in the case of further lockdowns, online teaching should be top priority. Also, this is important to give students a structure for their daily lives, thereby increase the likelihood of regular PA and sleep (Brazendale et al., 2017). This is significant, as recent research has shown that there is a link between the outbreak of COVID-19 (with the related consequences, such as restrictions on public life, daily media reports, etc.), sleep quality and generalized anxiety (Forte et al., 2020).

However, our research also had several limitations. As the restrictions on public life have changed rapidly, we had to keep the survey period as short as possible. This has influenced the sample size of the study. A larger sample would be desirable for better representativeness and group comparisons.

Also, the fear of COVID-19 questionnaire had to be designed quickly. This limits the standardization of the fear questionnaire, since it was originally made for health care workers and to our knowledge is not able to distinguish between fear and anxiety as desired in research articles (Sylvers et al., 2011). More precise COVID-19 questionnaires are available now, which are validated and are able to survey the fear of COVID-19 more selectively (Ahorsu et al., 2020). Additionally, it's important to collect more information about teenagers' parents, socioeconomic status and living conditions, as these could further explain differences in PA. We suspected that any additional question would weaken the quality of the survey, so that this data was not collected. Although the age-specific sample does not allow the extrapolation of the results to the general population, which can be considered a limitation, the specific focus on a vulnerable group of the population, adolescents (Xiong et al., 2020), can also be considered a strength. Since this study is a cross-sectional online study, it is impossible to show any causal relationships as well as to measure any changes in behavior due to the pandemic. An experimental approach to the topic could have enabled this. Another limitation is that PA was measured by self-report questionnaire, since more valid data could have been measured by testing and monitoring the physical fitness and the amount and level of PA supported by reliable devices. The used questionnaire, however, was highly correlated with physical fitness (Jacobs et al., 1993).

In summary, the results found in this study indicate that PA and boredom are significantly correlated to the quarantine experience of adolescent students. Our findings let us assume, that students who are physically more active, and do not feel bored, have less fear of the coronavirus. Future research should use a larger sample to analyze the individual variables in more detail. The factors PA and boredom should be taken into account in the design of quarantine safety measures.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because rights of use were only granted to the authors. Requests to access the datasets should be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Commission of the MSH Medical School Hamburg. Written informed consent to participate in this study was provided by the participants or their legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

VB and HB contributed to conception and design of the study and performed the statistical analysis. VB organized the database. VB, TG, SA-F, EM-R, SM, and HB wrote the first draft of the manuscript. All authors contributed to the manuscript revision, read, and approved the submitted version.

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REVIEW
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COVID-19 Pandemic and Physical Exercise: Lessons Learnt for Confined Communities

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The novel pandemic called "Coronavirus Disease 2019" (COVID-19), as a global public health emergency and global threat, has affected many countries in unpredictable ways and impacted on physical activity (PA) behaviors to various extents. Specific populations including refugees, asylum seekers, and prisoners, are vulnerable groups with multiple complex health needs and worse health outcomes with respect to the general population worldwide and at high risk of death from the "Severe Acute Respiratory Syndrome-related Coronavirus type 2" (SARS-CoV-2). Governments around the world have been implementing preventive healthcare policies, including physical and social distancing, isolation, and confinement, to mitigate against the burden imposed by the COVID-19 outbreak. This pandemic period is characterized by reduced or lack of movement. During this period of lockdown, PA can represent an immunotherapy and a preventative approach to avoid the harmful effects of inactivity due to the pandemic. Moreover, PA could be prescribed to improve the immune system of specific populations (refugees, asylum seekers, and prisoners), which particularly experience the condition of being confined. The present narrative review discusses the potential impacts of COVID-19 pandemic on these specific populations' health status and the importance of performing PA/exercise to reduce the deleterious effects of COVID-19 pandemic. In addition, we aim to provide useful recommendations on PA/exercise for these specific populations to maintain their level of independence, physical, and mental health as well as their wellbeing.

Keywords: coronavirus, physical activity, exercise, incarcerated, prison, health, sedentary

INTRODUCTION

Viral infections can have a profound effect on human life, in terms of morbidity and fatality rate. One of the most lethal outbreaks in the history of mankind is the 1918–1919 Spanish influenza pandemic (Kain and Fowler, 2019). Even though influenza is a commonly widespread respiratory infection, various serious complications, such as pneumonia, can occur if the disease is not quickly and effectively controlled (Kohut et al., 2004). Worldwide, according to some estimations, seasonal influenza can cause up to 3–5 million cases of severe illness, and result in approximately

500,000 deaths per year due to the increased susceptibility among populations, especially those vulnerable (Cao et al., 2011). Recently, in late December 2019, a pneumonia outbreak of unknown etiology started in the city of Wuhan (Hubei province, mainland China) and has spread rapidly to neighboring provinces in China and around the world. Human-to-human transmission of the virus, initially denied, has been subsequently acknowledged (Chan et al., 2020). As of February 14, 2021 (15:29 GMT), the total number of confirmed cases has significantly increased up to 109,189,351 in the world, with 2,407,133 deceased and 81,230,179 recovered. This infection has been named as "Coronavirus Disease 2019" (COVID-19), whereas the infectious agent has been termed as the "Severe Acute Respiratory Syndrome-related Coronavirus type 2" (SARS-CoV-2).

This novel pandemic, as a global public health emergency and a global threat, has affected many countries in unpredictable ways and impacted physical activity (PA) behaviors to various extents. Particularly, people's lifestyles and behaviors, such PA and sedentary behavior (SB) have been drastically affected due to the prolonged closures, isolation/confinement and physical and social distancing practiced during the COVID-19 pandemic. The still ongoing outbreak poses, indeed, challenges for all the population and, in particular, for specific populations including asylum seekers, refugees, and prisoners as the pandemic sweeps across the globe. The spread of the COVID-19 pandemic is threatening people's health and life safety and has critical impact on social life and national economy, at the same time (Wan et al., 2020). The aftermath of such outbreaks does not only harm physical but psychological and social health as well (Li S. et al., 2020). The issue has become increasingly relevant as an increasing number of incarcerated individuals test positive for COVID-19 (Stephenson, 2020). People residing in areas characterized by high population density or rural areas with poor access to health care facilities, living in shared or congregate housing and multi-generational households, immigrants, refugees, racial and ethnic minorities are at higher risk for contracting COVID-19 (Ainsworth and Li, 2020). Moreover, multiple wave outbreaks are occurring due to the relaxing/easing of the public health measures implemented and the insurgence of new coronavirus strains racing across many countries (Siu et al., 2020). Being confined, isolated, hospitalized, or incarcerated is likely to compromise human wellbeing. SB (e.g., prolonged sitting or screen time), as a global public health concern, represents a major risk to wellbeing (Katzmarzyk et al., 2009; Dunstan et al., 2010; Ghram et al., 2020a) and is related to the adoption of unhealthy behaviors and lifestyles (e.g., physical inactivity, and dietary habits) (Bao et al., 2020). Thus, decreasing SB, adopting good personal hygiene practices, and regular PA and exercise may be an effective way to counteract/mitigate the detrimental effects of living under restricted environments due to COVID-19 spread. The common saying, "prevention is better than cure," still holds true (Ghram et al., 2020a). Due to the lack of an appropriate antiviral agent and due to the scarcity of vaccine stocks, we need a safe intervention that can be globally implemented (Ramalingam et al., 2020). The European Union (EU), the United States (USA) and Canada, and Australia have significantly invested in sports-related programs and interventions aimed at engaging refugees and asylum seekers in sports-related and physical activities for health, therapeutic, or societal purposes (Spaaij et al., 2019). Indeed, PA and exercise could alleviate and mitigate against the symptoms and enhance the physical and psychological health status of individuals who are confined or incarcerated and exercise prescriptions could provide advice for these specific populations to be involved in suitable physical exercises and activities in order to promote the physical wellness as well as work efficiency (Ghram et al., 2020a). If, on the one hand, PA and exercise may facilitate the virus spread and, as such, should always be practiced under certain circumstances and strictly following the protective measures against COVID-19, on the other hand, PA and exercise might strengthen the immune system that could help to combat COVID-19 in these vulnerable populations (Ghram et al., 2020a; Laddu et al., 2020).

In the present narrative review, we aim to stress the importance of the public health measures that have been enforced to limit the COVID-19 spread and their effects among asylum seekers, refugees, and prisoners. Then, we focus on the risks of being isolated, physical inactivity and SB associated with the novel coronavirus outbreak. Finally, we discuss the consequences of being active, and the potential role of PA/exercise in counteracting the negative effects of the COVID-19 induced lockdown and reducing the risk of developing health problems among specific populations.

WHAT IS COVID-19?

Coronaviruses are enveloped, single-stranded, positive-sense RNA viruses that generally cause mild respiratory symptoms and occasionally severe and lethal infections (Fehr and Perlman, 2015). In the last decades, several large-scale coronaviruses-induced outbreaks have occurred, including the "Severe Acute Respiratory Syndrome" (SARS) outbreak in China (2003), and the "Middle Eastern Respiratory Syndrome" (MERS) outbreaks in the Kingdom of Saudi Arabia (2012) and in South Korea (2015) (Bok et al., 2020).

The current pandemic caused by SARS-CoV-2 can lead, as previously mentioned, to an usually mild but sometimes life-threatening infection (Wang et al., 2020), like bilateral pneumonia, myocardial injury, respiratory failure, acute respiratory distress syndrome (ARDS), multi-organ failure (MOF) and, in some cases, can even result in death (Holshue et al., 2020). Symptoms at the onset of COVID-19 infection as reported in hospitalized patients in China include fever, cough, fatigue, myalgia, sputum production, dyspnea, oppression in the chest, diarrhea, headache, anorexia, chest pain, sore throat, dizziness, palpitations, and vomiting (Gilani et al., 2020).

MODE AND TRANSMISSION OF THE COVID-19 VIRUS

Coronavirus Disease 2019 virus is mainly transmitted through respiratory droplets and physical contact routes

(Burke et al., 2020; Chan et al., 2020; Huang et al., 2020; Li Q. et al., 2020; Liu et al., 2020). Droplet transmission can occur when a subject is in close contact with an individual with respiratory symptoms (e.g., coughing or sneezing) and is at risk of having his/her mucosae (mouth and nose) or conjunctiva (eyes) exposed to potentially infective respiratory droplets. Viral spreading may also occur via fomites surrounding the infected person (Ong et al., 2020).

During the early stages of the outbreak, Africa has shown very few COVID-19 cases compared to the number of cases reported in European and Asian countries, which can be explained by differences in the number of swabs performed, in the large-scale testing and reporting, as well as by the low volume of travel connections, enhanced border screening policies and the beneficial impact of Africa's hot climate (Otu et al., 2020).

PREVENTIVE HEALTHCARE MEASURES OF COVID-19 IN THE COMMUNITY

Due to the highly contagious nature of the virus, it has rapidly spread globally, and many countries are experiencing overwhelmed and strained national health systems. Moreover, they are suffering from shortage of protection devices and human resources needed to adequately treat infected patients (ECDC, 2020). To cope with virus outbreak, the health care authorities have made dreadful decisions. Given the absence of effective therapeutic interventions at the time of the virus global spread, cities and countries have decided to adopt non-pharmacological measures, implementing self-isolation, social distancing, quarantine and even lock-down of entire communities and territories as well as travel restrictions (Wilder-Smith and Freedman, 2020).

According to the "World Health Organization" (WHO), several low-cost non-medical countermeasures that would contain spread have been recommended widely, including personal protective equipment like masks and gloves, reduction in the need for attending crowded public spaces, enhanced hygienic measures like frequent cleaning of door handles and other public surfaces, and similar measures (Bell et al., 2006).

While these measure, on the one hand, have contributed to saving lives, on the other hand, the COVID-19 pandemic is resulting in serious psychological effects such as anxiety, insomnia, panic behavior, fear, and hopelessness (Ammar et al., 2020b, 2021; Chtourou et al., 2020; Khan et al., 2020) and has caused and is still causing a massive economic shock across the world due to business interruptions, disruption and closures due to social-distancing measures (Martin et al., 2020). It was shown that COVID-19 home confinement has a negative effect on social participation and life satisfaction (Ammar et al., 2020a). To prevent viral infection, infected people should isolate themselves, which may increase the stress burden on family members due to the fear of getting infected (Khan et al., 2020).

In other words, preventive measurements during the massive lockdown may increase stress in the general and specific populations. Isolating infected individuals inside homes or jails/prisons may also increase the stress burden on family members due to the fear of getting infected. Indeed, the population must be informed during and after control of the pandemic about the possible impact of the viral outbreak, in terms of individual risk, outcomes of negative health behaviors, to take specific measures to mitigate such detrimental effects. Summarizing, public awareness regarding necessary actions to prevent the spread of a viral infection and counteract its negative impact is of paramount importance (Khan et al., 2020).

COVID-19 OUTBREAK'S IMPACT ON REFUGEES AND ASYLUM SEEKERS

Asylum seekers and refugees experience severe mental and physical strain (war, violence, political and religious persecution, poverty, imprisonment, torture as well as traumatic and hard living conditions, economic hardship, discrimination, social exclusion, exploitation) (Knappe et al., 2019). People in refugee camps live in a closed environment and in close proximity that facilitate transmission of diseases (WHO, 2020). They also have a greater underlying burden of disease and worse health conditions than the general population, and frequently face greater exposure to risks such as smoking, poor hygiene and weak immune defense due to stress, poor nutrition, or existing diseases (WHO Regional Office for Europe, 2020). People in places of detention should have comprehensive awareness of COVID-19 prevention strategies, including adherence to hand hygiene measures, respiratory etiquette (covering coughs and sneezes), practicing physical distancing (at least 1 meter from others), being alert to signs and symptoms of COVID-19, staying away from ill people (in the case of staff), and staying home when ill.

Many asylum seekers have complex mental health needs which can be exacerbated by the challenging circumstances in which they live and difficulties accessing health services (Haith-Cooper et al., 2018). Refugees have a higher prevalence rate for psychopathological disorders such as post-traumatic stress disorder (PTSD), depression, or anxiety disorders (Gerritsen et al., 2006). All this together makes COVID-19 spreading in world's refugee camps particularly concerning. Millions of displaced people in Bangladesh (Rohingya refugees), Syria (Idlib province), Lebanon, Africa (Kenya, Libya), and France (northern France), amongst others, have been gathered into crowded refugee camps and makeshift settlements, and threatened by the coronavirus spread (UNHCR, 2020).

In Bangladesh, refugee volunteers and aid workers have been struggling to educate people in these camps about the coronavirus to limit the spread of the virus (UNHCR, 2020). In Syria, families have been moved from large communal tents to individual tents, but social distancing is almost impossible (UNHCR, 2020). In Kenya, the United Nations High Commissioner for Refugees (UNHCR) has reduced contacts between residents and humanitarian workers (UNHCR, 2020). In addition to closing schools, some businesses and markets, and imposing curfews, UNHCR has been urging governments to include refugees and asylum-seekers in national plans to combat COVID-19 in Libya (UNHCR, 2020). In France, French authorities transferred up to 2,100 refugees and migrants in Calais and Dunkirk from informal camps to accommodation centers where they would be expected to follow the same coronavirus lockdown rules as the rest of France (UNHCR, 2020). In Lebanon, many steps have been taken to distribute soap, set-up isolation units and support Lebanon's health system to set up more intensive care units (UNHCR, 2020).

Refugees, asylum seekers, and displaced persons having fled the horrors of war, terrorism, and persecution, want to re-build their lives, and become a part of their new community. They have to face difficult living conditions, economic hardship, discrimination, social exclusion, and exploitation and, as mentioned before, are often exposed to severe mental and physical strain due to war, violence, political and religious persecution, poverty, imprisonment, or torture (Xin et al., 2017). Forced migration and resettlement are associated with distressing circumstances that contribute to poor physical and psychological wellbeing including high rates of trauma and other stress-related disorders (Ley et al., 2018; Ley and Barrio, 2019). Also, physical inactivity is a common phenomenon among refugees and immigrant populations (Crespo, 2000; Gerber et al., 2012). Refugee/asylum seeker status may affect the decision to engage with PA and/or exercise due to competing priorities, the temporary nature of living and mental and physical health (Haith-Cooper et al., 2018).

COVID-19 OUTBREAK'S IMPACT ON PRISONERS

The COVID-19 outbreak can occur easily in environments such as the jail and prison that represent shared or congregate living environments, due to the higher number of people working or residing in correctional facilities. Jails and prisons are constructed to maximize public safety to prevent the transmission of disease or to efficiently deliver health care. However, jails and prisons often lack sufficient hand washing areas, isolation rooms, and personal protective equipment (Bick, 2007) that may increase the probability of transmission of the virus amid inmates. Visits to prisons are temporarily suspended in many countries worldwide (Hewson et al., 2020) and the loss of such visits could lessen the use of social support for mitigating against and coping with mental distress and the risk of suicide and self-harm among prisoners (De Claire and Dixon, 2017).

As the virus continues to spread, the public health response to the pandemic in correctional facilities becomes more and more challenging and warrants a holistic approach. Attempts to control the COVID-19 community transmission are not likely to succeed if strict infection prevention and control measures, including testing, treatment, and care, are not implemented in prisons and other places of detention as well. As part of the response, the WHO has worked with relevant institutions and stakeholders to develop guidelines on preparedness, prevention, and management of COVID-19 in prisons as well as in other places of detention.

In addition, correctional facilities should provide sanitary guidelines to inmates who are exposed to air-borne droplets during staying in their cells or family visiting. Inmates, who tested positives and have the risk to transmit the virus through culinary activities in prison, should obviously be isolated and medically controlled and be careful regarding how to store, prepare and eat perishable food in their cells (CDC, 2020).

Staying home is not an option for people who are in prisons and jails across the world and social distancing is nearly impossible to practice except in solitary confinement. This results in dramatically impacting mental and physical health (Reiter et al., 2020). According to Human rights agencies, long-term solitary confinement is a torture (Reiter et al., 2020) and refers to the physical and social isolation of an individual which can induce psychological harms of segregation including self-harm, anxiety, depression, paranoia, and aggression (Kaba et al., 2014; Haney, 2018). Isolated prisoners would typically spend their time in a single cell for 22.5–24 h a day and solitary confinement can last for months or years, and can be of an indeterminate duration which can promote a sense of helplessness and increase hostility and aggression (Shalev, 2008).

Incarcerated inmates in jail facilities have an increased risk of human immunodeficiency virus infection, hepatitis B virus infection, hepatitis C virus infection, syphilis, gonorrhea, chlamydia, and *Mycobacterium tuberculosis* infection (Hammett et al., 2002), the acquisition of infection with airborne organisms, such as *M. tuberculosis,* influenza virus, and varicella-zoster virus (Bick, 2007), as well as high rates of hypertension (Binswanger et al., 2009; Trotter et al., 2018), poor sleep quality (Harner and Budescu, 2014), anxiety, and depression (Binswanger et al., 2010).

Practicing social distance in prisons is difficult due to the issues of overcrowding and the fear increases if correctional facilities become epicenters in the coronavirus pandemic. Correctional facilities try to minimize the risk of transmission by quarantining a sick prisoner which is the segregation that is usually used as a punitive measure. Another way to protect inmates who are elderly, immunocompromised, medically vulnerable, close to release, or associated with minor, non-violent crimes, is to decarcerate or release them. Indeed, sending them home can protect prisoners, correctional workers, their families and the broader community. Upon release from prison, many individuals experience difficulty in maintaining good health (Wallace and Wang, 2020) because infected prisoners might bring disease from jail into their communities. Therefore, in case of pandemic, released prisoners should pass by a quarantine period before entering in contact with their family members and community.

Imprisoned people have usually a poor health status in comparison with the general population (Fazel and Baillargeon, 2011; Mannocci et al., 2015). More than 40 of the 50 largest clustered outbreaks in the United States have occurred in jails and prisons (Macmadu et al., 2020) and the number of COVID-19 cases is 5.5 times higher among people who are incarcerated (Saloner et al., 2020). Several behavioral factors including use of intravenous drug, alcohol misuse, smoking, and physical inactivity could increase the risk of morbidity, mortality, and mental disorders (Brinded et al., 2001; Cashin et al., 2008; Fischer et al., 2012; Battaglia et al., 2015). As well, overcrowding, and high occupant turnover may increase the risks of transmission in prisons and jails (Macmadu et al., 2020).

PA/EXERCISE DURING COVID-19 PANDEMIC

As of today, clinical practice, community programs, mass-media campaigns, and population strategies have focused mainly on encouraging and supporting individuals to be more active, during staying at home. As the mortality rate of patients with positive COVID-19 test and confined and isolated people continues to increase and chronic medical problems from inactivity become increasingly prevalent, there is now an imperative to increase the PA levels of refugees, asylum seekers, and prisoners and overall total daily energy expenditure.

During the COVID-19 induced confinement, the behavior of prolonged sitting time that is a predictor of weight gain, requires that individuals should be aware of the amount of PA necessary to achieve better health outcomes, understand the importance of PA and exercise in relation to good physical and mental health, and prevent overweight, obesity and chronic disease (Owen et al., 2009). PA is defined as any bodily movement produced by skeletal muscles which results in energy expenditure and can be categorized into occupational, sports, conditioning, household, or other activities. Exercise is a planned and structured program of motor actions to improve or maintain components of physical fitness (Caspersen et al., 1985). As previously mentioned, PA/Exercise is a potent stimulus of immune function (Ghram et al., 2020a; Laddu et al., 2020) to fight against the mental and physical consequences of COVID-19 quarantine (Jiménez-Pavón et al., 2020). The types of exercise prescribed can vary by mode, dose, setting, the person who delivers the intervention, and any accompanying behavioral strategies (e.g. counseling, pamphlets) (Campbell et al., 2007). To attenuate negative effects of SB and physical inactivity, individuals are required to participate in regular PA and minimize the time they spend sitting to prevent cardiovascular and metabolic disease, certain types of cancer, and mental deficits (Vogel et al., 2009; Piercy et al., 2018).

Social and physical distancing and isolation are required to stop the transmission of infectious disease. Facing this new situation, exercise professionals encourage people to maintain good health and have recommended to use online technology to prescribe, and monitor exercise, such as mobile telephones messages, apps, email, video calls, or other internet-based strategies (de Oliveira Neto et al., 2020; Ghram et al., 2020a). Isolated/confined or imprisoned individuals should raise energy expenditure as much as is necessary by participating in moderate to vigorous PA to prevent obesity and decrease sedentary time. While the benefits of PA are not disputed, reducing sedentary time is of vital importance (Bowden Davies et al., 2019).

Physical exercise can be a major part of a multi-component strategy targeted at reducing psychological ill health in asylum seekers, refugees, and prisoners (Mannocci et al., 2017). Evidence shows that physical exercise is widely recommended for general and specific populations to maintain health status, improve daily life activities, play a fundamental role in protecting against disease, and provide biological and psychological benefits. The American College of Sports Medicine (ACSM) has released information on how to remain active during the COVID-19 pandemic (ACSM, 2020) and has emphasized the positive effects of the regular practice of physical exercise on the enhancement of the immunological system in humans, showing that physically active people have a lower risk of developing chronic-degenerative diseases, which is highly pertinent and related to COVID-19, as those affected are at higher risk if infected by SARS-CoV-2 (Pedersen and Saltin, 2015; de Oliveira Neto et al., 2020). Therefore, people in isolation and with a positive diagnosis for COVID-19, but who are asymptomatic, should be able to continue the regular practice of moderate intensity PA. However, in the presence of symptoms (e.g., fever, cough, and dyspnea), the practice of PA should be interrupted and medical assistance should be sought (Joy, 2020). Special attention should be paid to asylum seekers, refugees, and prisoners, because among these vulnerable populations PA and exercise have benefits on physical and mental health and can prevent psychological disorders.

PA/EXERCISE AS AN EFFECTIVE COUNTERMEASURE TO THE PSYCHO-SOCIAL EFFECTS OF COVID-19 AMONG REFUGEES AND ASYLUM SEEKERS

Considering that asylum seekers and refugees represent highly heterogeneous groups with different cultural backgrounds and might be more prone to the psychosocial impact of the COVID-19 pandemic, PA/exercise might be an effective and safe alternative to mitigate this risk and reduce the breadth and depth of physical and mental needs of these vulnerable groups.

Among immigrants and those seeking refuge into highly developed nations, PA level is not satisfactory and, in general, lower than among non-immigrants (Sternfeld et al., 1999; Crespo et al., 2000; Gadd et al., 2005), and programs aimed at increasing PA within 10 years of arrival may be particularly effective (Goel et al., 2004). Exercises and sports-related activities can be utilized to properly treat various psychiatric diseases (Lam and Riba, 2016), and are instrumental to human wellbeing (Lederman et al., 2017). Even though international organisms, such as the UNHCR, acknowledge the feasibility of exploiting exercise and sport as a peace-building measure in refugee camps with healthy individuals (Korsik et al., 2013), evidence has shown that adequate PA levels have also a beneficial impact on traumatized subjects (Rosenbaum et al., 2015, 2018).

Twelve weeks of biofeedback-based cognitive behavioral therapy (CBT-BF) combined with PA (including mixed activities such as flexibility, strength, and endurance training) resulted in enhanced coping strategies and mechanisms to face pain with respect to CBT-BF alone or a waiting-list control condition in 36 refugees from Germany and Switzerland reporting PTSD symptoms (Liedl et al., 2011). In another study from Denmark, Stade et al. (2015) reported high acceptability, compliance and satisfaction with basic body awareness therapy (BBAT). Positive effects on mental health outcomes were observed after 12 weeks of regular physical activity among Bosnian refugees in the United States (Xin et al., 2017). Regularly attending a 8-week sport and exercise program has been found to exert a positive influence on a wide range of mental health outcomes, including PTSD, depressive, anxiety symptoms, health-related quality of life, handgrip strength, and perceived and cardiorespiratory fitness (Knappe et al., 2019).

Moderate PA and/or sport can beneficially modulate physical and mental health and wellbeing for refugees and asylum seekers living in particularly challenging conditions. Refugees and asylum seekers should be instructed about accumulating adequate PA levels through changes in their lifestyle [for example, by walking faster or increasing intensity when carrying out housework (Haith-Cooper et al., 2018)]. Thus, performing PA during the COVID-19 pandemic could potentially help these populations better cope with their limited movement and difficult psychological conditions.

PA/EXERCISE AS AN EFFECTIVE COUNTERMEASURE TO THE PSYCHO-SOCIAL EFFECTS OF COVID-19 AMONG PRISONERS

Prisoners and inmates are at higher risk of adopting unhealthy lifestyles such as tobacco smoking, drug abuse, low physical activity and irregular dietary habits, factors that may lead to the insurgence of acute and chronic physical and psychological disorders (Mannocci et al., 2015).

Lack of PA may affect negatively psychological status of prisoners and inmates and increase anxiety (Boothby and Clements, 2000), stress, and depression (Plugge and Fitzpatrick, 2005) rates. One of the factors challenging their ability to practice PA and exercise is overcrowding (WHO Regional Office for Europe, 2020). Thus, prisoners experience difficulties in moving and undertaking the necessary amount of moderate PA necessary to benefit their health (WHO Regional Office for Europe, 2020). A "decent" prison regime should ensure that prisoners are able to be compliant with the WHO guidelines and recommendations on PA, and are sufficiently instructed how to make an informed choice about optimal PA and exercise programs and strategies (WHO Regional Office for Europe, 2020). It was shown that PA is a simple and cost-effective way to positively modulate the health-related quality of life (QoL) of prisoners and can contribute to achieving "healthy prison" objectives in practice (Meek and Lewis, 2012). Regular physical exercise can enhance inmates QoL, allow a better social cohesion and integration at the end of detention in prisons (Mannocci et al., 2015), reduce depression, anxiety, stress (Buckaloo et al., 2009), and sleep problems such as insomnia (Elger, 2009), increase muscle tone, strength, stamina (Nelson et al., 2006), and functional capacity (Battaglia et al., 2013), and improve overall physical fitness of incarcerated people (Pérez-Moreno et al., 2007).

Taking into consideration the health status of prisoners, the lack of availability of safe equipment for training, and the limited space derived from the condition of being incarcerated, we suggest to make a bodyweight workout plan to help the prisoner get ripped while being in isolation. Warm-up should last at least 10 min (jog on the spot, high knee tucks, butt kicks, skip, forward lunge and twist, carioca, lateral lunge and twist, slides, high knee crossovers, exaggerated backpedal). Other exercises can be performed easily such as Push-Up, Dips, Sit-Ups, Squats, Burpees, Star-Jumps, Wide-Grip Pull-Ups, and Step-Ups. Furthermore, relaxation techniques and stretching exercises are easy to carry out in a practical fashion without the risk of being exposed to a contaminated environment and are effective in promoting health gains and reduce stress levels (Bentlage et al., 2020; Ghram et al., 2020a). Stretching exercises may improve stability and balance of these vulnerable populations (Costa et al., 2009; Handrakis et al., 2010; Ryan et al., 2010; Chatzopoulos et al., 2014; Ghram et al., 2016, 2020b).

PRACTICAL RECOMMENDATIONS

Coronavirus Disease 2019 outbreak poses significant challenges to these specific populations. Preventative healthcare measures should be implemented to reduce disease transmissions within prisons and camps and decrease negative mental health problems wherever possible. Since less attention for these specific populations compared to the general population is generally paid, we recommend that these vulnerable populations are potentially encouraged to stay more physically active, and informed about the risk of SB and physical inactivity. There is increasing need in this community to encourage prisoners, asylum seekers, and refugees to engage at least in low exercise intensity to enhance their fitness, physical and psychological health, and wellbeing and reduce the risk of disability. In further research, researchers and scientists are required to focus on developing more efficient strategies to reduce the negative effect of pandemic spread. Future studies should investigate the impact of PA and exercise in these vulnerable groups during pandemic outbreak, as well as after having achieved the full control of the spread of the epidemic in non-infected and infected individuals.

CONCLUSION

The COVID-19 pandemic is still ongoing, exerting a dramatic, detrimental impact on PA-related patterns and sedentary lifestyle and posing severe challenges for asylum seekers, refugees, and prisoners, globally. The available body of evidence suggests that exercise is medicine and protects from infections, mainly among specific vulnerable and frail populations. Physical exercise, indeed, positively impacts mental wellbeing and provides protection to individuals against depression and anxiety as it causes biochemical and biophysical changes in the brain which can positively influence their mood. Since public health measures (confinement, isolation, social and physical distancing) are aimed to protect vulnerable populations during pandemic, but, on a long-term scale, may have secondary negative effects on health and well-being, these specific vulnerable populations should live in adequate physical conditions, having regular access to fresh, healthy air and being able to practice PA/exercise. Notwithstanding variations in individual tolerance to living in confined environments, there is remarkable evidence of the consistency of public health measures psychological as well as physiological health effects. In addition, PA/exercise can be considered as a viable tool for the treatment, and management of people who are living in confined environments and/or are experiencing limited movement because of virus-related outbreaks.

AUTHOR CONTRIBUTIONS

AG, NLB, and KC conceived the manuscript. All authors wrote and revised the manuscript.

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Home Confinement in Previously Active Older Adults: A Cross-Sectional Analysis of Physical Fitness and Physical Activity Behavior and Their Relationship With Depressive Symptoms

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Aim: The aim of our study was to analyze physical activity levels, sitting time, physical fitness, and their relationship with depressive symptoms after home confinement in previously active older adults.

Methods: This cross-sectional study sample comprised 68 older adults (74.24 ± 5.67 years) from a community-based exercise program conducted in Porto, Portugal. After home confinement, participants were assessed in person for lower-body strength (30-s chair stand test), cardiorespiratory fitness (6-min walking test), agility/dynamic balance (8-ft up-and-go test), handgrip strength, and anthropometry. Telephone interviews were performed to evaluate depressive symptoms with the Geriatric Depression Scale – 15 items (GDS-15) and physical activity levels through the International Physical Activity Questionnaire (IPAQ-SV). Individuals were also asked to self-report changes in their physical activity levels and time spent sitting.

Results: Ninety percent of older adults self-reported a decrease in overall physical activity levels, and nearly 65% increased daily sitting time during the home confinement. However, previously active older adults still presented high levels of physical fitness (scores above 50th compared with Portuguese normative values) after 11 weeks of home confinement. Overall, 52.9% of participants scored 5 or more points on GDS-15, which is suggestive of depression. Higher levels of moderate-to-vigorous physical activity (MVPA) and cardiorespiratory fitness were found in the non-depressed group compared with the depressed group. Finally, results from multiple regression analysis revealed that MVPA was negatively associated with depression. This model explained 16.4% of the variability seen in depression score, controlled for age, gender, and education.

Conclusion: Even reporting a decline in physical activity, older adults who previously participated in a formal exercise program, still presented high levels of physical fitness after 11 weeks of home confinement. However, MVPA, but not physical fitness, seems to be an associated depression score in previously active older adults. These results reinforce the importance of older adults to remain physically active, since higher levels of MVPA may have a protective effect on depressive symptoms and, therefore, mitigate the negative impact of home confinement on mental health. Future longitudinal research studies are needed to ascertain these results.

Keywords: depression, mental health, COVID-19, exercise, multicomponent training

INTRODUCTION

Currently, the number of new COVID-19 cases are on the rise worldwide. Most of the countries already adopted measures of social distance to contain the spread of the virus and even more strict measures like partial or full lockdown to relief their highly pressured health systems (Han et al., 2020).

This unprecedented scenario drastically changed daily routines and restricted individuals' freedom. In addition, the uncertainty around the pandemic progression, its economic, social, and public health impact, will undoubtedly contribute to emotional distress and increased risk for psychiatric illness among the general population (Pfefferbaum and North, 2020). In line, a recent systematic review found that the COVID-19 pandemic is associated with highly significant levels of psychological distress among the general population (Xiong et al., 2020). Indeed, these findings on mental health are clear and concerning, and can be explained by the fear of being infected or infecting others, mandatory home confinement, and the impossibility to spend time with loved ones that are dying or even for not being allowed to perform the usual farewell rituals. These factors can lead to negative feelings of anxiety, helplessness, depression, irritability, and anger (Mari and Oquendo, 2020). Shortly after the beginning of this pandemic, Holmes et al. (2020) published a call for action in *Lancet Psychiatry* highlighting the need to investigate the impact of COVID-19 on mental health, particularly, on vulnerable groups like older adults, in order to design strategies that mitigate its negative health consequences (Holmes et al., 2020).

Older adults are a vulnerable group that was particularly affected because they were asked to self-isolate at home and avoid any unnecessary contact with other people. While isolated at home, they are likely to have restricted access to physical activity and, therefore, prone to become more sedentary and less active (Valenzuela et al., 2020; Woods et al., 2020), which can lead to consequences such as functional decline, frailty, depression, metabolic syndrome, and increased risk of all-cause mortality (Roshanaei-Moghaddam et al., 2009; Rezende et al., 2014). Concomitantly, social isolation and loneliness are major risk factors linked with poor physical and mental health status (Wu, 2020). These aggregated factors can lead to an unprecedented negative cycle with impact on older adult's health and well-being.

Mental health problems are common in older adults, particularly depressive symptoms. In Portugal, the estimated prevalence of anxiety and depression are 9.6 and 11.8%, respectively (de Sousa et al., 2017). These numbers are expected to rise as a result of this health crisis. Krendl and Perry (2020) found that older adults reported higher depression and greater loneliness succeeding the onset of the pandemic (Krendl and Perry, 2020). Adding to this, Nguyen et al. verified that people aged 60 years or above had increased the likelihood of depression and poor health-related quality of life during the ongoing pandemic (Nguyen et al., 2020).

The relationship between physical activity and depression has been described. Physical exercise, a subcategory of physical activity, can positively impact several biological (from inflammation to the endocrine system) and psychosocial processes like social support and self-esteem that integrate the pathophysiology of depression (Kandola et al., 2019). Robust evidence from a meta-analysis of prospective cohort studies found a protective role of physical activity in the incidence of depression among older adults, since individuals with high levels of physical activity had 21% lower odds of depression compared with those with low levels of physical activity (Schuch et al., 2018). Moreover, low levels of physical activity and sedentary behavior (SB) are associated with a greater risk of depression and mental health problems (Mammen and Faulkner, 2013; Huang et al., 2020). SB has been associated with negative physical and mental health consequences, independent of the physical activity (Smith et al., 2018). The results, so far, indicate an association between SB and perceived stress, risk of insomnia and sleep disturbance, cognitive performance, and dementia (Falck et al., 2017; Yang et al., 2017; Ashdown-Franks et al., 2018), which are critical problems among older adults. However, some results are still unclear and inconsistent, and need further investigation.

Also, there seems to be an important association between physical fitness and depression. Another meta-analysis found that low cardiorespiratory fitness was associated with a 64% higher risk of depression when compared with high cardiorespiratory fitness; however, authors reinforced the substantial heterogeneity seen between studies (Kandola et al., 2019). In this sense, it is expected that physically active older adults might have increased protection against the detrimental impact of home confinement on mental health (Caputo and Reichert, 2020; Moreira et al., 2020).

The impact of home confinement caused by the COVID-19 outbreak on older adults' activity behaviors and mental health has yet to be investigated in depth, as this information can enlighten policy efforts during the next few months of this pandemic. Therefore, this study aims to analyze physical activity levels, sitting time, and physical fitness status and their relationship with depressive symptoms after home confinement in older adults that used to participate in formal exercise program.

MATERIALS AND METHODS

A cross-sectional study was conducted on post-confinement data aiming to analyze physical activity levels, sitting time, physical fitness, and their relationship with depressive symptoms in previously active older adults.

Sample

Participants were engaged since October 2019 in a program of physical activity called "Mais Ativos Mais Vividos" (MAMV), which consists of a community-based exercise program hosted at the Faculty of Sports of the University of Porto, Portugal. This scholar year intervention started in the middle of October 2019. Participants maintained their normal in-person exercise sessions until March 18, the day on which the country entered a state of emergency, and all activities ceased.

The eligibility criteria for this study were physically active subjects aged ≥65 enrolled at the exercise program MAMV in the scholar year 2019–2020. Participants who developed any acute health condition (e.g., cardiovascular events and osteoarticular or musculoskeletal injuries/conditions in which exercise is contraindicated) during the home confinement were excluded from this study since that could affect physical performance and testing procedures.

Before the COVID-19 pandemic, 107 older adults were participating in the MAMV exercise program. After 11 weeks of home confinement, all participants were contacted, and 72 accepted to participate and were evaluated. From those, 68 (74.24 ± 5.67 years) had valid data (**Figure 1**). Our sample was composed of participants that were enrolled in this program for at least 3 years (nearly 70% of the participants) for an average of 5 years.

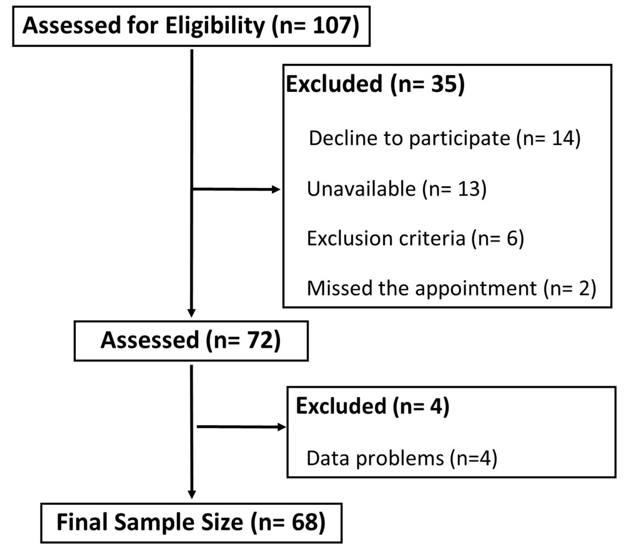

FIGURE 1 | Study flowchart.

Instruments

Anthropometry

Height (cm) was measured using a calibrated portable stadiometer (Seca 217, Hamburg) with 0.1-cm resolution. Body weight (kg) was measured to the nearest 0.1 kg (InBody Co., Ltd., South Korea). Body mass index (BMI) was calculated as the weight divided by the squared height (in meters). Overweight and obesity were classified according to WHO cutoff points (World Health Organization, 1995).

Physical Fitness

Physical fitness was measured using the Senior Fitness Test (SFT) (Rikli and Jones, 2001), a reliable instrument to assess older adults with ≥60 years old. This physical battery includes lower-body strength (30-s chair stand test), cardiorespiratory fitness (6-min walking test), and agility/dynamic balance (8-ft up-and-go test). To measure the lower body strength, participants were asked to sit in a 43-cm armless chair with their arms folded across the chest and execute the maximum of full stands within 30 s. The score was the total number of stands completed within that time. Cardiorespiratory fitness was measured using a 6-min walk test in which participants were asked to walk as fast as possible for 6 min. The score was the total distance walked along a 45.72-m rectangular course, which was marked every 4.57 m. Finally, to assess agility and dynamic balance, participants were asked to stand up, walk an 8-ft distance (2.44 m), turn the cone marker around, and return to the seated position, as quickly as possible. The time necessary to complete this test was registered (in seconds). Participants' scores were further compared with the normative functional fitness standards for the Portuguese older adults (Marques et al., 2014).

Handgrip strength was obtained with a Jamar Plus + Digital hand dynamometer (Sammons Preston Inc., Bolingbrook, IL, United States) (Mendes et al., 2017). Measurements were carried out following the American Society of Hand Therapists recommendations (American Society Hand Therapy, 1983), and each participant performed three attempts with a pause of 1 min between them. The maximum value of the three measurements with the dominant hand was registered in kilograms force (kgf).

Physical Activity

Physical activity was measured using the Portuguese validated short version of the International Physical Activity Questionnaire (IPAQ-SV) (Craig et al., 2003). The IPAQ-SV comprises the frequency and duration of vigorous and moderate physical activity, walking, and one additional item on time spent sitting. Participants were classified into three categories of physical activity: high, moderate, and low, according to IPAQ-SV scoring protocol available at http://www.ipaq.ki.se/ (IPAQ, 2010).

Participants were categorized as high if they performed vigorous-intensity activities on at least three days and accumulated at least 1,500 MET-min/week, or any combination of walking, moderate-intensity, or vigorous-intensity activities on at least 7 days, achieving a minimum of 3,000 MET-min/week.

As moderate, if they performed three or more days of vigorous activity of at least 20 min/day, or five or more days of moderate-intensity activity or walking of at least 30 min per day; or five or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum of at least 600 MET-min/week. Finally, participants were categorized as low if they did not meet the criteria for the categories moderate or high.

Additionally, similar to other studies (Cleland et al., 2018), average time spent on moderate to vigorous physical activity (MVPA) was computed as the result of the sum of the number of days with vigorous activity multiplied by the time spent in this intensity, plus the number of days with moderate activity multiplied by the time spent in this intensity, and then divided by 7 days. The questionnaire was applied in the form of an interview via phone calls.

Changes in Movement Behaviors

Participants were asked to self-report changes in physical activity and sitting time through two short answer questions: in comparison with your prior confinement routine, did your daily physical activity/sitting time increased, maintained, or decreased during home confinement? (DGS, 2020).

Depression

The Geriatric Depression Scale – 15 items (GDS-15) is a widely used self-report measure to screen depressive symptoms among older adults. Of the 15 items, 10 indicate the presence of depression when answered positively, while the question numbers 1, 5, 7, 11, and 13 indicate depression when answered negatively (Pocklington et al., 2016). A score $\geq$5 points is suggestive of depression (Pocklington et al., 2016). The validated Portuguese version present a good internal consistency (α Cronbach = 0.83) (Apóstolo et al., 2014). This evaluation was based in interviews, via telephone.

Procedures

The previous in-person MAMV exercise program encompassed a multicomponent training (MT), twice a week, in 60-min sessions. Sessions comprised 10 min of warm-up, 30 min of aerobic and resistance training, 10 min of balance and coordination exercises, and a cool down of approximately 10 min. Warm-up included mobility/stretching and low-intensity aerobic exercises such as walking. Afterward aerobic exercises at moderate-to-vigorous intensity (such as dance, step, and circuit training were performed. Leg press, squats, chest press, vertical row, core exercises, biceps' curl, and arm raises are some examples of the resistance training exercises aiming at major muscle groups (two sets of 10–12 repetitions at moderate intensity). Balance and coordination exercises will gradually reduce base support and include dynamic movements. The cool down was used for some respiratory and stretching/flexibility exercises.

The in-person exercise program ceased on March 18, the day on which the Portuguese government declared the state of emergency and mandatory lockdown. Therefore, very strict measures of physical–social distancing were adopted to control the outbreak. People were not allowed to circulate in public spaces or roads except to obtain essential goods and services, work, or go for short walks, alone or with members of the same household, following the safety and physical distance guidelines.

Data Collection

On June 1, mandatory confinement ended, and it was allowed to gather under 20 persons outdoors following the safety and physical distance guidelines. In the following days, participants from the MAMV program were contacted twice by phone. In the first contact, they were invited to participate in in-person evaluations of anthropometry (e.g., height and body weight) and physical fitness (e.g., SFT and handgrip strength). For those who agreed to participate, the in-person evaluations were scheduled.

The in-person evaluations were carried out in the outdoor park at the Faculty of Sports, University of Porto. Two participants were scheduled every 20 min to avoid potential contact between individuals. Facial masks were mandatory throughout all procedures, and safety guidelines were strictly followed. Afterward, a second contact was made to apply physical activity (e.g., IPAQ-SV and self-reported changes in movement behaviors) and depression questionnaires (e.g., GDS-15). Five phone call attempts were made, and those who did not answer were excluded.

All participants signed an informed consent form, and all procedures were conducted in full accordance with the Helsinki Declaration. The study was approved by the Ethical Committee of the Faculty of Sports of the University of Porto (Ref CEFADE15.2020).

Statistical Analyses

Data normality was verified using Kolmogorov–Smirnov tests. Measures of central tendency [mean and median (Mdn)] and dispersion [standard deviation and interquartile range (IR)] were used as appropriate to describe sample characteristics. Between-group comparisons were performed with both parametric (independent *t*-test) and non-parametric approaches (Mann–Whitney *U* test) for continuous variables and chi-squared test for categorical variables. Univariable linear regression models were performed to examine associations between the independent variables (i.e., MVPA, sitting time, and physical fitness variables) and depression score (continuous variable). Multivariable linear regression models were built by entering those variables that were statistically significant in the univariable analysis controlling for age, gender, and educational level, with enter selection of variables. Multicolinearity was verified using VIF. The significant level was set as 95%, and procedures were carried out with SPSS version 24 (IBM, Chicago, IL, United States).

RESULTS

Sample Characteristics

The characteristics of the sample are shown in **Table 1**. Participants had an average age of 74 years old (range 65–90), were predominantly female (60.3%), and with 6–12 years of education. Moreover, 21 participants (30.9%) completed primary school and 18 (26.5%) had a degree. The majority (73.5%) were classified as overweight or obese. Approximately 90% of

TABLE 1 | Characteristics of the study population.

	Overall (n = 68)
Age	74.24 ± 5.67
Gender	
Female, n (%)	41 (60.3)
Education	
<6 years, n (%)	21 (30.9)
6–12 years, n (%)	29 (42.6)
>12 years, n (%)	18 (26.5)
BMI, kg/m^2	27.15 ± 3.48
Overweight and obesity, n (%)	50 (73.5)
Physical activity and sitting time	
MVPA, min/day	13.93 [0.00–30.00]
Daily sitting time, min/day	300 [180–480]
Physical activity status	
Low PA, n (%)	29 (42.7)
Moderate PA, n (%)	28 (41.2)
High PA, n (%)	11 (16.1)
Changes in PA during confinement	
Decreased, n (%)	61 (89.7)
Maintained, n (%)	4 (5.9)
Increased, n (%)	3 (4.4)
Changes in daily sitting time	
Decreased, n (%)	2 (2.9)
Maintained, n (%)	22 (32.4)
Increased, n (%)	44 (64.7)
Physical fitness	
Cardiorespiratory fitness (m)	565.22 ± 82.48
Lower body strength (reps)	21.10 ± 4.22
Agility (s)	5.04 ± 1.02
Handgrip strength (kgf)	28.93 ± 9.15
Depression (score)	4.81 ± 2.63
Symptoms of depression, n (%)	36 (52.9)

Values are mean ± SD (continuous variables), median [interquartile range] or percentage (categorical variables). PA, physical activity; MVPA, moderate to vigorous physical activity; BMI, body mass index.

older adults self-reported a decrease in overall physical activity levels, while 64.7% increased daily sitting time during the home confinement. Participants report low levels of daily MVPA [13.93 min per day (0.00–30.00)]. Moreover, according to IPAQ-SV, 57.3% were included in the moderate or high category of physical activity.

Participants presented high levels of fitness on lower body strength (above the 90th percentile), on agility/dynamic balance (above the 75th percentile), and on cardiorespiratory fitness test (above the 50th percentile) when comparing with the Portuguese population functional fitness standards on the 75- to 79-year-old age group.

Participants presented an average GDS-15 score of 4.81 ± 2.63 points. Two groups were created based on the GDS-15 score: non-depressed group comprising participants with scores <5 and the depressed group for older adults who scored ≥5 points. Thus, 52.9% of the participants (n = 35) had suggestive symptoms of depression or indicative symptoms of depression (i.e., GDS > 10, n = 1).

Comparisons Between Non-depressed and Depressed Groups on Physical Fitness, Physical Activity, and Sitting Time

No significant differences were registered between groups for sitting time (p > 0.05). Additionally, MVPA was significantly higher within the non-depressed group [Mdn 25.71 (5.89–120)] compared with those in the depressed group [Mdn 4.29 (0–18.75), p = 0.029) (**Table 2**). Concomitantly, most participants from the depressed group were categorized as low physical activity levels on IPAQ-SV, whereas the majority of the non-depressed group were classified as moderate or high physical activity level (p < 0.001). No significant differences between groups were found for handgrip strength, lower-body strength, agility/dynamic balance, or cardiorespiratory fitness (all p > 0.05). After controlling for age, gender, and educational level, group differences were sustained for MVPA (data not shown).

Relationship Between Physical Activity, Sitting Time, and Physical Fitness With Depression Score

Linear regression analysis was conducted to explore the association between MVPA, sitting time, and physical fitness variables with depression score (continuous scale). Results from the crude analysis showed that MVPA [R^2 = 0.191; $F_{(1,63)}$ = 15.538; p < 0.001] and sitting time [R^2 = 0.067; $F_{(1,66)}$ = 4.759; p = 0.033] was associated with GDS-15 score. Physical fitness variables [cardiorespiratory fitness (p = 0.141), agility (p = 0.977), handgrip strength (p = 0.891), and lower body strength (p = 0.592)] were not associated with GDS-15 scores (**Table 3**). In multivariable analyses, after adjusting the model for age, gender, and education level, MVPA remained significantly associated with GDS-15 score (B = −0.019, 95% CI: −0.029 to −0.009, p < 0.001), whereas sitting time did not (p = 0.054). The whole model explained 16.4% of the variance seen in depression score (**Table 3**).

DISCUSSION

The present study analyzed the physical activity levels, sitting time, and physical fitness status after 11 weeks of home confinement due to the COVID-19 pandemic and explored their relationship with depressive symptoms on older adults that were previously regular participants of a formal exercise program. Overall, participants self-reported drastic changes in physical activity and sitting time, but presented high physical fitness levels after 11 weeks of home confinement, above the average for the Portuguese normative values (Marques et al., 2014). Symptomatology of depression was found in 52.9% of previously physically active older adults after confinement. Our data showed significant differences between groups as the non-depressed group presented higher values of MVPA compared with the depressed group. Furthermore, only MVPA remained negatively associated with GDS-15 scores in the regression analysis.

TABLE 2 | Comparisons between the non-depressed and depressed group.

	Non-depressed group (*n* = 32)	Depressed (*n* = 36)	Statistical inference
Age	73.56 ± 6.21	74.89 ± 5.16	$t(66) = -0.962$, $p = 0.340$
Gender			
Female, *n* (%)	21 (65.6)	20 (55.6)	$\chi^2(1) = 0.718$, $p = 0.397$
Physical activity and sitting time			
MVPA (min/day)	25.71 [5.89–120]	4.29 [0–18.75]	$U = 308.05$, $p = 0.001$
Daily sitting time (min/day)	300 [180–345]	360 [195–585]	$U = 668$, $p = 0.255$
Physical activity status			
Low PA, *n* (%)	7 (21.9)	22 (61.1)	$\chi^2(2) = 18.588$, $p < 0.001$
Moderate PA, *n* (%)	14 (43.8)	14 (38.9)	
High PA, *n* (%)	11 (34.4)	0 (0)	
Changes in PA during confinement			
Decreased, *n* (%)	27 (84.4)	34 (94.4)	$\chi^2(2) = 1.908$, $p = 0.385$
Maintained, *n* (%)	3 (9.4)	1 (2.8)	
Increased, *n* (%)	2 (6.2)	1 (2.8)	
Changes in daily sitting time			
Decreased, *n* (%)	2 (6.2)	0 (0)	$\chi^2(2) = 2.592$, $p = 0.274$
Maintained, *n* (%)	11 (34.4)	11 (30.6)	
Increased, *n* (%)	19 (59.4)	25 (69.4)	
Physical fitness			
Cardiorespiratory fitness (m)	584.79 ± 92.59	543.77 ± 66.68	$t(63) = 1.862$, $p = 0.067$
Lower body strength (reps)	20.61 ± 3.73	21.53 ± 4.61	$t(65) = -0.884$, $p = 0.380$
Agility (s)	5.03 ± 1.13	5.04 ± 0.92	$t(66) = -0.034$, $p = 0.973$
Handgrip strength (kgf)	28.18 ± 8.49	29.59 ± 9.77	$t(66) = -0.633$, $p = 0.529$

Values are mean ± SD (continuous variables), median [interquartile range], or percentage (categorical variables). PA, physical activity; MVPA, moderate-to-vigorous physical activity; BMI, body mass index; t, independent sample t-test; χ^2, Chi square test; U, Mann–Whitney U test.

TABLE 3 | Associations between moderate-to-vigorous physical activity, sitting time, and physical fitness with depression score.

Parameters	Unstandardized coefficients		95% IC	*p*-value
	B	**SE**		
MVPA model				
Unadjusted MVPA model (R^2 = 0.191)				
MVPA	−0.019	0.005	[−0.029 to −0.010]	<0.001
Adjusted MVPA model (R^2 = 0.164)				
MVPA	−0.019	0.005	[−0.029 to −0.010]	<0.001
Gender	0.095	0.602	[−0.827 to 1.793]	0.875
Age	0.071	0.053	[−0.070 to 0.167]	0.184
Education	0.091	0.395	[−0.933 to 0.777]	0.819
Sitting time model				
Unadjusted sitting time model (R^2 = 0.067)				
Sitting time	0.003	0.002	[0.001 to 0.007]	0.033
Adjusted sitting time model (R^2 = 0.028)				
Sitting time	0.003	0.002	[0.001 to 0.007]	0.054
Gender	0.216	0.649	[−1.082 to 1.513]	0.741
Age	0.062	0.057	[−0.052 to 0.175]	0.281
Education	0.112	0.435	[−0.758 to 0.982]	0.798
Physical fitness models				
Unadjusted cardiorespiratory fitness (R^2 = 0.034)	−0.006	0.004	[−0.014 to 0.002]	0.141
Unadjusted lower body strength (R^2 = 0.004)	0.042	0.078	[−0.113 to 0.197]	0.592
Unadjusted hand grip strength (R^2 < 0.001)	0.005	0.035	[−0.066 to 0.076]	0.891
Unadjusted agility (R^2 < 0.001)	−0.009	0.318	[−0.645 to 0.626]	0.977

Depression affects more than 264 million people worldwide, independently of age, gender, and ethnic background. This highly prevalent mental disorder is one of the leading causes of disability and a major contributor to the overall global burden of disease (World Health Organization, 2020a). The long-term mental health impact of COVID-19 may take weeks, months, or even years to become evident (Rajkumar, 2020). According to the World Health Organization, older adults may become more anxious, angry, stressed, agitated, and withdrawn during the outbreak or while in quarantine – particularly those isolated or with impaired cognitive function (World Health Organization, 2020b).

It is well known that PA, and particularly exercise, have a therapeutic effect on individuals' physical and mental health, especially when performed outdoors or in groups (Burtscher et al., 2020). However, our data showed that being previously active for an average of 5 years did not prevent older adults (52.9%) from reporting suggestive symptoms of depression. Despite not measuring if the participants were already experiencing this symptomatology before the home confinement, this finding was somewhat unexpected for two reasons: First, given the well-known therapeutic effects that PA, and particularly exercise, have on individuals' physical and mental health, especially when performed outdoors or in groups, as our program did (Burtscher et al., 2020), and second, because some reviews elicit the long-lasting effect of light-to-vigorous exercise on depressive symptoms (Helgadóttir et al., 2017), and only 11 weeks had passed between ceasing the exercise program and the post-confinement assessments. Nevertheless, findings in this matter are still controversial and inconsistent as a systematic review and meta-analysis of randomized controlled trials showed little evidence of a long-term beneficial effect of exercise in patients with clinical depression (Krogh et al., 2011) and suggested a short-term effect instead.

Several authors (Valenzuela et al., 2020; Woods et al., 2020) highlighted the severe consequences of physical–social distancing measures not only in mental health but also on the physical health of older populations. For example, the study results of Ammar et al. (2020) revealed a decline in all levels of PA during the home confinement period and a far more significant increase on sitting time. Our participants reported similar results as almost 90% of the sample decreased their usual PA levels, and 65% increased sitting time, therefore, changing drastically their usual behaviors with possible negative health consequences. The results on PA levels were expected because our sample was previously highly active older adults who performed exercise sessions at least twice a week. However, the results in sitting time may not truly represent their time spent on sedentary activities since it is well known that older adults tend to overestimate their PA levels, particularly MVPA, and underestimate the time spent on SB (Grimm et al., 2012; Harvey et al., 2013). Our non-significant difference on SB between groups of depression can be due to the differences among sedentary activities since a very recent study found that mentally passive SBs, such as watching television, could increase the risk of depression, whereas mentally activity sedentary activities were not associated (Huang et al., 2020). Therefore, more research on sedentary patterns is needed, particularly in these strange times. Nevertheless, and despite recommendations that home confinement should not preclude people from being physically active (Ammar et al., 2020; Centers for Disease Control and Prevention, 2020; Sepúlveda-Loyola et al., 2020), only 57.4% of our sample kept moderate-to-high levels of PA during confinement. In fact, 78.2% of the non-depressed participants were in the moderate and high PA group, while more than half of the participants with depression (61.1%) reported low PA levels.

Moderate-to-vigorous physical activity was negatively associated with GSD-15 score, explaining 16.4% of the variance of GDS-15 score, adjusted for age, gender, and education. Similarly, results of Callow et al. (2020) from a multiple regression model including total physical activity, age, sex, and education accounted for 7.2% of the variance in total depression scores; however, depression symptoms were measured using a 30-item GDS. In agreement, Carriedo et al. (2020), in their cross-sectional study conducted through an online questionnaire, emphasized that older adults who regularly engaged in MVPA during confinement reported lower scores in depressive symptoms. The potential role of physical activity in mitigating depressive symptoms in older adults seems in line with other studies (Kandola et al., 2019) conducted before the COVID-19 pandemic. Emerging research on the efficacy of home-based exercise training programs to maintain and improve PA levels and physical fitness during home confinement is now becoming available (Marcos-Pardo et al., 2020) and could be a way to mitigate the negative mental health impact of confinement. Moreover, many of the adopted strategies for exercise during the COVID-19 pandemic had involved technologies and virtual meetings reducing the possible negative effects of social distancing and isolation, keeping people active and in touch with each other (Armitage and Nellums, 2020; Burtscher et al., 2020; Jiménez-Pavón et al., 2020).

Regarding physical fitness, our participants were above the 50th percentile for the Portuguese population on cardiorespiratory fitness, and above the 75th and 90th percentile on the 8-ft up-and-go test and 30-s chair stand test, respectively (Marques et al., 2014). Therefore, as opposed to the expected, individuals presented higher levels of physical fitness after an 11-week home confinement period. Moreover, none of the physical fitness tests showed significant differences between groups. These results contrast with other investigations conducted either in the older or in younger groups. Rantanen et al. (2000) found that depressed mood was associated with increased risk of steep handgrip strength decline in older men. In another investigation, the results showed that women with depressive or anxiety disorders had significantly lower grip strength compared with healthy controls, but this association was not found in men (van Milligen et al., 2011). Research has also been pointing toward a significant inverse relationship between cardiorespiratory fitness and depressive scores (Galper et al., 2006) independent of physical activity levels and suggesting that exercise interventions aiming at aerobic endurance may play an important role in preventing depression in older adults (Yamagata et al., 2013). In contrast to our investigation, Lee (2015) divided 173 older women (65–80 years) into two groups (GDS-K score ≥ 14 and GDS-K score < 14) and found significant differences between the two groups in the 6-min walk and also in other physical performance tests. The author suggests that improvements in physical fitness through exercise can improve depression by helping the recovery of self-confidence or inducing emotional responses in older adults (Lee, 2015). A possible explanation for this lack of association in our study could be attributed to our sample having above-average levels of physical fitness contrasting to usual research that is conducted in non-exercisers. Nonetheless, the relationship between physical fitness and depressive symptoms remains partially unclear, and there is a need for additional research to clarify if a causal relationship exists.

In short, our study results reinforce the importance to remain active during home confinement due to the potential of MVPA in mitigating the negative impact on depressive symptoms. Further evidence is necessary to acknowledge the role of physical fitness components and SB patterns on preventing or mitigating depressive symptoms.

This cross-sectional study has some strengths that must be addressed. Several authors highlighted the need for research on mental health consequences of these unprecedented times on the general population (Callow et al., 2020; Carriedo et al., 2020; Moreira et al., 2020; Rajkumar, 2020; Torales et al., 2020) and specifically on vulnerable and older populations (Troutman-Jordan and Kazemi, 2020; Vahia et al., 2020), whether through online surveys (3), editorials or opinion papers (2), and review articles (2). Nevertheless, to the best of our knowledge, to date, the current study is the first to present results from in-person physical performance tests and telephone evaluations with previously physically active older adults.

Additionally, it is important to acknowledge some limitations. First, data on PA and depression were gathered via an interview by phone call, which could have a potential influence on our results. Second, self-reported PA assessment has well-known limitations in older adults. Furthermore, the cross-sectional nature of this study does not allow us to determine a cause-and-effect relationship between MVPA and depression score, and our small sample size limits the generalization of our results.

In summary, our findings suggest that MVPA is negatively associated with depressive scores in a home confinement situation. We considered that our findings can be used as a starting point to manage isolation restrictions more effectively and to develop strategies to promote physical activity among older adults during situations of forced lockdowns, as in the present COVID-19 pandemic. Therefore, a multidisciplinary team involving psychologists, social workers, and PA professionals should work together to create strategies to promote at-home physical activity and mental well-being programs during this pandemic as a key to limit depressive symptoms.

DATA AVAILABILITY STATEMENT

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee of the Faculty of Sports, University of Porto (CEFAD 15.2020). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Associations Between Depressive Symptoms and Physical Activity Intensity in an Older Adult Population During COVID-19 Lockdown

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Introduction: The COVID-19 pandemic led to the implementation of physical–social distancing measures–including self-isolation, home confinement, and quarantine around the world, with psychological consequences such as depression. Older adults are especially likely to develop depressive symptomatology. This study aims to investigate the association between physical activity intensities and sedentary behavior with depression levels among previously active older adults during the COVID-19 lockdown.

Methods: A total of 1,123 physically active older Brazilian adults (67.68 ± 5.91 years, 91.00% female) were interviewed by telephone in regard to sociodemographic, general health status, depression (GDS-15), and physical activity (IPAQ-SV) after being home-confined for 11.59 ± 2.42 weeks. Participants were also asked to self-report changes in their physical activity levels and time spent sitting. Descriptive statistics (mean, frequencies), between-groups comparisons (*t*-tests and chi-square), and hierarchical regression analysis were used.

Results: About 83.80% of older adults self-reported a decrease in daily physical activity levels and 73.90% increased sitting time. Overall, depressive symptoms were observed in 30.40, and 20.80% met physical activity recommendations. Daily moderate ($\beta = -0.174$; 95% CI = -0.026; -0.012) and moderate-to-vigorous ($\beta = -0.183$; 95% CI = -0.023; 0.011) physical activity intensities were negatively associated with depression score explaining 2.6 and 2.9% of depression variability, respectively, after adjusting for age, gender, education level, body mass index, and polypharmacy. Daily walking and sitting time were not associated with the depression score ($p > 0.05$).

Conclusion: The results provide empiric suggestion supporting moderate to vigorous physical activity as a way to reduce depressive levels among older adults during COVID-19 confinement. Supervised home-based exercise programs, specifically designed for older adults, might be an important strategy to maintain and improve older adults' mental health.

Keywords: depression, physical activity, pandemic, lockdown, association, intensity

INTRODUCTION

The world is facing the devastating effects of the COVID-19 outbreak, an infection caused by the virus SARS-CoV2 that rapidly propagated within communities. To contain the spread of the virus and to protect the most fragile groups, several countries have implemented strict measures of physical–social distancing, such as self-isolation, home confinement, and quarantine (Armitage and Nellums, 2020). These measures are indeed efficient to mitigate virus activity, with epidemiological data demonstrating an abrupt reduction in the number of new COVID-19 cases and consequently mortality (Shahid et al., 2020). Nevertheless, these measures are not free from psychological detrimental side effects, as augmented loneliness may have adverse effects in psychological distress among the general population (Banerjee and Rai, 2020), especially in the most vulnerable groups as older adults. Santini et al. (2020) have already demonstrated that the social isolation and consequent loneliness during the outbreak have increased depression symptoms such as persistent low mood, dysphoria, and impaired motivation in older adults. Considering that the prevalence of depression among older adults in Western countries is around 20% (Volkert et al., 2013), an important worsening of this health outcome as a result of this sanitary crisis can be expected (Armitage and Nellums, 2020).

Social isolation as a result of home confinement also affected daily physical activity levels and sedentariness behavior in older adults, since the possibilities to perform physical exercise were reduced, and activities in the sitting or reclined position (watching television, reading, crocheting, and knitting, etc.) were exponentially increased, as recent available evidence indicates (Schrempft et al., 2019; Jakobsson et al., 2020; Jiménez-Pavón et al., 2020).

The World Health Organization (WHO) has recognized that social distancing, along with an excessive time spent sitting and a lower level of physical activity, might enlarge depressive symptoms within populations (Bull et al., 2020). Both sedentary behavior and physical inactivity negatively affect mood and are also associated with depressive symptoms (Mura and Carta, 2013; Mumba et al., 2020). In this sense, it has been suggested that physical activity could have an important role in the mental health promotion (and preservation) due to its potential to buffer adverse effects of stress (Roux, 2007). Empirical evidence has reported that a greater amount of total physical activity was associated with lower depressive symptoms (Callow et al., 2020). Physical exercise, a subcategory of physical activity, protects older adults from depression due to its positive effects on biological and psychological processes (social support, self-esteem, and the social relations inherent to exercise participation) (Perez-Lopez et al., 2017; Kandola et al., 2019). Moreover, a poor functional fitness status is also one of the most important causes of late-life depressive symptoms (Blazer and Hybels, 2005), which could be reverted through the participation in well-designed individual-tailored exercise programs (Bull et al., 2020). To that extent, it is expected that older adults who participated in physical exercise programs might be more protected against depressive symptoms caused by more restrictive measures such as home confinement. However, to the best of our knowledge, studies exploring the association between physical activity levels and depressive symptoms during social isolation imposed by COVID-19 outbreak in a population of active older adults are scarce. Therefore, the aim of the present study is to determine the relationship between intensities of physical activity performed by physically active older Brazilian adults and their depressive symptoms during home confinement.

MATERIALS AND METHODS

Study Design

This is a cross-sectional observational study based in a non-probabilistic sample comprising 1,123 older Brazilian's adults enrolled in the exercise program "Fortaleza Cidade Amiga do Idoso." The exercise program is hosted at the "Núcleo de Produções Culturais e Esportivas" (NUPROCE), a non-governmental organization in Fortaleza, Ceará, Brazil. Eligibility criteria were physically active subjects aged ≥60 enrolled in the exercise program in the school year 2019–2020.

Participants and Procedures

"Fortaleza Cidade Amiga do Idoso" consists of an in-person social program that offers social, cultural, and sports activities. The latter include multicomponent training, hydro gymnastics, dance, and walking–running sessions. Older adults are free to choose the activities they want to enroll, as well as the weekly frequency. Each session lasted 60 min and, prior to the outbreak, used to take place in public facilities. All older adults attending any sports activity from the program in the school year 2019–2020 were contacted by telephone and invited to participate in the study during home confinement. In Fortaleza, the lockdown was initiated on March 19th, and the reopening phase, which finished with the duty of confinement, started on July 12th. Along this period, people from Fortaleza were only allowed to get out from their homes to perform essential activities such as acquisition of goods and services and health reasons. Data were collected during the month of June (1st–31st) via phone calls, when subjects were still under home confinement. Participants' contacts were provided by the NUPROCE secretariat after the study was approved by the ethics board.

Ethics Statement

The study was approved by the NUPROCE and the Secretaria de Direitos Humanos e Desenvolvimento Social of Fortaleza, Ceará, Brazil. All procedures followed the Helsinki Declaration. Each participant provided a verbal informed consent before starting to be interviewed. Participants could withdraw from the survey at any point in time without providing justification.

Data Collection

Twenty interviewers, who used to lead older adults' activities prior the confinement, were trained by three researchers to perform the interviews. The data were collected via telephone interviews, and answers were entered into a Google Form database. For each individual, there were up to six calling attempts, performed in different days and hours. As soon as the interviewers introduced a set of answers into the dataset, all three researchers checked for missing data or typing error.

Sociodemographic and Health-Related Conditions

Data on sociodemographic (sex, age, and years of education), lockdown duration, the number of exercise sessions per week previous to the lockdown, and the use of multiple medicines (i.e., polypharmacy) were obtained with open-answer questions. The presence of health conditions (hypertension, dyslipidemia, diabetes, cardiovascular disease, chronic respiratory disease, cancer, and COVID-19) was asked as yes/no questions.

Anthropometry

Body weight (kg) and height (meters) were self-reported, and the body mass index (BMI) was derived as body weight divided by squared height (kg/m^2).

Symptoms of Depression

Symptoms of depression were determined using the Brazilian validated Geriatric Depression Scale–Short Form (GDS-15) (Almeida and Almeida, 1999a). The GDS-15 comprises of 15 questions examining the older adult's mood in the previous week. Answers are "yes" or "no," and 1 point is given either to the answer "yes" or to the answer "no" depending on the question. The final score is the sum of total answers, with higher results reflecting worse depressive states. Scores were coded ranging from no depression symptoms (0–4) and presence of depression symptoms ($\geq$5) (Almeida and Almeida, 1999a). The validated Brazilian version presented a good internal consistency (Almeida and Almeida, 1999b).

Physical Activity

Physical activity was measured using the Brazilian validated short-version of the International Physical Activity Questionnaire (IPAQ-SV) (Craig et al., 2003). The participants were asked to provide information on frequency (days per week) and duration (hours or minutes per day) they spent walking, as well as in moderate and vigorous physical activity. The IPAQ-SV also includes a question about sitting time (time per day in sitting position). The daily duration of each intensity of physical activity (moderate and vigorous) and walking (i.e., light physical activity) was computed multiplying the number of days per week by the time per day in each intensity. After that, the results for each physical activity intensity and walking were divided by 7 to get the mean values per day (i.e., light physical activity/day, moderate physical activity/day, and vigorous physical activity/day). Additionally, moderate and vigorous physical activity per day was summed to get moderate to vigorous physical activity. Participants were also classified against physical activity guidelines ("<150 min per week" or "$\geq$150 min per week" of moderate to vigorous physical activity) (Bull et al., 2020). Participants were asked to self-report changes in physical activity and time spent sitting during home confinement in comparison to the prior-confinement period. Answer options were reduced, maintained, and augmented.

Statistical Analysis

Descriptive statistics and frequency analysis were used to describe the sample. Between-groups comparisons (no depression symptoms versus presence of depression symptoms) were performed using independent *t*-test and chi-square (χ^2) test as appropriate. Hierarchical multiple linear regression analysis, with the enter method, was used to determine the unique contribution of each physical activity intensity variable and sitting time in predicting the depression score. The base model (model 1) included the factors that have plausibility to determine depression (age, gender, educational level, body mass index, and polypharmacy). Model 2 included daily walking (i.e., light physical activity) plus variables from model 1. Model 3 was computed based on model 2 plus moderate physical activity intensity. Model 4 included additional vigorous physical activity plus variables from model 3. Model 5 was computed in line with model 2 with moderate to vigorous physical activity as one single variable. Model 6 was equal to model 1 plus sitting time. Finally, model 7 included model 1 plus daily walking, moderate to vigorous physical activity, and sitting time. The homoscedasticity of the models (residual variance) was checked by visual inspection of dispersion between residues and predicted values. Multicollinearity was checked and considered acceptable when the variance inflation factor (VIF) <10 (Myers, 1990). Sensitivity analysis, excluding older male adults, was also performed for hierarchical regression. All procedures were carried out using the statistical package IBM SPSS Statistics software, version 26 (Chicago, United States). *p*-values <0.05 were considered significant.

RESULTS

One thousand four hundred fifty-three older adults enrolled in the exercise program were contacted. From those, 107 older adults had contact problems, 197 did not answer phone calls, and 11 declined to participate. In total, 1,123 agreed to participate (67.68 $\pm$ 5.91 years old, 91.00% females).

Overall sample characteristics and between-groups comparisons are depicted in **Table 1**. Older adults were subject to 11.59 $\pm$ 2.42 weeks of home confinement. The two lowest levels of education were the most frequent among the older adults (<6 years: 38.6%; 6–12 years: 54.3%), with significant differences in the distribution of education according to the presence or absence of depression symptoms (p = 0.008). Overweight and obesity were present in 47.2% on older adults, with significant BMI differences between groups (presence of depression symptoms: 27.49 $\pm$ 4.37 kg/m^2; no depression symptoms: 26.92 $\pm$ 3.83 kg/m^2; p = 0.040). Regarding the overall risk factors, 62.2% had hypertension and 44.90% had dyslipidemia. At the moment of data collection, 4.7% were infected with COVID-19, and 30.40% had presence of depression symptoms. On average, older adults spent 325.51 $\pm$ 144.40 min/day in sitting time during the confinement period. Regardless of the presence of depression symptoms, all older adults reported to have augmented their sitting time per day (73.90%), but it was more frequent within the group with depressive symptoms compared to the

TABLE 1 | Descriptive and between-groups comparisons.

Variables	Overall (*N*: 1123)	No depression symptoms (*N*: 782)	Presence of depression symptoms (*N*: 341)	Statistical inference
Age, years	67.68 ± 5.91	67.66 ± 5.95	67.73 ± 5.87	t (1121) = −0.184; p = 0.854
Gender				
Female, %	91.00%	90.50%	91.20%	χ^2(1, N = 1123) = 0.125; p = 0.409
Male, %	9.00%	9.50%	8.80%	
Education				
<6 years, %	38.6%	38.00%	39.90%	χ^2: (2, N = 1123) = 9.624; p = 0.008
6–12 years, %	54.3%	53.30%	56.60%	
>12 years, %	7.10%	8.70%	3.50%	
Anthropometry				
Body mass index, kg/m^2	27.08 ± 4.00	26.92 ± 3.83	27.49 ± 4.37	t (557.996) = -2.062; p = 0.040
Overweight and Obesity, *N* (%)	530 (47.20%)	359 (46.60%)	161 (48.60%)	χ^2: (2, N = 1101) = 0.653; p = 0.721
Health conditions				
Hypertension, %	62.20%	58.80%	69.80%	χ^2 (2, N = 1123) = 33.098; p < 0.001
Dyslipidemia, %	44.90%	42.80%	49.60%	χ^2 (2, N = 1123) = 4.383; p = 0.112
Diabetes, %	29.50%	26.50%	36.40%	χ^2 (2, N = 1123) = 11.442; p = 0.003
Cardiovascular disease, %	9.80%	8.30%	13.20%	χ^2 (2, N = 1123) = 8.892; p = 0.012
Cancer,%	4.40%	3.50%	6.50%	χ^2 (2, N = 1123) = 12.870; p = 0.002
COVID-19,%	4.70%	4.70%	4.70%	χ^2 (2, N = 1123) = 0.510; p = 0.775
Chronic respiratory disease	12.90%	6.90%	26.70%	χ^2 (2, N = 1123) = 92.156; p < 0.001
Polypharmacy, *n*	2.40 ± 1.76	2.32 ± 1.76	2.60 ± 1.75	t (651.755) = -2.445; p = 0.015
Physical activity				
Daily walking, min/day	11.74 ± 21.68	12.08 ± 20.31	11.21 ± 25.78	t (1108) = 0,761; p = 0.447
Moderate PA, min/day	15.25 ± 26.13	16.96 ± 26.11	10.42 ± 22.73	t (669.271) = 4.025; p = 0.000
Vigorous PA, min/day	3.48 ± 9.90	4.05 ± 10.61	2.48 ± 8.54	t (721.410) = 2.497; p = 0.013
MVPA, min/day	18.70 ± 29.76	21.28 ± 31.02	12.78 ± 25.73	t (767.657) = 4.761; p < 0.001
Daily sitting time, min/day	325.51 ± 144.40	321.65 ± 146.11	334.45 ± 140.17	t (1115) = -1,360; p = 0.174
Meeting PA Guidelines,%	20.80%	23.50%	15.00%	χ^2 (1, N = 1117) = 10.247; p = 0.001
Changes in PA during confinement				
Reduced, %	83.80%	80.2%	92.10%	χ^2(2, N = 1123) = 25.786; p < 0.001
Maintained, %	12.90%	16.10%	5.60%	
Augmented, %	3.30%	3.70%	2.30%	
Changes in daily sitting time				
Reduced, %	4.20%	4.60%	3.20%	χ^2 (2, N = 1123) = 22.734; p < 0.001
Maintained, %	21.90%	25.60%	13.50%	
Augmented, %	73.90%	69.80%	83.30%	
Depression symptoms, score	3.57 ± 2.83	2.03 ± 1.31	7.09 ± 2.817	t (450.634) = −39.791; p < 0.001

PA, physical activity; MVPA: moderate to vigorous physical activity.

group without symptoms (83.30 versus 69.80%, respectively; $p < 0.001$). The depressive symptoms group spent, on average, 12.78 ± 25.73 min/day in moderate to vigorous physical activity, which was significantly lower compared to the mean of the group without depression symptoms (21.28 ± 31.02 min/day; $p < 0.001$). Overall, 83.80% of older adults diminished their physical activity levels, which was significantly higher within the group with depressive symptoms (92.10%) compared to the one without depressive symptoms (80.2%; $p < 0.001$); 20.8% of older adults met physical activity guidelines, with significant differences between groups (without depressive symptoms: 15%; depressive symptoms group: 23.5%; $p < 0.001$).

Table 2 presents hierarchical regression analysis aiming to determine the independent prediction of physical activity variables and sitting time on the depression score. Model 1 (R^2: 0.012; p = 0.020) was built considering the variables with clinical/physiological plausibility [age (β = −0.027; 95% CI = −0.042 to 0.016; p = 0.383), gender (β = −0.033; 95% CI = −0.912 to 0.253; p = 0.267), education level (β = −0.011; 95% CI = −0.332 to 0.230; p = 0.723), BMI (β = 0.056; 95% CI = −0.003 to 0.082; p = 0.067), and polypharmacy (β = 0.080; 95% CI = 0.031–0.224; p = 0.010). The independent variable "daily walking" (β = −0.019; 95% CI = −0.010 to 0.005; p = 0.528) within model 2 (R^2: 0.013; p = 0.031) did not significantly predict the outcome, increasing 0.1% of the depression score variance. Time spent in moderate physical activity (β = −0.174; 95% CI = −0.026 to −0.012); $p < 0.001$) within model 3 (R^2: 0.039; $p < 0.001$) significantly predicted the depression score, explaining

TABLE 2 | Hierarchical linear regression results for physical activity variables as a predictor of symptoms of depression.

		Age	Gender	Education level	BMI	Polypharmacy	Daily walking	Moderate PA	Vigorous PA	MVPA	Sitting time
Model 1 R^2: 0.012 *F* for change in R^2: 2.701 *p*: 0.020	B	−0.013	−0.330	−0.051	0.040	0.128					
	SE	0.015	0.297	0.143	0.022	0.049					
	β	−0.027	−0.033	−0.011	0.056	0.080					
	95% CI UB; LB	−0.042; 0.016	−0.912; 0.253	−0.332; 0.230	−0.003; 0.082	0.031; 0.224					
	p	0.383	0.267	0.723	0.067	0.010					
Model 2 R^2: 0.013 *F* for change in R^2: 2.326 *p*: 0.031	B	−0.013	−0.367	−0.042	0.040	0.126	−0.002				
	(SE)	0.015	0.299	0.145	0.022	0.050	0.004				
	β	−0.027	−0.037	−0.009	0.056	0.079	−0.019				
	95% CI UB; LB	−0.042; 0.016	−0.954; 0.220	−0.326; 0.242	−0.003; 0.083	0.029; 0.224	−0.010; 0.005				
	p	0.382	0.221	0.773	0.070	0.011	0.528				
Model 3 R^2: 0.039 *F* for change in R^2: 6.343 $p < 0.001$	B	−0.017	−0.293	−0.046	0.032	0.136	0.005	−0.019			
	(SE)	0.015	0.296	0.143	0.022	0.049	0.004	0.003			
	β	−0.035	−0.030	−0.010	0.045	0.085	0.040	−0.174			
	95% CI UB; LB	−0.045; 0.012	−0.873; 0.287	−0.327; 0.235	−0.011; 0.074	0.040; 0.232	−0.003; 0.013	−0.026; −0.012			
	p	0.252	0.322	0.748	0.142	0.006	0.207	0.001			
Model 4 R^2: 0.042 *F* for change in R^2: 5.947 $p < 0.001$	B	−0.015	−0.313	−0.033	0.033	0.136	0.006	−0.018	−0.015		
	(SE)	0.015	0.296	0.143	0.022	0.049	0.004	0.003	0.009		
	β	−0.032	−0.032	−0.007	0.046	0.085	0.047	−0.166	−0.054		
	95% CI UB; LB	−0.044; 0.014	−0.893; 0.267	−0.313; 0.248	−0.009; 0.076	0.040; 0.232	−0.002; 0.014	−0.025; −0.011	−0.033; 0.002		
	p	0.304	0.290	0.819	0.126	0.005	0.139	< 0.001	0.079		
Model 5 R^2: 0.042 *F* for change in R^2: 6.739 $p < 0.001$	B	−0.015	−0.316	−0.030	0.033	0.136	0.006			−0.017	
	(SE)	0.015	0.295	0.143	0.022	0.049	0.004			0.003	
	β	−0.032	−0.032	−0.006	0.047	0.085	0.047			−0.183	
	95% CI UB; LB	−0.044; 0.014	−0.895; 0.263	−0.311; 0.250	−0.009; 0.076	0.040; 0.232	−0.002; 0.014			−0.023; −0.011	
	p	0.303	0.285	0.832	0.122	0.005	0.141			< 0.001	

(Continued)

TABLE 2 | Continued

		Age	Gender	Education level	BMI	Polypharmacy	Daily walking	Moderate PA	Vigorous PA	MVPA	Sitting time
Model 6 R^2: 0.013 *F* for change in R^2: 2.368 *p*: 0.028	B	−0.016	−0.317	−0.037	0.038	0.129					0.000
	(SE)	0.015	0.297	0.145	0.022	0.049					0.001
	β	−0.033	−0.032	−0.008	0.054	0.081					0.024
	95% CI UB; LB	−0.045; 0.013	−0.901; 0.266	−0.322; 0.248	−0.005; 0.081	0.032; 0.226					−0.001; 0.002
	p	0.285	0.286	0.798	0.080	0.009					0.422
Model 7 R^2: 0.042 *F* for change in R^2: 5.878 $p < 0.001$	B	−0.017	−0.310	−0.041	0.034	0.135	0.006			−0.017	0.000
	(SE)	0.015	0.296	0.145	0.022	0.049	0.004			0.003	0.001
	β	−0.035	−0.031	−0.009	0.047	0.085	0.048			−0.184	−0.005
	95% CI UB; LB	−0.046; 0.012	−0.890; 0.270	−0.324; 0.243	−0.009; 0.076	0.039; 0.231	−0.002; 0.014			−0.023; −0.011	−0.001; 0.001
	p	0.258	0.295	0.779	0.122	0.006	0.133			< 0.001	0.876

Non-standardized and standardized beta coefficients are reported. CI, confidence interval; LB, lower bound; UB, upper bond; PA, physical activity; MVPA, moderate to vigorous physical activity. Gender, 0 females, 1 male; Education level, 0 = <6 years; 1 = 6–12 years; 2 = >12 years.

2.6% of its variance. Model 4 (R^2: 0.042; $p < 0.001$) added time spent in vigorous physical activity (β = −0.054; 95% CI = −0.033 to 0.002; $p = 0.079$), which explained an additional 0.3% of the depression variance. When considering time spent in moderate to vigorous physical activity (β = −0.183; 95% CI = −0.023 to −0.011; $p < 0.001$) together with daily walking and the other covariables, it significantly improved the model, explaining the depression score variance in 2.9% (model 5; R^2: 0.042; $p < 0.001$). Time spent in sitting position did not explain the depression score [models 6 (β sitting time = 0.024; 95% CI = −0.001 to 0.002; $p = 0.422$] and 7 (β sitting time = −0 to 005; 95% CI = −0.001 to 0.001; $p = 0.876$)]. The collinearity between variables was checked for each model, and the VIF values were always below 10. Sensitivity analysis excluding older male adults maintained the same results (**Supplementary Material**).

DISCUSSION

In this large observational study among previously active older adults, greater time spent in moderate and moderate to vigorous physical activity was associated with a lower depressive score during COVID-19 confinement. To the best of our knowledge, this is the first large community-based study to suggest that time spent in moderate and in moderate to vigorous physical activity during home confinement might impact depressive symptoms of previously active older adults. It was recommended that older adults engage in regular physical activity and avoid sedentary behaviors during confinement; however, 83.80% of older adults who participated in this study diminished their physical activity levels, and this was significantly higher in the participants who reported depressive symptomatology.

Depression is known to be a critical problem among aging populations, often being underdiagnosed and undertreated (Huang et al., 2015). Approximately 20% of older adults who live in the western countries suffer from depression (Volkert et al., 2013). This highly prevalent mental disorder is often related to physical health problems, disability, loss of functionality, and mortality (Cacioppo et al., 2006). The COVID-19 pandemic potentially increases the symptoms of anxiety, depression, and stress (Quittkat et al., 2020). The administrative measures of social isolation, in order to minimize the effects of COVID-19, can cause greater distress and feelings of sadness, especially for those who previously had a large proportion of social contacts in public places (Umberson and Karas Montez, 2010; Armitage and Nellums, 2020). Moreover, it is well known that social isolation and consequent loneliness are considered specific risk factors for depressive symptoms (Cacioppo et al., 2006). Our data showed that being previously active did not prevent 30.40% of the older adults from having depressive symptoms during the COVID-19 pandemic. However, these results, when compared to the prevalence of depression among the Brazilian general population during the COVID-19 pandemic (that was 68%) (Goularte et al., 2021), are much lower and could indicate that previously physically active older adults were somehow protected from depressive symptomatology during the COVID-19 confinement.

The benefits of physical activity in reducing scores of depressive symptoms in older adults are well documented (Kandola et al., 2019). In fact, physical activity and exercise may lower rates of anxiety and depression by triggering the release of endorphin, dopamine, and serotonin, neurotransmitters involved in the body's stress response, which could help the individuals to remain more stable during extrinsic demanding situations, such as the current pandemic situation (Craft and Perna, 2004). Our results have demonstrated that, from the large spectrum of physical activity intensities, moderate intensity explains 2.6% of the depression score variance, and moderate to vigorous physical activity together explains 2.9%. Conversely, light physical activity (evaluated as walking time) and vigorous physical activity alone were not significantly associated with the depression score. Our results might suggest moderate intensity physical activity as the variable most closely related with lower depression symptomatology. These results might be explained because, with advancing age, in many older adults, the ability to perform some types of physical activity might decrease; thus, moderate exercise intensity may be an especially important component of overall fitness routines. Previous evidence showed that physical activity and exercise have therapeutic effects on individuals' physical and mental health. For example, Mumba et al. (2020) have showed that recreational moderate and vigorous physical activity was associated with a lower depression score in 2,474 adults and older adults aged 50 years and older. Huang et al. (2015) revealed that exercising at moderate intensity, for 50 min, three times a week, for 12 weeks, was effective in reducing depressive symptoms. In another study with frail and pre-frail older adults, physical exercise was effective in significantly reducing the depression score (Ng et al., 2017). Langoni et al. (2019) developed a 24-weeks intervention with 52 mild cognitively impaired and sedentary older adults. Results demonstrated that the program reduced the median geriatric depression score against the initial value. In addition to reducing depressive symptoms, physical exercise also improves aerobic capacity and the perception of social support, balance, and mobility. These improvements positively affect older adults' quality of life, diminishing sadness, melancholy, and hopelessness (Huang et al., 2015), maintaining the ability to perform activities of daily living (Demura et al., 2005).

Social isolation, due to home confinement, can lead to reduced everyday physical activity and enlarge sedentary time (Schrempft et al., 2019). Some previous reports have suggested that such restrictions may lead older adults to perform less physical activity compared to the preconfinement period (Jakobsson et al., 2020; Jiménez-Pavón et al., 2020). In fact, our participants reported similar results, as 83.80% of the sample decreased their usual physical activity levels, and 73.90% increased sitting time. When comparing groups with and without depressive symptoms, those with depression symptoms showed a greater reduction in physical activity (92.10% versus 80.20%), as well as a significant increase in sitting time (83.30% versus 69.80%). In agreement, Callow et al. (2020), in a cross-sectional study conducted through an online questionnaire with North American and Canadian older adults, indicated that higher physical activity was associated with lower depressive symptoms during social isolation due to COVID-19. Our results also showed that older adults without depressive symptoms are more likely to meet WHO recommendations for physical activity (23%) compared with 15% among those with depressive symptoms. A reduction of moderate to vigorous physical activity among previously physically active older adults was found, and at least partially, it was a consequence of the interruption of structured physical activities realized by the "Fortaleza Cidade Amiga do Idoso" project. As mentioned by Schrempft et al. (2019), social restrictions and home confinement orders, including the temporary closure of usual activities, such as sports and physical fitness centers, may have compromised physical activity levels.

During the outbreak, the WHO published the new physical activity guidelines, including, for the first time, specific topics on mental health. Indeed, the 2020 WHO physical activity recommendations encourage older adults to exercise between 150 and 300 min per day at moderate to vigorous intensity and to replace sedentary time by any physical activity intensity to sustain physical and mental health (Bull et al., 2020). In this sense, it should be a priority to properly adapt previous in-person interventions to virtual/home-based formats, particularly to those who were physically active before COVID-19. Efficient and safe actions are needed to stimulate the practice of physical activity at home and consequently minimize the psychological effects of social isolation. Moreover, health systems and individual clinicians must be prepared to offer and implement specific physical activity and mental well-being programs in order to reduce the prevalence of depression.

Our analysis had several strengths. A large number of participants, data collection through telephone interviews carried out by acquainted individuals (older adults' trainers before confinement), and adjustment for a wide range of major risk factors minimized the potential impact of residual confounding. The telephone interview allowed for clear and precise explanations of each question, avoiding misunderstandings.

Potential limitations were also present. The cross-sectional design with a convenience sample makes causal inferences difficult. Results were attained predominantly for women and might not be generalizable to men. However, to overcome this bias, we conducted sensitivity analysis removing males from the procedures, and the results were maintained. Physical activity was assessed with questionnaires that tend to overestimate moderate to vigorous physical activity and underestimate sitting time. Moreover, the percentage of the level of depression explained by physical activity is not very high. This means that other factors may be involved in the changes of the depressive symptoms during the COVID-19 outbreak.

The data suggest that physical activity, particularly the time spent in moderate intensity, might have an important protective role on depressive symptoms during home confinement. Our findings are especially important given the fact that older adults are already more susceptive to depressive symptomatology and confinement might have exacerbated it, so strategies to control or diminish depressive symptoms are of extreme importance. These results support the need for clinicians and policy makers to focus on physical activity interventions through technology and remotely supervise to maintain and promote the mental health of older adults during the COVID-19 pandemic.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Núcleo de Produções Culturais e Esportivas (NUPROCE) and the Secretaria de Direitos Humanos e Desenvolvimento Social of Fortaleza, Ceará, Brazil. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LB, SG, and ES conceived and designed the analysis. AL, ES, and SG collected data. AL, SG, ES, and LB contributed data and analysis tools. AL, SC, and LB performed the analysis. AL, LB, SC, and LS-M wrote the manuscript. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.644106/full#supplementary-material

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Mental Health Status, Life Satisfaction, and Mood State of Elite Athletes During the COVID-19 Pandemic: A Follow-Up Study in the Phases of Home Confinement, Reopening, and Semi-Lockdown Condition

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Scientific reports notified that the pandemic caused by the Coronavirus disease 2019 (COVID-19) has raised an unprecedented mental health emergency worldwide. Abrupt changes in daily routine, environmental constraints, adopted home confinement measures, and uncertainty about a date for returning to usual activities can potentially affect mental health and sports activities in athletes. Hence, we designed a cross-sectional study with a within-subjects design to investigate the impact of the pandemic on mental health, mood states, and life satisfaction of elite athletes. During the three phases of home confinement (April 14–24, n = 525), reopening (May 9–19, n = 464), and current semi-lockdown (July 20–31, n = 428), elite athletes voluntarily responded to an online survey. The self-report questionnaire was prepared to collect demographic and epidemiological variables of interest and the COVID-19-related information. All participants also completed the Profile of Mood State (POMS), General Health Questionnaire-28 (GHQ-28), and Satisfaction with Life Scale (SWLS). The main result is that the training rate, mental health, life satisfaction, and positive mood have decreased during the home confinement period as compared with the reopening and semi-lockdown phases. However, the need for psychosocial services has increased during the pandemic period. The present study provides the first preliminary evidence that home confinement conditions during the COVID-19 pandemic might have negatively influenced elite athlete's mood state, mental health, and life satisfaction, as well as training rates. Monitoring the psychological parameters of elite athletes and developing strategies to improve their mental health during the COVID-19 pandemic should be on the agenda. Next studies, therefore, seem reasonable to focus on active interventions for athletes during the ongoing COVID-19 pandemic.

Keywords: mental health, mood states, life satisfaction, COVID-19, elite athletes, sport

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is an emerging infectious disease caused by newly discovered Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). It was firstly reported in Wuhan, Hubei province (World Health Organization, 2020b), causing an unprecedented pandemic, forcing governments to impose an almost global quarantine (Spinelli and Pellino, 2020). The infection has spread rapidly around the world and COVID-19 has caused many severe and fatal medical cases (Rothan and Byrareddy, 2020). The escalating global morbidity and mortality of COVID-19 have raised significant public health concerns. At present, the focus of governments and the World Health Organization (WHO) is on controlling and mitigating the impact of this pandemic by identifying, testing, and treating infected people, and developing drugs, vaccines, and treatment protocols (Salathé et al., 2020). However, despite such efforts to defeat this pandemic, the directions where the pandemic will take in the coming days unknown. The global community is concerned about COVID-19 and its long-term consequences, such as the economy, industries, global market, human health, and health care. The COVID-19 outbreak also negatively influences various sports activities. In this regard, the 2020 Olympics and many national and international sport events/competitions have been postponed or canceled, and many organized training and team practices were limited. Consequently, many athletes faced tight restrictions to continue their regular training or activities. Health authorities recommend these limitations due to the nature of many team-based activities and crowd attendance that may facilitate a rapid spread of COVID-19, resulting in additional pressure on the health care system (World Health Organization, 2020a). In this regard, big sports events that resumed during the midst of the COVID-19 outbreak are now being referred to as huge "biological bombs" due to the spreading of the virus during these events (Gilat and Cole, 2020).

The positive COVID-19 tests in world-class athletes at premier leagues presented that no one is potentially safe (Corsini et al., 2020). Moreover, according to media, COVID-19 has also been fatal to athletes. Many athletes are also required to train under isolation or home confinement conditions. Their daily routines such as doing primary outdoor activities, going to professional clubs, and utilizing tools counteract the current situation of home confinement and restrictions (Hargreaves et al., 2021). Reports are presented that numerous athletes have been able to overcome challenges to continue training and daily practice by other means and alternatives and adapted to necessary changes during the pandemic. On the other hand, mental health professionals have suggested that exercise could be a way to improve mental well-being during this pandemic (Kar et al., 2020). For instance, home-based physical activity programs may contribute to reducing the symptoms of depression and anxiety (Iannaccone et al., 2020). This might reflect a positive view; however, exercise at an ordinary level might have a different impact compared with those requirements for athletes, in particular, those in preparation for athletic competition. There are still several potential issues that must be considered for the negative impact of the pandemic on athletes (Jiménez-Pavón et al., 2020).

WHO has also expressed its concern over the pandemic's mental health and psycho-social consequences (World Health Organization, 2020c). It speculates that new measures such as self-isolation and quarantine have affected usual activities, routines, and livelihoods of people that may lead to both physical and mental challenges for athletes (Mehrsafar et al., 2020), including an increase in fear of COVID-19 (Alsalhe et al., 2020), rumination (Satici et al., 2020), anxiety and depression (Gouttebarge et al., 2020), gambling problems (Håkansson et al., 2020), sleep and eating disorders (Pillay et al., 2020), psychological inflexibility (Fuentes-García et al., 2020), obsessive–compulsive disorder (Edwards and Thornton, 2020), family conflicts (Mehrsafar et al., 2020), concerns about not getting back to previous fitness (Clemente-Suárez et al., 2020; Mon-López et al., 2020b), sedentary lifestyle and negative habits (León-Zarceño et al., 2021), low mood (Ammer et al., 2020a), harmful consumption of alcohol and drugs (Clay and Parker, 2020), and self-harm attempts or suicidal behavior (Fegert et al., 2020). Of note, several coaches and specifically sports psychologists and even psychiatrists reported that some psychological disorders have been diagnosed among athletes, and those can pose a negative effect on their life (Ammer et al., 2020b; Schinke et al., 2020). A recent narrative review indicated that the COVID-19 pandemic has created several new stressors for elite athletes and that elite athletes suffer from many mental health symptoms and disorders at rates equivalent to or exceeding those in the general population (Reardon et al., 2020). Besides, researchers state that athletes need to receive psychological counseling also in addition to careful screening and monitoring of athletes during the COVID-19 pandemic (Reardon et al., 2020; Schinke et al., 2020).

It is noteworthy that after the quarantine, the governments decided to reopen the community and, consequently, sports with some recommendations (Jorstad and van den Aardweg, 2020; Ludvigsen and Hayton, 2020). However, a previous study on French athletes has shown higher scores of anxiety upon returning to the competition after lockdown by COVID-19, and also competition is considered a new stressor for elite athletes (Ruffault et al., 2020). In this regard, sports medicine specialists and other managers designed plans and strategies for the participation in sport and return to training and competitions (Mohr et al., 2020; Quchan and Kordi, 2020). However, after reopening, governments reported that the number of COVID-19 patients increased rapidly. There are also reports that some elite athletes have contracted the COVID-19 since reopening. Following the increase in the number of patients and virus mutations, some governments decided to pose semi-lockdown conditions and sports activities are somewhat restricted and many sports clubs are closed again. However, researchers showed that after 7 weeks of reopening of sport, a positive psychological adaptation occurred for the athletes similar to the pre-COVID-19 pandemic (Rubio et al., 2020).

Elite athletes as a target group might need specific help for their psychological needs, including maintenance of mental health during outbreaks to minimize the psychosocial toll. An accurate understanding of the psychological impact accompanying the COVID-19 lockdown, reopening, and semi-lockdown is necessary to plan for a crisis-oriented base research and intervention to foster a healthy lifestyle and physical and mental well-being in athletes (Zhang et al., 2020). Consistent with this standpoint, and to address the call by the scientific and sports community to identify challenges and plans to reduce mental health consequences of the COVID-19 pandemic in athletes, we performed an online survey to determine changes in mental health status, mood state, and adaptive behaviors of elite athletes during the COVID-19 pandemic in home confinement, reopening, and semi-lockdown phases. To the best of our knowledge, no study has examined the status of mental health factors during the reopening and semi-lockdown periods.

MATERIALS AND METHODS

Study Design and Participants

The first phase (home confinement) of the study was conducted through an online survey between April 14 and April 24, 2020. This time frame was chosen to assess participants' responses during an early phase of the COVID-19 outbreak, following the Iranian Government declaration of lockdown and the WHO announcement of the COVID-19 as a pandemic (March 11, 2020). Moreover, at this time, all sports facilities and clubs were closed and all sports events were canceled. The second phase (reopening condition) of this study was performed between May 09 and May 19, 2020. In this phase, athletes were able to continue sports training with some restrictions and more sports clubs opened. Finally, the third phase (semi-lockdown) of our study was launched between July 20 and July 31, 2020. During this period, the Iranian Government announced the semi-lockdown condition for the community and more sports clubs were closed, and the daily routine of elite athletes was difficult and limited. It should be noted that the second and third phases of this study were performed similarly to the first phase procedure.

Efforts were made to recruit participants from all regions in the country, affected by the pandemic to different extents, to obtain a representative population. Eligible participants were in the age range of 18–45 years, were competing in the super league, national, and international levels (Lorenz et al., 2013); had lived in Iran, and were fluent in both written and spoken Persian. Exclusion criteria were as follows: non-elite athletes, non-Persian language speakers, current hospitalization, and a history of mental disorder. All participants completed the questionnaire online via the Cofepardazesh platform. A link was distributed via a range of methods: invitation via e-mails, shared in faculties and organizations' official pages, and other social media platforms such as Telegram™, Instagram™, and WhatsApp™. It is necessary to mention that athletes and some research and sports organizations were also involved in the dissemination plans of our research through the promotion of the survey in their networks.

Ethics Statement

The study was approved by the Ethics Committee of the Tehran University of Medical Sciences (number: 1399-335) and was conducted according to the Declaration of Helsinki. The participant could withdraw from the survey at any moment without providing any justification. We also provided scores and status reports for anyone who wished. The survey was anonymous, and data confidentiality was assured according to the privacy policy. This web-based questionnaire was completely voluntary and non-commercial.

Data Collection

The survey included an introductory page describing the background and the aims of the survey and the ethics information for participants. A dedicated, self-report questionnaire was set up to collect demographic and epidemiological variables of interest (age, gender, marital status, life form, educational level, sport type, and competitive levels), information on lockdown conditions (exercise before COVID-19$^{h/w}$, exercise during COVID-19$^{h/w}$, and coaches follow-up for plans and fitness and COVID-19-related information (infection, acceptance of quarantine rules and COVID-19 instructions, economic damage, and need for psychosocial services). All participants completed five standardized Persian versions of these questionnaires including General Health Questionnaire-28 (GHQ-28), Profile of Mood State Short Form (POMS-SF), and Satisfaction with Life Scale (SWLS).

To ensure the quality of the survey, we set the response range of some items (some items needed to be answered in reverse) and encouraged participants to answer carefully through questionnaire explanations. Moreover, questionnaires that were completed less than 1 min or more than 20 min would be excluded from the analysis.

Psychometric Assessments

General Health Questionnaire-28 (GHQ-28)

General Health Questionnaire-28 (GHQ-28) has been developed by Goldberg (1978) and Sterling (2011). This questionnaire has 28 items and four subscales including somatic symptoms (items 1–7), anxiety (items 8–14), social dysfunction (items 15–21), and severe depression (items 22–28). This scale is a four-point Likert scale from not at all (score 0), no more than usual (score 1), rather more than usual (score 2), to much more than usual (score 3). The total possible score on the GHQ 28 ranges from 0 to 84 and the high score in this questionnaire indicates a greater disorder in the mental health of individuals. The reliability of the Persian form of the GHQ-28 using Cronbach's alpha coefficient was acceptable in the range of 0.73 to 0.89. Moreover, four factors have been extracted by using factor analysis and the principal component analysis, and the confirmatory factor analysis confirmed four subscales with 28 items (Noorbala and Mohammad, 2009).

Satisfaction With Life Scale

The SWLS was designed as a measure of individuals' global judgment of their life (Diener et al., 1985). The SWLS consists of five statements, scored on a scale ranging from 1 (completely disagree) to 7 (completely agree). The total score is the sum of the item scores (range, 5–35). The validity and reliability of SWLS have been confirmed in the Iranian population (Maroufizadeh et al., 2016). In more detail, the Cronbach's alpha reliability of the scale was 0.90, and also confirmatory factor analysis confirmed a one-factor model with good fit statistical indexes.

Profile of Mood State Short Form

The POMS-SF is a reliable and valid measure of subjective mood states that has been used extensively in a wide variety of studies (Chen et al., 2002). This questionnaire has 30 items and six subscales including tension, depression, anger, vigor, fatigue, and confusion. Participants respond on a five-point, Likert-type scale ranging from 0 (not at all) to 4 (extremely). Each of these six dimensions is defined by five adjectives. The reliability of the Persian of POMS-SF using Cronbach's alpha coefficient was acceptable in the range of 0.74 to 0.88. Besides, the confirmatory factor analysis has confirmed a six-factor model as a good fit with strong statistical evidence (Farrokhi et al., 2012).

Statistical Analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS, version 22.0, Chicago, IL, United States). Data were checked for missing, outliers, and normal distribution. The Kolmogorov–Smirnov normality test showed that most variables were not normally distributed. Values were computed and reported for illustrating purposes as mean ± SD (standard deviation) and frequency (n) and percentage (%).

To test the effect of COVID-19 pandemic condition on the self-reported measure (training during COVID-19 pandemic), a repeated measure analysis of variance (ANOVA) with a within-subject factor was conducted for the three conditions (home confinement, reopening, and semi-lockdown). Moreover, we applied Bonferroni correction for multiple comparisons, when the ANOVA outcomes were significant. For those variables without normal distribution and ordinal variables, we utilized Friedman tests for comparison of the three conditions (home confinement, reopening, and semi-lockdown) and subsequently, Wilcoxon Signed Ranks tests as *post hoc* comparisons. The nominal variable (COVID-19 infection) was analyzed using Cochran's Q test for comparison of three conditions and McNemar Tests were utilized as *post hoc* comparisons. Furthermore, Kruskal–Wallis and Mann–Whitney U tests were utilized for the comparison of psychological variables in gender, age categories, types of sport, and competitive levels in each phase of this study. Pearson correlation tests were used to assess possible relationships in the difference scores (Δ) of three phases of study between the assessed psychological parameters (mental health, life satisfaction, and mood states). Statistical significance was evaluated as $p < 0.05$ for all tests.

RESULTS

For the first phase (home confinement condition), 525 (100%) valid responses were received. Our sample decreased by 61 (11.6%) people in the second phase (n = 464). In the third phase (semi-lockdown condition), 36 (n = 97, 18.5%) people did not participate compared with the second phase (reopening condition) (n = 428). Descriptive statistics presenting the demographic information of the participants, including age, gender distributions, educational level, marital status, life form, sports type, and competitive levels, are summarized in **Table 1**.

The mean age of participants was 27.85 ± 9.09 years at the home confinement condition, 27.53 ± 8.74 years at the reopening condition, and 27.43 ± 8.56 years at the semi-lockdown condition. Of the total sample, 205 (39%) were men and 320 (61%) were women at the first phase of this study. In the second phase, 39.4% of the sample were men and 60.6% were women. In the third phase, we observed that 169 (39.5%) of the sample were men and 259 (60.5%) were women; 69.9% of our sample were single and 26.7% were married and 3.4% were divorced or widow/widower at the first phase. In the second phase, 70.3% were single, 26.1% were married, and 3.7% were divorced or widow/widower. At the final phase, 70.1% were single, 26.9% were married, and 4% were divorced or widow/widower. Only 7.4% of the elite athletes lived alone and 92.6% were with family. The same results were found at the second and third phases. The elite athletes were active in individual (home confinement condition: 51%, n = 268; reopening condition: 49.1%, n = 228; semi-lockdown condition: 48.1%, n = 206) and team (home confinement condition: 49%, n = 257; reopening condition: 50.9%, n = 236; semi-lockdown condition: 51.9%, n = 222) sports. Most respondents competed at the national level (home confinement condition: 41.4%; reopening condition: 41.8%; semi-lockdown condition: 43.5%), followed by at the international level (home confinement condition: 31.7%; reopening condition: 32.5%; semi-lockdown condition: 32.2%) and super league (home confinement condition: 26.9%; reopening condition: 25.6%; semi-lockdown condition: 24.3%).

Table 2 describes the personal situation of the respondents about economic damage by COVID-19, acceptance of the rules of quarantine, and health recipes of COVID-19, COVID-19 infection, training during the COVID-19 pandemic (at home and clubs), coaches follow-up, and need for psychosocial services during the pandemic. Moreover, the participants reported their training rate before the COVID-19 pandemic (hours/week: 11.02 ± 8.58).

As shown in **Table 2**, the change of economic damage by COVID-19 during the three conditions was significant [$\chi^2(2) = 217.11, p = 0.001$]. Furthermore, Wilcoxon Signed Ranks tests as *post hoc* comparison showed that economic damage by

TABLE 1 | Participants' demographic characteristics.

Variables/Phase	Home confinement condition (N = 525)		Reopening condition (N = 464)		Semi lockdown condition (N = 428)	
	Mean or n	±SD or valid %	Mean or n	±SD or valid %	Mean or n	±SD or valid %
Age (years)	27.85	±9.09	27.53	±8.74	27.43	8.56
18–25 (years)	256	48.8%	228	49.1%	210	49.1%
26–30 (years)	106	20.2%	99	21.3%	92	21.5%
31–35 (years)	69	13.1%	59	12.7%	55	12.9%
36–40 (years)	50	9.5%	42	9.1%	38	8.9%
41–45 (years)	44	8.4%	36	7.8%	33	7.7%
Gender						
Male	205	39.0%	183	39.4%	169	39.5%
Female	320	61.0%	281	60.6%	259	60.5%
Marital status						
Single	367	69.9%	326	70.3%	300	70.1%
Married	140	26.7%	121	26.1%	111	25.9%
Divorced, Widow/widower	18	3.4%	17	3.7%	17	4.0%
Life form						
Alone	39	7.4%	33	7.1%	28	6.5%
With family	486	92.6%	431	92.9%	400	93.5%
Education level						
Less than high school and High school graduate	120	23.0%	117	25.2%	107	25.0%
Bachelor's degree	231	44.3%	205	44.2%	191	44.6%
Master's degree	128	24.6%	106	22.8%	97	22.7%
Doctoral degree	42	8.1%	36	7.8%	33	7.7%
Sport type						
Individual sports	268	51.0%	228	49.1%	206	48.1%
Team sports	257	49.0%	236	50.9%	222	51.9%
Competitive levels						
International	164	31.7%	151	32.5%	138	32.2'%
National	214	41.4%	194	41.8%	186	43.5%
Super league	139	26.9%	119	25.6%	104	24.3%

COVID-19 was significantly different for the home confinement condition compared with the reopening condition (Z = 12.68, p = 0.001) and home confinement condition compared with the semi-lockdown condition (Z = 11.77, p = 0.001). However, no significant difference was found between the reopening condition and semi-lockdown condition (Z = 0.92, p = 0.353).

Related to the acceptance of the rules of quarantine and COVID-19 instruction, our findings revealed a significant difference in the COVID-19 condition [$\chi^2(2)$ = 27.20, p = 0.001]. Furthermore, *post hoc* comparison by Wilcoxon Signed Ranks tests indicated that this variable was significantly different for the home confinement condition compared with the reopening condition (Z = 2.70, p = 0.007) and home confinement condition compared with the semi-lockdown condition (Z = 5.25, p = 0.001). There was a significant difference between the reopening condition and the semi-lockdown (Z = 3.09, p = 0.001).

The COVID-19 infection factor was not statistically significant in three studied conditions (Cochran's Q = 0.33, p = 0.846). In this regard, McNemar tests as for *post hoc* comparison did not show any significant difference between the studied conditions (all $p > 0.05$).

The repeated measure ANOVA showed a significant difference for COVID-19 condition in training during the pandemic (F[2,844] = 8.18, p = 0.001). Bonferroni correction for multiple comparisons revealed a significant difference between the home confinement condition and the reopening condition (p = 0.001), as well as the home confinement condition and the semi-lockdown condition (p = 0.047). There was no significant difference between the reopening condition and the semi-lockdown (p = 0.308).

The coaches follow-up variable did not show any significant change between the three conditions [$\chi^2(2)$ = 1.64, p = 0.438]. In this regard, Wilcoxon Signed Ranks tests as *post hoc* comparison confirmed this finding (home confinement condition vs. reopening condition: Z = 0.20, p = 0.839; home confinement condition vs. semi-lockdown condition: Z = 1.10, p = 0.271; reopening condition vs. semi-lockdown: Z = 1.34, p = 0.180).

The analyses yielded significant differences in need for psychosocial services variable [$\chi^2(2)$ = 17.15, p = 0.001]. Subsequently, Wilcoxon Signed Ranks tests as *post hoc* comparison showed that the need for psychosocial services was significantly different for the home confinement condition

TABLE 2 | COVID-related characteristics influencing the participants during the three phases of study.

Variables/phase	Home confinement condition (N = 525)		Reopening condition (N = 464)		Semi lockdown condition (N = 428)		F/χ^2/Cochran's Q	p
	Mean or n	±SD or valid %	Mean or n	±SD or valid %	Mean or n	±SD or valid %		
Economic damage by COVID-19								
Completely	54	10.3%	224	52.3%	261	56.3%	217.11	0.001
To some extent	252	48.0%	154	36.0%	153	33.0%		
Not at all	219	41.7%	50	11.7%	50	10.8%		
Acceptance of the rules of quarantine and COVID-19 instructions								
Completely	243	46.3%	252	54.3%	257	60.0%	27.20	0.001
Most of the time	168	32.0%	139	30.0%	127	29.7%		
Rarely	79	15.0%	53	11.4%	34	7.9%		
Not at all	35	6.7%	20	4.3%	10	2.3%		
COVID-19 infection								
No	519	98.9%	454	97.8%	422	98.6%	0.33	0.846
Yes	6	1.1%	10	2.2%	6	1.4%		
Training during COVID-19 pandemic (at home and clubs)$^{h/w}$	1.34	±1.14	1.65	±1.20	1.51	±1.07	8.18	0.001
Coaches follow-up								
Completely	128	24.4%	116	25.0%	94	22.0%	1.64	0.438
Most of the time	138	26.3%	132	28.4%	122	28.5%		
Rarely	136	25.9%	103	22.2%	99	23.1%		
Not at all	123	23.4%	113	24.4%	113	26.4%		
Need for psychosocial services								
Completely	34	6.5%	47	10.1%	69	16.1%	17.15	0.001
To some extent	312	59.4%	267	57.5%	248	57.9%		
Not at all	179	34.1%	150	32.3%	111	25.9%		

compared with the semi-lockdown condition ($Z = 4.41$, $p = 0.001$) and the reopening condition compared with the semi-lockdown condition ($Z = 4.21$, $p = 0.001$). However, no significant difference was observed between the home confinement condition and the reopening condition ($Z = 1.61$, $p = 0.108$).

The means and standard deviations for the self-report measures (general health questioners-28, life satisfaction, and mood states) for each of the studied conditions are shown in **Table 3**.

As shown in **Table 3**, Friedman tests showed significant influence of the studied phases on anxiety and insomnia [$\chi^2(2) = 153.39$, $p = 0.001$], somatic symptoms [$\chi^2(2) = 54.35$, $p = 0.001$], social impairment [$\chi^2(2) = 100.52$, $p = 0.001$], depression [$\chi^2(2) = 143.10$, $p = 0.001$], and total score [$\chi^2(2) = 337.72$, $p = 0.001$].

Figure 1 presents findings from the general health questionnaire-28 subscales and life satisfaction during the phases of home confinement, reopening, and semi-lockdown conditions. *Post hoc* comparison analysis with Wilcoxon Signed Ranks tests revealed that in home confinement condition, GHQ-28 subscales and total score were higher (except for anxiety and insomnia between home confinement condition and semi-lockdown condition: $Z = 1.27$, $p = 0.203$), whereas in the reopening condition (anxiety and insomnia: $Z = 12.33$, $p = 0.001$; somatic symptoms: $Z = 8.13$, $p = 0.001$; social impairment: $Z = 11.16$, $p = 0.001$; depression: $Z = 11.99$, $p = 0.001$; total score: $Z = 16.30$, $p = 0.001$) and in the semi-lockdown condition (somatic symptoms: $Z = 4.92$, $p = 0.001$; social impairment: $Z = 6.74$, $p = 0.001$; depression: $Z = 2.52$, $p = 0.012$; total score: $Z = 7.67$, $p = 0.001$), those parameters were lower. Moreover, there was a significant difference between the reopening condition and the semi-lockdown condition (anxiety and insomnia: $Z = 10.37$, $p = 0.001$; somatic symptoms: $Z = 3.12$, $p = 0.002$; social impairment: $Z = 6.35$, $p = 0.001$; depression: $Z = 11.73$, $p = 0.001$; total score: $Z = 14.11$, $p = 0.001$).

At the home confinement condition, our results using Kruskal–Wallis test indicated that there is no significant difference between age categories [anxiety and insomnia: $\chi^2(4) = 2.79$, $p = 0.593$; somatic symptoms: $\chi^2(4) = 4.42$, $p = 0.328$; social impairment: $\chi^2(4) = 1.49$, $p = 0.828$; depression: $\chi^2(4) = 6.38$, $p = 0.172$; total score: $\chi^2(4) = 3.89$, $p = 0.441$] and competitive levels [anxiety and insomnia: $\chi^2(2) = 0.323$, $p = 0.851$; somatic symptoms: $\chi^2(2) = 3.34$, $p = 0.178$; social impairment: $\chi^2(2) = 1.46$, $p = 0.482$; depression: $\chi^2(2) = 0.87$, $p = 0.957$; total score: $\chi^2(2) = 0.56$, $p = 0.756$]. According to the Mann–Whitney U test, no significant difference was found in gender (anxiety and insomnia: $Z = 2.01$, $p = 0.053$; somatic symptoms: $Z = -0.37$, $p = 0.710$; social impairment: $Z = -1.11$, $p = 0.264$; depression: $Z = -0.91$, $p = 0.359$; total score: $Z = -0.57$, $p = 0.564$) and types of sport (anxiety and insomnia: $Z = -1.46$, $p = 0.143$; somatic symptoms: $Z = -0.16$, $p = 0.868$; social

TABLE 3 | Changes in factors of General health questionnaire-28, Life satisfaction and Mood states for the three phases of study and results from Friedman test.

Variable/phase	Home confinement condition (*N* = 525)		Reopening condition (*N* = 464)		Semi lockdown condition (*N* = 428)		χ^2	*p*
	Mean	±*SD*	Mean	±*SD*	Mean	±*SD*		
General health questioners-28 scores								
Anxiety and insomnia	9.11	2.00	7.01	2.00	8.85	2.48	153.39	0.001
Somatic symptoms	10.06	2.67	8.54	2.29	9.13	2.86	54.35	0.001
Social impairment	13.33	2.85	10.34	3.32	11.85	2.56	100.52	0.001
Depression	12.59	3.46	9.49	2.28	11.99	2.62	143.10	0.001
Total score	45.10	5.89	35.38	5.13	41.82	5.25	337.72	0.001
Life satisfaction score	16.18	4.61	17.34	4.18	18.65	5.48	38.18	0.001
Mood states scores								
Confusion	7.08	0.64	6.66	0.47	6.82	0.69	123.92	0.001
Anger	7.58	0.76	7.07	0.75	7.27	0.82	108.40	0.001
Depression	8.66	0.47	7.41	0.49	7.59	0.49	839.98	0.001
Vigor	5.58	0.63	6.67	1.03	5.83	1.03	365.88	0.001
Fatigue	8.33	0.85	7.42	0.63	8.08	0.76	314.48	0.001
Tension	8.16	0.98	7.07	0.86	7.81	0.69	280.08	0.001

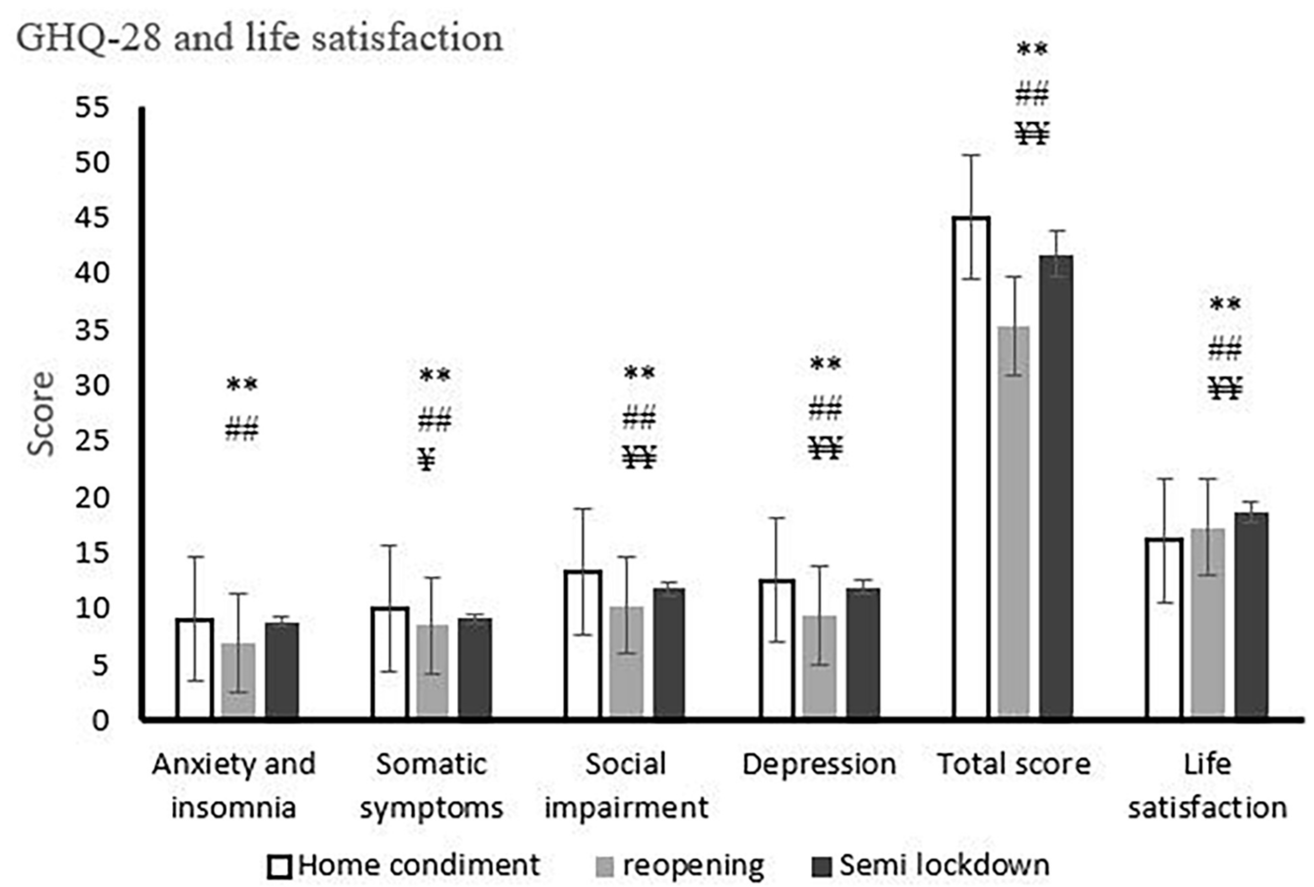

FIGURE 1 | General health questionnaire-28 subscales and life satisfaction during phases of home confinement, reopening, and semi-lockdown conditions. *$p < 0.05$ (between home confinement condition and reopening condition), **$p < 0.01$ (between home confinement condition and reopening condition), $^{\#}p < 0.05$ (between home confinement condition and semi-lockdown condition), $^{\#\#}p < 0.01$ (between home confinement condition and semi-lockdown condition), $^{¥}p < 0.05$ (between reopening condition and semi-lockdown condition), $^{¥¥}p < 0.01$ (between reopening condition and semi-lockdown condition). Each column represents the mean ratings ± S.E. (standard error).

impairment: $Z = -1.28$, $p = 0.221$; depression: $Z = -0.15$, $p = 0.878$; total score: $Z = -0.1.98$, $p = 0.056$).

Under the reopening condition, our results using Kruskal–Wallis test indicated that there is no significant difference between age categories [anxiety and insomnia: $\chi^2(4) = 7.74$, $p = 0.101$; somatic symptoms: $\chi^2(4) = 7.36$, $p = 0.118$; social impairment: $\chi^2(4) = 1.24$, $p = 0.871$; depression: $\chi^2(4) = 7.52$, $p = 0.111$; total score: $\chi^2(4) = 1.08$, $p = 0.896$] and competitive levels [anxiety and insomnia: $\chi^2(2) = 2.499$, $p = 0.287$; somatic symptoms: $\chi^2(2) = 1.05$, $p = 0.589$; social impairment: $\chi^2(2) = 4.48$, $p = 0.106$; depression: $\chi^2(2) = 0.50$, $p = 0.777$; total score: $\chi^2(2) = 3.56$, $p = 0.168$]. According to the Mann–Whitney *U* test, no significant difference was found in gender (anxiety and insomnia: $Z = -0.81$, $p = 0.416$; somatic symptoms: $Z = -1.37$, $p = 0.168$; social impairment: $Z = -0.54$, $p = 0.586$; depression: $Z = -1.76$, $p = 0.077$; total score: $Z = -0.76$, $p = 0.442$) and types of sport (anxiety and insomnia: $Z = -0.22$, $p = 0.826$; somatic symptoms: $Z = -0.30$, $p = 0.759$; social impairment: $Z = -1.41$, $p = 0.157$; depression: $Z = -0.63$, $p = 0.524$; total score: $Z = -1.30$, $p = 0.191$).

The same results were found for semi-lockdown condition in age categories [anxiety and insomnia: $\chi^2(4) = 3.89$, $p = 0.420$; somatic symptoms: $\chi^2(4) = 5.57$, $p = 0.223$; social impairment: $\chi^2(4) = 4.54$, $p = 0.337$; depression: $\chi^2(4) = 4.65$, $p = 0.312$; total score: $\chi^2(4) = 4.72$, $p = 0.330$], competitive levels [anxiety and insomnia: $\chi^2(2) = 1.128$, $p = 0.569$; somatic symptoms: $\chi^2(2) = 2.77$, $p = 0.250$; social impairment: $\chi^2(2) = 1.53$, $p = 0.465$; depression: $\chi^2(2) = 2.00$, $p = 0.366$; total score: $\chi^2(2) = 0.61$, $p = 0.735$], gender (anxiety and insomnia: $Z = -0.82$, $p = 0.410$; somatic symptoms: $Z = -0.50$, $p = 0.614$; social impairment: $Z = -0.69$, $p = 0.486$; depression: $Z = -1.68$, $p = 0.099$; total score: $Z = -1.66$, $p = 0.96$), and type of sport (anxiety and insomnia: $Z = -1.62$, $p = 0.105$; somatic symptoms: $Z = -4.14$, $p = 0.253$; social impairment: $Z = -1.69$, $p = 0.090$; depression: $Z = -0.31$, $p = 0.976$; total score: $Z = -1.01$, $p = 0.144$).

Our results for life satisfaction scores indicated a significant difference between the studied phases [$\chi^2(2) = 38.18$, $p = 0.001$]. Furthermore, Wilcoxon Signed Ranks tests as *post hoc* comparison showed that life satisfaction was significantly different for the home confinement condition compared with the reopening condition ($Z = 3.56$, $p = 0.001$) and the home confinement condition compared with the semi-lockdown condition ($Z = 6.51$, $p = 0.001$). Moreover, a significant difference was found between the reopening condition and the semi-lockdown condition ($Z = 3.60$, $p = 0.001$).

The Kruskal–Wallis test indicated that there is no significant difference between age categories in life satisfaction scores in the home confinement condition [$\chi^2(4) = 1.27$, $p = 0.875$], reopening condition [$\chi^2(4) = 4.32$, $p = 0.363$], and semi-lockdown condition [$\chi^2(4) = 6.48$, $p = 0.166$]. The same results were found for competitive levels [home confinement condition: $\chi^2(2) = 4.13$, $p = 0.127$; reopening condition: $\chi^2(2) = 0.39$, $p = 0.821$; semi-lockdown condition: $\chi^2(2) = 0.81$, $p = 0.666$]. No significant difference (based on Mann–Whitney *U* test) was found by gender (home confinement condition: $Z = -0.91$, $p = 0.367$; reopening condition: $Z = -0.89$, $p = 0.371$; semi-lockdown condition: $Z = -0.26$, $p = 0794$) and sport type (home confinement condition: $Z = -0.30$, $p = 0.761$; reopening condition: $Z = -0.98$, $p = 0.323$; semi-lockdown condition: $Z = -0.50$, $p = 0.612$).

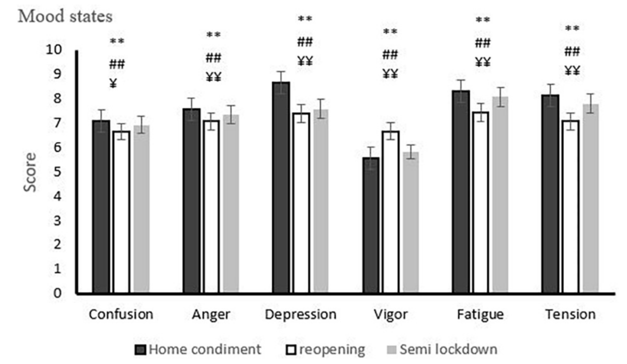

FIGURE 2 | Mood states profile during phases of home confinement, reopening, and semi-lockdown conditions. $^{*}p < 0.05$ (between home confinement condition and reopening condition), $^{**}p < 0.01$ (between home confinement condition and reopening condition), $^{\#}p < 0.05$ (between home confinement condition and semi-lockdown condition), $^{\#\#}p < 0.01$ (between home confinement condition and semi-lockdown condition), $^{¥}p < 0.05$ (between reopening condition and semi-lockdown condition), $^{¥¥}p < 0.01$ (between reopening condition and semi-lockdown condition). Each column represents the mean ratings ± S.E. (standard error).

The analyses yielded significant differences in confusion [$\chi^2(2) = 123.92$, $p = 0.001$], anger [$\chi^2(2) = 108.40$, $p = 0.001$], depression [$\chi^2(2) = 839.98$, $p = 0.001$], vigor [$\chi^2(2) = 365.88$, $p = 0.001$], fatigue [$\chi^2(2) = 314.48$, $p = 0.001$], and tension [$\chi^2(2) = 280.08$, $p = 0.001$] between the studied conditions. In this regard, Wilcoxon Signed Ranks tests as *post hoc* comparison revealed that mood states scores were significantly different for the home confinement condition compared with the reopening condition (confusion: $Z = 10.02$, $p = 0.001$; anger: $Z = 20.37$, $p = 0.001$; depression: $Z = 20.30$. $p = 0.001$; vigor: $Z = 15.16$, $p = 0.001$; fatigue: $Z = 14.93$, $p = 0.001$; tension: $Z = 15.08$, $p = 0.001$) and for the home confinement condition compared with the semi-lockdown condition (confusion: $Z = 2.82$, $p = 0.005$; anger: $Z = 11.83$, $p = 0.001$; depression: $Z = 20.21$. $p = 0.001$; vigor: $Z = 4.62$, $p = 0.001$; fatigue: $Z = 6.47$, $p = 0.001$; tension: $Z = 7.66$, $p = 0.001$). Moreover, there was a significant difference between the reopening condition compared with the semi-lockdown condition (confusion: $Z = 6.10$, $p = 0.001$; anger: $Z = 4.08$, $p = 0.001$; depression: $Z = 8.77$. $p = 0.001$; vigor: $Z = 14.38$, $p = 0.001$; fatigue: Z = 13.41, $p = 0.001$; tension: $Z = 13.22$, $p = 0.001$) (**Figure 2**).

At the home confinement condition, our results using Kruskal–Wallis test indicated that there is no significant difference between age categories [confusion: $\chi^2(4) = 4.75$, $p = 0.313$; anger: $\chi^2(4) = 3.47$, $p = 0.482$; depression: $\chi^2(4) = 5.57$, $p = 0.234$; vigor: $\chi^2(4) = 3.31$, $p = 0.381$; fatigue: $\chi^2(4) = 4.18$, $p = 0.381$; tension: $\chi^2(4) = 1.48$, $p = 0.830$] and competitive levels [confusion: $\chi^2(2) = 0.52$, $p = 0.768$; anger: $\chi^2(2) = 0.963$, $p = 0.618$; depression: $\chi^2(2) = 0.09$, $p = 0.956$; vigor: $\chi^2(2) = 0.64$, $p = 0.728$; fatigue: $\chi^2(2) = 0.32$, $p = 0.851$; tension: $\chi^2(2) = 0.11$, $p = 0.945$]. According to the Mann–Whitney *U* test, no significant difference was found by gender (confusion: $Z = -0.82$, $p = 0.408$;

TABLE 4 | Correlation among mental health, mood states and life satisfaction.

Variable Δ	1	2	3	4	5	6	7	8	9	10	11	12
(1) Total score-GHQ	–	0.374**	0.611**	0.475**	0.630**	0.008	−0.014	−0.046	−0.012	−0.108*	−0.035	−0.050
(2) Anxiety and insomnia		–	−0.024	0.071	−0.018	−0.095	−0.029	−0.072	0.015	−0.027	−0.049	0.051
(3) Social impairment			–	0.025	0.178**	0.052	−0.071	−0.039	−0.039	−0.120*	−0.056	−0.029
(4) Somatic symptoms				–	−0.004	0.006	0.029	−0.007	−0.072	0.047	0.012	−0.057
(5) Depression					–	0.024	0.036	0.009	0.062	0.069	0.015	−0.058
(6) Life satisfaction						–	−0.048	−0.0012	−0.001	−0.019	−0.037	0.035
(7) Confusion							–	−0.074	0.556**	−0.062	0.512**	0.482**
(8) Anger								–	0.422**	0.035	0.071	0.386**
(9) Depression									–	0.109*	0.270**	0.255**
(10) Vigor										–	−0.314**	−0.238**
(11) Fatigue											–	0.130**
(12) Tension												–

$^{**}p < 0.01$, $^{*}p < 0.05$.

anger: $Z = -1.67$, $p = 0.094$; depression: $Z = -0.96$, $p = 0.337$; vigor: $Z = -0.60$, $p = 0.544$; fatigue: $Z = -0.22$, $p = 0.822$; tension: $Z = -1.16$, $p = 0.130$) and types of sport (confusion: $Z = -0.26$, $p = 0.792$; anger: $Z = -0.14$, $p = 0.989$; depression: $Z = -0.21$, $p = 0.827$; vigor: $Z = -0.56$, $p = 0.572$; fatigue: $Z = -0.57$, $p = 0.569$; tension: $Z = -0.15$, $p = 0.875$).

The same results were found for reopening condition in age categories [confusion: $\chi^2(4) = 3.80$, $p = 0.433$; anger: $\chi^2(4) = 2.93$, $p = 0.568$; depression: $\chi^2(4) = 7.23$, $p = 0.055$; vigor: $\chi^2(4) = 3.06$, $p = 0.547$ fatigue: $\chi^2(4) = 2.06$, $p = 0.716$; tension: $\chi^2(4) = 2.41$, $p = 0.659$], competitive levels [confusion: $\chi^2(2) = 3.67$, $p = 0.160$; anger: $\chi^2(2) = 5.286$, $p = 0.071$; depression: $\chi^2(2) = 5.328$, $p = 0.070$; vigor: $\chi^2(2) = 4.45$, $p = 0.108$; fatigue: $\chi^2(2) = 5.14$, $p = 0.076$; tension: $\chi^2(2) = 3.69$, $p = 0.157$], gender [confusion: $Z = -1.27$, $p = 0.204$; anger: $Z = -0.18$, $p = 0.851$; depression: $Z = -0.23$, $p = 0.816$; vigor: $Z = -0.26$, $p = 0.799$; fatigue: $Z = -1.23$, $p = 0.219$; tension: $Z = -1.76$, $p = 0.078$), and types of sport (confusion: $Z = -0.76$, $p = 0.442$; anger: $Z = -0.44$, $p = 0.660$; depression: $Z = -1.01$, $p = 0.309$; vigor: $Z = -0.35$, $p = 0.724$; fatigue: $Z = -1.40$, $p = 0.159$; tension: $Z = -0.76$, $p = 0.447$).

Similar to the previous findings, no significant differences were found in the semi-lockdown condition between age categories [confusion: $\chi^2(4) = 4.45$, $p = 0.348$; anger: $\chi^2(4) = 1.71$, $p = 0.789$; depression: $\chi^2(4) = 3.06$, $p = 0.546$; vigor: $\chi^2(4) = 1.57$, $p = 0.813$; fatigue: $\chi^2(4) = 3.58$, $p = 0.465$; tension: $\chi^2(4) = 2.73$, $p = 0.603$], competitive levels [confusion: $\chi^2(2) = 1.72$, $p = 0.423$; anger: $\chi^2(2) = 1.76$, $p = 0.414$; depression: $\chi^2(2) = 2.017$, $p = 0.365$; vigor: $\chi^2(2) = 2.47$, $p = 0.290$; fatigue: $\chi^2(2) = 0.76$, $p = 0.682$; tension: $\chi^2(2) = 0.26$, $p = 0.874$], gender (confusion: $Z = -1.42$, $p = 0.153$; anger: $Z = -0.62$, $p = 0.530$; depression: $Z = -1.02$, $p = 0.314$; vigor: $Z = -1.30$, $p = 0.221$; fatigue: $Z = -0.20$, $p = 0.838$; tension: $Z = -1.10$, $p = 0.302$), and types of sport (confusion: $Z = -0.50$, $p = 0.960$; anger: $Z = -0.82$, $p = 0.408$; depression: $Z = -1.07$, $p = 0.282$; vigor: $Z = -0.81$, $p = 0.417$; fatigue: $Z = -0.93$, $p = 0.350$; tension: $Z = -1.66$, $p = 0.095$).

Finally, the Δ changes between three phases of the COVID-19 pandemic were calculated from the general health questioners-28, life satisfaction score, and mood states profile. **Table 4** shows the correlation between the changes of the assessed variables.

Pearson correlation showed significant positive correlations between total score of GHQ-28 with anxiety and insomnia ($r = 0.374$, $p = 0.001$), social impairment ($r = 0.611$, $p = 0.001$), somatic symptoms ($r = 0.475$, $p = 0.001$), depression ($r = 0.630$, $p = 0.001$), and a negative correlation with vigor ($r = -0.108$, $p = 0.040$). Moreover, there was a positive significant correlation between social impairment with depression ($r = 0.178$, $p = 0.001$) and a negative correlation with vigor ($r = -0.120$, $p = 0.023$). In addition, confusion ($r = 0.556$, $p = 0.001$) and anger ($r = 0.422$, $p = 0.001$) showed significant correlations with depression in mood state profile. There was a significant correlation between anger and tension ($r = 0.386$, $p = 0.001$). Additionally, there were significant correlations between confusion with fatigue ($r = 0.512$, $p = 0.001$) and tension ($r = 0.482$, $p = 0.001$), as well as depression with vigor ($r = 0.109$, $p = 0.023$), fatigue ($r = 0.270$, $p = 0.001$), and tension ($r = 0.255$, $p = 0.001$). The vigor subscales were negatively correlated with fatigue ($r = -0.314$, $p = 0.001$) and tension ($r = -0.238$, $p = 0.001$). Finally, the correlation between fatigue and tension was also found significant ($r = 0.130$, $p = 0.001$). No significant correlation, however, was found between the other tested variables.

DISCUSSION

The purpose of this study was to analyze the status of mental health, life satisfaction, and mood states of elite athletes affected by the COVID-19 pandemic during the phases of home confinement, reopening, and semi-lockdown conditions. The results illustrated that the rate of COVID-19 infection was not different and the rate was low during the studied phases. It is speculated that a large amount of information is given about COVID-19 and slow adaptation to the pandemic conditions together with the application of the health guidelines and the abundance of health equipment (e.g., facemask and antiseptics) have played a role in controlling the COVID-19 infection rate in the studied population. More research is needed to compare the rate of infection with the general population (and in other sport disciplines) to investigate if the rate is different and what are potential reasons under sports and competition settings.

The acceptance of the quarantine rules and massive instructions related to the pandemic were in general higher in the phases of reopening and semi-lockdown compared with the confinement phase. A case study indicated that sports persons have a positive approach toward this crisis, rules, and instructions in comparison with the rest of the population during the COVID-19 pandemic (Jaenes et al., 2020a; Pandey, 2020). It is noteworthy that most likely for the post-pandemic, there will be many instructions for returning to sports safely and that athletes must follow some guidelines for training (DiFiori et al., 2020; Toresdahl and Asif, 2020). Further studies should be considered to determine the underlying mechanism(s) of acceptance of the rules of COVID-19, in particular in athletes.

As expected, our results indicated that the economic conditions have deteriorated during the COVID-19 pandemic. In more detail, the number of people who have suffered from the economic damage caused by the COVID-19 has increased during the studied phases (e.g., 10.3% in the confinement condition, 52.3% in the reopening condition, and 56.3% in the semi-lockdown conditions). Recent publications have reported similar findings relevant to the economic influence of the COVID-19 pandemic (García-Tascón et al., 2020; Nicola et al., 2020; Polyakova et al., 2020). In the context of elite athletes, Drewes et al. (2020) reported that in those who have sport-based income, 65% indicated that their funding, sponsorship, or salary had been affected. The way in which the athletes had been affected, however, varied. In their study, 44% no longer received any compensation for matches or competitions due to the cancelation of most competitive sports activities. However, there is no similar longitudinal study in the literature that we could compare our data during the COVID-19 pandemic. Researchers have proposed that such economic hardships lead to a much higher prevalence of expressing mental health issues, including feelings of depression and anxiety (Witteveen and Velthorst, 2020). Therefore, governments and sports organizations must consider financial support for the affected athletes and sports teams, not only under the current situation but also for future prevention strategies (Mehrsafar et al., 2020).

The training rate was found to be negatively affected in our study. Despite recommendations that home confinement should not hinder people from being physically active, present results showed a decline in training rate during the COVID-19 home confinement phase. Moreover, we found that the training rate during the reopening phase was higher as compared with the home confinement and semi-lockdown conditions. This finding is in line with previous studies (Pillay et al., 2020). It has been reported that the home confinement period by COVID-19 caused reductions in training volume and intensity and decreased sleep quality in handball players and professional and non-professional football players (Mon-López et al., 2020a,b). Moreover, a multicenter study reported that COVID-19 home confinement had a negative effect on the level of sports activities (Ammar et al., 2020a).

Despite the physical activity guidance provided to athletes (World Health Organization, 2020d), our results indicated that it has not been possible for individuals to adequately maintain their normal sport activity patterns at home or in private clubs. The decline in sport activities was accompanied by increased sedentary behavior (Wong et al., 2020). However, the extent to which training and sports activities are impacted by the current COVID-19 pandemic will be linked to the stringency of individual government confinement policies. However, after the reopening and in the semi-lockdown conditions, the amount of sports activity and training showed an increase, but the level is still very low compared to the pre-pandemic time. One of the most important factors is related to the returning to competition and regular form of sports activities. It has been shown that low tolerance during COVID-19 pandemic conditions caused high levels of dysfunctional response (e.g., anxiety, stress, depression, and alexithymia) in Spanish elite athletes (Hernández et al., 2021). Although reopening and semi-lockdown conditions increase sports activity rates, the fear of infection and restrictions in many sports (e.g., contact sports) are no different from home quarantine. This result is in line with previous research done in New Zealand, which reports that the rate of physical activity was lower at post-lockdown compared to pre-lockdown in highly active people (Hargreaves et al., 2021). Sports at the elite levels require sports equipment, spaces, and the presence of coaches and training opponents. These needs are difficult to meet during the COVID-19 pandemic; it can be one of the reasons for the decline in sports activity in these conditions (Herrero-Gonzalez et al., 2020; Latella and Haff, 2020). Sports organizations and sports medicine professionals need to find solutions for these issues in training and competitions related to elite athletes, especially in sports where competitions and training have not started, such as some sports in which the return to competition has begun. Failure to return to competitive conditions can cause many mental health problems in elite athletes, such as reduced fitness and income (Ernstsen and Havnen, 2020; Mehrsafar et al., 2020). Future sports activities can benefit from the solutions offered by Information and Communications Technology (ICT), such as home-based training and fitness apps (Ammar et al., 2020b). For instance, a study showed that participants who were users of eHealth for exercise and physical activity presented significantly higher levels of vigorous physical activity and total physical activity per week than non-users during the COVID-19 pandemic (Marchant et al., 2021).

Regarding coach–athletes interaction, our elite athletes reported a moderate rate of follow-up and monitoring of the training during the COVID-19 studied phases. A recent study reports that the coaches have experienced a wide spectrum of emotional and cognitive reactions such as disappointment, frustration, confusion, and relief after the postponement of the Tokyo 2020 Olympic and Paralympic Games by the COVID-19 pandemic (Taku and Arai, 2020). Moreover, a group of researchers illustrated that 80% of Italian athletes stayed in contact via the web with their coaches or other professionals during the Italian lockdown caused by the COVID-19 (di Fronso et al., 2020). The coach follow-up can help athletes to feel less stress, avoid behavioral and motivational problems, and reduce negative emotional states. To our knowledge, our study is the first to report coach follow-up in athletes during the COVID-19 pandemic in the three phases of home confinement, reopening, and semi-lockdown. Future studies could investigate whether these findings would be similar in other athletes, and if any difference exists, what can be potentially a reason behind that. Moreover, artificial intelligence and digital-based platforms can potentially provide help and plans for athlete–coach communication and training, and consequently, recommendations for physical and mental fitness and return to sports competition can be provided (Lim, 2020).

As recently have been discussed by Van Bavel et al. (2020), the widespread term "social distancing," implying that one needs to cut off meaningful interactions, should be fully replaced by "physical distancing.". Additionally, some athletes have stated that they are isolated and feel lonely, which has impacted their mental health (Gorczynski and Aron, 2020). In line with these challenges, our result highlighted that the elite athletes have been in constant need of psychosocial services throughout the COVID-19 pandemic. A narrative review by Reardon et al. (2020) has also noted that the COVID-19 pandemic has created changes in dealing with mental health symptoms and disorders in elite athletes, as a special population, to receive specific psychosocial services. This review has recommended that within the realm of psychotherapy, crisis counseling, and other forms of individual psychotherapy, couple/family and group psychotherapy might be helpful during the COVID-19 pandemic (Reardon et al., 2020). Besides, Psychological First Aid (PFA), telemental health, and video conference, plus other virtual health care interventions can be utilized in line with the psycho-social approach (Reardon et al., 2020; Yang et al., 2020). Furthermore, media co-creation, following the advice shared by athletes and teams, engagement with challenges, and fundraising contributions can be a new direction in social services, social responsibility, and altruistic behavior (Sharpe et al., 2020). In particular, messages on social media promoting hygiene, physical distancing, and sport provide a simple yet productive way for athletes and sports organizations to connect with sports fans and contribute to the global effort to slow down the spread of COVID-19.

The WHO has warned communities about the pandemic-related mental health problems among the general public (World Health Organization, 2020c). Studies in the field of sports have also emphasized the importance of this issue in elite athletes (Mehrsafar et al., 2020; Reardon et al., 2020). The result of our study indicated that home confinement caused a negative impact on the mental health status of elite athletes. In more detail, we found that the anxiety and insomnia, somatic symptoms, social impairment, and depression were the highest negatively affected parameters during the home confinement phase as compared with the reopening and semi-lockdown phases. This finding is in line with the previous studies that have reported a decreased level of mental health parameters in athletes (Bowes et al., 2020; Håkansson et al., 2020; Lamberts and Gomez-Ezeiza, 2020; Makarowski et al., 2020; Pillay et al., 2020). A study has reported that the martial art athletes did not engage frequently in active coping strategies, such as planning, or positive reframing during the COVID-19 pandemic (Makarowski et al., 2020). This approach may put elite athletes in a negative cycle that puts mental health at risk. Moreover, acceptance of the COVID-19 situation might be linked to stress-related growth among the athletes; in this situation, athletes think that they are in a dark period of their professional life and it is difficult for them to return to previous fitness and competitive level, which can be a source of stress and anxiety. It has been known that it may cause anxiety and post-traumatic stress symptoms in athletes similar to non-athletes (Şenışık et al., 2020). Besides, spending a long time at home during home confinement and reduction of communication have reduced the level of social support for elite athletes in general. These observations and reports point to a reduced mental health situation with a potential increased psychological disorder symptom known as "adding stress to the stressed." Since physical activity is recognized with antidepressant and anxiolytic effects, this change alone could substantially worsen the elite athletes' mental health. Sports activity has been considered a way in preventing psychiatric symptoms and poor mental health (Reardon et al., 2020). Therefore, sports organizations, coaches, and other guideline providers should consider proper plans for elite athletes to optimize their training programs. Moreover, a safe strategy with risk–benefit evaluation on how to return to competitions would help restore both mental and physical health in this population. On the other hand, planning for monitoring, evaluation, intervention, and management of mental health should be considered with a high priority. In this vein, interventions can benefit from a variety of psychotherapy approaches to psychiatric therapies with a specific approach to fit the elite athletes' needs (Reardon et al., 2020).

Our study revealed that life satisfaction changed to the home confinement, reopening, and semi-lockdown phases. Life satisfaction after the home confinement period showed an increase over time, where the highest rate was at the semi-lockdown condition. A multicenter study also reports a negative impact of home confinement on the life satisfaction scores (Ammar et al., 2020a) and the fact that concerns about the illness and COVID-19 infection can be associated with lower life satisfaction (Von Soest et al., 2020). Additionally, physically active people might be more susceptible to well-being issues and lower life satisfaction during a lockdown (Zhang and Tower, 2020). However, one must also consider that we studied the home confinement phase along with the reopening and semi-lockdown conditions, and there is no similar study in the literature that we could compare our data. Different studied populations under different conditions posed by the COVID-19 pandemic and different instruments to study the influence of the pandemic on mental health in athletes make it difficult for comparisons between studies at this time point. However, a general trend of the negative effects of the pandemic on mental health seems currently accepted.

Some speculations can help to explain these results. Feeling dissatisfied with life during the home quarantine period might be a result of the social distancing from emotionally attached individuals, such as team members and coaches, and the inability to engage in professional sports activities, which is known as psychological stress that can eventually lead to dissatisfaction with life. In addition, adapting to the COVID-19 conditions and improving the mood and, to some extent, returning to continued activities and sports (albeit with limitations) can probably be among other reasons to improve life satisfaction. Therefore, to maintain an acceptable level of life satisfaction, it is important to stay in touch and be able to pursue activities during the COVID-19 condition while physical distance is maintained. In this regard, a longitudinal study indicated that athletes have a tendency toward a psychological adaptation to the stressful conditions they have to face (Rubio et al., 2020). Providing online meetings to reduce or close the gap can be helpful. More research is needed to find strategies to improve the quality of life during the COVID-19 pandemic; however, the puzzle seems complex with multiple layers of confounding factors.

The effect of COVID-19 on the mood responses in elite athletes is an important indicator of how athletes are coping with the pandemic. We found that the pattern of mood responses reflected as an inverse iceberg profile, characterized by significantly elevated scores for depression, anger, fatigue, tension, and confusion, and lower scores for vigor during all studied phases. However, the vigor subscale was higher in the reopening condition, whereas the depression, anger, fatigue, tension, and confusion subscales were lower. Moreover, depression, anger, fatigue, tension, and confusion subscales during the home confinement revealed the highest scores compared with the other phases of the study. According to the inverse iceberg profiles that have been reported in the literature to increase the risk of psychopathology (Terry et al., 2020) or cause failure and reduce well-being in elite athletes (Terry and Parsons-Smith, 2019), we assume that these can also explain what we observed in this study. A recent survey indicated that tension, depression, anger, fatigue, confusion, and reduced vigor were identified in 1,062 Australian people during the periods of COVID-19 restrictions, representing significant mood disturbances (Terry et al., 2020). Moreover, Mon-López et al. (2020b) showed that home confinement affects training load, the recovery process, and mood states in top-level football players.

There are several plausible explanations for the observed increase in negative feeling states. The pandemic has undoubtedly caused fear and loss for many elite athletes; health fears for self and loved ones, fear of isolation, loss of income, or social support, and a sense of lack of normality (Mehrsafar et al., 2020; Terry et al., 2020). During this pandemic, elite athletes have lost livelihoods, relationships, and opportunities for participation in national and international tournaments, or have been denied access to simple activities that give them pleasure, such as physical contact with friends and family, or interacting with sports colleagues. In this regard, a reluctance or inability to share grief and loss with others may be associated with mood decrements and increased potential for psychopathology to open a window of vulnerability (Terry et al., 2020). Moreover, the anti-negative mood effect of exercise training has a strong evidence base (Siqueira et al., 2016; Jaenes et al., 2020b). In this line, reduced exercise duration during the pandemic has been associated with higher scores in depression, anxiety, and stress as well as negative mood states (Mon-López et al., 2020b; Stanton et al., 2020). Therefore, physical activity (and even virtual reality exercise) could be recommended to reduce the negative emotional effect in periods of confinement and COVID-19-related restrictions (Gao et al., 2020). In addition, adaptive strategies such as acceptance, reappraisal, and problem-solving in a different setting (e.g., ICT and digital interventions) are techniques increasingly being used under the current condition (Aldao et al., 2010).

Strengths and Limitations

Previous studies have suggested that studies in the field of COVID-19 in elite athletes must be performed with a follow-up setting. We assessed the elite athletes during the home confinement, reopening, and semi-lockdown phases, which allowed us to analyze the dynamic changes that occurred overtime. This expanded our understanding of the needs and challenges of this special population and could show a diversity of the negative impact on elite athletes during the three studied phases.

The present study has limitations, mainly associated with the fact that this is an anonymous online survey, with limited possibilities for in-depth questions or full diagnostic instrument to be used, and a relatively low response rate as well as truthful answers. Moreover, we utilized online data collection based on social media platforms and internet pages. Several studies have recommended that an online survey research can be helpful under crisis more than a face-to-face method, and this method has some advantages during COVID-19 conditions (e.g., prevent transmission of infection, travel, and quarantine restrictions, time, cost, large sample size, and repetition of study) (Wright, 2005; Rice et al., 2017). However, there are several disadvantages that are mentioned in previous studies (e.g., this method is not able to guarantee the pure sampling and accurate demographic or characteristic information) (Rice et al., 2017). For solving this limitation, future studies can get the membership lists of athletes from sports organizations and send an invitation link to recognized athletes. Additionally, next studies should consider more rigorous methods for data collection (e.g., personal surveys, telephone surveys, and mobile software surveys). It should also be noted that our questioners are not replacements of diagnostic tools, and hence, although our results may signal an increased risk of clinical psychopathology among elite athletes, they could equally be seen in society. Accordingly, comparing the results with the general population can better determine the pandemic status of COVID-19 in elite athletes. Besides, our study used only questionnaires, other studies can use physiological markers (e.g., immunity and hormonal markers) that are related to mental health. In this regard, studies with a mixed methodology can be used in the future for better diagnosis.

We did not include a status of the pre-lockdown condition about mental health, life satisfaction, and mood state profiles; thus, our present findings cannot be compared to those parameters of the pre-lockdown condition.

Future study designs could consider including more variables about returning to the competition [duration and intensity of training, monitoring systems for the training quantity and quality, competitive camps, place (home or away competition), COVID-19 infection during the competitive phase, isolation of elite athletes by COVID-19 infection, etc.] and new restrictions posed during this pandemic. Besides, comparing results in different countries with different languages and cultures, per capita income levels, diverse support, and diverse constraints over a single period or at different times can help to integrate conclusions. Future studies can also be conducted experimentally and a variety of psycho-behavioral interventions (under an ICT setting or face-to-face and even group therapy) and training plans for elite athletes can be applied to investigate if any improvement would show up for mental health factors and physical fitness.

CONCLUSION

Findings from this explorative study suggest that mental health, life satisfaction, and mood states were influenced during the different phases of the COVID-19 pandemic. Reopening and semi-lockdown phases were found to be associated with higher mental health, mood state, and life satisfaction. Home confinement created problems with trainings and plans and economic damage. Overall, this study provided the first evidence on dynamic changes of the COVID-19 phases on several psychological factors in elite athletes. According to the results, specific programs to support elite athletes at a psychological level could be recommended, especially to improve training rate, mental health, mood states, and life satisfaction. Accordingly, safe conditions and a rigorous monitoring system must be established by federations and institutions to protect the integrity of elite athletes. Learning from the past crises caused by the previous pandemics, planning for the current situation, and eventual future strategies seem crucial.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of the Tehran University of Medical Sciences (number: 1399-335) and was conducted according to the Declaration of Helsinki. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JCJS conceived the original study in Spain. AM, AZ, PG, MN, and MT conceived the study and collected the data. AM, MT, MA, and AZ designed the questionnaire and analyzed the data. All authors wrote the manuscript. AM, AZ, PG, JCJS, MN, and MA provided critical revisions on the successive drafts. All authors read and approved the final manuscript.

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Adherence Rate, Barriers to Attend, Safety, and Overall Experience of a Remote Physical Exercise Program During the COVID-19 Pandemic for Individuals After Stroke

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Introduction: The actions taken by the government to deal with the consequences of the coronavirus diseases 2019 (COVID-19) pandemic caused different levels of restriction on the mobility of the population. The need to continue offering physical exercise to individuals after stroke became an emergency. However, these individuals may have barriers to adhere to the programs delivered remotely. There is a lack of evidence related to adherence, attendance, safety, and satisfaction of remote exercise programs for this population.

Objective: The aim was to evaluate adherence and barriers to attend a remote physical exercise program for individuals after stroke. We aimed (a) to identify adherence and attendance rate of the remote physical exercise program (i.e., number of participants engaged, number of sessions attended, and exercise time in remote program); (b) to identify the safety of a remote physical exercise program (i.e., falls, pain, or dizziness when performing the exercises, fear, or insecurity); and (c) to identify the overall experience to participate in a remote program.

Materials and methods: This is a longitudinal study, including 36 stroke survivors who already attended a face-to-face physical exercise program prior to the COVID-19 pandemic. The remote physical exercise program included sessions for 2 days/week for a duration of 22 weeks, with a total of 44 sessions, which were delivered asynchrony *via* recorded video sessions. As outcome measures, we performed two questionnaires (via weekly telephone calls) to identify attendance, barriers, safety, and overall experience related to the program.

Results: The adherence rate was 86 (9%). The attendance rate was 19, with a total of 8 sessions (108.3 min/week). The main barriers for lower attendance rate were as follows: lack of motor skills and physical fitness to workout in 80 reports (20.6%), followed by no exercise companion in 44 reports (11.3%). The remote physical program has been shown to be safe, and the overall experience was positive from the perspectives of the participants and the family members.

Conclusion: Although the adherence rate was high, the attendance rate was low on the remote physical exercise program. The main barriers to attending the program remotely reflect the need of tailoring individually an asynchrony mode of delivering the sessions to individuals after stroke. Our results also indicate how the COVID-19 impacted the health conditions of stroke survivors. The program was safe, and the overall experience indicated a change in the mental, physical, and social health of individuals after stroke and their family members.

Keywords: stroke, telemonitoring, barriers, COVID-19, physical activity, telehealth, social isolation, physical exercies

INTRODUCTION

Social distancing was applied to mitigate the effects of the pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [coronavirus disease 2019 (COVID-19)], leading to mobility restrictions and suspending face-to-face services. Physical exercise facilities (e.g., gyms and public parks) were closed, constraining the physical activity for physical conditioning, therapeutic exercise, or leisure purposes. In particular, physical activity programs for individuals with chronic health conditions were suspended or were dramatically reduced. To overcome such limitations, alternatives based on remote-supervised activities emerged (Hosseiniravandi et al., 2020).

Since the late 1960s, the development of Internet protocols has created opportunities for teleservices, such as monitoring and supervision. At present, remote sensing, nanotechnology, and the Internet of Things have potentiated the emergence of mHealth or health services provided at a distance (McCue et al., 2010; Linder et al., 2015). Remote physical exercise programs (e.g., telerehabilitation, telemonitoring, or home-based rehabilitation) can offer guided exercises with remote monitoring to people with musculoskeletal and neurological disorders (Hosseiniravandi et al., 2020), who are isolated by social distance. Such remote monitoring allows health professionals to adapt the exercises and physical activities according to the needs of the individuals with neurological diseases (Laver et al., 2020), facilitates access to health services, and improves equity, thus reducing the costs of the rehabilitation programs (Chen et al., 2020; Ghorbel et al., 2020; Han et al., 2020; PUi Kei et al., 2020; Salawu et al., 2020; Zedda et al., 2020).

Stroke is a neurological condition that can cause impairments in functions and structures, limitation of activity, and restraint of participation. Thus, the practice of physical exercises is an approach that presents benefits in all affected areas (Saunders et al., 2020). In the current scenario, remote physical exercises were the only way to keep them active. Appleby et al. (2019) identified that a remote physical exercise program has moderate evidence to improve motor function, independence in activities of daily living (ADLs), satisfaction, and quality of life for individuals after stroke.

Laver et al. (2020) conducted a systematic review to compare telerehabilitation programs, face-to-face interventions, and usual care for stroke survivors, thus, less evidenced studies suggest that remote and face-to-face rehabilitation programs have similar effects on ADLs, balance, and upper limb function, while moderately evidenced studies suggest that remote programs and usual care (or no care) have similar effects on ADL independence, quality of life, and depression. Only two studies (Laver et al., 2020) reported adverse effects during the remote intervention.

Still, this review (Laver et al., 2020) raises some important points to be addressed in future studies, in particular, there is the importance of knowing whether study participants are satisfied with the program, and additionally, which participants could benefit more from this mode of delivery. At the same time, barriers to engaging in remote physical exercise programs during such a pandemic are not clearly stated. Individuals with neurological disorders have barriers to attend a face-to-face program, e.g., time restrictions; resource limitations; geographical isolation; compliance with rehabilitation; fear of falling and more severe motor restrictions; and expectation of low results (Dobkin, 2016; Afshari et al., 2017; Appleby et al., 2019). Would these same barriers affect similarly the adherence and attendance on a remote exercise program?

To answer this question, this study aims to evaluate barriers to adhere and attend remote physical exercise programs for individuals after stroke. Specifically, we aim (a) to measure the adherence rate and attendance to a remote physical exercise program (i.e., number of participants engaged, number of sessions attended, and exercise time); (b) to describe how safe a remote physical exercise program is (i.e., falls, pain, or dizziness when performing the exercises, fear, or insecurity); and (c) to measure the overall experience to participate in a remote physical exercise program for individuals after stroke and their family members.

MATERIALS AND METHODS

This is a phase-I clinical trial, and the CONSORT checklist is used. It was developed at the Motor Behavior Laboratory of the School of Physical Education and Sport of the University of São Paulo, São Paulo, Brazil. We have the approval of the Human Ethics Committee (# 4.119.009; CAAE No. 32005420.4.0000.5391; plataformabrasil.saude.gov.br). All individuals accepted to participate and provided their written informed consent.

Participants

Individuals with a stroke diagnosis who attended the face-to-face community rehabilitation program at the School of Physical Education and Sport, University of São Paulo, São Paulo, Brazil earlier were invited to join this study after the COVID-19 pandemic had started. The inclusion criteria were as follows: confirmed diagnosis of stroke by image or medical report; either types of stroke (ischemic and hemorrhagic) in chronic phase (Bernhardt et al., 2017); above 18 years old; no orthopedic, other neurological, and cardiac risk factors to exercise; and Montreal Cognitive Assessment (MoCA) score higher than 14 [no dementia (Phannarus et al., 2020); walking speed ≥0.4 m/s (home walker) (Fulk et al., 2017); and perform the face-to-face community rehabilitation program for at least 6 months]. The exclusion criteria were to show a cardiovascular or respiratory condition impairing performance training and/or health safety during exercise. Individuals who missed sessions were not excluded because we aimed to identify the reasons and barriers for attendance. Therefore, the permanence of an individual in the study even without carrying out the activities becomes important. In terms of definition, the adherence rate was described as the relative frequency of individuals who accepted to engage in the remote exercise program (Ellis et al., 2019; Landers and Ellis, 2020).

Characterization of Participants

Demographic data (e.g., sex, age, schooling, time since diagnosis, and known comorbidities before social isolation) of the participants were recorded previously in January and February, during the face-to-face physical exercise program, before the start of the COVID-19 pandemic in Brazil. Physical information from each participant, as a prerequisite to engaging in the face-to-face program, was obtained. The activity-specific balance confidence scale (ABC) (Branco, 2010) and the Mini-Balance Evaluation Systems test (MiniBESTest) (Bambirra et al., 2015) were used to characterize the perception of balance and balance itself; the 6-minute walk test (6 MWT) (ATS, 2002) was used to characterize aerobic capacity; the 10-meters walk test (10 m) (Tyson and Connell, 2009) was used to characterize the gait speed; the Timed Up and Go (TUG) (Richardson, 1991) test was used to characterize mobility; the MoCA was used to characterize cognitive deficit (Nasreddine et al., 2005); and the Stroke Impact Scale (SIS) was used to characterize the quality of life (Carod-Artal et al., 2008; Branco, 2010).

Remote Exercise Protocol Development

An exercise protocol was developed for this remote program maintaining the same objective as the face-to-face program: to reduce physical inactivity, to increase physical function, such as aerobic capacity, muscle resistance, mobility, balance, and gait, and to improve balance confidence and cognition (Billinger et al., 2015). All activities follow the recommendations for physical exercise training for stroke survivors (Billinger et al., 2014; Sarfo et al., 2018; Saunders et al., 2020). Every Monday and Wednesday, a full session of videotaped activities was sent *via* mobile phone and email to all participants. The videos contained different exercises each day. Initially, the instruction on how to perform the exercise was given, such as execution time, perceived effort (intensity), the number of series, and repetitions given by the trainer. All exercises had different levels of intensity and complexity so that all participants were able to perform the exercises and adapt them to their own level. **Table 1** shows the content of the videos with their respective aims, description of the activities, practice duration, and video duration. Participants were encouraged to do the exercise sessions on different, non-consecutive days. Required exercise equipment were household-like tools (e.g., broomstick, chair, cushion, and bottles of water or sand).

The attendance rate was described by the number of attended sessions based on 48 sessions in total. Additionally, the accumulated time (in min) per week of performed exercise was also considered. Furthermore, we aimed to describe the higher and lower attendance frequencies, including the participants who attended more than 80% and <20% of the sessions.

The working team for this remote exercise program was composed of a team leader (faculty member), a physical education instructor (faculty member), a health instructor team (four graduate students and an in-charge to supervise the intern team), and an intern team (20 undergraduate students). The entire team was trained and familiarized with how to apply the questionnaires. The intern team was in charge of weekly calls (voice or video calls) with each participant, where it was asked how hard it was to perform the proposed activities. Although every participant had the same videos, those weekly calls were designed to adapt the sessions to personal limitations and needs.

Monitoring Procedures

A digital consent term copy was sent via mobile phone and email to all individuals who were interested in joining this study. The research team called the potential participants to explain all the procedures to them and their family members or their caregivers. Then, those who agreed to participate replied with the informed consent option checked.

Every week, the researcher team called each participant to talk about the barriers, how often he/she exercised, and how hard it was to exercise. Through a questionnaire using mostly yes-or-no answers, this tool assessed the perceived barriers (i.e., environmental, pandemic, and health condition related). Safety was evaluated based on adverse sensations (i.e., pain, dizziness, and nausea) during the session, fear, or insecurity to exercise, and adverse events such as falls. Participants also expressed their reasons not to do the remote physical exercise program in an open question. The perceived barriers were based on all the comments about how hard it was to exercise. These barriers were clustered within domains and counted.

Developing Questionnaire: Overall Experience

This questionnaire was developed in three steps (**Figure 1**). In step 1, questions were proposed. In step 2, writing and

TABLE 1 | Description of the content of the video sessions.

Aim	Description	Practice duration	Video duration
Warm-up	Low-intensity exercises with dual tasks, cognition, manual skills, and balance.	10 min	1–3 min
Aerobic	Low to moderate cyclic and rhythmic exercises with large muscle groups demanding the cardiorespiratory system.	12–15 min (two repetitions)	6 min
Resistance training	Dynamic and isometric exercise for trunk, lower, and upper limb. The prescription was three series between 15 and 20 repetitions depending on the muscles.	15 min	5 min
Coll down	To decrease the heart rate and blood pressure. Breathing and stretching exercises.	2 min	1–2 min

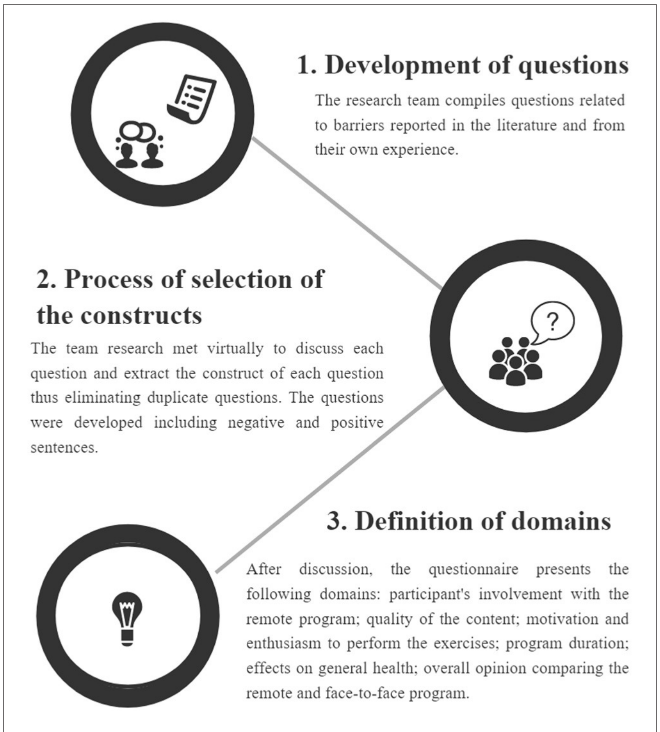

FIGURE 1 | The development process of the overall experience questionnaire.

meaning were discussed in team meetings using a word cluster (Mentimeter, www.mentimeter.com) (Interactive Presentation Software–Mentimeter, 2020). Each research team member gave three words to identify each question, and the most cited words were used to define the construct of the questions. In step 3, constructs were clustered into domains. **Table 2** depicts each question, construct, and domain. No validated questionnaire was found to assess barriers to remote exercises, and for this reason, this one was created by the authors. Given the urgent need to understand the limitations of physical exercise during the pandemic, it was not possible to validate the instrument satisfactorily.

Once a month, the researcher team inquired the participants and their family members or caregivers about the overall experience (i.e., motivation, involvement, understanding of activities, connectivity, communication, interaction, satisfaction, and quality of life regarding both professionals and exercise sessions) using an 18-item questionnaire created by the authors. Participants answered 12 questions, while family members/caregivers answered the other 6 questions. After the phone call with the participant, the call was directed to the caregiver, who answered the corresponding questions in the questionnaire. The same caregiver answered these questions every month. A 5-point Likert scale was applied based on the positive and negative statements (Likert, 1932). The answers were followed at five levels; for positive statements, "fully disagree" was 1 and "fully agree" was 5, while for negative statements, "fully disagree" was 5 and "fully agree" was 1. The average time to complete the questionnaire was 20 min. The maximum score was 55 points and the minimum score was 11 points. The positive questions include 1, 2 5, 6, 7, 8, and 11. Question 12 was used to classify whether the participants needed a family member or caregiver to perform the sessions. Regarding the family members or caregiver questionnaire, questions 13, 14, 15, 16, and 18 were positive. The minimum score was 6 points and the maximum score was 30 points (Interactive Presentation Software–Mentimeter, 2020).

Statistical Analysis

Mean, mode, and median were used to depict data information. SD and 95% CI were used to describe data variability. We used Origin (version 2020, Origin Lab Corp, Northampton, MA, USA) for the plots and SPSS (version 20, IBM Corp, Armonk, New York, NY, USA) for statistical analysis.

The adherence rate was defined as the relative frequency of individuals who accepted to engage in the remote exercise program (Ellis et al., 2019; Landers and Ellis, 2020). The attendance rate was calculated by the median of the number of performed sessions (based on the total of 48 sessions) and the mean of accumulated time per week of exercise performed (in minutes).

Furthermore, we aimed to describe the higher and lower frequencies of attendance, including the participants who attended more than 80% and <20% of the sessions. The barriers of attendance were described as the frequency based on the weekly report. Safety was described as the frequency of reported adverse effects per session. The overall experience was described as the median and range of the monthly questionnaire responses.

TABLE 2 | Constructs, subdomains, and definitions of the overall experience questionnaire.

Construct	Domain	Questions	Definition
Personnel	Satisfaction concerning the professional team	(2) The program made me feel safer in activities at home, such as walking. (3) The program interfered negatively with my mood and general health.	These questions are related to safety and health conditions while performing remote physical exercises.
Communication	Connectivity and interpersonal relationships between participants and team members	(7) During the online exercise program, I had easy communication with the professional team. (10) During the online exercise program, I had difficulties connecting with technology and I had problems with my internet connection.	These questions are related to the individual's perception of connectivity and communication with team members.
Program	Satisfaction concerning the program	(1) The format of this online program allowed me to participate and get involved satisfactorily. (4) I was not able to carry out all the activities and exercises prescribed to me. (5) I liked the online program and I think it could replace the face-to-face program. (8) During sessions, the professional showed that he understood my difficulties and managed to feedback on my performance, and provide the needed support to me.	These questions are intended to evaluate satisfaction, involvement, understanding of the exercises, the feasibility of performing exercises, and empathy.
Social support	Social interaction and available resources	(6) The weekly personal contact with the professional during the program made me feel assisted and welcomed. (9) I would not go back to doing online activities with this professional or with this team. (11) The online exercise program positively interfered with my family/friend's relationship.	These questions focused on the quality of content, enthusiasm while practicing the exercises, the effects on general health, and comparison between the remote and the face-to-face program.
Caregiver or family member	Family member's or caregiver's perceptions related to the program	(13) My family member felt comfortable performing physical exercises online with my support beside him (her). (14) According to the instructions, I received from the team members each session, it was possible to help my family member to carry out the exercises. (15) Helping my family member during the program interfered negatively with my routine, because it took a lot of time. (16) Monitoring my family member was easy and did not physically require much effort on my part. (17) I considered my family member and I had fun doing physical exercises every session. (18) I think the online physical exercise program positively interfered with my family's life during the COVID-19 pandemic period.	These questions addressed the family member or caregiver's perception about the remote program, the need for support and attention from the participants.

For the overall experience questionnaire, median, first and third quartiles, and range were presented for each question.

RESULTS

Table 3 describes the sample characterization, demographic, and assessment data referring to the initial evaluation. The sample was composed of individuals in the chronic phase of the stroke, who were community walkers based on the 10 MWT. Their aerobic capacity was categorized as an unlimited walker based on the 6 MWT. In terms of risk of falls, they present a low risk that was assessed by the TUG and a moderate risk of falling that was assessed by the Mini-BESTest. The confidence to do activities that require balance was well-assessed by ABC. Cognition, according to MoCA criteria, shows that most of the participants had cognitive impairment. The perception of the participants about the quality of life was good with a high report of the feeling of recovery after the stroke, according to SIS.

Adherence

The study flowchart is described in **Figure 2**. We have invited 46 individuals who were engaged in a face-to-face physical exercise program for stroke survivors. Two participants who were invited did not want to attend the remote program, and another four were excluded due to technological problems. Forty participants have accepted and engaged in the remote exercise program. The adherence to the program was 86.9%. However, during this study, three participants had problems with communication and were not available for the weekly phone calls and one of them had a medical problem. Therefore, 36 of them participated in the final overall experience.

Attendance

Sessions

A total of 48 sessions, for a duration of 24 weeks, were delivered through the asynchronous remote exercise program. Average individual attendance was 19.8 ± 14.8 sessions (44.9 ± 33.7%, 95% CI 15.2–24.4). Ten (25%) participants attended 80% or

TABLE 3 | Demographic sample characterization.

Variable	Mean (Standard deviation)
Sex[a]	23 M/17 F
Age (year)	55.1 (15.3)
Schooling[b] (year)	10.6 (5.1)
Time since stroke (month)	98 (63.8)
Type of stroke[a]	26 I/11 H/3 both
Affected hemisphere[a]	13 R/20 L/4 both
10-m walk test (m/s)	0.9 (0.3)
TUG test (s)	14.7 (9.1)
6-min walk test (min)	302.9 (105.5)
MiniBESTest	19.9 (5.5)
ABC (%)	74 (16)
MoCA test	21.6 (4.5)
SIS	222.5 (28.6)
SIS (%)	75 (18)

[a]Simple count; M, male; F, female; [b]Years studied, I, ischemic; H, hemorrhagic; R, right; L, left; TUG, Time up and Go test; MiniBESTest, Mini-Balance Evaluation Systems test; ABC, activity-specific balance confidence scale; MoCA, Montreal Cognitive Assessment; SIS, Stroke Impact Scale.

more sessions, and 13 (32.5%) participants attended <20% of the sessions.

Volume

Based on the sessions attended, the active participants utilized 99.1 ± 19.4 min/week of physical exercise of the program.

Barriers

Pandemic refers to the changes in the daily routine due to the home office and the need to move out with the family to assure social isolation. The health-related factors include lack of physical capacity, impairments due to the stroke, and other health problems that may have been described as barriers to performing the remote physical exercise program (**Table 4**).

To illustrate the most cited health conditions-related barrier (lack of motor skills and physical fitness to workout—20.6%), we described the following statements:

> "*I have difficulty to perform the exercises using my affected upper limb. Although I see the staff member performing the exercise on the video, I cannot do the same. I have difficulty going to the mat and exercise on the floor. I feel I cannot stand up safely by myself. It is difficult to stand up.*"

To illustrate the environmental-related barriers, we have extracted sentences from the reports of the participants:

> *"I don't have a companion to exercise with myself because my daughter says she does not have time to assist me during the activities due to her professional commitments."*

Other aspects that were included as environmental-related barriers were "problems with communication and lack of knowledge to use Internet devices and tools" (5.4%). To illustrate this barrier, we extracted the following sentence:

> *"I have difficulty accessing the videos because of poor Internet connection."*

The main barrier related to the pandemic construct was "job commitments during the coronavirus pandemic." To illustrate it, we presented the following statement from the participants:

> *"I can't manage my work hours with my need for physical exercise. It seems even harder to do home office during this pandemic situation."*

Safety

In 48 sessions, the individuals described 45 reports (5.7%) of pain during the sessions and pain a day after the session in 50 reports (6.3%). Participants just reported one fall (0.1%), dizziness in 30 reports (3.8%), motion sickness in seven reports (0.9%), and fear of exercising in 92 reports (11.6%) during the exercise sessions. In terms of activity, for every 10,000 min, there was 0.2% fall, 9.5% pain reports during the session, 10.5% pain reports a day after the session, 6.3% seizures, 1.5% motion sickness, and 19.4% fear of exercising reports during the sessions.

Overall Experience

For the personnel construct, the median answer for question 2 was 5 (range 3), and for question 3 the median was 1 (range 4). In question 2, participants agreed with "to feel safe in activities." In question 3, participants strongly disagreed with the fact that the program interfered negatively with their mood.

For the communication construct, the median answer to question 7 was 5 (range 4) and question 10 was 1 (range 4); therefore, participants fully agreed with how easy the communication with the team members was established, and question 10 reflects that they had problems with technology and the Internet connection.

For the program construct, the median answer for questions 1 and 8 was 5, but with different ranges (3 for question 1 and 4 for question 8), question 4 was 3 (range 4), and question 5 was 1 (range 4). Thus, participants felt involved (question 1) and supported (question 8) with the program, but neither they felt that they were able to perform all the proposed activities (question 4), nor they think that the remote program should replace the face-to-face program.

For the social support construct, the median answer for questions 6 and 11 was 5 (range 4), and question 9 was 1 (range 4); thus, participants felt assisted (questions 6), which positively affected their relationships (question 11), and they disagreed about the fact that they would not do activities with these professionals or teams again (question 9).

For the caregiver construct, the median answer for questions 13 and 14 was 5 (ranges 3 and 4), question 15 was 1 (range 1), question 16 was 4 (range 4), and questions 17 and 18 were 5 (ranges 2 and 4). Thus, the family member or caregiver felt comfortable doing exercises with their family members (question 13), and he/she was assisted by the instructions they had (question 14). The family members and caregivers did not feel affected in their routine by supporting the participant

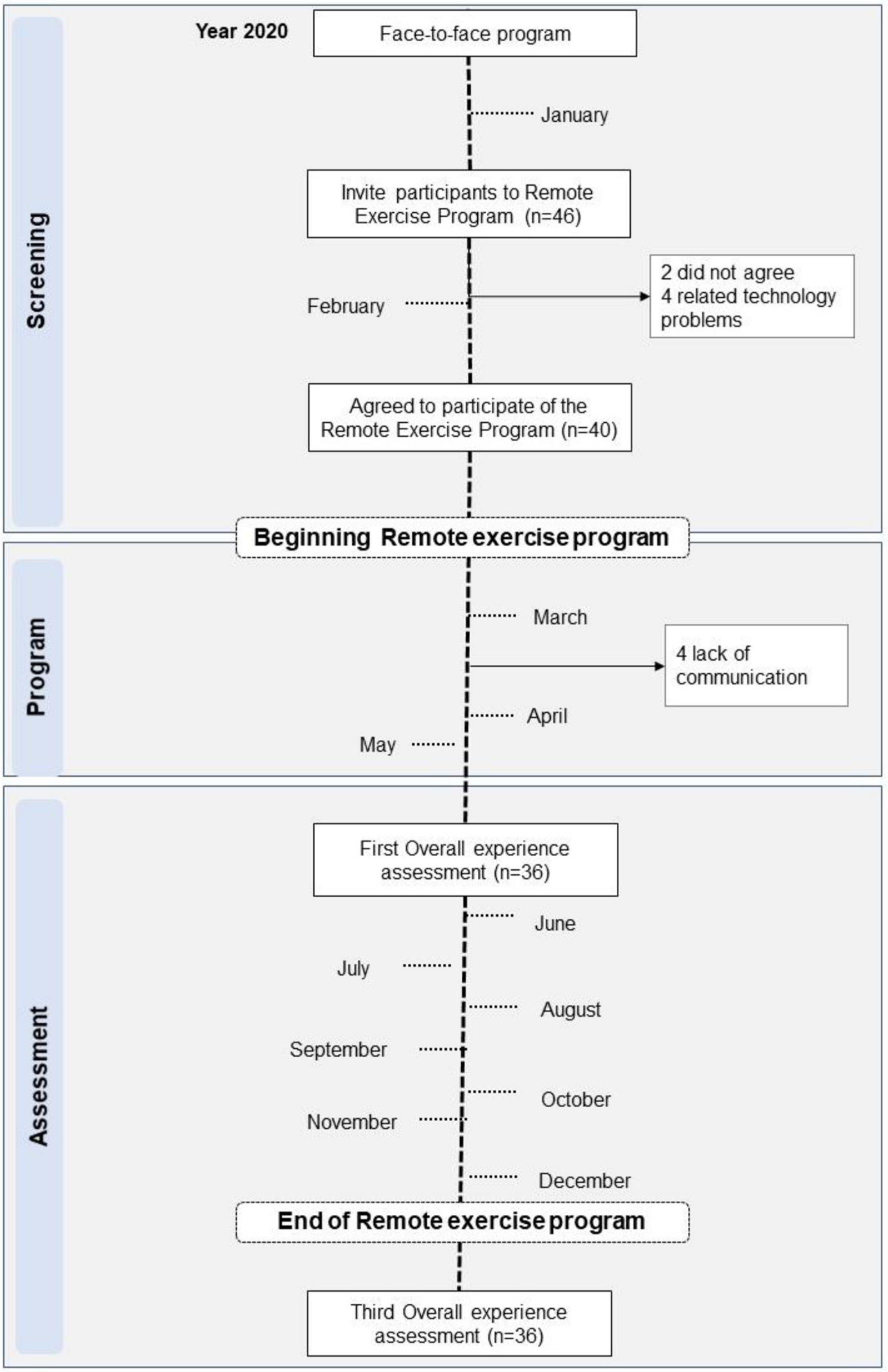

FIGURE 2 | Flowchart of the study.

(question 15). They thought that monitoring family members did not require much effort (question 16). They had fun doing the exercises with their family member involved in the remote program (question 17) and the overall experience doing the exercises positively affected their life during the pandemic (**Table 5**).

DISCUSSION

This study has evaluated adherence, attendance rate, and barriers to attend to a remote physical exercise program for stroke survivors. Our remote physical exercise program presented a high adherence. The barriers to attending the remote exercise

TABLE 4 | Absolute and relative frequency of reported barriers.

Barriers	Definition	*N*	%
Health condition-related barriers			
Lack of motor skills and physical fitness to workout	Muscle weakness, lack of balance, lack of motor coordination, mobility.	80	20.6
Health condition appointments	Medical appointments, medication effects, injury recovery, dizziness, labyrinthitis, seizure.	37	9.5
Constrains to use the most affected side while exercising	Partial or total paralysis on one side of the body affecting the capability to perform the video exercises prescribed.	31	8.0
Lack of time	Lack of routine organization and time.	30	7.7
Pain	Presence of pain (e.g., shoulder, lumbar, spine, knee, leg).	28	7.2
Behavioral issues	Lack of motivation and tiredness.	17	4.4
Constraints to do mat workout	Difficulty performing the physical exercises on the mat due to lack of mobility.	15	3.9
Fear of injury	Feeling insecure to perform the exercise.	9	2.3
Personal issues	Personal reasons not specified.	8	2.1
Fear of fall	Fear of fall while performing the exercise.	3	0.8
Dual-Task performance	The participant feels he (she) is unable to perform two tasks simultaneously.	1	0.3
Grieve	Emotional issues related to the loss of a family member.	1	0.3
Environmental related barriers			
No exercise companions	The caregiver or family member could not help the participant, lack of motivation to exercise due to being alone.	44	11.3
Problems with communication and lack of knowledge to use internet devices and tools	Problems with internet connection and the use of mobile phone difficulty to access or download video sessions.	21	5.4
Lack of a safe place to exercise	Lack of adequate space to exercise.	8	2.1
Domestic life	Daily life commitments (e.g., homeschooling, house repairs, relatives' appointments).	7	1.8
Weather condition	Climate conditions related to the seasons of the year (cold or hot weather).	3	0.8
Pandemic related barriers			
Job commitments during the coronavirus pandemic	Due to the pandemic, individuals do not have time to do the exercises because they have to do the home office.	17	4.4
Coronavirus pandemic issues	The caregiver or family member does not have time to help (routine changed dramatically due to pandemic); the family member or caregiver was diagnosed with Covid-19.	16	4.1
Traveling	The participant had to travel with the family and was unable to access the video sessions.	12	3.0
Total			100%

program were difficulties related to health conditions (including the use of the most affected side), the pandemic (change in daily routine and implications imposed by social isolation), and environmental issues (lack of company to perform the exercises, or problems with family members or caregivers). These barriers were different from other studies with the same population. In general, barriers to exercise are described to understand why sedentary people do not engage in physical exercise activities. Due to the COVID-19 pandemic, barriers to switching between a face-to-face group exercise program to a remote mode of delivery are mandatory. Our results show that specific barriers have emerged from this condition.

The adherence to the remote physical exercise program was higher compared with the literature (Beit Yosef et al., 2019; Wu et al., 2020). Such a high adherence rate might have two reasons, namely, these participants were already engaged in a face-to-face physical exercise and they were highly informed about how important it is to exercise. The two recommendations from WHO for a better life, namely, health education and an active lifestyle, are the aims of our face-to-face and remote programs (van Wijck et al., 2019).

While two participants who were involved in the face-to-face exercise program refused to engage in the remote program, four other participants who reported difficulties with Internet connectivity have also refused to join the remote program. In Brazil, the stroke prevalence is higher in individuals with low education and low income (O'Donnell et al., 2016; De Santana et al., 2018). Although only 8.7% participants involved in the face-to-face program have reported poor Internet connection to not engage, such results suggest that the low-income population also has reasonable Internet connection or such conditions (low education and low income) are not common features in our group.

Mean participation was less than half of all sessions, impacting the attendance rate. Only 10 participants have attended more than 80% of the sessions. This finding suggests how important it

TABLE 5 | Median and range results across the answers of all the participants for the overall experience questionnaire.

Domain	Questions	Results
Personnel	(2) The program made me feel safer in activities at home, such as walking. (3) The program interfered negatively with my mood and general health.	2–"I fully agree," **Median 5 (range 4)** 3–"I fully disagree," **Median 1 (range 4)**
Communication	(7) During the online exercise program, I had easy communication with the professional team. (10) During the online exercise program, I had difficulties connecting with technology and I had problems with my internet connection.	7–"I fully agree," **Median 5 (range 1)** 10–"I fully disagree," **Median 1 (range 4)**
Program	(1) The format of this online program allowed me to participate and get involved satisfactorily. (4) I was not able to carry out all the activities and exercises prescribed to me. (5) I liked the online program and I think it could replace the face-to-face program. (8) During sessions, the professional showed that he/she understood my difficulties and managed to feedback on my performance and provide the needed support to me.	1–"I fully agree," **Median 5 (range 1)** 4–"Neutral," **Median 3 (range 4)** 5–"Fully disagree," **Median 1 (range 4)** 8–"Fully agree," **Median 5 (range 4)**
Social support	(6) The weekly personal contact with the professional during the program made me feel assisted and welcomed. (9) I would not go back to doing online activities with this professional or with this team. (11) The online exercise program positively interfered with my family/friend's relationship.	6–"I fully agree," **Median 5 (range 4)** 9–"I fully disagree," **Median 1 (range 4)** 11–"I fully agreed," **Median 5 (range, 4)**
Caregiver or family member	(13) My family member felt comfortable performing physical exercises online with my support beside him (her). (14) According to the instructions, I received from the team members each session, it was possible to help my family member to carry out the exercises. (15) Helping my family member during the program interfered negatively with my routine, because it took a lot of time. (16) Monitoring my family member was easy and did not physically require much effort on my part. (17) I considered my family member and I had fun doing physical exercises every session. (18) I think the online physical exercise program positively interfered with my family's life during the COVID-19 pandemic period.	13–"I fully agree," **Median 5 (range 1)** 14–"I fully agree," **Median 5 (range 3)** 15–"I fully disagree," **Median 1 (range 4)** 16–"I agree," **Median 4 (range 4)** 17–"I fully agree," **Median 5 (range 2)** 18–"I fully agree," **Median 5 (range 4)**

Median of responses of questionary and range (ranking) of these responses are indicated in bold.

is to motivate and tailor the remote physical exercise program to the need of each stroke survivor. Our participants have different clinical impairments, and they might have not felt safe and comfortable to exercise. Studies (van Wijck et al., 2019; Wu et al., 2020) suggest that the need to attend a remote program is related to transportation issues (home-to-facility distance or access to reference rehabilitation centers). Although they have approved the remote program, they did not agree to stay on the remote mode when the face-to-face mode was available again (Chen et al., 2020).

To attend a remote physical exercise program during the COVID-19 pandemic is a human development issue (that involves health, education, and economics). Our results must be read through the cultural lenses of a country, highly impacted by the COVID-19 socially and economically (Tyagi et al., 2018). The need for a family member or a caregiver to support the attendance of the participants and the basic education level of the participants are factors that affect the motivation to engage in a remote physical exercise program. A stimulating environment can promote an active life and counteract these factors. On a synchronous mode, a remote physical exercise would increase social bonding with other participants and could improve motivation and self-efficacy (Lewthwaite and Wulf, 2012; Wulf and Lewthwaite, 2016).

This remote physical exercise program was important to reach WHO recommendations for a healthy life. Active participants covered about two-thirds of WHO recommendations (150 min of moderate activity per week) (Bull et al., 2020). Information concerning the time spent in moderate to vigorous physical activity for stroke survivors is scarce (Fini et al., 2017). For the subacute phase, stroke survivors did, on average, 27 min/day. It is a study limitation not to control how intense were the exercises. For fragile populations, reaching vigorous intensity in exercising can be a high-risk activity without the proper support, which is barely available at home. Participation in our study was an important action to make our attendees physically active.

The main barrier to attending the remote program was the difficulty to do the proposed exercises due to motor impairments. To tailor exercises to personal features was a challenge at this remote model because each participant had different impairments. The asynchronous participation gives opportunities to the attendees to judge how safe it is to do the whole exercise session and also demands self-motivation to engage, family support, and the willingness for a healthy lifestyle after a stroke.

The second most related barrier was the lack of someone to aid the exercise at home. Even though they are considered independent for self-care and walking, stroke survivors have limitations of activities, such as physical exercise (Campos et al., 2019). Despite the physical exercise being carried out at home, he/she depended on a caregiver to ensure the organization of the environment and the safety in the execution of the exercises. During our orientation, safety for carrying out the exercises was emphasized to minimize adverse effects.

In the category of pandemic issues, "job commitments during the pandemic coronavirus" was the most frequent issue. This finding correlates with the present environmental category, a profile of individuals who present a perception that their physical condition is a barrier to physical exercise and they need a family member or caregiver to advise them. However, those family members/caregivers are facing new home office obligations due to the change in routine caused by the COVID-19 pandemic.

Most of the participants reported that the remote physical exercise was safe. Just one fall was reported across all the sessions. To the best of our knowledge, this is the first telemonitoring study for stroke survivors to report these data. Individuals tend to experience social discomfort, loss of confidence and personal identity, long-term functional disability, and loss of independence when falls happen (Schmid and Rittman, 2009). To manage falls and their consequences is fundamental to improve self-efficacy and autonomy. Our video sessions contained safety instructions, and all participants were encouraged to pay attention to this issue when performing the exercises. Rare adverse events were reported in our study suggesting that remote exercises program are safe for stroke survivors (Piotrowicz et al., 2015).

Pain complaint was one of the most reported issues. The main changes related to physical activity are a high frequency of pain and discomfort (Jones et al., 2016). Participants expressed such feelings:

> "Physical activity causes me pain or discomfort."
> "I think physical activity is very tiring."
> "I am afraid to do my physical exercises alone."

Opinions of the participants concerning the overall experience about this remote program suggest that it was safe from the view of the participants, thus allowing a major interaction with the program. The ease of communication between the participants and the team allowed us to be aware of all the issues that harmed the progress of the program and allowed us to correct these flaws.

According to reports of the program, it was well-accepted, despite the fact that most of the participants prefer the face-to-face program. Remote programs are well-accepted (Chen et al., 2017; Sarfo et al., 2018), and this acceptability impacts the social support related to them in a positive way. The recognition and the knowledge of the points of view of the participants are important and are currently missing in many studies (Laver et al., 2020). The family members or caregivers also had a good experience overall with this remote physical activity program. Our results express the presence of a family member as a facilitator for the commitment of remote physical exercise (Chen et al., 2017; Sarfo et al., 2018).

Due to the COVID-19 pandemic, our sample was selected by convenience and all participants were already engaged in a face-to-face program. Another limitation was not having a control group with no intervention or face-to-face intervention to contrast our results. Our questionnaires were not previously validated but were developed for this study. It would be important to add other tools to evaluate the psychosocial domains within a telemonitoring program.

CONCLUSIONS

The remote exercise program has a high adherence rate among stroke survivors to engage and a low attendance rate. The main reported barriers involved the need to individually tailor the exercises to personal impairments. Attending a remote physical exercise program is safe, and the overall experiences of the participants and their family members/caregivers were positive. A remote physical exercise program can reduce sedentary behavior and increase the physical activity level in individuals who had a stroke.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by School of Physical Education and Sport of the University of São Paulo, São Paulo, Brazil. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CT-P: an idealizer and coordinator of the physical activity program, coordinated the conversion of the face-to-face model to the remote program, collaborated in the creation of the questionnaires, coordinated the collections, and writing and revision of the text. GP, MM, and BA: conversion of the face-to-face model to the remote program, collaborated in the creation of the questionnaires, monitored the individuals, and writing and revision of the text. AL: creation of the questionnaires and writing and revision of the text. TS, MC, and RJ: performed individuals monitoring and data analysis. VD and TF: conversion face-to-face model to the remote program and collaborated in the creation of the questionnaires. LM: creator of the project, creation of the questionnaires, performed data analysis, text writing, and text review. All authors contributed to the article and approved the submitted version.

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METHODS
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Perception of the Sports Social Environment After the Development and Implementation of an Identification Tool for Contagious Risk Situations in Sports During the COVID-19 Pandemic

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This study details the methodological process for creating a tool for the identification of COVID-19 potential contagion situations in sports and physical education before, during, and after practice and competition. It is a tool that implies an educational and methodological process with all the agents of the sports system. This tool identifies the large number of interactions occurring through sports action and everything that surrounds it in training, competition, and organization. The aim is to prepare contingency protocols based on an exhaustive analysis, risk detection, and proposal of contingency measures trying to reduce the residual risk to a minimum. In the second part, the results of the implementation of this tool in the sports system of Galicia (Spain) are shown. The technicians have changed their perceptions about the coronavirus transmission in sports. They highlight the problem for returning to sports participation for athletes under 18 years in the pandemic context.

Keywords: COVID-19 virus disease, sport, pandemics, infectious disease transmission, health risk assessments, teaching-learning process, risk perception

INTRODUCTION

Pandemic vigilance and reducing the risk of global spreading of the contagious coronavirus (SARS-CoV-2) are now the primary concern in all sectors. Even more, if we talk about sports, massive events present considerable public health challenges to health authorities and governments (McCloskey et al., 2020). The WHO published a risk assessment tool that enables sports organizers to methodically review critical considerations and risk management steps for hosting an event, assess risks with a weighted-system approach, and factor in risk reduction through various mitigation measures. However, sport is not only preparation for mass events but also daily sports practice. Most sports federations do not always count on enough economic resources, such as mass media sports, to use expensive mitigation measures every day (i.e., test, medical staff). Thus, managing and assessing the intrinsic contagion risk inside the practice is of paramount importance.

The everyday sports practitioners are not spectators and have been placed in very harsh circumstances with the current COVID-19 norms, and with specific difficulties in avoiding physical contacts. Unlike shopping in the supermarket, traveling by public transport, or going to school, sports cannot be done in a static position. In many sports specialties, body movement is mandatory, often intense, sharing, and changing spaces with huge alterations in respiratory frequency. However, both the WHO and the Council of Europe consider sports a fundamental part of health that should be maintained (Habersaat et al., 2020). Nevertheless, isolation and confinement have limited mobility and increased sedentary behaviors and their harmful effects (Hall et al., 2021), so how do we make it possible to increase risk control in exposure in sports while also resuming practice again? The de-escalation of regulations require sports managers and practitioners to face situations for which they were not prepared, nor have they received guidance with the necessary detail from international or national health and sports authorities. Sports activity implies specific risks. Therefore, their identification, analysis, and control must be much more precise and validated than in other sectors. Resume sports practice in compliance with regulations and with the greatest possible benefit for its users, entities, organizations, human and material resources, applying plans and procedures so that the residual risk is minimal is the great goal.

Recognizing the risks and mitigating them will increase the quality of life, providing safeness for the sports community and for each person who belongs to it. The United Nations Office for Disaster Risk Reduction (Schweizer and Renn, 2019; United Nations, 2019) already warned that risk is systemic; and, therefore, any study and protocol on risk analysis must integrate the subsystems that comprise it. Institutions and political leaders pursue, through the deployment of risk communication strategies, to reduce the lack of knowledge on specific relevant issues associated with the risk trigger, as well as to reduce and minimize false and distorted information about reality (Mora-Rodríguez, 2021). Communication strategies allow to culturalize the public about why and what the risks are providing expert knowledge on the subject (Rosas-Rodríguez and Barrios-Puga, 2017). Detecting risks is a critical factor in changing social behaviors. Risk analysis is a methodology that helps to understand essential predictors of risk also in sports activities [Asociación Española de Normalización y Certificación [AENOR], 2011, 2018]. Risk perception and security are parts of the same continuum, so it is essential to explore in detail the risks to understand how to manage them. Resilience and sustainability are needed to make entities, events, and training viable (Kemp et al., 2020; Stokes et al., 2021).

The sports system of Galicia (Spain) has suffered damage from external causes (crisis, confinement, and de-escalation) and must attend to the peculiarities by specialties, so that the situation does not worsen and that it can build new sustainability, so the resilience of a system, community, or society exposed to hazards is to resist, absorb, adapt, and recover from the effects of a hazard in a timely and efficient manner, such as preservation and restoration of its essential basic structures and functions. Try to resist so that the crisis does not become chronic requires the sports community to be prudent to preserve health, its social balance, and its economic viability. Ideally, authorities should ensure that they fully understand the reality of the situation faced by the people affected by their decisions, drawing on principles of co-production of policy (Han et al., 2020). The sports administration of Galicia and its social environment have promoted a very proactive attitude trusting and supporting each other, seeking to create measures to enable continuity of sport.

Until the development, validation, and implementation of the FISICOVID-DXTGALEGO (FCOVID-DXTG) tool (Xunta de Galicia, 2020), the leaders and managers of federations, clubs, town councils, and other entities only had general national legal health regulations and recommendations from non-specific sports organizations like other countries (Pierce et al., 2020). Their plans and protocols have been drawn up with this tool to move prudently toward the practice of individual sports and also fighting and team sports. Thus, this article presents two aims: the development and implementation of a methodological process and a tool for identifying contagions in practice and competition at each time-point, from the transportation for sporting activity, during it, and on the return from it, and the changes in perception of the social environment in each phase of the implementation.

METHODOLOGICAL PROCESS

This study details the methodological process for creating a tool for the identification of COVID-19 potential contagion situations in sports and physical education before, during, and after practice and competition. It is a tool that implies an educational and methodological process with all the agents of the sports system. This tool identifies the large number of interactions occurring through sports action and everything that surrounds it in training, competition, and its organization. The aim is to prepare contingency protocols based on an exhaustive analysis, risk detection, and proposal of contingency measures trying to reduce the residual risk to a minimum. The creation process, implementation within the sports system of Galicia (Spain), and the operation of this tool are explained in the subsequent subsections. The feedback of this process is shown in the results section. All the processes described took place during lockdown and de-escalation periods between March and the first 2 weeks of April.

Tool Construction

For the development of the tool, the standards UNE-ISO 31000: 2010 and UNE-EN 31010: 2011 [Asociación Española de Normalización y Certificación [AENOR], 2011, 2018] were used as references (**Figure 1**). It was necessary to determine the variables that would allow the establishment of categorical contextual frameworks for identification requirements of contagion situations during sport. First, five experts in health, sports, and risk management in the field of sports were consulted. Two risk assessment techniques were used: a preliminary hazard analysis (PHA), as a simple and inductive method, recognized as highly applicable in novel situations and at the beginning of the development of a project (UNE-EN 31010); and the

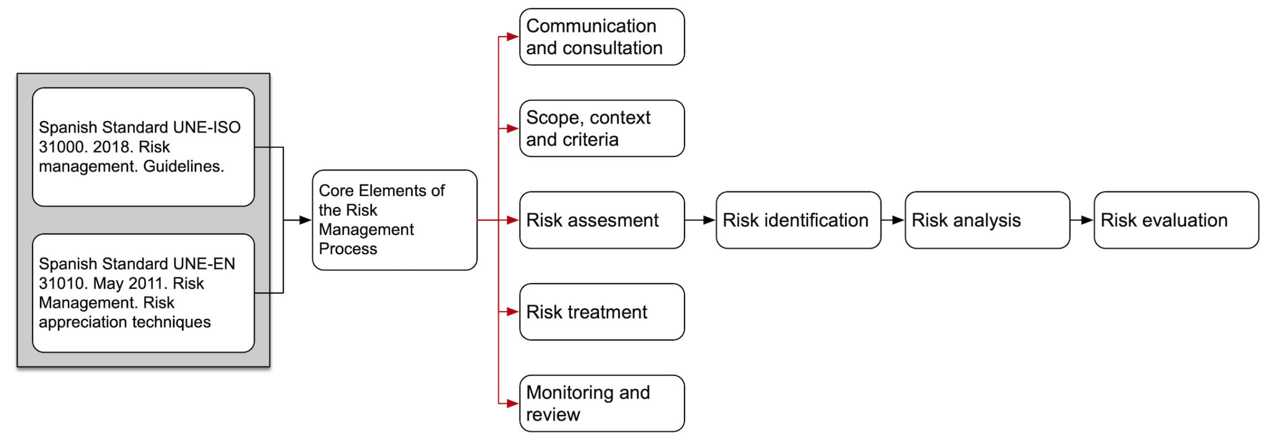

FIGURE 1 | Risk management standards applied for the development of the FISICOVID-DXTGALEGO.

other the elaboration of verification lists (UNE-EN 31010); both became part of the FCOVID-DXTG tool. Also, meetings for continuous feedback were regularly settled with all the agents involved in the process.

Levels of Specificity of the Tool

FCOVID-DXTG considers two levels of detail in the assessment of risks. The first level addresses the possible routes of contagion in sports situations at a general level. For its design, the PHA method [Asociación Española de Normalización y Certificación [AENOR], 2011] was used through a systematic and structured process carried out by a group of experts of the administration and technicians of the sports administration of Galicia. The objective was to identify dangerous situations through a series of input elements, such as information on the variables and categories involved in the virus transmission processes and, therefore, the potential contagion. The selected variables respond to the characteristics of the risk context, the novelty of the situation, and the limited information available. The objective of developing this level, in this first phase of the design, is to determine an initial list of generic risks for each specialty and applicable as an initial risk matrix. That risk matrix was configured as a checklist to confirm or not the existence of a situation of potential contagion, considering the combination of all the factors involved in the different transmission routes (**Table 1**) iteratively. The preliminary risk analysis comprises a series of variables and categories:

The second level of detail of the risk matrix describes the specific situations of each sports specialty. Situations are described related to each of the items in the checklist. One or several measures are suggested by the COVID-19 federative officials for the treatment of the risk contagion following the available recommendations and the possibility of adapting sports practice. There was a lack of knowledge about the disease and its transmission during the process, and this changing situation continues even nowadays (Brooks et al., 2020); so, logically, the principle of prudence guided this methodological process. Thus, we considered that each situation of potential contagion could entail a risk of transmission and that the different agents involved may be risk agents. Moreover, contemplating the uncertainty generated by the contagion of asymptomatic and pre-symptomatic people, surfaces with fomites, suspension of the virus in aerosols, etc., (**Figure 2**).

Agents

A total of 58 federative officials in charge of the COVID protocols for each federation and its 300 sports specialties participated in this study. The Galician regional sports administration (Secretaria Xeral para o Deporte – Xunta de Galicia), together with a group of experts composed of university specialists in education, sports sciences, and sports management, developed the tool and its methodological process (**Figure 3**).

Process of Implementation and Teaching-Learning in Federative Sport

The process to create the FCOVID-DXTG tool implicitly involved the training and learning of federative sports agents during all phases: the first phase of making contact, presenting the problem, and establishing collaboration between the administration and the external multidisciplinary committee of experts; the second phase with the participation of all the federative officials for the delimitation of the context, specification of objectives, and determination of the working method; the third phase for the design, review, and testing of the tool and its application procedure with working materials about risk perception in sports; and the final phase including a final product like a web application, presentation, and regulation of use as a tool for reactivating federated sports in Galicia. At the end of the process, each federation developed its protocol based on this FCOVID-DXTG methodological process to achieve the validation of the Autonomous Administration and to be able to resume the practice of their sport.

Permanent communication and consultation between the interested parties involved in this process were part of the risk management process of FCOVID-DXTG. The requirements of the risk assessment were based on the UNE-ISO 31000 and

TABLE 1 | Variables of contagion routes for COVID-19 in the FISICOVID-DXTGalego tool.

Variable	Contagion route
Moment or time condition	Concerning the sporting moment, before practice, during practice, and after practice or competition.
Personal agent involved	Considering the subjects involved in the sporting activity, acting as potential transmitters or infected, and that were categorized according to their functional relationship with the practice environment: *athletes*, *staff* of the entity or the facility, and *others* not directly related to the practice such as the public, the families that accompany the practitioners.
Condition of virus transmission	Contact Person to person, directly between agents; indirectly through the use of spaces, sporting tools or surfaces; Aerial Indirect contagion due to the sharing spaces, materials, or surfaces. Ingestion Indirect by sharing food or drinks.

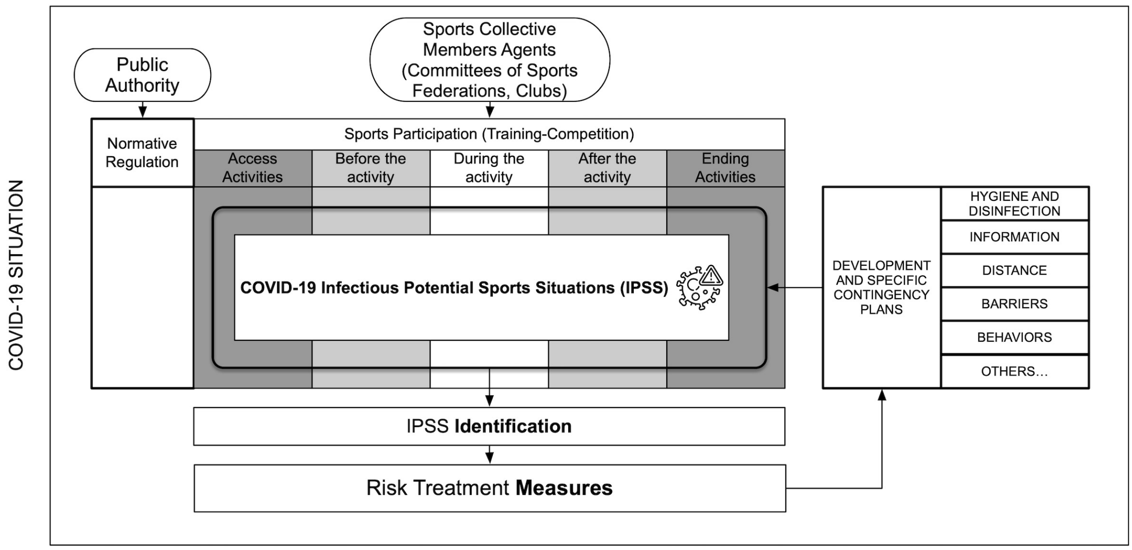

FIGURE 2 | Methodological procedure for applying the FISICOVID-DXTGALEGO.

31010, namely, risk identification, analysis, and evaluation. The treatment of risk through mitigation measures was contemplated in the contingency protocols of each specialty with permanent monitoring, supervision, and actualization with the present scientific information of the virus.

Operating Mode

This tool was designed to guide the thinking process regarding the risk control of promoters of federated sports activity in training and competitions. At the same time, the organization of the categories of registration/analysis involves a pedagogical process where those responsible evaluate each situation repeatedly, starting from a series of standard items, varying the moments and agents involved according to the specialty. In this way, it is possible to reduce the possibility of forgetting some daily situations, but with the same contagion potential as others more visible and commonly perceived (**Figure 4**).

The operation of the FCOVID-DXTG can be verified by performing a step by step: First, the moment is evaluated (i.e., before training), then all the agents who have action or effect at this time are reviewed (staff, athletes, or others unrelated to sports) and each of the possible routes of contagion (person to person, air, or through food and drink). Within this matrix, all the categories are checked. Once the moment, agent, route, and contagion situation have been identified, the FCOVID-DXTG tool leads us to the first question: does this situation occur in sports practice? There will only be two possible answers. If the answer is negative, it is necessary to justify why this situation does not occur in sports practice. If the answer is affirmative, then users will have to collect the situation described as precisely as possible in the corresponding section. Once the situation is registered and described in a univocal way, the tool proposes a second question. Can this situation be avoided, or treatment applied to it? Again, the answer is dichotomous: yes/no. In the affirmative case, it is requested to collect one or more measures to counteract this situation, be it modifications in practice, use of PPE, hygiene and disinfection measures, or others. If the case is negative, there is a situation to be completely avoided or to modify sports practice until the greatest margin of safety can be provided to practitioners.

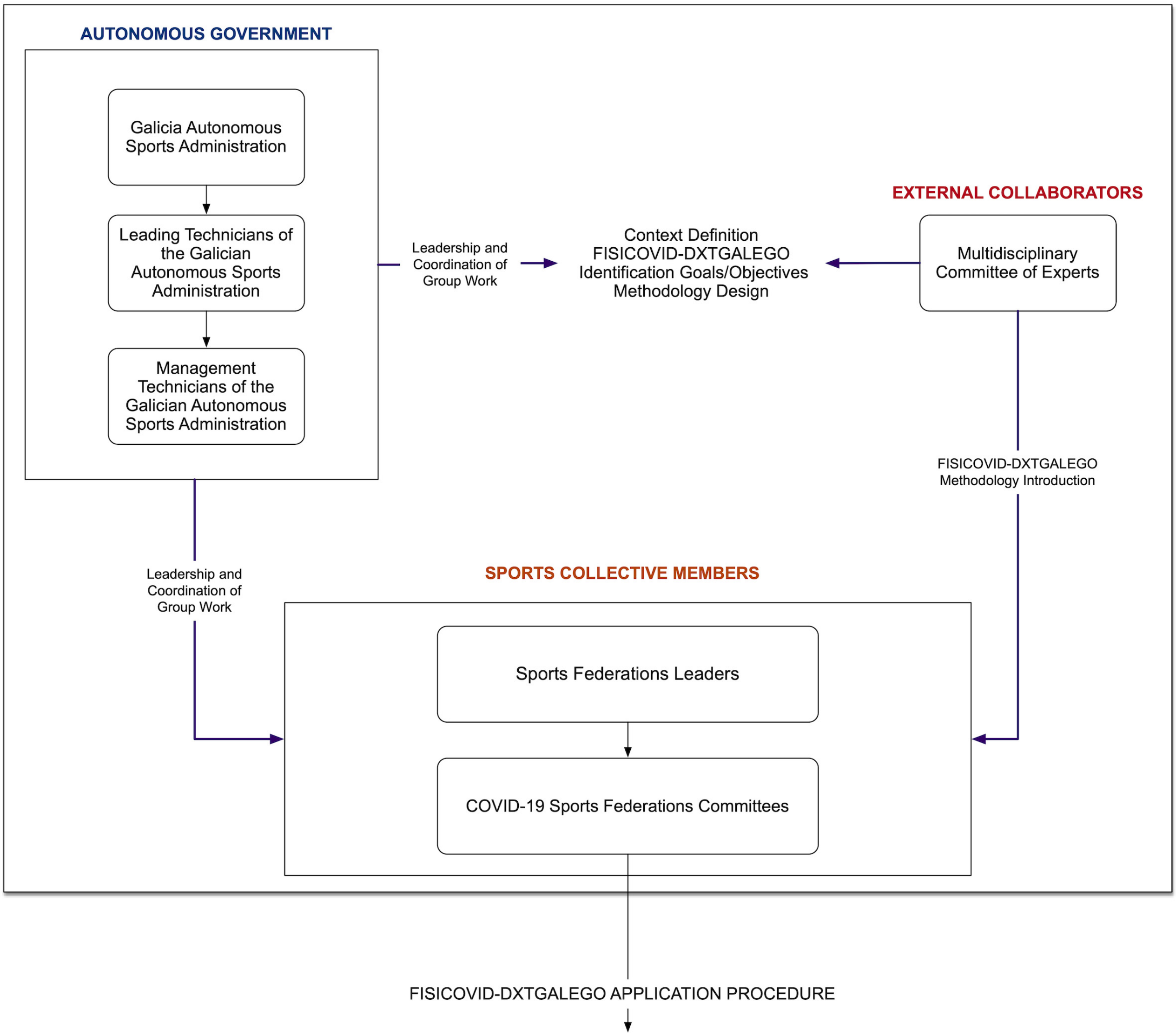

FIGURE 3 | Agents involved in the development of the FISICOVID-DXTGALEGO.

The FISICOVID methodological process must be self-improved in each part of all the processes. It is essential to know how each phase has been developed and what the points of improvement are. Therefore, to achieve this objective, an *ad hoc* questionnaire was proposed to understand all parts of the process from the design to the implementation of the tool.

Methods

We analyzed how this FCOVID-DXTG methodological process and the working tools were received and implemented by the 58 sports federations with more than 300 specialties, staff, and families with an *ad hoc* 1–5 Likert scale questionnaire. The questions explored the implementation process, perceived learning, satisfaction with the tool, perceptions of change for the sports environment, and expectation for returning to sports after the implementation of the FCOVID-DXTG protocols. Only nine of the 29 items of the original questionnaire are presented to meet the objectives of this article (**Table 2**). The total number of federated athletes affected by protocols based on FCOVID-DXTG was 246.126 and distributed as follows: 51% of team sports and 9% from combat sports. The other 40% was from other sports (**Figure 5**).

RESULTS

Sports officials declared that with the FCOVID-DXTG methodological process, they have learned about identification, assessment, and accuracy in measures to prevent contagion risks in sports (4.6 ± 0.6), and they have changed their perception about the coronavirus infection in sports (3.9 ± 0.9). They consider the implementation of the protocols improved the

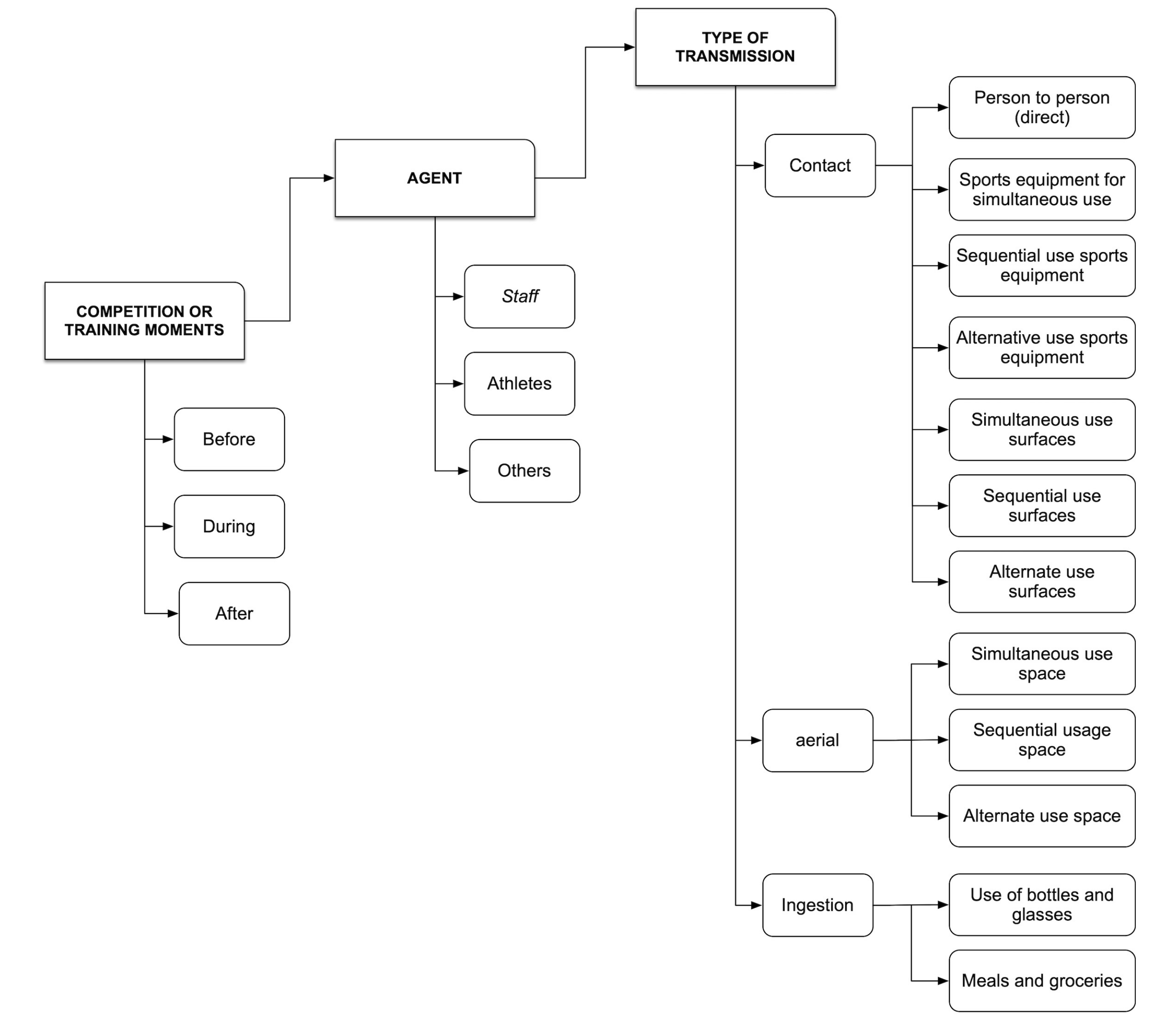

FIGURE 4 | Categories and items for the identification of situations of potential contagion in sport.

overall perception about preventing coronavirus infection of the federative collective (4.1 ± 0.9). They declared there was a lack of protocols for avoiding COVID-19 risks before and after sports practice (1.9 ± 1.3) and during the sporting activities (2.6 ± 1.4). They perceived it is easier for young people under 18 to attend sports activities by having protocols with a high level of precision after communicating it among families (4.1 ± 0.9). The satisfaction with the way of working throughout this methodological process was very positive (4.5 ± 0.7). We also asked about their estimation of return to sporting activities for young and adults (**Figure 6**); and 48% declared that returning will be less than 60% for under 18 years practitioners while 79% answered that more than 60% of +18 years practitioners will return. The estimation of the return to participation is 29 points lower for athletes who are under 18 years of age.

DISCUSSION

The participation of federative sports promoters in the FCOVID-DXTG methodological process has changed its safety perception after its implementation. The families have been provided with detailed information with the protocols coming up from this tool, making more accessible the return to sport for children. However, 30 points of difference between estimations for under and + 18 practitioners stress the importance of an existing barrier for children and young people to resume their sports habits after a crisis like the COVID-19 pandemic.

Methodological Process

The main objective has been to generate a methodological procedure to search for safe, specific, and flexible solutions that

TABLE 2 | Selected questions of each item and results related to each part of the teaching-learning process of FISICOVID.

Question	Item	Mean	SD
Has your participation in this process led you to learn about identification, assessment, and accuracy in measures to prevent contagion risks in your sport?	Learning in the FISICOVID process	4,6	0,6
Your participation in this process of the elaboration of the protocols FISICOVID-DXTGalego, do you think that it has changed your perception on the infection by coronavirus (COVID-19) in your sport and/or specialties?	Risk perception in the FISICOVID process on your sport	3,9	0,9
With the development and implementation of the protocols, do you think it has improved the overall perception of your federation (leaders, managers, coaches, judges, athletes, families, and other agents) about preventing coronavirus (COVID-19) infection in your sport?	Risk perception in the FISICOVID process of the whole federation	4,1	0,9
Did you have protocols and general measures of NON-SPORTING ENTITIES to avoid risks of contagion before COVID-19 BEFORE and AFTER sports practice?	Before-after protocols of non-sportive entities	1,9	1,3
Did you have protocols and general measures of sports organizations to avoid risks of contagion to covid-19 during sports?	During Sport Protocols of sportive entities	2,6	1,4
Do you think that having a precise and specific protocol and communicating it among families has a positive influence on the decision for children and young people UNDER 18 to attend sports activities?	Protocol influence for returning to activity of children under 18	4,1	0,9
What is your level of satisfaction with the FORM OF WORK CARRIED OUT (collectively, openly and sharing information) in the development of the whole FISICOVID-DXTGalego process?	SATISFACTION with work Methodology	4,5	0,7
What is your estimate for the return to sport of those under 18 years of age?	Estimation of Return under 18 years	(In text)	
What is your estimate for the return to sport of those over 18 years of age?	Estimation of Return above 18 years	(In text)	

would allow the identification of situations of potential contagion in the highly complex field of sports participation. At the end of the application of the FCOVID-DXTG methodological process, each organization obtains information documenting a complete list of risks for each sports specialty, with the applicable measures to minimize the residual risk to be included in its protocol for the coronavirus. The tool establishes a homogeneous language for communication and feedback between sports specialties and entities, being a service to the sporting community that could not solve in isolation, because of its limited management capacity and resources. The union of administration, federations, and universities with FCOVID-DXTG represent an example of an open way of working as international authors suggested (Habersaat et al., 2020) and (Kemp et al., 2020). Also, The Council of Europe (06/26/2020) urged the governments of the member states to "*support the recovery and promote the sustainable development of the sport, to provide support to the sports sector through programs and EU funds. To study the possibilities within the framework of relevant horizontal measures and initiatives of EU initiatives for recovery. To promote the continuity of regular sport funding programs and initiatives, especially for grassroots sports organizations.*" Galician sports administration had anticipated in March to what today are the recommendations of the Council of Europe assuming the greatest possible implication for protection and support of the sports sector: promoting broad cooperation and collaborating at all levels to resume sports activities safely, gradually, and cautiously, evaluating all the potential risks.

The development and application of FCOVID-DXTG tackle the complexity of the federated sports organization before and after the practice [McCloskey et al., 2020; World Health Organization [WHO], 2020]. It also provides a solution against generic and non-specific protocols that did not promote the identification of contagion risks during the own motor activity of each sports specialty. This will not leave loopholes for the appearance of unexpected situations where contagion can occur. Thus the tracking and monitoring of contagion situations will be easier. Besides, FCOVID-DXTG can be adapted to other areas of action, such as the education sector or private gyms. To the knowledge of the authors, this tool is being applied in the field of recreation and educational summer camps, agreeing in many of the evaluated items with the document that the United States Centers for Disease Control and Prevention (CDC) has published as a checklist for camping activities (Suggestions for Youth Programs and Camps: Readiness and Planning Tool) (U.S. Centers for Disease Control and Prevention, 2020).

Perception of the Sports Social Environment

Change in perception of risk is the first step to manage it with guarantees. In the FCOVID-DXTG methodological process, the federative officials responsible for the sports organization declared that their ability to identify contagion risk was highly improved as well as their virus perception. This is of great importance since Spain has been one of the countries most affected by the pandemic, and the level of information and counter-information has been enormous since having a well-trained criterion would make fewer mistakes (Mora-Rodríguez, 2021).

Participation in all parts of the process generated great satisfaction perceived by the federative leaders, who declared a very high satisfaction for making better protocols

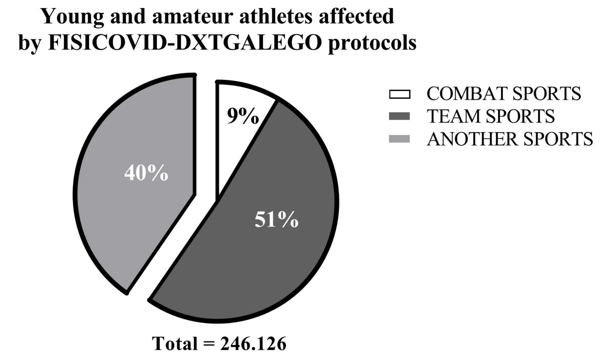

FIGURE 5 | Young and amateur athletes affected by FISICOVID-DXTGalego protocols.

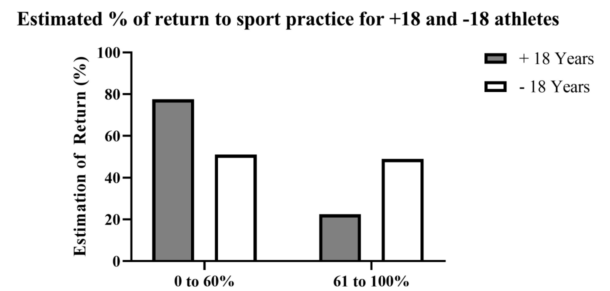

FIGURE 6 | Estimated percentage of return to sport practice for athletes above and under 18 years.

throughout FCOVID-DXTG. This is in agreement with the recommendations of Schweizer and Renn (2019) on the risk mitigation with systemic hazards like the COVID-19 pandemic. Also, the FCOVID-DXTG methodological process has met the criteria of the *Crisis and Emergency Risk Communication* working model of Reynolds and Seeger (2007), promoting changes in the behavior of sports agents to reduce the likelihood of harms; developing consensual recommendations by experts and first responders; trying to reduce uncertainty improving self-efficacy; and generating empathy, reassurance, and reduction in emotional turmoil and creating a better public understanding of new risks and new understandings of risk as well as new risk avoidance behaviors and response procedures.

The estimation of federative officials for the return to sporting activities of young people will be less than 60%; this is a significant problem since the resumption of sports and recreation activities can contribute to physical, psychological, and emotional benefits to societies emerging from COVID-19 restrictions (Hughes, 2020). This not only affects federated sports but all sporting promotion activities, such as the Galician sports program "XOGADE" where 128.614 children who practice sports every week during school hours are also affected (Rico-Díaz et al., 2020). However, technicians consider that it is easier for children to return to sport by having protocols with a high level of precision due to its influence on the decision of families comparing to non-sport-specific general protocols. This would help to overcome the deleterious psychological effects of a lockdown (Brooks et al., 2020). The Sports Innovation Institute at IUPUI, a partnership between Indiana and Purdue Universities in Indianapolis, and Grand Park Sports Campus (Westfield, IN, United States) collaborated to better understand how COVID-related adaptations are perceived by parents, athletes, coaches, officials, and administrators with good results in how specific adaptions are received by these stakeholders who are looking to return to youth sports in a timely but safe manner with a positive response about mitigation measures such as sanitizing playing areas, mask use, monitoring of social-distancing guidelines, and limiting personal contact between players (Pierce et al., 2020).

Some proposals and recommendations on this topic were published. However, the critical point of sports interactions was not stressed enough. Youth Sports Program FAQs from the United States government agency CDC, through its National Center for Immunization and Respiratory Diseases (NCIRD) (U.S. Centers for Disease Control and Prevention, 2020) strongly recommended using the facemask to solve the sports interaction issue. Others, like the proposal for the active tourism of Aragon (Turismo Deportivo Aragón, 2020), also developed a checklist system for the control of risks with an external consultant. The most similar contagion control proposal in a sports context has been made by Jones et al. (2020), the authors provide a team sports risk exposure framework to provide stakeholders with a practical method to inform discussions around the return-to-sports. Thus, to the best knowledge of the authors, this is the first tool that had addressed the reality of the complexity, diversity, and quantity of situations that sports practice implies before, during, and after training and competition.

Conclusion

Sharing information and having a common language for communication and feedback have been provided new solutions for the technicians to the common and specific problems of the sports specialties. The technicians consider that a safe return to sport is possible with an in-depth analysis of the risks and contacts of each sports specialty. The problem to be addressed is framed in the interaction of two determining variables of the situation, the possibility of contagion and that sports involves a whole series of situations and behaviors that require greater precision in the measures for its prevention. Given this, it is worth asking: are the general measures to prevent contagion sufficient and applicable for sports practices? How can training and sports competition be resumed with guarantees? In all sports specialties, would the contagion prevention measures to be adopted be the same? Facing a changing situation and uncertainty, we need tools that make it possible to configure contingency protocols, so that in each specialty, once preventive measures are applied, residual risk is reduced to a minimum.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The Galician Sports Administration (Spain) approved all the procedures. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JL-L did manage the sports and political administration to work together. JR-D coordinated all the working groups. RM-A created the intervention model. JR-D, RM-A, JG-V, and DR-R designed the tool. RM-A, JG-V, and DR-R contributed equally to the development of the manuscript. All authors approved the manuscript in its final form.

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