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Physical Activity, Sedentary Behavior, and Health States of University Students During the First Wave of COVID-19 Community Quarantine in the Philippines

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This study examined the impact of the first wave of COVID-19 pandemic community quarantine on university students' physical activity (PA) levels, sedentary behaviors, and health states in the Philippines. A total of 1,042 university students completed the International Physical Activity Questionnaire (IPAQ) short version and rated their health states using an online survey. The Wilcoxon signed-rank test and Spearman's rank correlation coefficient were used for statistical analyses to compare changes in PA and sedentary behaviors (prior to and during COVID-19) and determine the relationship between changes in the total volume of PA and various health states of male and female students respectively. Overall, the total PA of students significantly declined during COVID-19 compared to before the pandemic. Total PA of male students did not significantly change during COVID-19 but did for females. Female students' sitting time significantly reduced during weekdays. Changes in PA was associated with different aspects of health, particularly for female students, during the COVID-19 community quarantine. The finding extends the literature about the impact of COVID-19 on students' PA and health and underscores the importance of PA as a way in alleviating negative perceptions related to health in university students despite the implemented community quarantine regulations.

Keywords: COVID-19, Filipino students, health, psychosocial states, community quarantine, IPAQ-SF

INTRODUCTION

The COVID-19 pandemic has drastically altered people's lives. To curb the spread of the disease, strategies such as social distancing, national lockdowns, or community quarantines to limit movement and physical contact among people have been implemented in many countries worldwide (Barkley et al., 2020; Castañeda-Babarro et al., 2020; Kohls et al., 2021). While these strategies have been shown to be effective in reducing infections (Newbold et al., 2020; Patel et al., 2020), the restrictions on movement and social contact have also led to significant changes in people's physical activity (PA) levels (Barkley et al., 2020; López-Valenciano et al., 2021) and health

(Active Minds, 2020; Stanton et al., 2020; Coakley et al., 2021; Kohls et al., 2021). For instance, substantial reduction in PA and the rise in sedentary/sitting behaviors were found in both sexes and different age groups (Maugeri et al., 2020; López-Valenciano et al., 2021). Similarly, variations in people's health aspects, like increased anxiety, stress, and depression, higher level of fatigue, decline in social interaction, enhanced feelings of loneliness and sadness, and difficulty in focusing on work and studies were observed (Active Minds, 2020; Maugeri et al., 2020; Tee et al., 2020, 2021; Violant-Holz et al., 2020).

Like other countries, the Philippines, has implemented movement restrictions and social distancing strategies in response to COVID-19 since March 2020 (IATF, 2020). Under the enhanced community quarantine, all households are mandated to stay at home with movement limited to what is necessary for acquiring essential goods and services; public transportation is inaccessible, mass gatherings are forbidden, non-essential businesses (e.g., fitness centers) are prohibited from operating, and schools of all levels are closed (IATF, 2020).

The president of the Philippines, Rodrigo Duterte announced the nationwide suspension of classes after a state of public health emergency was declared in March 2020 (Atienza, 2021). Thereafter, the delivery of education shifted to alternative distance learning methods from face-to-face classes (Pouezevara et al., 2020) for almost 30 million learners across all academic levels (Commission on Higher Education, 2021; Hernando-Malipot, 2021). This nationwide school-level suspension of face-to-face classes, along with other quarantine guidelines and movement restriction protocols may also have adverse consequences on students' PA levels and health aspects. While these variables have been documented in other countries (Coakley et al., 2021; Kohls et al., 2021; Lee et al., 2021; López-Valenciano et al., 2021) it is not clear how the enhanced community quarantine guidelines have affected PA and health of collegiate students in the Philippines due to lack of empirical data.

Hence, the purpose of this study was to examine the impact of the first wave of COVID-19 enhanced community quarantine on university students' PA levels, sedentary behaviors, and health states in the Philippines. Particularly, the study aimed to determine the changes in PA levels and sedentary behaviors of male and female students during quarantine and to assess the relationship between changes in PA and various health states of male and female students.

MATERIALS AND METHODS

Participants

A total of 1,667 university students participated in the study. During the initial stage of data screening, the collected surveys were rigorously checked and matched participants' prior and during COVID-19 responses. After pairing each participant's prior and during COVID-19 survey data, they were reviewed again for completeness of response, double submission, and data omissions. After excluding invalid cases, 1,042 samples were found to be valid and included in the study, which yielded a completeness rate of 62.5%. There were 469 (45%) males and 573 (55%) females between 16 and 30 years of age. All participants were undergraduate students enrolled in a private university in Cebu City, the second largest metropolitan area in the Philippines.

Questionnaire

Physical Activity Measure

Students were requested to fill out the International Physical Activity Questionnaire short version (IPAQ-SF) (Craig et al., 2003) to determine their levels of PA and sedentary behavior prior to COVID-19 and during the city government's implementation of community quarantine regulations. The IPAQ-SF was used to assess specific types of activity, namely walking and moderate- and vigorous-intensity activities. The frequency and duration of each type of activity were also recorded. To determine the volume-of-activity scores for each type of activity in metabolic equivalent task minutes per week (MET-minutes/week), the corresponding energy requirements of each type of activity (walking = 3.3; moderate intensity = 4.0; vigorous intensity = 8.0) were multiplied by the duration (in minutes) and frequency (number of days per week). Then, total PA MET-minutes/week was determined by computing the sum of the walking, moderate intensity, and vigorous intensity PA MET-minute/week scores. From the calculated total PA MET-minutes/week scores, students were classified into low (<600 MET-minutes/week), moderate (≥600 MET-minutes/week), and high (≥3,000 MET-minutes/week) groups (IPAQ, 2004). Durations of sitting during weekends and weekdays were also determined to estimate sedentary behaviors. Reliability and validity of the IPAQ-SF in assessing PA levels are well documented not only among the general population (Craig et al., 2003; Macfarlane et al., 2006) but also in college students (Dinger et al., 2006).

Aspects of Health

Participants were asked to rate their physical, emotional, mental, social, and spiritual states while in community quarantine which correspond to various aspects of personal health/wellness (World Health Organization, 1948; Corbin et al., 2006; Stoewen, 2017). Using a 6-point Likert scale ranging from extremely low (1) to extremely high (6), students rated their perceived strength and endurance to perform daily physical tasks (physical), feelings of positive emotions (emotional), level of attention and learning (mental), interaction with friends/classmates (social), and awareness of meditation and prayer (spiritual) during the quarantine. This *ad hoc* questionnaire was composed of single-item questions to measure perceived health status of students during the implementation of the enhanced community quarantine regulations and nationwide school suspension.

Procedure

This quantitative cross-sectional study was a two-part survey administered online using Google Forms. Using a non-probabilistic sampling method, the survey was emailed to students *via* the university's portal system. The study was conducted in the second half of the year (late November to December 2020), which was during the first semester of the

academic year 2020–2021. For the first survey, students were requested to fill out the IPAQ-SF (Craig et al., 2003) to determine their levels of PA and sedentary behavior prior to COVID-19. After a fortnight, the second survey was emailed to the students. They survey form contained the same IPAQ-SF questionnaire with a revised statement anchored to determine students' PA and sedentary behaviors during the city government's implementation of community quarantine regulations as well as the health states questionnaire. Before the students answered the questionnaire, the purpose and objectives of the study, declaration of anonymity and confidentiality, and management of data for educational purposes were disclosed. All participants provided informed consent. Participants took 15–25 min to complete the survey. This study was exempted from ethical approval by the institutional ethics committee in view of its retrospective nature. The procedures of this study followed the ethical principles outlined in the Declaration of Helsinki regarding human participants, and by the national psychological association of the country where the research was conducted. Participants provided their informed consent prior to answering the survey.

Data Analysis

First, all relevant data were tested for normality using Kolmogorov–Smirnov test and found to be not normally distributed. Non-parametric Wilcoxon signed-rank test was used to compare changes in PA and sedentary behaviors (prior to and during COVID-19) for the whole sample. Next, the data were stratified by sex and the same analysis was performed again. Finally, Spearman's rank correlation coefficient was estimated to determine the relationship between changes in the total volume of PA in MET-minutes/week by subtracting pre-COVID total PA to during COVID-19 total PA and various health states of male and female students. IBM SPSS statistical software version 25 was used to perform all relevant analyses and statistical significance was set at $p < 0.05$.

RESULTS

Table 1 shows the overall PA and sedentary behaviors of university students before and during COVID-19. Results showed that the total PA level of university students significantly decreased during COVID-19 compared with before COVID-19 ($Z = -2.84$, $p < 0.01$). Reviewing the types of PA, students were found to have increased their vigorous and moderate PA, but the changes were insignificant. However, the PA of walking declined significantly ($Z = -8.04$, $p < 0.001$) during COVID-19 compared to pre-pandemic times. Sitting behavior during weekdays significantly decreased ($Z = -3.22$, $p < 0.001$) whereas sitting during weekends increased slightly during the pandemic, but the difference was not significant.

Table 2 shows the PA and sedentary behaviors of male students before and during COVID-19. The Wilcoxon signed-rank test indicated that in males, only walking activity showed a significant change between time points. The results indicated that walking activity during COVID-19 substantially decreased compared to before COVID-19 ($Z = -5.37$, $p < 0.001$).

Table 3 shows the PA and sedentary behaviors of female students before and during COVID-19. Total PA, vigorous activity, walking, and sitting during weekdays showed significant changes between the time points. The results indicated that total PA ($Z = -3.23$, $p < 0.001$), walking activity ($Z = -5.95$, $p < 0.001$), and weekday sitting behavior ($Z = -2.82$, $p < 0.01$) substantially decreased during COVID-19 compared with before. In contrast, vigorous activity significantly increased during COVID-19 ($Z = -2.52$, $p < 0.05$).

Before COVID-19, 9.16% of male students were categorized as low (<600 MET-minutes/week), 46.90% as moderate (≥600 MET-minutes/week), and 43.92% as high (≥3,000 MET-minutes/week). During COVID-19, the percentage of high active males decreased to 41.79%, whereas the moderate and low groups increased to 47.12 and 10.87%, respectively (see **Figure 1**).

Among female students, 11.69% were classified as low, 45.89% as moderate, and 42.40% as high prior to quarantine. During quarantine, high group females decreased to 32.98%, while both moderate and low groups increased to 54.10 and 12.91%, respectively (see **Figure 2**).

Spearman's rank correlation results showed no significant correlations between changes in total PA and all aspects of health in male students. In contrast, significant positive correlations were found between changes in total PA and physical, emotional, mental, and social aspects of health in female students (see **Table 4**).

DISCUSSION

We determined changes in PA and sedentary behaviors of Filipino male and female university students during the first wave of COVID-19 community quarantine in the Philippines, and examined the relationship between PA and health states of students. Overall, a significant reduction in the total volume of PA by students during COVID-19 was found, which supports previous studies conducted on student populations (Luciano et al., 2020; Öncen and Tanyeri, 2020; Maher et al., 2021). Regarding students' sedentary behaviors, while sitting during weekends marginally increased, a significant reduction in sitting during weekdays was found. This latter result contrasts with previous studies in which weekday sitting also increased (Luciano et al., 2020; Öncen and Tanyeri, 2020). Household chores and/or short errands outside the house (e.g., buying groceries) are a possible explanation for the decline in hours spent sitting during weekdays.

Physical Activity and Sedentary Behaviors of Male Students

Some previous studies have shown a substantial decrease in total and specific types of PA in males (Manthou et al., 2020; Rodríguez-Larrad et al., 2021), while others demonstrated varied results (Romero-Blanco et al., 2020; Öncen and Tanyeri, 2020). For instance, Öncen and Tanyeri (2020) found an increase in walking in men, while other types of PA decreased. Our

TABLE 1 | Physical activity and sedentary behaviors of students before and during COVID-19 (total sample).

	Before COVID-19 MET-min/week		After COVID-19 MET-min/week		Difference (pre–during) MET-min/week	% Change
	Mean	SD	Mean	SD		
Vigorous PA	1,568.29	2,150.58	1,631.12	2,144.85	−62.83	−4.01
Moderate PA	794.51	1,131.50	810.72	1,159.86	−16.21	−2.04
Walking*	1,234.74	1,476.74	909.73	1,248.87	325.01	26.32
Total PA*	3,597.55	4,758.83	3,351.58	4,553.58	245.97	6.84
Sitting WDAY*	394.84	478.76	343.78	168.64	51.06	12.93
Sitting WEND	334.20	171.00	335.33	172.30	−1.13	−0.34

*PA, physical activity; WDAY, weekday; WEND, weekend. Negative score in the difference and % change means increased in behavior. *p < 0.01.*

TABLE 2 | Physical activity and sedentary behaviors of male students before and during COVID-19.

	Before COVID-19 MET-min/week		After COVID-19 MET-min/week		Difference (pre–during) MET-min/week	% Change
	Mean	SD	Mean	SD		
Vigorous PA	2,080.68	2,531.37	2,006.99	2,427.75	73.69	3.54
Moderate PA	933.13	1,206.77	980.47	1,255.00	−47.33	−5.07
Walking*	1,197.92	1,360.03	946.73	1,299.32	251.19	20.97
Total PA	3,616.07	3,463.20	3,542.35	3,627.60	277.55	0.07
Sitting WDAY	385.27	458.80	333.97	167.57	51.30	13.32
Sitting WEND	330.32	170.76	333.26	171.81	−2.94	0.89

*PA, physical activity; WDAY, weekday; WEND, weekend. Negative score in the difference and % change means increased in behavior. *p < 0.01.*

TABLE 3 | Physical activity and sedentary behaviors of female students before and during COVID-19.

	Before COVID-19 MET-min/week		After COVID-19 MET-min/week		Difference (pre–during) MET-min/week	% Change
	Mean	SD	Mean	SD		
Vigorous PA*	1,148.90	1,668.21	1,322.94	1,826.76	−174.04	−15.15
Moderate PA	681.05	1,053.52	671.54	1,056.52	9.51	1.40
Walking*	1,264.88	1,566.35	879.40	1,206.23	385.48	30.48
Total PA*	3,582.38	3,501.93	3,195.77	3,393.63	220.95	7.14
Sitting WDAY*	402.67	494.76	351.82	169.24	50.85	12.63
Sitting WEND	337.38	171.28	337.03	172.83	0.35	0.10

*PA, physical activity; WDAY, weekday; WEND, weekend. Negative score in the difference and % change means increased in behavior. *p < 0.01.*

findings showed a decline in total PA like some studies (Manthou et al., 2020; Rodríguez-Larrad et al., 2021) but contradict the findings of Romero-Blanco et al. (2020) who found an increase in total PA in men.

In terms of type of PA, walking drastically decreased during COVID-19 and corroborates previous reports (Gallo et al., 2020; Manthou et al., 2020; Rodríguez-Larrad et al., 2021) and assumed to be due to students' limited movement during the enhanced quarantine regulations implemented by the government. However, Öncen and Tanyeri (2020) found a significant increase in walking, which conflicts with the results of this study. This disparity may be due to the established restriction guidelines and stricter compliance by male students. Under the community quarantine guidelines of the Philippines, face-to-face classes are prohibited, and 100% stay-at-home is mandatory for the whole population. Thus, students are forced to stay in their homes and attend online classes, thereby limiting their walking. On the other hand, earlier studies have speculated that the increased walking was due to lower compliance of male students to the restriction guidelines (Öncen and Tanyeri, 2020).

Sedentary behaviors are described as activities with very low energy expenditure requirement ranging from 1 to 1.5 METS and sedentary activities typically involve sitting such as watching TV or working in front of the computer (Pate et al., 2008; Owen et al., 2010). Sedentary behavior is also defined to equate with sitting (Mclaughlin et al., 2020) and commonly measured using sitting time (Healy et al., 2008). The World Health Organization recommends that adults should replace sedentary time with PA regardless of intensity level due to the potential detrimental health effects associated with sedentary behaviors

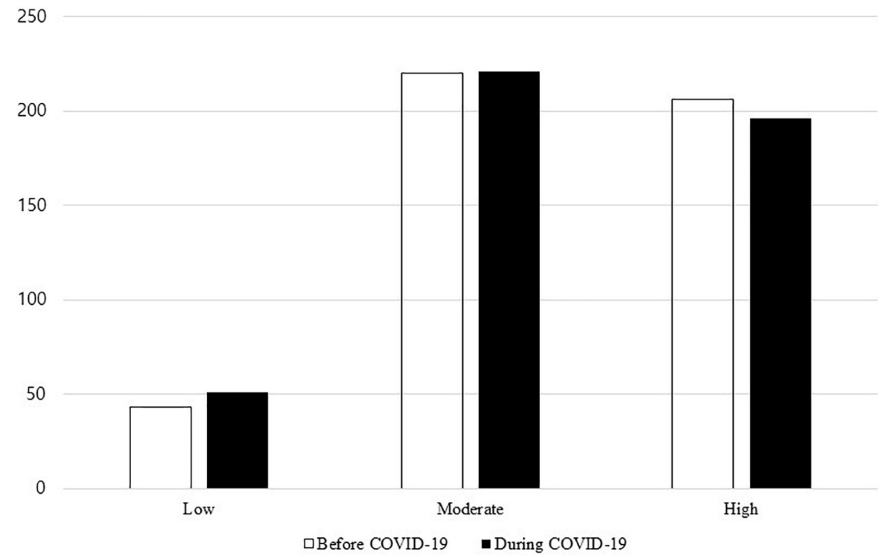

FIGURE 1 | Physical activity classification of males before and during COVID-19.

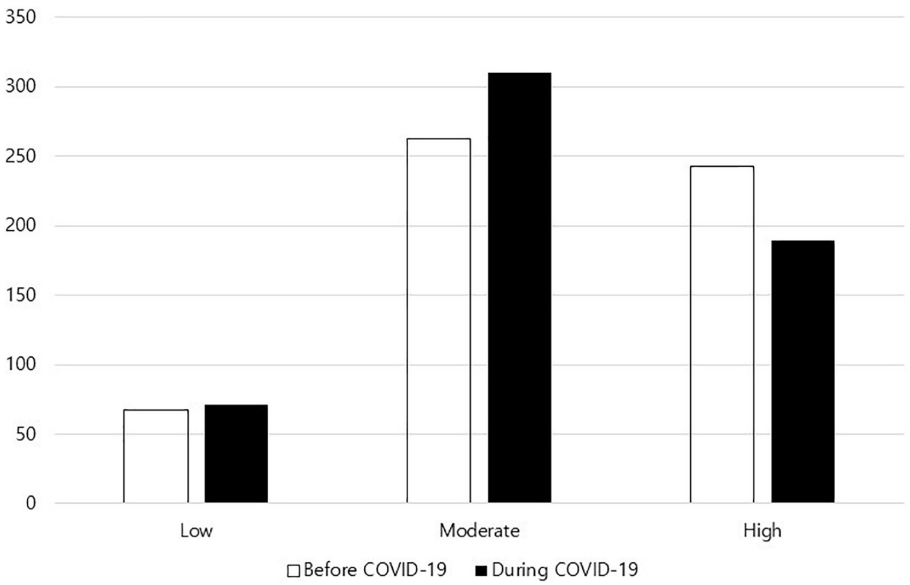

FIGURE 2 | Physical activity classification of females before and after COVID-19.

TABLE 4 | Relationship between change in total physical activity level and health states of male and female students.

	Physical	Emotional	Mental	Social	Spiritual
Male	3.99 ± 1.27	3.90 ± 1.25	3.58 ± 1.39	4.17 ± 1.42	4.29 ± 1.38
r	0.036	0.066	0.089	0.017	0.070
p-Value	0.440	0.151	0.053	0.720	0.132
Female	3.75 ± 1.30	3.60 ± 1.26	3.39 ± 1.47	4.42 ± 1.32	4.32 ± 1.37
r	0.150	0.141	0.190	0.138	0.033
p-Value	0.001	0.001	0.001	0.001	0.432

(Bull et al., 2004; Ekelund et al., 2019; Bailey et al., 2020). For instance, a higher risk of cardiovascular mortality was found in adults who spent more than 8 h sitting (Ekelund et al., 2019). Likewise, physical inactivity is found to cause other diseases such as diabetes, colon and breast cancers (Bull et al., 2004). While the average sitting time of male students is still below 8 h, more than 18% of the total male students sat more than 8 h/day, increasing their risk of cardiovascular diseases, diabetes, and cancer. Further, in a study conducted in adults, Owen et al. (2010) observed negative associations between sedentary time and waist circumference, systolic blood pressure and 2-h plasma glucose in men despite being physically active suggesting the detrimental impact of prolonged sedentary time. Therefore, to avoid the negative health consequences related to a sedentary lifestyle, male students should neither limit nor eliminate their PA, despite the movement restrictions enforced by the government. In fact, PAs that can be performed at home, including strengthening exercises, stretching workouts, stair climbing, chair squats, sit-ups, and push-ups, may simultaneously help to avoid contracting the virus and maintain fitness levels (Chen et al., 2020).

Physical Activity and Sedentary Behaviors of Female Students

The present study found a decrease in total PA of Filipino female students before and during COVID-19, like other studies (Maher et al., 2021; Rodríguez-Larrad et al., 2021). In terms of specific types of PA, walking in female students significantly reduced confirming previous studies (Romero-Blanco et al., 2020; Maher et al., 2021). Interestingly, vigorous PA significantly increased during COVID-19 compared with pre-COVID-19 times. This noteworthy finding indicates that female students were able to perform vigorous PA despite being at home. This result contradicts previous studies, which found a decrease in vigorous PA (Öncen and Tanyeri, 2020; Maher et al., 2021). The difference in results may be attributed to female students' active involvement in online PE classes, which helped them engage in higher intensity PA. It is also possible that female students helped out in several household chores which required hard physical effort to accomplish (e.g., manual laundry and heavy lifting) thereby contributing to the increase in their vigorous PA scores. Finally, another potential reason may be over reporting of female students' vigorous PA that led to the conflicting results from previous findings.

Sitting time during weekdays significantly decreased suggesting that female students spent less time sitting at a desk, reading, or lying down at home during weekdays, while under quarantine, compared with the prior period. This is an interesting result, considering that earlier studies found an increase in sedentary behaviors during COVID-19 (Öncen and Tanyeri, 2020; Rodríguez-Larrad et al., 2021) in female university students. Again, active participation in vigorous activities in PE class (2-h sessions/week) and/or increased in moderate to high-intensity activities such as house chores, grocery and other essential supplies shopping errands, lifting heavy objects or yard work may be possible explanations for the decrease in weekday sitting time of Filipino female students. Underreporting of sitting time may also be a potential reason for such result. Previous report revealed a significant negative dose-response associations between TV time and waist circumference, systolic blood pressure, 2-h plasma glucose, fasting plasma glucose, triglycerides, and HDL-cholesterol in healthy and physically active women (Healy et al., 2008; Owen et al., 2010). Hence, to avoid the adverse effects of prolonged sedentary behaviors, especially sitting, on metabolic health (Hamilton et al., 2007; Owen et al., 2010) and to avoid future health problems (Ekelund et al., 2019: Gallo et al., 2020), it is important for female students to decrease their sedentary behaviors, since more than 20% of the total sample reported spending more than 8 h seated, on both weekdays and weekends.

Relationship Between Physical Activity and Health States

Numerous studies have verified the relationship between PA and health during COVID-19 in students (Maugeri et al., 2020; Coakley et al., 2021; Maher et al., 2021; Fennell et al., 2022). For instance, Coakley et al. (2021) found students who achieved the recommended moderate-vigorous intensity PA (MVPA) during the pandemic had less severe symptoms of depression and anxiety. Fennell et al. (2022) declared a significant negative relationships between PA and depression, anger and overall mood. They also found that PA was significantly associated with vigor. Maher et al. (2021) reported positive association between MVPA (in minutes per week) and positive affect. Maugeri et al. (2020) conveyed a significant positive correlation between PA variation and psychological health. General findings from these earlier studies showed a positive association between variation in PA and health outcomes, highlighting the importance of PA in alleviating the adverse consequences of COVID-19 on university students' health.

In the current study, the results revealed significant positive relationships between PA and physical, emotional, mental, and social aspects of health in female university students suggesting that female students who increased their total PA tended to have better health states, or conversely, female students who decreased their total PA were likely to feel worse in terms of their physical, emotional, mental, and social health states. The present findings could not be directly compared to previous studies due to differences in how health states were measured, however, the results are consistent with previous studies conducted in students that revealed positive association between PA and emotions (Maher et al., 2021), overall mood state (Fennell et al., 2022), and psychological health (Coakley et al., 2021). On the other hand, the result partially confirms a previous report on adults (Maugeri et al., 2020) that demonstrated a positive correlation between PA and psychological well-being in females. Maugeri et al. (2020) also reported a significant positive correlation between the relevant variables in males but not in the current result. Changes in total PA levels between the studies may be the reason for the discrepancy in results (lack of significant relationship), wherein the change in total PA of Filipino males decreased only by

277.55 ΔMET-minutes/week, while it decreased by 1,244 ΔMET-minutes/week for Italian males.

Female students who participated in PA reported better physical health state suggesting that these students gained the beneficial health effects of PA through the improvement of their cardiovascular endurance and muscular functions resulting to improved physical capacity and resistance to fatigue (Corbin et al., 2006) despite the movement restrictions due to COVID-19. In contrast, female students who decreased their total PA, predominantly contributed by insufficient walking PA, tended to have lower energy level perhaps due to loss of muscle strength and reduction in endurance capacity (Paoli and Musumeci, 2020). This present result concurred similar findings that as students increased their PA, their energy levels also increased during lockdown (Fennell et al., 2022).

Significant positive relationship between PA and social state was also observed, which is an interesting finding in the present study. This indicates that female students who were physically active during COVID-19 reported better social condition (meeting friends/classmates). The enhanced community quarantine and school closure had greatly reduced opportunities for students to meet friends and classmates as well as to participate in outdoor and school-related PA such as commuting to school, transferring from one school building to another, and participating in sports and exercise (i.e., basketball, volleyball, running, and group aerobics) which are normal PA routine of students in the Philippines. Previous study that examined factors affecting people's perception of social isolation during COVID-19 revealed that 39% of the participants reported social interaction to be the most affected aspect of their lives (Bezerra et al., 2020). However, the current study showed that despite of these restrictions, female students who increased their PA participation during COVID-19 were associated with higher level of perceived social interaction. According to the health and wellness dimensions, an individual who is socially well and healthy has a general characteristic of being involved and has the ability to interact with others and create meaningful relationships (Corbin et al., 2006; Stoewen, 2017). It is also recognized that one of the benefits of PA participation is the opportunity for social interactions (Corbin et al., 2006). Perhaps those female students who were actively engaging in PA at home were also performing it with their friends or classmates *via* online group exercise sessions. This type of online exercise sessions, such as special group aerobics or even during online physical education classes, provides an opportunity for students to see their friends and classmates even just through their desktop or mobile devices which then foster social interactions. Hence, the present finding provides evidence about the importance of PA participation during COVID-19 in enhancing social interactions, establishing meaningful relationships, and even preventing the feeling of isolation and opens another opportunity for further investigation since it is still not clear how these students interact with others during COVID-19.

The current findings imply that changes in PA levels can influence perceptions related to health states, especially in female students. That is, as female students increased their PA, the stronger, happier, more learning-enabled, focused, and connected they felt while under community quarantine. In contrast, female students who decreased their PA while under community quarantine tended to feel weaker, depressed, less focused, and alienated. However, the strength of the relationship is weak which suggests that other factors may contribute to female students' health state aside from PA thereby warrants further investigation. Nonetheless, the findings thereby support the notion concerning the beneficial influence of PA and exercise which considered to induce mitochondrial biogenesis and vasculature and myocardial perfusion improvements (Sleiman et al., 2016; Pinckard et al., 2019), chronic inflammation reduction (Sleiman et al., 2016), and brain derived neurotrophic factor (BDNF) promotion (Voss et al., 2011; Chang et al., 2012; Tarassova et al., 2020) leading to enhanced physical fitness, psychological state, and cognition (Kramer et al., 2005; Hillman et al., 2008).

Limitations and Future Directions

To the best of our knowledge, this is the first study to examine the changes in PA and sedentary behaviors of Filipino university students following the strict community quarantine during COVID-19 in the Philippines. Moreover, with the addition of health states as outcome variables, this study contributes to the body of literature that examines how participation in PA relates to various health aspects among university students during COVID-19, showing how the association among these variables affects males and females differently. Finally, the sample size (N = 1,042), which is larger than most previous studies on the impact of COVID-19 on university students' PA, offers a firmer basis from which to draw conclusions and support existing knowledge regarding this population.

This study has several limitations. A bias toward over-reporting PA, underreporting of sedentary behaviors, and health states prior to COVID-19 and a similarity of responses before and during COVID-19 are likely because the data were collected retrospectively. To minimize this concern, a 2-week interval was given to the students before the second survey. Another limitation is the single-item measure to identify students' health states. However, a single-item questionnaire is a common method for determining feelings or perceptions about a certain topic because of its convenience and reduced effort required for participant responses. Finally, details on the activities performed while sitting were not collected in this study. This can be a noteworthy inclusion for future studies to further understand sedentary behaviors in students.

CONCLUSION

Overall, the total PA of students significantly declined during COVID-19 compared to before the pandemic. Based on sex-specific results, the total PA of male students did not significantly change during COVID-19 but did for females. Interestingly, based on the IPAQ-SF classification, 91 and 85% of male and female students, respectively, were classified as moderate to high active individuals during COVID-19, despite the 100% stay at

home quarantine protocol. Sitting behaviors did not substantially vary, except for female students' sitting time during weekdays. Finally, variations in PA was significantly associated with different aspects of health in female students, during the COVID-19 community quarantine.

It is apparent that notwithstanding the movement restrictions, the curtailment of outdoor activities, social gatherings, and the shift to online education caused by COVID-19, the Filipino university students in this sample who were able to adjust their lifestyles and PA habits appropriately reported positive perceptions related to their general health.

It is therefore suggested that educational interventions about the value and benefits of participating in moderate and vigorous PAs to achieve and develop overall wellness should be provided to university students. In addition, more endeavors to increase the PA of university students, such as participation in online physical education classes or special online exercise programs that are interactive, enjoyable, and physically effortful should be offered, so that they may benefit from PA and experience better perceived well-being, despite facing a very difficult and stressful event such as 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

AC, H-DK, and JC conceptualized the study. JC collected the data. AC and H-DK performed the statistical analyses. AC wrote the manuscript. H-DK and JC reviewed the final draft. All authors have read and approved the final version of the manuscript.

REFERENCES

Active Minds. (2020). *Student mental health survey*. Available online athttps://www.activeminds.org/wp-content/uploads/2020/10/Student-Mental-Health-Data-Sheet-Fall-2020-1.pdf. [Accessed August 1, 2021]

Atienza, M. (2021). *The Philippines a year under lockdown: Continuing executive dominance, threats to democracy, and unclear pandemic response*. Available online at https://verfassungsblog.de/the-philippines-a-year-under-lockdown/ [Accessed August 2, 2021].

Bailey, D. P., Hewson, D. J., Champion, R. B., and Sayegh, S. M. (2020). Sitting time and risk of cardiovascular disease and diabetes: a systematic review and meta-analysis. *Am. J. Prev. Med.* 57, 408–416. doi: 10.1016/j.amepre.2019.04.015

Barkley, J. E., Lepp, A., Farnell, G., Beiting, J., Wiet, R., Dowdell, B., et al. (2020). The acute effects of the COVID-19 pandemic on physical activity and sedentary behavior in university students and employees. *Int. J. Exerc. Sci.* 13, 1326–1339.

Bezerra, A., Silva, C., Soares, F., and Silva, J. (2020). Factors associated with people's behavior in social isolation during the COVID-19 pandemic. Fatores associados ao comportamento da população durante o isolamento social na pandemia de COVID-19. *Cien. Saude. Colet.* 25(Suppl. 1), 2411–2421. doi: 10.1590/1413-81232020256.1.10792020

Bull, F. C., Armstrong, T. P., Dixon, T., Ham, S., Neiman, A., and Pratt, M. (2004). ""Physical inactivity,"," in *Comparative Quantification of Health Risks. Global and Regional Burden of Disease Attributable to Selected Major Risk Factors*, eds M. Ezzati, A. D. Lopez, A. Rodgers, and C. J. L. Murray (Geneva, Switzerland: World Health Organization), 729–881.

Castañeda-Babarro, A., Arbillaga-Etxarri, A., Gutiérrez-Santamaría, B., and Coca, A. (2020). Physical Activity Change during COVID-19 Confinement. *Int. J. Environ. Res. Public Health* 17:6878. doi: 10.3390/ijerph17186878

Chang, Y. K., Labban, J. D., Gapin, J. I., and Etnier, J. L. (2012). The effects of acute exercise on cognitive performance: a meta-analysis. *Brain Res.* 1453, 87–101. doi: 10.1016/j.brainres.2012.02.068

Chen, P., Mao, L., Nassis, G. P., Harmer, P., Ainsworth, B. E., and Li, F. (2020). Coronavirus disease (COVID-19): The need to maintain regular physical activity while taking precautions. *J. Sport Health Sci.* 9, 103–104. doi: 10.1016/j.jshs.2020.02.001

Coakley, K. E., Lardier, D. T., Holladay, K. R., Amorim, F. T., and Zuhl, M. N. (2021). Physical activity behavior and mental health among university students during COVID-19 lockdown. *Front. Sports Act. Liv.*. 3:682175. doi: 10.3389/fspor.2021.682175

Commission on Higher Education. (2021). *Regional distribution of higher education institutions*. Available online at https://ched.gov.ph/wp-content/uploads/Higher-Education-Data-and-Indicators-AY-2009-10-to-AY-2019-20.pdf. [Accessed August 2, 2021].

Corbin, C. B., Welk, G. J., Corbin, W. R., and Welk, K. A. (2006). *Concepts of Physical Fitness. Active Lifestyles for Wellness 13th ed*. New York: McGraw Hill.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., et al. (2003). International physical activity questionnaire: 12-country reliability and validity. *Med. Sci. Sports Exerc.* 35, 1381–1395. doi: 10.1249/01.MSS.0000078924.61453.FB

Dinger, M. K., Behrens, T. K., and Han, J. L. (2006). Validity and reliability of the international physical activity questionnaire in college students. *Am. J. Health Educ.* 37, 337–343. doi: 10.1080/19325037.2006.10598924

Ekelund, U., Brown, W. J., Steene-Johannessen, J., Fagerland, M. W., Owen, N., Powell, K. E., et al. (2019). Do the associations of sedentary behaviour with cardiovascular disease mortality and cancer mortality differ by physical activity level? A systematic review and harmonised meta-analysis of data from 850 060 participants. *Br. J. Sport Med.* 53, 886–894. doi: 10.1136/bjsports-2017-098963

Fennell, C., Eremus, T., Puyana, M. G., and Sañudo, B. (2022). The importance of physical activity to augment mood during COVID-19 lockdown. *Int. J. Environ. Res. Public Health* 19:1270. doi: 10.3390/ijerph19031270

Gallo, L. A., Gallo, T. F., Young, S. L., Moritz, K. M., and Akison, L. K. (2020). The impact of isolation measures due to COVID-19 on energy intake and physical activity levels in Australian university students. *Nutr* 12:1865. doi: 10.3390/nu12061865

Hamilton, M. T., Hamilton, D. G., and Zderic, T. W. (2007). Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. *Diabetes* 56, 2655–2667. doi: 10.2337/db07-0882

Healy, G. N., Dunstan, D. W., Salmon, J., Shaw, J. E., Zimmet, P. Z., and Owen, N. (2008). Television time and continuous metabolic risk in physically active adults. *Med. Sci. Sports Exerc.* 40, 639–645. doi: 10.1249/MSS.0b013e3181607421

Hernando-Malipot, M. (2021). *Only 1.1 Million Learners did not Enroll This Year*. Available online at https://mb.com.ph/2021/03/01/deped-only-1-1-million-learners-did-not-enroll-this-year/ [Accessed February 8, 2021].

Hillman, C. H., Erickson, K. I, and Kramer, A. F. (2008). Be smart, exercise your heart: exercise effects on brain and cognition. *Nat. Rev. Neurosci.* 9, 58–65. doi: 10.1038/nrn2298

IATF. (2020). *IATF resolution no.12*. Available online at https://iatf.doh.gov.ph/wp-content/uploads/2021/02/IATF-Resolution-No.-12.pdf. [Accessed October 8, 2021].

IPAQ. (2004). *Guidelines for Data Processing and Analysis of the InternationalPhysical Activity Questionnaire (IPAQ)*. Available online at https://www.physio-pedia.com/images/c/c7/Quidelines_for_interpreting_the_IPAQ.pdf. [Accessed July 23, 2021]

Kohls, E., Baldofski, S., Moeller, R., Klemm, S. L., and Rummel-Kluge, C. (2021). Mental health, social and emotional well-being, and perceived burdens of university students during COVID-19 pandemic lockdown in Germany. *Front. Psychiatr.* 12:643957. doi: 10.3389/fpsyt.2021.643957

Kramer, A. F., Colcombe, S. J., McAuley, E., Scalf, P. E., and Erickson, K. I. (2005). Fitness, aging and neurocognitive function. *Neurobiol. Aging* 26(Suppl. 1), 124–127. doi: 10.1016/j.neurobiolaging.2005.09.009

Lee, H., Park, S. J., Kim, J. E., Kong, F., Zhao, B., Nam, H., et al. (2021). International comparison of depression during the COVID-19 pandemic among university students in 13 countries: A web-based cross-sectional survey. *Asia Pac. J. Public Health* 33, 928–931. doi: 10.1177/10105395211034062

López-Valenciano, A., Suárez-Iglesias, D., Sanchez-Lastra, M. A., and Ayán, C. (2021). Impact of COVID-19 pandemic on university students' physical activity levels: an early systematic review. *Front. Psychol.* 11:624567. doi: 10.3389/fpsyg.2020.624567

Luciano, F., Cenacchi, V., Vegro, V., and Pavei, G. (2020). COVID-19 lockdown: physical activity, sedentary behaviour and sleep in Italian medicine students. *Eur. J. Sport Sci.* 21, 1459–1468. doi: 10.1080/17461391.2020.1842910

Macfarlane, D. J., Lee, C. C., Ho, E. Y., Chan, K. L., and Chan, D. (2006). Convergent validity of six methods to assess physical activity in daily life. *J. Appl. Physiol.* 101, 1328–1334. doi: 10.1152/japplphysiol.00336.2006

Maher, J. P., Hevel, D. J., Reifsteck, E. J., and Drollette, E. S. (2021). Physical activity is positively associated with college students' positive affect regardless of stressful life events during the COVID-19 pandemic. *Psychol. Sport Exerc.* 52:101826. doi: 10.1016/j.psychsport.2020.101826

Manthou, E., Fotiou, A., Kanavou, E., Pigos, G., and Kalapotharakos, V. I. (2020). Acute changes in physical activity associated with home confinement due to Covid-19: A retrospective cross-sectional study in a collegiate population in Greece. *Eur. J. Fit. Nutr. Sport Med. Stud.* 1, 57–76. doi: 10.46827/ejfnsm.v1i2.84

Maugeri, G., Castrogiovanni, P., Pippi, R., D'Agata, V., Palma, A., et al. (2020). The impact of physical activity on psychological health during Covid-19 pandemic in Italy. *Heliyon* 6:e04315. doi: 10.1016/j.heliyon.2020.e04315

Mclaughlin, M., Atkin, A. J., Starr, L., Hall, A., Wolfenden, L., Sutherland, R., et al. (2020). Worldwide surveillance of self-reported sitting time: a scoping review. *Int. J. Behav. Nutr. Phys. Act.* 17:111. doi: 10.1186/s12966-020-01008-4

Newbold, S. C., Finnoff, D., Thunström, L., Ashworth, M., and Shogren, J. F. (2020). Effects of physical distancing to control COVID-19 on public health, the economy, and the environment. *Environ. Resour. Econ.* 1, 1–25. doi: 10.1007/s10640-020-00440-1

Öncen, S., and Tanyeri, L. (2020). Evaluation of the physical activity levels of the students in a physical education and sports science department before and during the coronavirus pandemic. *Int. Educ. Stud.* 13, 148–156. doi: 10.5539/ies.v13n10p148

Owen, N., Healy, G. N., Matthews, C. E., and Dunstan, D. W. (2010). Too much sitting: the population health science of sedentary behavior. *Exerc. Sport Sci. Rev.* 38, 105–113. doi: 10.1097/JES.0b013e3181e373a2

Paoli, A., and Musumeci, G. (2020). Elite athletes and COVID-19 lockdown: future health concerns for an entire sector. *J. Funct. Morphol. Kinesiol.* 5:30. doi: 10.3390/jfmk5020030

Pate, R. R., O'Neill, J. R., and Lobelo, F. (2008). The evolving definition of "sedentary". *Exerc. Sport Sci. Rev.* 36, 173–178. doi: 10.1097/JES.0b013e3181877d1a

Patel, A., Patel, S., Fulzele, P., Mohod, S., and Chhabra, K. G. (2020). Quarantine an effective mode for control of the spread of COVID-19? *A review. J. Fam. Med. Prim. Care* 9, 3867–3871. doi: 10.4103/jfmpc.jfmpc_785_20

Pinckard, K., Baskin, K. K., and Stanford, K. I. (2019). Effects of exercise to improve cardiovascular health. *Front. Cardiovasc. Med.* 6:69. doi: 10.3389/fcvm.2019.00069

Pouezevara, S., Ryan, J., and Bazer, S. (2020). *School-based technology and the shift to remote learning during COVID-19: Exploring Remote Learning Readiness of School Districts in the Philippines*. Available online at https://pdf.usaid.gov/pdf_docs/PA00XBQ6.pdf. [Accessed November 13, 2021].

Rodríguez-Larrad, A., Mañas, A., Labayen, I., González-Gross, M., Espin, A., Aznar, S., et al. (2021). Impact of COVID-19 confinement on physical activity and sedentary behaviour in Spanish university students: role of gender. *Int. J. Environ. Res. Public. Health* 18:369. doi: 10.3390/ijerph18020369

Romero-Blanco, C., Rodríguez-Almagro, J., Onieva-Zafra, M. D., Parra-Fernández, M. L., Prado-Laguna, M., and Hernández-Martínez, A. (2020). Physical activity and sedentary lifestyle in university students: changes during confinement due to the COVID-19 pandemic. *Int. J. Environ. Res. Public Health* 17:6567. doi: 10.3390/ijerph17186567

Sleiman, S. F., Henry, J., Al-Haddad, R., El Hayek, L., Abou Haidar, E., Stringer, T., et al. (2016). Exercise promotes the expression of brain derived neurotrophic factor (BDNF) through the action of the ketone body β-hydroxybutyrate. *eLife* 5:e15092. doi: 10.7554/eLife.15092

Stanton, R., To, Q. G., Khalesi, S., Williams, S. L., Alley, S. J., Thwaite, T. L., et al. (2020). Depression, anxiety and stress during COVID-19: associations with changes in physical activity, sleep, tobacco and alcohol use in Australian adults. *Int. J. Environ. Res. Pub Health* 17:4065. doi: 10.3390/ijerph17114065

Stoewen, D. L. (2017). Dimensions of wellness: Change your habits, change your life. *Can. Vet. J.* 58, 861–862.

Tarassova, O., Ekblom, M. M., Moberg, M., Lövdén, M., and Nilsson, J. (2020). Peripheral BDNF response to physical and cognitive exercise and its association with cardiorespiratory fitness in healthy older adults. *Front. Physiol.* 11:1080. doi: 10.3389/fphys.2020.01080

Tee, M., Wang, C., Tee, C., Pan, R., Reyes, P. W., Wan, X., et al. (2021). Impact of the COVID-19 pandemic on physical and mental health in lower and upper middle-income Asian countries: a comparison between the Philippines and China. *Front. Psychiatr.* 11:568929. doi: 10.3389/fpsyt.2020.568929

Tee, M. L., Tee, C. A., Anlacan, J. P., Aligam, K. J. G., Reyes, P. W. C., Kuruchittham, V., et al. (2020). Psychological impact of COVID-19 pandemic in the Philippines. *J. Affect. Disord.* 277, 379–391. doi: 10.1016/j.jad.2020.08.043

Violant-Holz, V., Gallego-Jiménez, M. G., González-González, C. S., et al. (2020). Psychological health and physical activity levels during the COVID-19 pandemic: a systematic review. *Int. J. Environ. Res. Pub. Health* 17:9419. doi: 10.3390/ijerph17249419

Voss, M. W., Nagamatsu, L. S., Liu-Ambrose, T., and Kramer, A. F. (2011). Exercise, brain, and cognition across the life span. *J. Appl. Physiol.* 111, 1505–1513. doi: 10.1152/japplphysiol.00210.2011

World Health Organization. (1948). *Constitution of the World Health Organization*. Available online at https://www.who.int/governance/eb/who_constitution_en.pdf. [Accessed February 11, 2022]

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