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Psychological variables, physical activity and physical education

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Víctor Arufe Giráldez, Rui Matos, Rubén Navarro-Patón and Alberto Sanmiguel-Rodríguez

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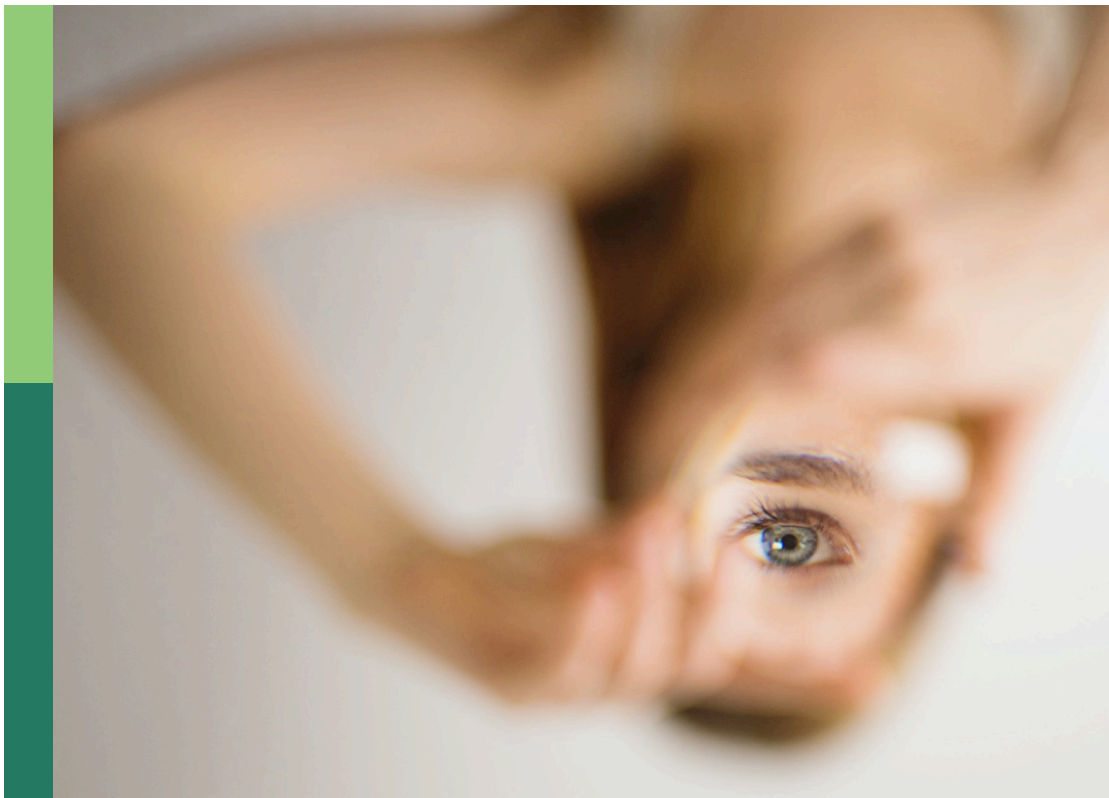

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Psychological variables, physical activity and physical education

Topic editors

Víctor Arufe Giráldez — University of A Coruña, Spain
Rui Matos — Quality of Life Research Center (CIEQV), Portugal
Rubén Navarro-Patón — Universidade de Santiago de Compostela, Spain
Alberto Sanmiguel-Rodríguez — Camilo José Cela University, Spain

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MINI REVIEW
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The Importance of Creativity in the Sportification of Breakdance

Zhi Yang[1], YuJie Bai[1] and MingTao Wei[2]*

[1] Melbourne Graduate School of Education, The University of Melbourne, Parkville, VIC, Australia, [2] Teachers College, Changshu Institute of Technology, Suzhou, China

Many historical works have attempted to reveal the process of the sportification of physical activity that originated in the eighteenth century. The process of sportification can be divided into three basic mechanisms: The institutionalization of practices, the formalization of standards, and the specialization of roles. Marginalized and discriminated lower-class American youths first used breakdancing to express their emotions. Nowadays, it has been announced by the International Olympic Committee as part of the Paris 2024 Olympic program in Paris, France. Therefore, this change may also further the specialization of breakdance teaching. In addition, this mini-review believes that it is necessary for breakdancing teachers, students, and judges to have a clear understanding of creativity, as it is often used as an essential scoring criterion in breakdancing competitions. This mini-review also shows the origins and evolution of breakdance. Cipher as a form of artistic communication produced the domino effect, which promoted the widespread popularity of breakdance worldwide. Creativity has also driven the evolution of breakdance moves. Finally, this article discusses the advantages and examples of the Four C models and suggests a set of methods for breakdance teachers to foster creativity in breakdance students.

Keywords: creativity, breakdance, hip-hop culture, teaching methods, sportification, cipher

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Rui Matos,
Life Quality Research Centre (CIEQV), Portugal

Reviewed by:
Giuseppe Mannino,
Libera Università Maria SS. Assunta, Italy

****Correspondence:***
Zhi Yang
yangzy2@student.unimelb.edu.au

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INTRODUCTION

Breakdance as a creative dance originated from the American hip-hop cultural movement in the 1970s. The lowest classes of American society initially used breakdancing to express their emotions (Forman, 2002). However, nowadays, breakdancing has been announced by the International Olympic Committee (IOC) for inclusion in the 2024 Paris Olympics (IOC, 2019). This change could indicate a new development opportunity for the breakdancing instruction industry. One reason is that an increasing number of commercial companies and advertising agencies will be investing money in the breakdancing industry (Li and Vexler, 2019; Zuma and Rooijackers, 2020). This article derives from the author's ongoing thinking on two questions about the breakdancing teaching industry. One question needs to be asked. When breakdancing is included in France's 2024 Paris Olympic event, how do breakdancing teachers train their students to win? One possible explanation for this is that creative students are more likely to win breakdancing competitions. One reason is that creativity is often used as a crucial scoring criterion in breakdancing competitions (Shimizu and Okada, 2018).

The two authors of this article visited many breakdance studios in China. They shared their teaching methods with many breakdance teachers. An interesting finding was that the execution of the dance movements demonstrated by almost all the students was similar; even the emotions and facial expressions were highly similar. This phenomenon may indicate that these children do not have a high level of creativity in dance. Essentially, the most distinctive feature of creative dance is that the expressive aspect is more important than the functional aspect (Bergmann, 1992); it is an expression of the inner self through physical movement, rather than imitation and copying the moves of others (Bergmann, 1992). Heyes (2011) argued that students' conscious or unconscious copying of the content presented by the teacher could lead to imitation. This phenomenon is widespread, especially in dance learning, and students' lack of self-expression and creativity is equally seen as a problem to be addressed by other dance education researchers (Giguere, 2011; Foley, 2016; Pürgstaller, 2021).

These persistent and truly wicked phenomena of imitation or copying, and the equally persistent concerns expressed by teachers, frame a second serious question for breakdance teachers: What is the way or better way for breakdance teachers to foster their students' creativity in dance? Lucas (2016) believed that students' level of creativity is closely related to the level of creativity of teachers and that if teachers do not understand creativity, they probably will not develop the creativity of learners. There are different definitions of creativity. Common definitions of creativity are usually usefulness and originality (Runco and Albert, 2010). In the case of usefulness, it usually refers to whether the things created by people satisfy their physical and psychological needs (Runco and Albert, 2010). For example, when people creatively design and participate in physical activity, their memory and attention can be effectively improved (Mannino et al., 2019). The second part of this article also provides a new case for the usefulness of creativity. For example, numerous literature reviews suggest that the birth of breakdancing represented a vision of youth from the underclass of American society against violence and discrimination (Blagojević, 2009; Langnes and Fasting, 2016; Bode Bakker and Nuijten, 2018). As a critical element of hip-hop culture, breakdance, with its philosophy of peace, unity, love, and fun, has positively impacted young people worldwide (Li and Vexler, 2019).

In addition, according to Clements and Redding (2020), students' creativity in dance can be developed through performance, technique, and theoretical study. The third part uses the concept of creativity levels to discuss how to breakdance teachers can foster children's creativity in their teaching and provides a new case study for Clements' argument. In other words, if our research can offer breakdance teachers a way to foster creativity in their students, then we can help more children create unique and attractive choreography in their future dance careers. Furthermore, if Chinese breakdance students can make more outstanding breakdance works, then we can lay the groundwork for a future research question: whether breakdance, as a product of American hip-hop culture, can be adapted to the traditional cultures of other countries.

THE EVOLUTION AND SPREAD OF BREAKDANCING

As stated in the introduction, breakdance as a creative dance originated from the American hip-hop cultural movement in the 1970s. As racial discrimination and social segregation continue to spread, this has led to performing breakdancing as a way for young people to construct identity and express their emotions. According to Evans Pim (2018), breakdancing became an alternative in the past for young people to address physical violence with dance moves, and today, it still plays positive effects in preventing violence. A new form of artistic exchange was born when youths from the lower classes of society and those who suffered from discrimination started to come together to share the joy of hip-hop culture. At the time, older hip-hop artists referred to this form of art sharing as cipher and battle (Li and Vexler, 2019).

Before the advent of the internet and self-media applications, cipher became the primary method of communication for promoting hip-hop culture and events (Li and Vexler, 2019). DJs use music to cipher, graffiti artists use graffiti to cipher, dancers use dance moves to cipher, and so do all the elements of hip-hop. Those boys and girls who use dance moves to cipher are often called b-boys, b-girls, or breakers (Chew and Mo, 2019). Cipher as a form of art sharing is often seen at hip-hop parties and DJ's music shows, where breakers usually move their body regularly to the beat of the DJ's music, creating a dance called breakdance. Gottschild (1996) noted that breakdance originated as a creative dance because breakers combine dance moves with music to express their emotions and thoughts. In hip-hop parties, the DJ can provide the beats, the MC provides the lyrics and the breaker shows the dance moves, these three elements of hip-hop combine to create a uniquely artistic atmosphere.

Third, creativity also promotes the development of breakdance. More specifically, the older breakers used their ideas and wisdom to create diverse breakdance moves. For instance, b-boy (and UCLA dance expert) Ken Swift, a famous breaker of the older generation, created a breakdance move called crazy legs by moving and spinning his body and feet rapidly across the floor (Breaking history, 2021). Even today, these moves, created by the older generation of breakers, can still be found in various breakdance competitions. For young dancers who are eager to advance in their dance careers, they can attend a cipher to learn from the older generation of experienced breakers (Li and Vexler, 2019). The older breakers also advise the new generation to create their dance style based on the original moves, rather than copying others' moves. One reason is that the philosophy of hip-hop art encourages artists to be creative (Lora, 2012). Therefore, we should pay tribute to the older generation of dancers who used their wisdom to create different breakdancing moves.

With the popularity of hip-hop culture in the 1970s, American breakers began to share their dance with tourists in New York. Some breakers spread the dance during their travels, and a new cipher emerged around the world (Li and Vexler, 2019). Another part of breakdance has been spread worldwide by media companies through online videos (Burton, 2005). When a breaker starts a cipher in a new place, other interested people learn how to join the cipher. Local breakers began to grow rapidly and practice in other areas nearby, forming their dance teams and meeting other teams for ciphers. Cipher produced a domino effect as the core of promoting hip-hop cultural events (Li and Vexler, 2019). Nowadays, breakers worldwide are also using the global cipher to keep spreading breakdance, which is the history of breakdance.

Many historical works have attempted to reveal the process of the sportification of physical activity that originated in the eighteenth century (Collinet et al., 2013; Li and Vexler, 2019). Collinet et al. (2013) argued that the process of sportification can be divided into three basic mechanisms: the institutionalization of practices, the formalization of standards, and the specialization of roles (coach, player, and judge). The formalization of standards usually occurs with the implementation of competitive events, such as setting rules based on the player's age, gender, and level (Collinet et al., 2013). As mentioned in the introduction, breakdance was first used by marginalized and discriminated lower-class American youths to express their emotions, and nowadays, it has been announced by the International Olympic Committee as part of the Paris 2024 Olympic program in Paris France. Therefore, this change may also further the specialization of breakdance teaching. It is necessary for breakdance teachers to understand how to foster creativity in their students because creativity is usually a criterion for scoring in breakdance competitions (Shimizu and Okada, 2018). In the next section, this article will discuss the impact of creativity on breakdance competition and teaching.

THE IMPACT OF CREATIVITY ON BREAKDANCE TEACHING AND COMPETITION

All dance genres emphasize the importance of creativity in their philosophy (Butterworth, 2004; Farrer, 2014), and breakdance is no exception, encouraging people to create different dance moves in cipher. Breakdance is so attractive that even the Olympics wish to add it to the program. The International Olympic Committee announced that a competitive event called breakdance would be added to the 2024 Olympic Games in Paris, France (IOC, 2019). For breakdance teachers, it is essential to understand creativity because it may affect the performance of students in breakdance competitions. For instance, in breakdancing competitions, creativity usually accounts for the highest scores in the four scoring criteria (i.e., fundamentals, dynamics, execution of moves, and creativity) (Shimizu and Okada, 2018). The literature is voluminous, and there is a general tendency to fail to define creativity (Torrance, 1988; Plucker et al., 2004). One interesting finding is that common creativity is usually defined in some literature as usefulness and originality (Mumford and Gustafson, 1988; Jones et al., 2016). However, these definitions have some limitations, such as they are more product-oriented. In other words, these definitions may be inappropriate when used to explain creativity in dance. Torrance (1988) supports this view that creativity can not be defined precisely, but a common understanding of creativity is needed when it becomes an assessment criterion. Therefore, if judges, teachers, or athletes do not have a common understanding of the definition of creativity, then this phenomenon is likely to affect breaker's competition scores.

Secondly, if teachers understand creativity, then they are likely to teach students how to use creative thinking to integrate with dance movement. A fact clearly documented by authors, such as Foley (2016) and Shimizu and Okada (2018), is that creative teachers usually teach their students ideas for choreography (e.g., changes in the direction of dance movements, sequential combinations of dance elements, control of power, etc.) and even use deliberate practice theory to help learners improve the elaboration of their dance movements. The psychological view is that one of the criteria for assessing creativity is elaboration (Clements and Redding, 2020), which refers to the degree to which an idea is developed and refined (Goff, 2002). If breakdance teachers have a good understanding of creativity, then they can more effectively foster learners' creativity.

Finally, Hattie (2008) argued that creativity is positively correlated with students' learning effectiveness. According to Hattie (2008), if breakdance teachers can develop a creative learning program, then creative learning plans are likely to improve students' effectiveness of learning dance. Foley's (2016) research provides a new case for our argument. In Foley's (2016) b-baby project, she differentiated and explained the movement structures of breakdance (e.g., top rock, footwork, transition, power move, and freeze) and sorted each movement from easy to difficult level. The purpose of this approach is to better adapt to the physical conditions of students of different ages and to set a flexible after-school training schedule, which in turn increases the efficiency of students' learning. Similarly, OFSTED (2010) also argued that creative learning plans could improve students' learning efficiency and attendance in dance classes. Therefore, developing a creative learning plan is essential for breakdance teachers and students. This section discusses the impact of creativity in breakdance competition and teaching. The next section of this article will discuss how to breakdance teachers can enhance children's creativity from creativity level theory. As noted by Clements and Redding (2020), creativity in dance can be developed through technique and theory.

THE FOUR C MODEL OF CREATIVITY IN BREAKDANCE TEACHING

Kaufman and Beghetto (2009) define creativity as having four levels: Mini-C creativity (subjectively recognized creativity), Little-C creativity (creativity recognized from others), Pro-C creativity (creativity classified as a novel and significant contribution by experts in the area), and Big-C creativity (major creative achievements that only a few people can achieve). Based

on the concept of creativity levels, breakdance teachers should first ensure children's creativity reaches the mini-c and little-c levels and then help students to reach pro-c creativity and big-c creativity levels. One reason is that this process follows the physical and mental development of the child. Unlike adults, children have not formed a clear perception of the rules and definitions of dance, and they can live freely and happily without being influenced by the opinions of others (Pürgstaller, 2021).

Secondly, in terms of little-c creativity (creativity that is recognized as such by someone else), breakdance teachers should encourage and support children to explore the integration of dance movements with personal emotional expression and provide materials that can be choreographed because the focus of the creative dance is to explore the possibilities of personal, expressive movement. Foley's (2016) baby project gives an excellent example of our argument; for instance, breakdance teachers can encourage children to show like superheroes during the dance, making the dance moves more dynamic. During the improvisation process, teachers should give positive encouragement and feedback, regardless of whether the children's presentation is good or bad (e.g., lack of fluency in movement and anxiety). Similarly, Starko (1999) argued that finding a problem, identifying a question to answer, or investigating an area can be a crucial component of creative productivity.

Finally, Giguere (2011) argued that the social aspects of dance creation are essentially collaborative. Collaboration is shared creativity and discovery between two or more people with complementary skills, interacting to create a shared understanding that no one had previously possessed or might have known on their own (Moran et al., 2003). If breakdance teachers divide students into groups and require them to follow a set routine to choreograph, pupils may not collaborate. Therefore, breakdance teachers can support children to work in groups and share and exchange ideas, laying the foundation for developing children's mini-c creativity (subjectively recognized creativity).

CONCLUSION

When breakdance is included as a competitive sport in the 2024 Olympic Games in Paris, France, breakdance teachers and judges need to have a common understanding of the definition of creativity. This is because creativity is usually used as one of the scoring criteria for breakdance competitions. This article discusses the advantages and examples of the four C models. In terms of teaching methods, breakdance teachers should first ensure children's creativity reaches mini-c and little-c levels and then help students achieve pro-c and big-c creativity levels. One reason is that, unlike adults, children have not developed a clear perception of dance rules and the definition of creativity. In terms of Mini-C creativity, breakdance teachers can support children working in groups and sharing and exchanging ideas with each other, laying the foundation for developing children's creativity (subjectively recognized creativity) because the social aspects of dance creation are essentially collaborative. The second aim is to describe the development and evolution of breakdance. To be specific, cipher as a form of hip-hop art communication produced a domino effect, which contributed to the widespread popularity of breakdance worldwide. Creativity has also contributed to the emergence of different styles of breakdance moves. A limitation of this article is that it does not adequately describe the divergence between breakdance as a product of the American hip-hop cultural movement and other national cultures. Despite its limitations, the article indicates that creativity positively influences the teaching and competition of breakdance.

AUTHOR CONTRIBUTIONS

ZY and YB designed and researched the article and wrote the manuscript. MW as an expert in sports reviewed the manuscript. All authors contributed to the article and approved the submitted version.

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ORIGINAL RESEARCH
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Personality and Sport Experience of 20–29-Year-Old Polish Male Professional Athletes

Paweł Piepiora[1], Zbigniew Piepiora[2] and Justyna Bagińska[3]*

[1]Faculty of Physical Education and Sports, Wroclaw University of Health and Sport Sciences, Wrocław, Poland, [2]Faculty of Environmental Engineering and Geodesy, Wrocław University of Environmental and Life Sciences, Wrocław, Poland, [3]Faculty of Economics and Management, University of Business in Wrocław, Wrocław, Poland

More and more research reports assert that sport experience has an influence on shaping the personality of athletes. This paper aims at validating the connection between personality and sport experience. The research subject of were young Polish male athletes ($N = 1,260$) aged 20–29, out of 42 sports disciplines, with sport experience ranging from 3 to 12 years. In order to test the personality of the research subjects, a five-factor model of personality called the Big Five was applied. Statistical calculations and analyses were carried out with ver. 25 of the IBM SPSS Statistics software. The research has shown that all personality traits correlate in a statistically significant way with sport experience ($p < 0.001$): there is a negative correlation of sports experience with neuroticism and a positive correlation with traits such as extraversion, openness to experience, agreeableness, and conscientiousness. Thus, we have identified a relationship between sport experience and personality traits of the researched Polish male athletes—the longer the sport experience, the lower level of neuroticism and higher levels of extraversion, openness to experience, agreeableness, and conscientiousness. Duration of sport experience has a considerable influence on forming the personality of Polish male athletes. However, the interpretation of just the results regarding high level of extraversion and conscientiousness distinguishes Polish male athletes (20–29 years old) from the Polish male population of non-training people.

Keywords: sports psychology, personality, sport experience, physical activity, society

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Marcos Mecías-Calvo, University of Santiago de Compostela, Spain

****Correspondence:***
Paweł Piepiora
pawel.piepiora@awf.wroc.pl

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INTRODUCTION

Research on personality in sport is important to both the field of sports psychology and personality psychology, which aims at defining what causes various processes, predispositions, and mental functions to make a certain definite whole in a person, with coherent and integrated activities. These issues in the physical culture field are often raised upon description and explanation of various interindividual psychological and physical properties and behaviors of athletes or those who pursue physical culture goals, such as organizers, teachers, and educators (Jarvis, 1999). Personality in sport theoretical research background involves factor theories, sometimes referred to as trait theories, with the Big Five personality model frequently being used for this purpose. Because personality traits explain relatively constant human dispositions, their pursuit in repeated behavioral patterns is even more reasonable. The advantage of the

Big Five model is that it explains some socially and culturally important behaviors which normally depend on several personality traits simultaneously. The Big Five is made up of five major traits or dimensions: neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness, which can be classified disjointly. Neuroticism reflects emotional adjustment in relation to emotional imbalance, that is sensibility in terms of negative emotions, and includes six formally distinguished components: anxiety, angry hostility, depression, impulsiveness, vulnerability, and self-consciousness. Extraversion characterizes the quality and quantity of social interactions as well as activity level, energy, and ability to experience positive emotions and has six distinguished components: gregariousness, warmth, assertiveness, activity, excitement-seeking, and positive emotions. Openness to experience describes an individual's tendency to seek and positively value life experiences, tolerance toward novelty, and cognitive curiosity and includes six components: fantasy, esthetics, feelings, actions, ideas, and values. Agreeableness describes a positive or negative attitude toward other people, an interpersonal orientation manifested in altruism in relation to antagonisms, experienced in feelings, thoughts, and actions. This dimension is comprised of trust, straightforwardness, altruism, compliance, modesty, and tendermindedness. Conscientiousness characterizes an individual's degree of organization, persistence, and motivation in goal-oriented activities and describes a person's attitude toward work. The components of conscientiousness are as: competence, order, dutifulness, achievement striving, self-discipline, and deliberation (McCrae and Costa, 2003).

It was assumed that the duration of sport practice has an impact on the athletes' personality (Eysenck et al., 1982; Eyesenck, 1995). The longer the sport practice, the clearer outline of an athlete's personality, and that is what distinguishes athletes from the general population (Piedmont et al., 1999; Paunonen, 2003; Watson and Pulford, 2004; Shrivastaval et al., 2010; Mirzaei et al., 2013; Steca et al., 2018). The shaping of an athlete's personality alongside with gaining experience is associated with the acquisition of skills instrumental in dealing with stressful situations in sport (Piepiora, 2021a). This could be related to the specificity of sports rivalry and the psychological requirements which sport poses to athletes (Piepiora, 2021b). It was presumed that sports activity influences the personality and in turn the formed personality traits influence the undertaken decisions (Piepiora and Witkowski, 2020a). Upon taking up a sports task, athletes know their competences, know what they are able to do and assume that they can perform this task, regardless of the circumstances and difficulties posed by the opponent. And the differences in the value-to-behavior relations may result from normative pressures on the performance of specific personality behaviors (Piepiora and Witkowski, 2020b).

It is known from prior research of other nationalities that sport experience may have an impact on the personality development of athletes (Eysenck et al., 1982; Eyesenck, 1995; Piedmont et al., 1999; Paunonen, 2003; Watson and Pulford, 2004; Shrivastaval et al., 2010; Mirzaei et al., 2013; Steca et al., 2018). Therefore, we assume that the longer the sport experience, the more clearly the athletes' personality is outlined, and that is what tells them apart from the general population. That is why it is worth examining how sport (training and competition) shapes the personality of Polish male athletes. Such relationships have not yet been verified in the aforementioned population (Piepiora and Witkowski, 2020a,b; Piepiora, 2021a,b; Piepiora and Piepiora, 2021). Accordingly, we have verified whether the obtained results in the Polish sports environment may confirm that sport is an example of a model personality moderator (according to the Big Five model: low neuroticism, high extraversion, openness to experience, agreeableness, and conscientiousness) and considered the use of sports activity as an important social element (Papacharisis et al., 2005). Taking the above into consideration, the aim of this paper is to verify the relationship between personality and sport experience of Polish male professional senior athletes: 20–29 years.

MATERIALS AND METHODS

Participants

The research was carried out between 1 October 2015 and 30 September 2019, independently from the Olympic cycle. The data were collected throughout 4 years in order to include the maximum number of Polish athletes in the senior age from the widest possible array of sports disciplines. The subject of the study was 1,260 men, selected non-randomly and purposely from the population of Polish male athletes between the ages of 20 and 29. The inclusion criteria for the respondents were following: free will to participate, age range of 20–29 years, they had to represent at least the second sports class, several years of sports experience (3 years and up), a valid competition license, and documented sports achievements at different competition levels. The criterion of minimum 3 years experience was reasonable because these were the athletes who had already had sport results. The exclusion criterion for the study was the omission of any of the questionnaire items by the respondents.

The study population consisted of athletes "from the following sports disciplines: alpine skiing, American football, archery, athletics – long runs, athletics – short runs, ballroom dancing, basketball, beach volleyball, biathlon, bodybuilding, Brazilian jiu-jitsu, break dance, canoeing, cycling, equestrian, fitness, floorball, football, freestyle wrestling, futsal, handball, indoor volleyball, judo, ju-jitsu, karate kyokushin, kickboxing, mixed martial arts, mountaineering, Olympic karate, orienteering, Oyama karate, rugby, shidokan karate, shotokan karate, snowboarding, sport climbing, sport shooting, style taekwondo, swimming, tennis, tobogganing, ultimate frisbee" (Piepiora and Piepiora, 2021, p. 6297). The study was designed so that in each sports group, there were samples of 30 athletes from the same sport discipline. They included Polish medalists of the World Championship, European Championship, World Cup, European Cup, World Games 2017, and other prestigious international ranking tournaments. All the researched athletes train sport professionally (however, sport is not the only source of their income).

Mean values of personality traits of the studied Polish male population of 1,260 athletes aged between 20 and 29 were calculated, and their level was determined with the

use of a sten scale. These results are summarized in **Table 1**. Then, the sten results of the entire studied Polish group of athletes and the mean of the general Polish population—which was 5.5 sten—according to the Polish version of the Personality Inventory NEO-FFI (that had been elaborated on the basis of a 2041-person sample) have been juxtaposed in **Figure 1**.

The surveyed athletes were distinguished from the general population by a high level of extraversion and conscientiousness. It was found that in the dimensions of neuroticism, openness to experience, and agreeableness, the personality traits psychometrics of the studied athlete population did not differ from the general population.

Research Tool

A five-factor personality model, known as the Big Five, was applied to examine the athletes' personality with the use of the NEO—Five-Factor Inventory (NEO-FFI; Costa and McCrae, 2007). The NEO-FFI items are comprised of five measuring scales marked with abbreviations of the following factors: neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness, forming a NEOAC acronym. The inventory comprises 60 self-report statements whose truthfulness was evaluated by the athletes on a five-point scale: "I definitely disagree"; "I disagree"; "I have no opinion"; "I agree"; and "I definitely agree." The NEO-FFI has sten score norms for 5 age groups, established separately for males and females basing on big population samples. Additionally, the inventory is internally compatible. Its validity was proven by comparing the questionnaire results and the assessment of the respondents made by observers, as well as the correlation of the assessed traits with other dimensions of personality and temperament. Likewise, the factor validity was verified. The five-factor personality model meets the formal assumptions regarding personality traits. The Big Five dimensions are characterized not only by their universality and biological conditioning, but most of all by invariance and genuineness: they are a generalization of many personality characteristics and play an important role in the process of an individual's adaptation to the environment. In this sense, NEO-FFI can be useful in the analysis of a number of psychological problems, both of theoretical and utilitarian nature. The results enable a comprehensive description of the respondents' personalities within the Big Five framework and can be instrumental in forecasting their adaptation possibilities to the sport environment.

TABLE 1 | Analysis of the mean and sten values of the studied athlete population according to personality traits.

Variables	All athletes (N = 1,260)	
	M	Sten
Neuroticism	14.4	4
Extraversion	31.26	7
Openness to experience	25.78	5
Agreeableness	28.1	5
Conscientiousness	34.47	7

Costa and McCrae (2007) assumed that in psychometrics, the results between 1 and 3 sten should be treated as low, and results from 7 to 10 sten—as high. The results ranging from 4 to 6 should be interpreted as average.

Procedure

All the tested athletes consented to take part in the research after acquainting themselves with the information on its objectives and principles, likely effects, and potential benefits of the study. Moreover, the respondents understood the risk associated with taking part in the study, as well as its mode and the withdrawal possibility at any stage. The respondents could also ask questions and get answers. All tested athletes consented to the processing of data related to their participation in the research. The research was carried out in quiet rooms and the respondents were given 60 min to respond to the Inventory statements on paper. Moreover, the research was done in groups of maximum 30 people. After the completion of this research stage, the participants' data were encoded.

The project received a positive opinion for using the research results issued by the Senate Committee on Ethics of Scientific Research at the Wroclaw University of Health and Sport Sciences, number 20/2019.

Statistical Analysis

Statistical descriptive analyses, Pearson's linear correlation coefficient, and linear regression models were performed using IBM SPSS Statistics, version 25. All linear regression models, except for neuroticism, were performed using the least squares method. For the neuroticism regression, the Weighted Least Squares method was used due to the broken assumption of the homoscedasticity of variance. In the performed models, the rule of thumb was also used for removing outliers above |3SD| for standardized residue values.

RESULTS

In the first stage, the athletes were divided into 10 groups according to the length of sport experience measured in years, from 3 to 12 years ($M = 5.85$; $SD = 2.67$). Group sizes are shown in **Figure 2**.

The skewness value for the seniority measurement (Sk. = 0.76; Kurt. = −0.47) was within the adopted range; therefore, Pearson's r correlation coefficients were used for the analyses.

It was found that all personality traits correlate significantly statistically with the sport experience of the surveyed athletes. A very strong ($r > 0.7$) and negative correlation was observed with the measurement of neuroticism. Weak and positive relationships ($0.1 < r < 0.3$) were noted for the measurements of extraversion, openness to experience, and conscientiousness. The relationship with agreeableness was very weak and positive ($r < 0.1$).

The following relationship between personality traits and sport experience among the surveyed Polish athletes was noticed as: the longer the sport experience, the lower neuroticism level,

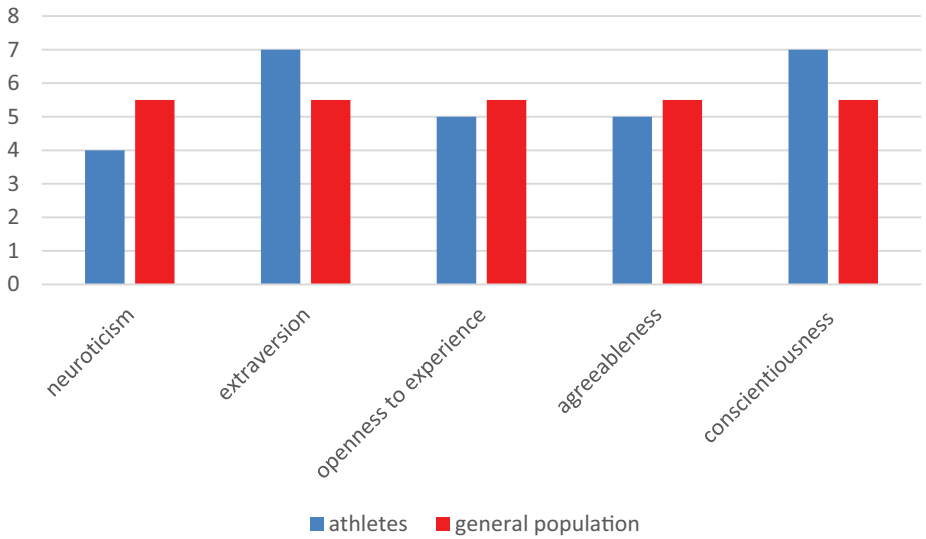

FIGURE 1 | A column chart of the sten scores for personality profile of all tested athletes and the general population.

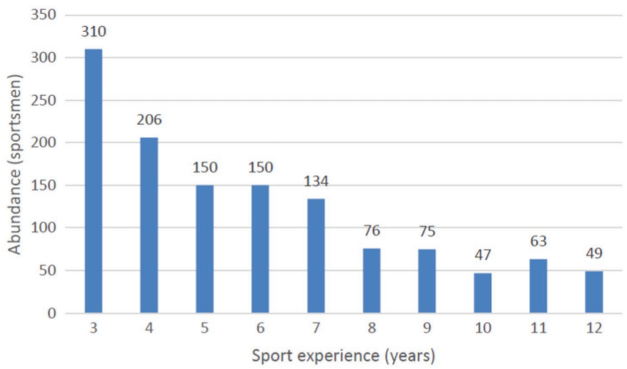

FIGURE 2 | Distribution athlete groups regarding the sport experience measured in years.

TABLE 2 | Coefficients of Pearson's *r* correlation analyses between personality traits and sport experience among the surveyed athletes.

Personality traits		Sport experience
Neuroticism	Pearson's *r*	−0.82
	significance	<0.001
Extraversion	Pearson's *r*	0.24
	significance	<0.001
Openness to experience	Pearson's *r*	0.16
	significance	<0.001
Agreeableness	Pearson's *r*	0.09
	significance	0.001
Conscientiousness	Pearson's *r*	0.30
	significance	<0.001

and the higher the remaining Big Five dimensions indicators. The results are summarized in **Table 2**.

In the last stage, a series of linear regression models was created for the relationship between personality traits from the Big Five model and the sports experience of Polish athletes measured in years. All the performed regression models turned out to be statistically significant, which means that for each personality trait, seniority was their significant predictor. Such results are partly the result of a very large research sample ($N = 1{,}260$); therefore, an important aspect when interpreting the results is the analysis of the effect size measured with the standardized Beta—ranging from −1 to 1.

The prediction power for the model with the neuroticism measurement turned out to be very strong and the largest among all the models made. The direction of the relationship between neuroticism and sports training was negative, which means that the longer the training period, the lower the level of neuroticism. The relationships between extraversion, openness to experience, and agreeableness, and experience in sports were, respectively, weak and moderately strong. However, their direction was positive, which means that the longer the period of experience in a given sport, the higher the level of extraversion, openness to experience, and agreeableness. The last relationship between conscientiousness and sports experience should be described as very weak, and its direction was also positive. This means that the longer the training period, the higher the level of conscientiousness. The results are presented in **Table 3**.

DISCUSSION

The aim of this paper is to verify the relationship between personality and sport experience of Polish male professional senior athletes aged 20–29 years. It has been shown that all personality traits correlate significantly statistically with sport experience: negatively with neuroticism and positively with extraversion, openness to experience, agreeableness, and conscientiousness. It was found that there is a relationship

TABLE 3 | Coefficients of linear regression models predicting individual personality traits based on sports experience in years.

Personality trait		*B*	*SE*	*Beta*	|*t*|	*p*	R^2	*F*	*df*
Neuroticism[a]	(constant)	24.49	0.19		128.00	<0.001	0.84	6578.02*	1; 1,243
	experience (years)	−1.74	0.02	−0.92	81.11	<0.001			
Extraversion	(constant)	28.13	0.37		75.57	<0.001	0.07	88.72*	1; 1,251
	experience (years)	0.55	0.06	0.26	9.42	<0.001			
Openness to experience	(constant)	23.68	0.39		60.04	<0.001	0.03	35.33*	1; 1,256
	experience (years)	0.37	0.06	0.17	5.94	<0.001			
Agreeableness	(constant)	27.02	0.41		66.52	<0.001	0.01	8.94*	1; 1,253
	experience (years)	0.19	0.06	0.08	2.99	0.003			
Conscientiousness	(constant)	30.30	0.40		76.01	<0.001	0.10	142.67*	1; 1,249
	experience (years)	0.74	0.06	0.32	11.94	<0.001			

*$p < 0.001$.
[a]*With WLS method.*

between personality traits and sport experience among the surveyed Polish male athletes between 20 and 29 years of age—the greater the sport experience, the lower the level of neuroticism, and higher markers of extraversion, openness to experience, agreeableness, and conscientiousness. This statistically significant result is probably a consequence of a large research sample and meets the research goal. The relationship between personality and sport experience in the Polish sporting environment has been confirmed. The longer the competition period, the clearer the personality of the athletes. The development of an athlete's personality, alongside with gaining experience, is connected with the acquisition of the ability to cope with stressful situations in sport. This result fully applies to the dispositional theory of Zimbardo et al. (2012) stating that temperament is "the foundation of personality, deeply rooted in our individual biological nature" (Zimbardo et al., 2012, p. 422). Traits are treated as multiple dimensions of personality, characterizing to some extent the personality of each person. Traits are responsible for the consistency of personality in different situations and can be conditioned both by heredity and by learning. Bearing the above in mind, it was confirmed that the frequency of undertaking sports competition positively modifies human personality. It has been confirmed that sport shapes the personality of athletes (Eysenck et al., 1982; Eyesenck, 1995; Piepiora, 2019).

As we do not have prior knowledge about the personality of the examined athletes from the earlier periods of their sports careers, we have no foundation for determining how many years of sports training may have an impact on alterations of this vital human characteristic. Additionally, we do not know to what extent the specificity of trained sports and coaching might have had an impact on shaping the athletes' personality (Harvey et al., 2020; Wallhead et al., 2021). The coach-athlete system is essentially a conflict system and it may be a desirable situation, as conflict often fosters development, and its absence may cause stagnation (Farias et al., 2015). Yet, the social and cultural factors cannot be excluded (Seippel, 2018). Therefore, the results of Polish athletes were compared with the Polish non-training population on the sten scale. It turned out that the Polish male athletes are distinguished from non-training Poles only by a high level of extraversion and conscientiousness. The other dimensions of personality are at an average level. This result highlights the importance of interpersonal relationships between athletes (high extraversion) and the impact of the training regime (high conscientiousness).

Our earlier study demonstrated differences between champions (Polish athletes with international sports successes) and other athletes (only with national, Polish, and sports successes) in all dimensions of personality in the Big Five model. The champions were distinguished by a "lower level of neuroticism and a higher level of extraversion, openness to experience, agreeableness and conscientiousness in relation to other athletes. But only neuroticism was a significant personality determinant predicting the level of achievement of the studied athletes: the lower the level of neuroticism, the greater the probability of an athlete being classified as a champion" (Piepiora and Piepiora, 2021, p. 6297). Previous studies have shown differences in the intensity of individual personality traits in combat sports (Piepiora and Witkowski, 2020a), individual sports (Piepiora, 2021b), and team sports (Piepiora, 2021a). The results of the study proved that there are differences in personality traits between athletes depending on the practiced sports, that is athletes show specific personality profiles according to the practiced sport. In each studied sport discipline, a different intensity of personality dimensions was found, and a different personality dimension was dominant. It was assumed that personality traits play a somewhat different role in the sport activity of athletes from different sports. The variation in the intensity of personality factors should be linked with the specificity of sports competition in the examined sports disciplines. Differences between champions and other athletes have also been found in combat sports (Piepiora and Witkowski, 2020a), individual sports (Piepiora, 2021b), and team sports (Piepiora, 2021a). The results suggest that the personality determinants of athletes are specific to

particular sport groups. In each sport group, there were differences between champions and athletes in the factors of neuroticism and extraversion. The other dimensions were different depending on the sport group. In contrast, only one difference was found upon comparison between champions of each sport group. Combat sports champions demonstrated a statistically significant lower level of neuroticism in comparison with individual sports champions. This was presumed to depend on the physiognomy of the sport. Furthermore, a utilitarian factor characteristic only for combat sports became apparent (Piepiora and Witkowski, 2020b).

Sports activity affects the personality of people who do sports. In the athletic performance context, personality traits influence long-term athletic success, interpersonal relationships, and mental states of athletes before, during, and after the competition (Eysenck et al., 1982; Eyesenck, 1995). In the health-related exercise context, personality traits influence leisure time management, strength, and mobility in old age, but also some unhealthy or addictive physical behavior. Sport fosters the development of character, consistency in behavior and persistence in achieving goals (Hastie et al., 2011). The influence of sport on personality is evident. Sports competition is mostly about overcoming and testing oneself, revealing one's abilities, predispositions, and skills; it is also a chance to overcome one's weaknesses. Therefore, sports rivalry teaches an athlete how to follow the rules adopted in a given sports field, but also the general principles: equal chances and respect for the opponent (Witkowski et al., 2016). Without this, many achievements in sport, culture, or science would not have taken place. Development usually takes place through the clash of incompatible and competing views and their justifications. Furthermore, competition unquestionably kills boredom, brings animation, joy, and excitement. It generates an environment where people can fulfill their need for achievement. Through competition, the attractiveness of success also increases (Brock et al., 2009).

Thus, it is worth promoting sports activity among children, adolescents, and adults (Corneliu et al., 2012). The future use of sport activity as an important social component should be considered (Piepiora et al., 2021b). Sport teaches people to live in society. It is conducive to the development of character, consistency in behavior, and persistence in pursuing the goal (Piepiora et al., 2018). Also, sports competition is an opportunity to overcome one's weaknesses, reveal one's abilities, skills and predispositions, and test oneself. Thus, sports rivalry teaches an athlete not only how to follow the rules of a given sport, but also other common rules: equal chances and respecting the opponent (Cynarski et al., 2021; Piepiora et al., 2021a). Deprived of it, we would not have had numerous achievements in sport, culture, or science. Development frequently takes place through the clash of competing or incompatible viewpoints and their explanations. Competition also kills boredom, brings animation, excitement, and joy (Kalina, 2012; Evans, 2020; Petre et al., 2021).

Darwinian approach to sport is fully justified here (De Block and Dewitte, 2009). It takes into account a deeply cultural character and thus overcomes the traditional dichotomies of nature culture in the sport sociology. Sport should be viewed as culturally developed signaling systems that perform a function similar to the biological rituals of courtship in animals. Therefore, social learning underpins many aspects of cultural control of sport. And sport has developed new cultural functions because cultural evolution itself has become important to people (Bairner, 2012; Piepiora et al., 2016; Kalina and Kondzior, 2019; Klimczak and Kalina, 2020). Therefore, the Grand Unified Theory of sports performance is important: it assumes that the patterns of coordination and control, which directly determine the effect of performance, emerge from the confluence of interacting organismal, environmental, and task constraints through the creation and self-organization of coordination structures (Glazier, 2017). This theory provides the scientific basis for the integration of the sub-disciplines of sport sciences with the programs of support for applied sciences in sport adopted by international federations that govern various sports disciplines. But, on the other hand, it should be noted that the individual differences of athletes, as manifested in their ability to train, are at least partly determined by the genetic component. MTHFR A1298C appears to be one of the many polymorphisms involved (Cięszczyk et al., 2016). Therefore, we cannot exclude that genetic determinants influencing the performance of athletes may have influenced the respondents' answers.

Research Limitations

This study only covers the Polish population of male professional athletes aged 20–29. The study is limited by nationality, age, gender, and sports disciplines. Despite a large sample, it was not possible to test athletes from all sports disciplines trained in Poland. Therefore, the obtained results cannot be interpreted as universal. In the future, the study should be expanded to include other male and female age groups, possibly the largest possible population of athletes from all sports and nationalities. Our results can be a good point of reference for similar research, however.

Utilitarian Value

Proper preparation of an athlete for sports competition includes factors related to physical and mental preparation. Therefore, the obtained research results may have great application during sports selection, training, and sports competition. They may constitute the basis for the development of suitable practical directives, important in the sports training of high-class players. In the sports selection of high-class players between the ages of 20 and 29 for the national male representation, the first verification stage may be the distribution level of personality traits. Candidates meeting the criteria of a model personality may be the desired individuals at the stage of mental selection. Only in the second stage, physical criteria should be taken into account, i.e., somatic build as well as motor, technical, and tactical predispositions as well as the achievements of the athletes.

CONCLUSION

There is a relationship between personality traits and sport experience among the surveyed Polish male athletes between

20 and 29 years of age—the greater the sport experience, the lower the level of neuroticism, and the higher the levels of extraversion, openness to experience, agreeableness, and conscientiousness. But the interpretation of the results just in a high level of extraversion and conscientiousness distinguishes Polish male senior age athletes (20–29 years) from the non-training Polish male population. Therefore, extraversion and conscientiousness should be granted a leading role in shaping the personality through sport.

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.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Senate Committee on Ethics of Scientific Research at the Wroclaw University of Health and Sport Sciences, number 20/2019. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

PP conceptualized and designed the study, organized the database, performed the statistical analysis, and wrote sections of the manuscript. PP, ZP, and JB wrote the first draft of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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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

*Angelita B. Cruz[1], Jean Marie Cando[2] and Hyun-Duck Kim[3]**

[1] Department of Physical Education, Keimyung University, Daegu, South Korea, [2] Physical Education Department, Cebu Institute of Technology – University, Cebu City, Philippines, [3] Department of Sport Marketing, Keimyung University, Daegu, South Korea

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***Correspondence:**
Hyun-Duck Kim
kimgolf@kmu.ac.kr

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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

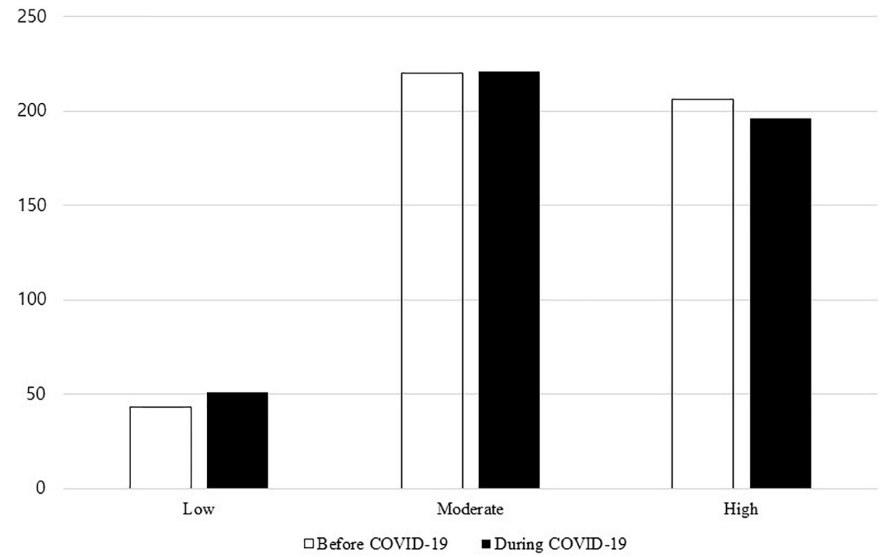

FIGURE 1 | Physical activity classification of males before and during COVID-19.

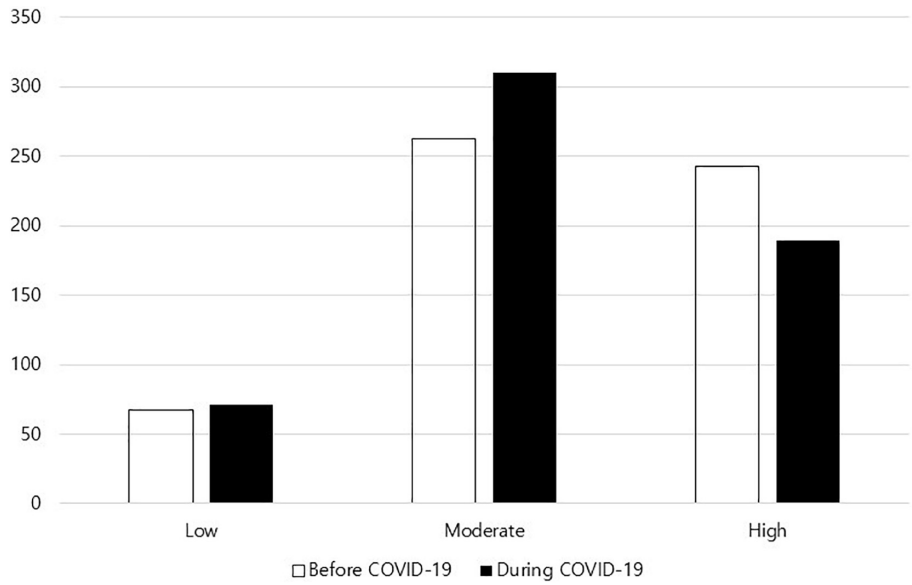

FIGURE 2 | Physical activity classification of females before and after COVID-19.

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.

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Handball Training and Competition With Facemasks in Galicia: The FISICOVID-DXTGALEGO Protocols Experience

Javier Rico-Díaz[1], *Dan Río-Rodríguez*[2,3]*, *Joaquín Gómez-Varela*[2] and *Rafael Martín-Acero*[2]

[1] Facultade de Ciencias da Educación, Universidade de Santiago de Compostela, Santiago de Compostela, Spain, [2] Grupo de Aprendizaje y Control del Movimiento Humano, Facultade de Ciencias do Deporte e a Educación Física, Universidade da Coruña, A Coruña, Spain, [3] ATP Entrenamiento Personal, A Coruña, Spain

Objective: COVID-19 caused a complete stop in non-professional sports. The use of face masks for team sports is not a widely used measure in non-professional sports. The study aimed to evaluate the perception about using the mask and the adaptation difficulties related to training and competition in team sports following the FISICOVID-DXTGALEGO protocol.

Methods: Seven hundred eighty-seven handball players from the Galician Handball Federation were followed during their return to participation after months of confinement through an electronic questionnaire of perception and experience on the use of a mask.

Results: There is an excellent adaptation to the mask in training and competition with medium and high correlations. The 86,41% of players reported an adaptation to the mask in 3 weeks with a three times a week training frequency. The negative opinion on the mask was drastically reduced (-66.86%) after use. The 80,44% of players considered the use of a mask as an essential measure to resume competitions.

Conclusions: It is very feasible to adapt to training and compete with a mask (hygienic or surgical) in a short period. The use of a mask following these protocols changed previous opinions on the disadvantages of the mask during training and competition.

Keywords: infectious disease transmission, facemask, public sport policies, perception, COVID-19

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Raul Antunes,
Polytechnic Institute of Leiria, Portugal
Nuno Amaro,
Polytechnic Institute of Leiria, Portugal

***Correspondence:**
Dan Río-Rodríguez
dan@resultadoatp.com

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INTRODUCTION

The practice of amateur sports has been severely affected during the lockdowns due to COVID-19 despite its well-recognized health benefits (Bull et al., 2020; Driggin et al., 2020; Comisión Europea, 2021). Maintaining sports practice during the COVID-19 outbreak is essential due to its effects on the immune system and physical condition, increasing the immune response capacity against the disease (Barker-Davies et al., 2020; da Silveira et al., 2021). However, control over the risk of contagion must be strict (Barker-Davies et al., 2020). Professional sports have returned with high safety investments (DiFiori et al., 2021; Meyer et al., 2021), while amateur and recreational sports suffer from restrictions that will weigh them down for a long time

(Timpka, 2020; Ugbolue et al., 2020). The challenge now is to have specific measures for this group, especially considering young people (OECD, 2020) and women (Pons et al., 2020).

Research and opinion polls reported that most of the population is willing to use the mask (Angus Reid Institute, 2020; Tendencias COFARES, 2020; Yermal, 2020; Taylor and Asmundson, 2021); however, it has not been applied as a widespread solution in sports. In Galicia, the challenge has been met through the FISICOVID-DXTGALEGO protocols (Lete Lasa et al., 2021a,b), from deconfinement to the present. These protocols have established COVID-specific operational measures for all sports federations under the command of the Galician Administration (i.e., mandatory use of mask). Its objective was to create specific measures for each sport through a risk analysis methodology with the participation of all stakeholders, which increases the perception of the risk-security continuum (Stokes et al., 2020; Kemp et al., 2021; Mora-Rodríguez and Melero-López, 2021) and its successful implementation (Prasetyo et al., 2020).

Minimizing the risks (Schweizer and Renn, 2019; United Nations, 2019) was critical even in team sports like handball or soccer, with "brief and sporadic contact" (Randers et al., 2021). Handball is characterized by high intermittent efforts (Karcher and Buchheit, 2014; Wagner et al., 2014), with high demands on the respiratory (Romer and Polkey, 2008; Janssens et al., 2013) system causing fatigue (Wells and Norris, 2009), and therefore, an adaptation period must be considered when practicing with a mask (Santos-Silva et al., 2020).

The use of a mask reduces the probability of contagion and does not cause CO_2 poisoning or O_2 deficiency (Clapp et al., 2020; Steinbrook, 2020; WHO, 2020a). Experts and entities recommend evaluating and determining the use of a mask while training and competing (Kampert et al., 2020; NCAA Sport Science Institute, 2020; SEMED CGCOM, 2020a,b; American Academy of Pediatrics, n.d.; U.S. Centers for Disease Control and Prevention, n.d.), which has been associated with a lower incidence of COVID-19 (Stutt et al., 2020; Watson et al., 2021). An inverse relationship between protection and breathability along the fascemask spectrum (from cloth to N95) (Hamuy Blanco and Janse van Rensburg, 2020; Janse Van Rensburg et al., 2020) that causes discomfort (Scheid et al., 2020). The available data reported a non-relevant clinical impact on health such as cardiorespiratory, physiological (Fikenzer et al., 2020; Shaw et al., 2020; Epstein et al., 2021; Hopkins et al., 2021; Samannan et al., 2021), perceptual (Hopkins et al., 2021), or cognitive (Spang and Pieper, 2020) parameters. The respiratory rate and the activity of the muscles involved are increased (Lavin et al., 2015; Porcari et al., 2016; Chan et al., 2020), CO_2 fluctuations alter the respiratory drive (Patel et al., 2022), and although the CO_2 trapped between the mask and the mouth/nose does not become toxic (Xu et al., 2015), it can trigger an alarm without an actual decrease in available O_2 (Guyenet and Bayliss, 2015). In some people, this available oxygen variation causes anxiety due to hypersensitivity to the increase in CO_2 (Smoller et al., 2014). Thus, the mask for a team sport should leave enough space between it and the mouth/nose (Xu et al., 2015) to fit the face well (Alcamí et al., 2020). It should be either elastic or semi-elastic, without it entering the mouth when breathing while avoiding exposing the nose or chin (Martín Acero et al., 2020). An authorized and certified mask must be employed (Ministerion De Consumo, 2020). The choice of the mask implies that the tolerance of each person is assessed before the normal use of the mask (WHO, 2020b), in addition to adjusting the load at the beginning of use:

- Decreasing the time and/or intensity, and/or increasing the pauses (Johnson, 2016).
- Wait for an adaptation after several weeks (Johnson, 2016).
- Athletes with cardiovascular and/or respiratory health conditions should consult their doctor (Scheid et al., 2020; Epstein et al., 2021).

The coping strategy with stressful events such as COVID-19 is individual due to perceived ability, experiences, and sociocognitive biases (Cheng and Tang, 2004). The last published review of 348 studies in 65 journals of 85 countries on the topic of Non-Pharmaceutical Interventions against COVID-19 reported the inexistence of studies on the adaptation of masks during the practice of a team sport (Perra, 2021). Therefore, this research has been proposed with these main objectives: To evaluate the perception of the use of mask and adaptation difficulties in handball training and competition; to know the influence of perceptual responses regarding gender, age, and sporting experience; and finally, to evaluate the change in perception between the time of training without a mask and after using it. The results of this study will serve to objectively inform the new decision making in the control of contagion risks using a mask without the need to entirely suspend the practice of team sports.

METHODOLOGY

This study is carried out within the FISICOVID-DXTGALEGO methodological process (Lete Lasa et al., 2021a) of the Galician Sports Administration (Secretaría Xeral para o Deporte, Xunta de Galicia) with the Handball Galician Federation, implementing together a COVID-19 specific protocol that identifies the possible routes of contagion in sports situations.

Participants and Recruitment

The whole population of handball players with a federative handball license (4,570 players) was invited for answering the questionnaire. The inclusion criteria were being active players between 9 and 36 years old. At these ages, they regularly competed in Galician handball when the study takes place. A total of 787 active players answered the questionnaire (SE95% = 3.18%), 40.8% women and 59.2% men with a mean age of 17.2 (SD $\pm$ 5.2), of which 62.5% were under 18 years of age, and 37.5% were 18 or over.

Electronic Survey Instrument

The present study examined athletes' self-reported perceptions about using the mask in training and competition contexts. The Galician Sports Administration developed an electronic questionnaire with a group of experts from the university (professor of statistics and research methodology) and health

system (Doctors of the General Directorate of Public Health). The aim was to know athletes' assessment and opinions about the use of masks incorporated into their training routines and competition events and their relationship with health in general. It was pilot tested with 80 handball players not included in this analysis. The time required to complete the questionnaire was 5 min. It was sent to the entire population of Galician handball federated players 12 weeks after starting the sport with masks. After that period, the questionnaire was administered from 31/11/20 to 05/12/20, following the CHERRIES recommendations (Eysenbach, 2004).

The questionnaire consisted of 34 questions divided into five sections for the collection of: sociodemographic and player experience data, frequency of training and sports level (**Table 1**), the impact of the pandemic on the continuity of sports practice, data related to their health that could be related to the use of the mask and finally a section for training and competition on aspects of adaptation to the use of the mask, comfort and perceived effort (**Tables 2**, **3**).

Closed questions with various response categories were mainly used, except when the numerical response was requested for age. In the case of questions related to perception, a Likert-type scale of five levels were used, with 1 being the lowest value and 5 the highest.

Data Analysis

All data analyses were conducted using the Statistical Package for Social Sciences (SPSS 26.0, IBM) with a significance level set at $P > 0.05$. Data were expressed as mean ±SD, or percentages, as appropriate; percentages were used to compare groups. Another non-parametric measure used to explore association in categorical and ordinal variables was Chi-Square performed to analyze gender groups, age groups, and years of practice related to training context variables and competition, mask use, and perception. Kendall's tau-b was used for ordered values.

Ethical Considerations

Deputy Director General of Plans and Programs of the General Secretariat of Sports of the Xunta de Galicia approved all the procedures. Data that would allow personal identification was not requested. The athletes who responded to the questionnaire gave their express written consent; in the case of minors, those who had their guardianship were given the written consent. All participants and managers were informed that the data would be used to improve the work carried out in the face of the COVID-19 pandemic by the Administration regarding the health of athletes and citizens in general in compliance with the seventeenth additional provision of Organic Law 3/2018, of December 5, on Protection of Personal Data and guarantee of digital rights.

RESULTS

Description of Participants

Sports Identification Data

93.77% of the athletes who responded to the questionnaire only practice handball. 71.79% of the athletes surveyed have been practicing the sport for more than 6 years (see **Table 1**),

TABLE 1 | Participants characteristics.

		Sex				Seniority in sport								Self reported respiratory disease				Regular smoker?			
		Female		Male		Less 6 months		6 months–1 year		1–3 years		4–6 years		More than 6 years		No		Yes		No		Yes	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
AGE Groups	Under 18	203	63.24	289	62.02	12	57.14	7	50.00	41	87.23	125	89.29	307	54.34	436	63.19	56	57.73	486	66.76	6	10.17
	+18 years	118	36.76	177	37.98	9	42.86	7	50.00	6	12.77	15	10.71	258	45.66	254	36.81	41	42.27	242	33.24	53	89.83
	Total	321		466		21		14		47		140		565		690		97		728		59	

TABLE 2 | Perception of the mask in handball training.

Do you know that your club/federation is applying a protocol, approved by the Xunta de Galicia, of safety measures against the contagion of COVID-19 in your sports practice?	***n***	**%**
No	7	0.89
Yes	779	99.11
In reference to the use of the mask in your training, indicate the option that best suits your case	***n***	**%**
I don't train with a mask	1	0.13
I train with a mask depending on the context	23	2.92
I always train with a mask	763	96.95
What type of mask do you use to COMPETE?	***n***	**%**
Medical mask	203	25.86
Fabric mask (washable)	45	5.73
Elastic hygienic mask (washable)	98	12.48
Semi-elastic hygienic mask (keep its shape in front of the face—washable)	429	54.65
FFP2/KN95 mask	10	1.27
How many times a week do you train with mask?	***n***	**%**
Once a week	14	1.78
2 times a week	186	23.66
3 times a week	387	49.24
4 times a week	170	21.63
5 times a week	24	3.05
More than 6 times a week	5	64
How long does your workout last on average?	***n***	**%**
Between 30 and 60 min	51	6,49
Between 60 and 90 min	534	67.94
More than 90 min	201	25.57
In your club, team or sports facility: are there rest breaks to breathe without a mask? (keeping the distance of more than 1.5 m)	***n***	**%**
No	190	24.17
Yes	596	75.83
Do you consider that you are already adapted to the use of a mask during training?	***n***	**%**
No	157	21.69
Yes	567	78.31
How many weeks did it take you to adapt to the use of the mask while training?	***n***	**%**
1 week	178	31.39
2 weeks	192	33.86
3 weeks	120	21.16
4 weeks	39	6.88
More than 4 weeks	38	6.70
Before you started wearing the mask in training, WHAT PERCEPTION DID YOU HAVE ABOUT USING IT FOR TRAINING?	***n***	**%**
1 Very negative opinion	193	24.55
2	226	28.75
3	236	30.03
4	75	9.54
5 Very positive opinion	56	7.12
CURRENTLY, how do you feel TRAINING with a mask (COMFORT)?	***n***	**%**
1 Very uncomfortable	73	9.29
2	108	13.74
3	251	31.93
4	268	34.10
5 Very comfortable	86	10.94
In your training, using the mask do you perceive that your BREATHING (VENTILATION) is negatively altered...?	***n***	**%**
1 Heavily altered breathing	47	5.98
2	190	24.17
3	230	29.26
4	218	27.74
5 Unchanged breathing	101	12.85
Using the mask: do you perceive MORE OR LESS EFFORT in TRAINING?	***n***	**%**
1 Less effort	13	1.7
2	51	6.5
3	225	28.8
4	305	39.0
5 More effort	188	24.0
Do you think that wearing a mask during training can negatively affect your health?	***n***	**%**
No	495	68.37
Yes	229	31.63
How much do you think can negatively affect your health?	***n***	**%**
1 Nothing at all	4	1.75
2	26	11.35
3	89	38.86
4	76	33.19
5 Very much	34	14.85

85.39% of the athletes stopped doing physical exercise during the period between the declaration of the state of alarm, and 92.28% returned to participation in sport.

Description of Use and Perception of the Mask in Handball Training

Considering the distribution by gender, significant differences were found between women and men considering the training variables. The percentage distribution of responses for all questions can be found in **Table 2**. Regarding the type of mask used, χ^2 (4, $N = 785$) = 19.913, $p \leq 0.01$, 34.06% of the women used the medical mask compared to 20.22% of the men, and 58.71% of the men used the semi-elastic hygienic mask, compared to 48.75% of the women. The number of sessions per week, χ^2 (5, $N = 786$) = 23,732, $p \leq 0.0.001$, were 3 in 50.78% of men and 48.75% of women; the mean duration of the sessions, χ^2 (2, $N = 786$) = 6.319, $p \leq 05$, was 60 and 90 min in 72% of women compared to 64.95% of

TABLE 3 | Description of use and perception of the mask in competition.

Mostly you compete at the level of		
Regional competitions (only within galicia)	604	90.28
National competitions (in galicia and/or outside galicia)	65	9.72
Do you wear the mask in competition?	***n***	**%**
No	18	2.69
Yes	651	97.31
Do you use a different type of mask training compared to competing?	***n***	**%**
Different mask	729	92.63
Same mask	58	7.37
What type of mask do you use to COMPETE?	***n***	**%**
Basic surgical type mask	4	0.61
Hygienic cloth mask (washable)	8	1.23
Elastic hygienic mask (washable)	73	11.21
Semi-elastic hygienic mask (keep its shape in front of the face—washable)	565	86.79
FFP2/KN95 mask	1	0.15
CURRENTLY, how do you feel COMPETING with a mask (COMFORT)?	***n***	**%**
1 Very uncomfortable	68	10.45
2	119	18.28
3	236	36.25
4	194	29.80
5 Very comfortable	34	5.22
In your competition, using the mask do you perceive that your BREATHING (VENTILATION) is negatively altered...?	***n***	**%**
1 Heavily altered breathing	24	3.69
2	125	19.20
3	227	34.87
4	189	29.03
5 Unchanged breathing	86	13.21
Using the mask: do you perceive MORE OR LESS EFFORT in COMPETITION?	***n***	**%**
1 Less effort	5	0.77
2	37	5.73
3	182	28.17
4	277	42.88
5 More effort	145	22.45
Since you used the mask IN THE COMPETITION. has your opinion about using it in THESE ACTIVITIES changed?	***n***	**%**
A lot worse	29	4.45
Much worse	86	13.21
It did not vary	277	42.55
Much better	250	38.40
A lot better	9	1.38
How important do you think the mask was to resume competition and continue competing?	***n***	**%**
1 Not important	26	3.56
2	21	2.87
3	96	13.13
4	138	18.88
5 Very important	450	61.56

men. Considering the perception of the use of the mask in training, with respect to the perceived global effort, χ^2 (4, $N = 782$) = 12.188, $p \leq 0.05$, 66.09% of the men valued that it was more, or something more than effort compared to 58.62% of women.

Considering the distribution by age in the two established categories of under 18 years (−18) or 18 years and older (+18) in the context of training, significant differences were found between the athletes of (+18) and those of (−18) in relation to the type of mask used, χ^2 (4, $N = 785$) = 19.391, $p = 0.001$, 64.16% of (+18) used the semi-elastic hygienic mask compared to 48.89% of the (−18 the number of sessions per week who trained with a mask, χ^2 (5, $N = 786$) = 26.069, $p \leq 0.001$, were 3 in 54.08% of (+18) vs. 46, 34% of (−18); mean duration of the training sessions with a mask, χ^2 (2, $N = 786$) = 18.205, $p \leq 0.001$, between 60 and 90 min, 70.07% of the athletes of (+18) trained compared to 66.67% (−18), considering the perception of adaptation to the mask, χ^2 (1, $N = 724$) = 14.020, $p \leq 0.001$, the percentage of (−18) (82.65%) was >70.72% of those of (+18). Regarding the number of weeks required to adapt to the use of the mask, χ^2 (1, $N = 567$) = 10.880, $p \leq 0.05$, the (+18) presented higher percentages than the (−18) in 2, 3 and 4 weeks in the perception prior to starting training with a mask, χ^2 (4, $N = 786$) = 18.398, $p = 0.001$, the percentages of (+18) were higher in negative evaluations, and much compared to (−18) that were higher than (+18) in the intermediate evaluations and on the perception of whether the use of the mask while training negatively affects their health, χ^2 (1, $N = 724$) = 6.905, $p \leq 0.05$, 71.80% of the group of (−18) considered that it does not affect them negatively, compared to 62.36% of the group (+18).

The distribution of the responses for the of use and perception of the mask in competition can be found in **Table 3**. A Kendal's tau-b correlation was run to determine the relationship between participants' previous mask perception for competition, and competition participants comfort wearing mask perception, harmful disturbance of breathing, and general perception of effort during training using a mask. Positive, weak associations were found between previous mask perception for sports practice (training and competition) and participant mask comfort perception in competition context ($\tau_b = 0.256$, $p \leq 0.001$), which was statistically significant. Negative, weak associations were found between previous mask perception for sports practice (training and competition) and harmful disturbance of breathing ($\tau_b = -182$, $p \leq 0.001$), and general perception of effort during training ($\tau_b = -155$, $p \leq 0.001$), both statistically significant. A double-entry table comparing previous users mask perception with the current perception of adaptation can be found in **Table 4** shows that despite the previous perception, the current majority situation is to be adapted to the use of mask in competition.

Medium and high correlations were found between the same variables in training and competition situations for the use of the mask: Comfort (Kendall's Tau-b = 0.588, $p < 0.0001$) Breathing (Kendall's Tau-b = 0.626, $P < 0.0001$), Effort (Kendall's Tau-b = 0.672, $p < 0.0001$) and Change of Opinion after use (Kendall's Tau-b = 0.838, $p < 0.0001$).

TABLE 4 | Double-entry table comparing previous users mask perception with the current perception of adaptation.

Before you started wearing the mask in training, WHAT PERCEPTION DID YOU HAVE ABOUT USING IT DURING TRAINING?	1		2		3		4		5		χ^2	p
	n	%	*n*	%	*n*	%	*n*	%	*n*	%		
Do you think that you are already adapted to its use?												
No	67	36.4	46	22.7	31	14.3	5	7.0	8	16.3	40.404	0.000
Yes	117	63.6	157	77.3	186	85.7	66	93.0	41	83.7		

DISCUSSION

This is the first study on a sport where the mask is mandatory for all practitioners. The study aimed to evaluate the perception of masks and adaptation difficulties in handball training and competition. The main results show an excellent adaptation to the mask in training and competition with medium and high correlations. The vast majority adapted to the mask in 3 weeks with training frequencies of 3 times a week.

Perception and Time Until the Mask Adaptation in Sport

Wearing a mask while doing sports produces discomfort. Although it has a specific effect on ventilation, effort and perception, our results showed a more significant increase (39.8%) in positive than negative opinion (17.7%) after continuous use in training and Handball competitions of 12 weeks on average. These results are very positive even though handball is trained and competed indoors, which significantly increased perceived discomfort (Liu et al., 2020).

Our results on adaptation are similar between female and male athletes in training and competition. Most athletes were able to adapt to the mask's sporting use in 3 weeks with an average of 3 workouts per week. These results are in line with other studies (Santos-Silva et al., 2020), for example, when the differences when performing an aerobic effort in a group were analyzed of athletes with a restrictive mask (EG) and a control group (CG) without a mask, reaching the EG to equal the CG workload after 3 weeks with cardiorespiratory (Porcari et al., 2016) adaptation. This study also reported an increase of 1.5–2 points on a perceived exertion scale (RPE), which is very similar to other studies (Kido et al., 2013) and in line with our results where 60% of athletes both in training and in competition reported an increase in perceived effort.

Social Environment and Acceptance of the Use of the Mask

More than 80% of the athletes questioned considered the masks as totally necessary for returning to the practice of their sport. Before their return to participation, previous expectations of athletes with more years of experience had a somewhat more negative perception than those with fewer years of practicing that sport. Our results show the importance of knowing athletes' attitudes before using the mask in their practice since a significant association has been found concerning the perception and assessment of their experience after using it, training and competing. Regardless, the perception of 40% of the athletes improved after regular use. The Galician sports administration has worked together with all the stakeholders to ensure the human factor contributed so that the adopted measures could be accepted and effective (Lete Lasa et al., 2021a).

Our results reinforce the need to create an informed and positive environment (Bhatt et al., 2020; Kasting et al., 2020;

Stokes et al., 2020), thus avoiding resistance to using a mask due to lack of comfort avoiding the delay in its proper use, as showed athletes' opinions on the necessity of the specific measures. Regarding the use of a mask, the population's opinion is different depending on the context. A positive majority opinion has been identified in Spain (GTM, 2020; Tendencias COFARES, 2020) between 18 and 25 (74.2%). However, negative attitudes toward masks found in the US and Canada formed a network (Taylor and Asmundson, 2021). The central nodes were first to believe that masks were not effective, which is in line with other studies in the US and UK. In these studies, respondents who considered masks as an effective measure did not exceed 40% (Bhatt et al., 2020; Geldsetzer, 2020; Kasting et al., 2020; Samannan et al., 2021). Thus, a node of psycholgical to facemasks reactance was conformed due to mandatory use (Taylor and Asmundson, 2021). In the USA (Pierce et al., 2020), more than 10,000 parents of athletes were surveyed in 45 states, from 13 sports, resulting in perception favoring masks of only 24.3% and against 33%. The sports managers of Galicia significantly improved their ability to identify and perceive the risk of contagion and declared high satisfaction with the participatory methodology FISICOVID-DXTGALEGO (Lete Lasa et al., 2021b). In China, it was also found that cultural differences and people's perception styles include their ability to cope with stressful events related to COVID-19 (Cheng and Tang, 2004), so it is reasonable to think that there are athletes with different styles of coping with stress in the face of stress. COVID-19 (Lete Lasa et al., 2021b), there may also be different response levels to sports mask use.

Practitioners: Difficult Return to Sports Participation

In Galicia, the pandemic suspended the sporting activity of contact sports for about 6 months, which, together with the uncertainty, was foreseeable that it would cause the participants to either change their sport (Choi and Bum, 2020) or abandon it. The efforts of all socio-sports agents have allowed the maintenance of 55% of Handball practitioners in Galicia. Forty-Nine percentage of those under 18 years of age have returned, a percentage expected by the federative managers of Galicia (Lete-Lasa et al., 2020). Maintaining this number of practitioners during crisis (Brooks et al., 2020) is due to their motivation and because 99% of athletes have and know the FISICOVID_DXTGALEGO protocol. This has highlighted the continuum of risk and safety perceived by families and athletes. Exiting the restrictions caused by COVID-19 is a challenging and essential success that means recovering and stopping the abandonment of the practice of physical-sporting activity, with the associated physical, psychological and emotional benefits associated with it (Hughes, 2020). While in the neighboring country of Portugal, the most popular team sports (handball, basketball, soccer/football, futsal, roller hockey) have retained only the 20.9% of athletes in early ages of sports training (Barbosa, 2020).

PRACTICAL APPLICATIONS

The following practical applications are extracted from our results:

- The participation of stakeholders in the protocols is necessary for better compliance with the rules.
- It is feasible to adapt to training and competition quickly with a mask.
- Considering the 3 weeks necessary for adaptation to the mask, Starting with shorter periods of effort than regular training and competition would be advisable, reaching a greater number of practitioners with a favorable opinion.

LIMITATIONS

Although athletes were instructed to use multiple masks if the current one was too wet, it wasn't controlled and this might affect the perception of athlete's adaptation to the mask. Also humidity and temperature of the pavilion were not controlled. This issues should be considered in future investigations on this subject.

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. Written informed consent to participate in this study was provided by the participants or participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

JR-D and his collaborators managed data collection. JG-V and RM-A performed data analysis and interpretation. RM-A and DR-R prepared the draft of the article. All authors equally contributed to the design of the study, performed critical revision, and final approval. All authors contributed to the article and approved the submitted version.

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BRIEF RESEARCH REPORT
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Barriers to Physical Activity in Spanish Children and Adolescents: Sex and Educational Stage Differences

José Manuel Delfa-De-La-Morena[1], *Daniel Bores-García*[1,2*], *Adrián Solera-Alfonso*[1] and *Nuria Romero-Parra*[1,3]

[1] Department of Physiotherapy, Occupational Therapy, Physical Medicine and Rehabilitation, Rey Juan Carlos University, Móstoles, Spain, [2] Research Group of Humanities and Qualitative Research in Health Science, Rey Juan Carlos University, Madrid, Spain, [3] LFE Research Group, Department of Health and Human Performance, Faculty of Physical Activity and Sports Science, Universidad Politécnica de Madrid, Madrid, Spain

According to worrisome childhood obesity and inadequate physical activity (PA) levels worldwide, especially exacerbated in adolescents girls, this work aimed to identify sex and educational stage differences in barriers to meet PA requirements and international guidelines in Spanish children and adolescents considering the entire educational pathway (primary, secondary, and college). The Short Form of the International PA Questionnaire and the Scale of Perceived Barriers were administered to primary, secondary, and college education students (13,491 boys and 13,238 girls, 9–19 yrs). Two-way ANOVA was performed to analyze barriers to PA according to sex and educational stage with physical status as covariate. Higher disliking and time barriers were reported by females (1.5 ± 1.2 and 3.2 ± 1.5 points) in comparison to males (1.2 ± 1.0 and 2.8 ± 1.4), while primary students showed lower disliking and time (1.2 ± 1.0 and 2.8 ± 1.5) and higher safety (3.1 ± 1.8) constraints in comparison to secondary (1.4 ± 1.1, 3.1 ± 1.4, and 2.8 ± 1.7) and college (1.5 ± 1.2, 3.2 ± 1.5, and 2.8 ± 1.6; $p < 0.05$ for all comparisons). College females showed higher disliking (1.7 ± 1.2) and time (3.5 ± 1.4) barriers than secondary females (1.5 ± 1.2 and 3.3 ± 1.4; $p < 0.05$). Sex and educational stage were determinant for time and dislike of PA barriers, which were rated higher by female students in comparison to their male counterparts and from primary education onwards. Altogether this, suggests promotion strategies should carefully consider girls and the step into secondary school.

Keywords: MVPA, exercise, inhibitors, high-school, kids

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Víctor Arufe Giráldez, University of A Coruña, Spain

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Cassiano Ricardo Rech, Federal University of Santa Catarina, Brazil
Rui Paulo, Instituto Politécnico de Castelo Branco, Portugal

***Correspondence:**
Daniel Bores-García
daniel.bores@urjc.es

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INTRODUCTION

A growing body of evidence shows the benefits of regular physical activity (PA) (Poitras et al., 2016; Biddle et al., 2019) and the negative effects of sedentary lifestyles. In fact, PA abandonment at an early age have potential repercussions throughout the lifespan and even shorten the years of life (Pinheiro Gordia et al., 2015). Unfortunately, inadequate levels of PA have been observed among adolescents (Kurdaningsih et al., 2016). There are currently more than fifty national and international guidelines on the type, intensity and frequency of PA recommended for each age group (Parrish et al., 2020), being those of the World Health Organization (WHO) the best known and globally recognized (Bull et al., 2020). According to these recommendations adolescents should

engage in at least 60 min of mostly aerobic PA of moderate to vigorous intensity per day (MVPA), in addition to strength training 3 days per week. However, the reality is that more than 77% of boys and 84% of girls in adolescence worldwide show insufficient levels of PA in relation to these international guidelines (Palou et al., 2019; Guthold et al., 2020) with higher percentages in populations belonging to lower socioeconomic strata (Martins et al., 2021).

This trend, which has been growing in recent decades, has generated a serious public health problem due to the increase in diseases and problems related to overweight and obesity (Vasquez et al., 2021). Spain is one of the countries in the world with the highest rates of childhood overweight (20.7%) and obesity (14.2%) with an increase of two percentage points in the last two decades (Gómez et al., 2020; Mendoza-Muñoz et al., 2020). The factors that most hinder the practice of regular PA are the lack of time (Calogiuri and Chroni, 2014; Chacón-Cuberos et al., 2017; Jodkowska et al., 2017; Rodrigues et al., 2019; Alves et al., 2021), economic cost (Rodrigues et al., 2019), overuse of technologies (Divyasree et al., 2018; Harvey et al., 2018), lack of energy and willpower (Jodkowska et al., 2015, 2017; Rosselli et al., 2020), lack of family and institutional support (Stanley et al., 2012; Alsubaie and Omer, 2015; Vasquez et al., 2021), or shortage of accessible sports facilities (Alsubaie and Omer, 2015; Divyasree et al., 2018; Marconnot et al., 2019).

Regarding sex and age differences, girls seem to be more prone to inactivity than boys, reporting a gender imbalance in the sports offer and in the policies for the promotion of physical activity, more oriented to the male population (Madsen et al., 2009; Guthold et al., 2020; Rosselli et al., 2020). In addition, a gradual decline in PA levels has been observed in the transition from primary school to adolescence, mainly due to changing priorities in the use of leisure time, increased academic demands and a lack of motivation to engage in physical activity when the social relationships involved are not sufficiently satisfactory (Dumith et al., 2011; Jago et al., 2012; Van Hecke et al., 2016). This pattern of higher levels of PA practice in boys has also been observed in Spanish adolescents (Sánchez-Miguel et al., 2017), being the most decisive barriers to PA practice the lack of time, the participation in leisure activities to which they give a privileged position with respect to PA and the lack of motivation due to the imposition of unchosen activities. Additionally, girls reported concerns about body image and diet in relation to PA (Fernández-Prieto et al., 2020). However, after a thorough review of the literature, no studies in the Spanish population have researched on these sex and age differences in barriers to PA with representative samples of children and adolescents from different grades of the educational system (primary to college). We hypothesized that female students rate higher the barriers to meet PA levels, especially the time-related ones, than males, being these barriers accentuated from the adolescence period. Therefore, the purpose of the present study was to identify sex and educational stage differences in the existing barriers to PA in children and adolescents from 5th grade of primary school to 2nd grade of college.

METHODS

Participants and Study Design

Participants from all stages within the entire educational pathway (primary, secondary, and college) were recruited from different schools of Madrid Region to participate in this cross-sectional study. Madrid Region is located in the center of Spain and is the 3rd most populated region of the country out of 17 regions, with 6.8 million inhabitants, being the total population of Spain 47.4 million inhabitants. However, within the region, a wide range of population levels is present, which makes the sample representative of either overpopulated urbanized areas or underpopulated rural areas commonly found in Spain. Inhabitants' information from the different areas of Madrid where data were collected are presented in **Table 1**. Levels of MVPA and barriers to PA were examined in a total of 26,729 students, with a balanced distribution by sex (13,491 boys and 13,238 girls), from 5th and 6th levels of primary school (n = 11,122, 11.7 ± 1.9 years), 1st, 2nd, 3rd, and 4th levels of secondary school (n = 12,379, 14.5 ± 2.0 years) and 1st and 2nd levels of college (n = 3,228, 17.6 ± 2.3 years). Participants were classified as non-active (n = 17,803) or active (n = 8,926) considering the accomplishment of 60 min per day of MVPA according to WHO guidelines (Bull et al., 2020). An informative introductory letter was sent to all schools of Madrid Region and those volunteered to accept participated in the study. Participants and their parents when appropriate were asked to read and sign a consent form. All procedures complied with the Declaration of Helsinki and were approved by the Universidad Rey Juan Carlos ethics committee board (registration number 1306201809818).

Instruments

The International Physical Activity Questionnaire Short-Form (IPAQ-SF) was used to evaluate PA levels (Craig et al., 2003). The instrument was developed to provide cross-national information of PA, and this short form showed acceptable reliability and validity getting more acceptance between both investigators and respondents (Craig et al., 2003). It, has been previously administered in children and adolescents (Pandolfo et al., 2016; Brand et al., 2017; Duncan et al., 2017; Sánchez-Miguel et al., 2017) and it has been validated in Spanish population (Roman-Viñas et al., 2010; Román Viñas et al., 2013).

To assess perceived barriers the instrument used was the Scale of Perceived Barriers (Chinn et al., 1999) which has been previously used in Spanish population (Zaragoza et al., 2011). Prior to completing the questionnaire, participants were provided with the definition of barriers toward PA as factors that may prevent an individual from being physically active. The questionnaire consisted of 17 items preceded by the sentence "*How much of a problem are the following reasons for you to do physical activity?*". Each item's response was graded on a Likert scale from 0 being "no problem at all to perform PA" (and hence no barrier was considered), to 6 meaning "a reason that is very likely to prevent PA from being performed". The 17 items were grouped into four categories or constructs whose internal

TABLE 1 | Inhabitants per area in Madrid Region.

	Inhabitants	
Area	***N***	**Mean ± SD**
City center	6,315	166386.5 ± 53901.4
North	2,732	76437.4 ± 32708.3
South	6,165	145462.9 ± 64767.0
East	2,400	109453.7 ± 67232.2
West	3,595	54566.2 ± 26091.9
Nordwest	304	7762.2 ± 4856.6
Southwest	1,699	14873.4 ± 12031.8
Southeast	972	34255.3 ± 38409.7
Central M.	1,643	10966.3 ± 4575.9
Northern M.	610	3543.2 ± 1957.0
Southern M.	294	3223.8 ± 2103.3
Avg	26,729	100910.7 ± 75509.1

Avg, average; M, mountains.

reliability was previously assessed (Cronbach's Alpha values ≥ 1.0 were retained and a factor loading cutoff of 0.45 were considered to be significant; Zaragoza et al., 2011): Disliking physical activity with 8 items (e.g., *"Not good at physical activity and sports")*, Time constraints with 4 items (e.g., *"I have too much school work"),* Safety reasons with 2 items (e.g., *"Physical activity outdoors is not safe"*) and Environmental/contextual reasons with 3 items (e.g., *"I don't have the right equipment"*).

Statistical Analysis

Data are presented as mean ± SD. The statistical analysis was conducted using the software package SPSS for Windows, version 27.0 (IBM Corp, Armonk, NY). A Kolmogorov-Smirnov test for normality was used. Two-way ANOVA (sex × stage) was performed to examine MVPA. A *t*-test was performed to compare differences in barriers to PA between non-active and active participants. Two-way ANOVA (sex × stage) was performed to analyze barriers toward PA practice but using individuals non-active or active status as covariate for environmental and disliking domains since differences between these two groups were observed from the *t*-test. Where appropriate, the Bonferroni *post-hoc* test was applied to examine pairwise comparisons of each significant factor. The ES was calculated by partial eta-squared (η_p^2) which was interpreted based on the following: small, moderate, and large effect for values greater than 0.010, 0.059, and 0.138, respectively (Cohen, 2013). The alpha level was set at $p < 0.05$.

RESULTS

Effects of sex [$F_{(1, 26)} = 634.14$, $p < 0.001$, $\eta_p^2 = 0.023$], educational stage [$F_{(2, 26)} = 28.10$, $p < 0.017$, $\eta_p^2 = 0.002$] and interaction [$F_{(2, 26)} = 28.10$, $p < 0.032$, $\eta_p^2 = 0.001$] between both factors were observed for MVPA levels, indicating that boys perform more min of PA (58.6 ± 45.9 min) than girls (43.4 ± 38.7 min), in each educational stage (primary: 60.1 ± 47.0 and 46.4 ± 40.0; secondary: 57.8 ± 44.9 and 41.7 ± 33.6; college: 56.7 ± 45.9 and 39.6 ± 37.7 min, respectively, for males and females) being the primary school the stage with more active students (53.3 ± 44.2 min) in comparison to secondary (49.9 ± 42.3 min) and college (48.0 ± 42.8 min).

Barriers results include data from participants indicating the presence of barriers (punctuation > 0 in the questionnaire). Results from *T*-tests revealed higher values for Environmental and Disliking barriers ($t = 6.80$ and $t = 28.87$, respectively, $p < 0.001$ for both comparisons) in non-active (1.7 ± 1.2 and 1.5 ± 1.2 points, respectively) vs. active (1.6 ± 1.2 and 1.0 ± 0.9 points) participants. No differences were observed for Safety and Time domains between non-active (1.7 ± 1.2 and 1.5 ± 1.2 points) and active (1.7 ± 1.2 and 1.5 ± 1.2 points) students ($p > 0.05$). Hence, being non-active or active was used as covariate to explore differences in Environmental and Disliking barriers to PA according to sex and educational stage.

Results and main effects of sex, stage, and interaction between both variables are presented in **Table 2**. The covariate "non-active vs. active" based on the accomplishment of the 60 min of MVPA resulted significant for both Environmental and Disliking barriers with η_p^2 values 0.003 and 0.025, respectively ($p < 0.001$ for both domains).

DISCUSSION

The aim of this study was to identify sex and educational stage differences in the barriers to PA in children and adolescents from 5th grade of primary school to 2nd grade of college. The major finding was, on one hand, that female children and adolescents report higher disliking and time barriers to PA than their male counterparts in the entire educational pathway.

Our results showed no effect of sex on environmental and safety barriers, which contrasts with a previous study indicating greater environmental barriers for girls (Jongenelis et al., 2018). Greater disliking and time barriers observed in females could be between the underlying reasons for the higher levels of MVPA observed in boys at all educational stages in comparison to girls, which is in accordance with the existing literature (Madsen et al., 2009; Fernández et al., 2017; Guthold et al., 2020; Rosselli et al., 2020). Previous studies have also observed that girls report more barriers to PA than boys (Jodkowska et al., 2015; Rosselli et al., 2020; Lazarowicz et al., 2021). Specifically, within disliking reasons, the lack of skills is one of the major barriers reported by girls (Jodkowska et al., 2015). Low perceive competence is even more exacerbated in overweight girls and may be affected by the pressure to perform well in team sports, and altogether with fear of criticism and embarrassment, especially in the presence of males, hold a negative attitude toward exercise and act as a barrier for girls to participate and attempt new activities (Jodkowska et al., 2015; Corr et al., 2019; Cowley et al., 2021). Another major reason within disliking barriers highly stated in girls is tiredness or lack of energy and willpower (Fernández et al., 2017; Rosselli et al., 2020). In fact, a previous study indicated that the greater the distance from classroom to schoolyard facilities the greater recess in schoolyard PA, especially in older girls

TABLE 2 | Barriers to PA according to sex and educational stage.

							Main effects		
		Primary	Secondary	College	Avg		Sex	Stage	Sex*Stage
Environmental	Males	1.65 ± 1.22	1.69 ± 1.20	1.68 ± 1.19	1.67 ± 1.21	$F =$	1.425	0.537	0.093
	Females	1.71 ± 1.25	1.73 ± 1.25	1.72 ± 1.20	1.72 ± 1.24	$p =$	0.233	0.584	0.911
	Avg	1.68 ± 1.23	1.71 ± 1.23	1.70 ± 1.19	1.70 ± 1.23	$\eta_p^2 =$	0.001	0.001	0.001
Disliking	Males	1.11 ± 0.97[§]	1.21 ± 1.04[§,*]	1.26 ± 1.03[§,*]	1.18 ± 1.01[#]	$F =$	227.945	76.114	11.851
	Females	1.31 ± 1.10	1.54 ± 1.19*	1.67 ± 1.22[†,*]	1.47 ± 1.17	$p =$	**<0.001**	**<0.001**	**<0.001**
	Avg	1.22 ± 1.05	1.38 ± 1.13*	1.48 ± 1.15[*,†]	1.33 ± 1.10	$\eta_p^2 =$	0.010	0.007	0.001
Safety	Males	3.03 ± 1.84	2.82 ± 1.75	2.80 ± 1.69	2.91 ± 1.78	$F =$	0.858	24.524	0.035
	Females	3.07 ± 1.81	2.86 ± 1.70	2.82 ± 1.65	2.94 ± 1.73	$p =$	0.354	**<0.001**	0.966
	Avg	3.05 ± 1.83	2.84 ± 1.71*	2.80 ± 1.66*	2.92 ± 1.76	$\eta_p^2 =$	0.001	0.004	0.001
Time	Males	2.65 ± 1.43[§]	2.91 ± 1.42[§,*]	2.94 ± 1.45[§,*]	2.81 ± 1.44[§]	$F =$	324.550	225.891	18.920
	Females	2.88 ± 1.49	3.33 ± 1.44*	3.48 ± 1.43[†,*]	3.16 ± 1.48	$p =$	**<0.001**	**<0.001**	**<0.001**
	Avg	2.77 ± 1.47	3.12 ± 1.45*	3.22 ± 1.46[*,†]	2.99 ± 1.47	$\eta_p^2 =$	0.013	0.016	0.002

PA, physical activity; Avg, average. [§]*Different from females ($p < 0.001$);* [#]*Different from females ($p = 0.017$);* [*]*Different from Primary ($p < 0.001$);* [†]*Different from Secondary ($p < 0.001$). Bold values are the main effects of the dependent variables.*

(Pawlowski et al., 2019). Both, lack of skills and tiredness are items included in the disliking barriers group provided by the questionnaire used in our study. However, we have not evaluated the weight of the different items in the entire disliking barriers group, which should be considered in future studies. In fact, tiredness together with body image reasons have been considered the most relevant perceived barriers to perform PA, especially in females (Fernández et al., 2017). Previous research has suggested that girls feel a pressure to look good when exercising and reluctance to sweat and wear not-fitting uniforms, altogether results in serious barriers to participation (Rosselli et al., 2020; Cowley et al., 2021; Duffey et al., 2021). In this regard, despite being previously validated, our questionnaire did not include body image items, which may be considered as a limitation and should also be addressed in future studies. Interestingly, in our Spanish sample, disliking barriers resulted less rated than time barriers which may be related to the increase in school workload or even in home responsibilities (Corr et al., 2019; Duffey et al., 2021). This seems to especially affect females, since in the same way as it occurs with disliking reasons, female students in our study reported greater time barriers than their male counterparts, which agrees with other studies (Rosselli et al., 2020; Lazarowicz et al., 2021). A reason that literature states is the change in leisure activities, especially girl's desire to do different things like shopping or hanging out with friends instead of being physically active (Corr et al., 2019; Rosselli et al., 2020). Another reason suggested is the remaining socio-cultural pattern of increased home duties and household work in girls in comparison to boys (Lazarowicz et al., 2021). There were also studies showing no sex differences in time barriers (Fernández et al., 2017) or even no sex differences in the perception of any barriers (Gunnell et al., 2015). However, it is important to highlight that all these findings are not entirely comparable with ours since neither the educational stages nor the range of student ages evaluated nor the perceived barriers questionnaire used were the same.

On the other hand, in terms of differences among educational stages, primary school turned out to be the most active educational stage in comparison to the other two stages, which is in accordance with previous studies (Dumith et al., 2011; Jago et al., 2012; Van Hecke et al., 2016), and likewise, in disliking, safety and time barriers there were differences from primary school to the other two educational stages. Both time and disliking barriers were more prevalent among secondary and college students than among primary school students. The lack of time has been shown as a recurrent barrier for both girls and boys, especially in secondary and college stages (Calogiuri and Chroni, 2014; Jodkowska et al., 2017; Divyasree et al., 2018) being the increasing workload and academic demands suggested as the main reasons (Harvey et al., 2018) while greater disliking barriers from primary school onwards have been observed by previous authors (Jodkowska et al., 2015; Payán et al., 2019) and could be due to a decrease in motivation to PA in the transition from childhood to adolescence (Martins et al., 2015) and a preference for other non-physically active but more social activities (Corr et al., 2019; Rosselli et al., 2020). In contrast, the safety barrier resulted higher in primary school than in later stages. These results may be easily explained by the gradual disappearance of misgivings about outdoor PA as children grow older and their families give them greater autonomy and greater levels of responsibility for moving around on their own and managing their time, although authors such as Marconnot et al. (2019) and Vasquez et al. (2021) continue to mention this barrier among older adolescents, with lesser extent than among primary school students though. Finally, the two barriers showing interaction between sex and educational stage are the lack of time and dislike of PA practice. Both barriers are perceived more strongly by girls than boys, although both sexes mention these barriers more frequently in adolescence than in childhood, which is in accordance with previous studies (Jodkowska et al., 2017; Divyasree et al., 2018). In the college period, only girls reported further increased barriers of time and dislike for PA practice in

comparison to secondary. In this regard, the above stated ideas regarding greater tiredness in older girls and their interest in other activities different from PA for their leisure time could explain our result (Jodkowska et al., 2015; Corr et al., 2019; Rosselli et al., 2020; Cowley et al., 2021; Duffey et al., 2021; Lazarowicz et al., 2021).

Finally, some limitations should be stated. First of all, the use of subjective self-reported instruments may elicit errors related to respondent recall or desirability bias. Moreover, the use of different questionnaires in literature (Niñerola et al., 2006; Rosselli et al., 2020) despite being all validated and reliable, result in different items and barrier groups evaluated, thus impairing an accurate comparison of findings. Indeed, as previously mentioned, our study did not include body centered issues (Fernández et al., 2017), but either items related to peers, family and friends support (Dishman et al., 2017; Corr et al., 2019; Mehtälä et al., 2020; Cowley et al., 2021) or items related to screen-based recreation very present in adolescents' life nowadays (Jongenelis et al., 2018; Mehtälä et al., 2020). Therefore, to elaborate a more comprehensive questionnaire, more connected with current adolescent population should be interesting for future studies. Additionally, differences in educational systems worldwide in terms of stages and grades should be cautiously considered when different countries are compared to determine if differences in barriers to PA (e.g., time barriers), are more depending on higher workload associated to the educational stage or they are more related to psychosocial processes associated to age development.

In terms of applicability, the results obtained in the present study should encourage the reflection on the policies that should be carried out from health and educational spheres, in order to reduce the time and displeasure-related barriers to PA, especially in adolescent girls. Strategies should increase the opportunities to practice sport regardless of educational stage and sex, taking into account the specific needs and demands of each population group in order to provide an adapted response to them. Close collaboration between the education administration and physical activity promoters is needed for proper time management, given the proven evidence of the benefits associated with daily physical activity.

CONCLUSION

Throughout the different educational stages of the Spanish Educational System, the main sex differences in barriers to PA are the lack of time and dislike of PA which female students rated higher than their male counterparts. In addition, a gradual decrease or abandonment of PA is observed from primary school onwards, likewise more accentuated in females. These findings may suggest that Spanish PA promotion strategies should carefully consider girls and the step into secondary school.

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 de Ética de la Universidad Rey Juan Carlos. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

JD-D-L-M: conception and design of the study. JD-D-L-M, DB-G, and AS-A: data collection. NR-P: data analyses and interpretation. DB-G and NR-P wrote the initial draft. All authors critically reviewed the content and approved the final version.

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REVIEW
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A Bibliometric Analysis on Motivation Between 2016 and 2020 of Physical Education in Scopus Database

Chi-Jung Chen[1], *Hung-Ying Lee*[2,3]*, *Ren-Jie Lin*[4] *and Jenn-Kuen Farng*[2]*

[1] Chung Cheng Armed Forces Preparatory School, Kaohsiung, Taiwan, [2] Department of Ball Sports, University of Taipei, Taipei, Taiwan, [3] Department of Physical Education and Sport Sciences, National Taiwan Normal University, Taipei, Taiwan, [4] Department of Education, National Taichung University of Education, Taichung, Taiwan

Purpose: In the field of physical education (PE), which encompasses a wide range of variables, the question of motivation has become increasingly important. The bibliometric methods can help researchers and educators understand the related research of motivation. The purpose of this study was to explore the bibliometric characteristics of motivation in the field of PE from 2016 to 2020 that try to discover the related research context and topics.

Methods: By using the keywords "motivation" and "physical education," the bibliographic records and references have been retrieved from the Scopus databases (date of search: September 7, 2021). The Vosviewer software tool and Bibliometrix R package were used for information analysis and visualization. The themes include the annual publication, countries/regions, journals, authors, co-occurrences, and theme trends. Finally, it is presented with the characteristics of the big picture of bibliometrics.

Results: From the analysis of the above theme, this study showed that there were 623 studies published over the 5 years, with the number gradually increasing in 2017 and peaking in 2020. The number of citations was the highest in 2016. In terms of total publications, Spain, the United States, and Australia are the top three countries/regions. Most of the articles were published in sport pedagogy and public health relevant journals. The four main research directions were identified: Education, activity, health, and self-determination theory.

Conclusion: This study helped us to comprehend the consistent publishing and rapid development of motivation in PE research. Via the bibliometric analysis, we can also incorporate previous research and predicted trends. All these works can help us to understand the basic psychological needs, leadership styles, and teacher support of PE teachers, and the intrinsic and extrinsic motivations of students at different ages. It is suggested that the in-depth study could be conducted on a single variable or emerging issues for future investigation. Researchers can keep tracking and reviewing motivation-related models.

Keywords: bibliometrics, quantitative research, self-determination theory, physical education, motivation

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***Correspondence:**
Hung-Ying Lee
80930018a@ntnu.edu.tw
Jenn-Kuen Farng
farng888505@gmail.com

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INTRODUCTION

Motivation is an innate and autonomous psychological process that relies on internal needs and emotional–cognitive factors. The internal aspect of motivation is a series of processes ranging from no motivation to external motivation to internal motivation (Ryan and Deci, 2002). In motivation theory, self-determination theory, expectancy theory, situational interest, achievement motivation, and other related theoretical models are used to explore the concept of a multi-directional continuum of motivation from the perspective of motivation connotation. In recent years, there has been an increase in the number of topics related to motivation in the field of physical education (PE), and there have been a growing number of studies examining motivation in PE classes from different perspectives (Sun et al., 2017; White et al., 2021).

In this era of rapid publication and publishing, Howard et al. (2020) use meta-analysis to understand the development of motivational research in the field of education over the past 30 years and similarly suggest that the rapid growth of the literature in recent years has led to the analysis of retrospective articles that may be influenced by the sample (journal articles). Therefore, the article concludes by suggesting that future research could include more data to analyze and determine the impact potential in the field. Although academic journals are the main channel of knowledge dissemination, given the rapidity of knowledge renewal, researchers need to review the expertise in the field appropriately and regularly. Therefore, this study examines the status of PE in motivation-related research through the characteristics of Bibliometric, in order to synthesize and predict various topics for the reference of subsequent researchers.

MOTIVATION IN PE

Contextually, the ultimate goal of PE as a school subject is to help students develop good motor skills and lead healthy lives. Over the past few decades, many theories have been developed to better understand and explain motivational learning behaviors and processes, and one of the more widely explored and applied models of school sport is the self-determination theory. Ryan and Deci (2020) explained the importance of motivation in PE from a self-determination perspective and showed that the perception of internal and external motivation was positively related to confidence, happiness, and intention to participate in PE.

In addition, the motivation for PE-related research also includes "physical literacy," which has been a hot topic in the field of PE and public health in recent years. Whitehead (2010) first outlined the concept of physical literacy, which encompasses the ability to move physically, meaning that individuals have the motivation, confidence, physical competence, and knowledge and understanding to apply and integrate purposeful physical activity into their individual lives. Motivation is one of the four domains of physical literacy, and a physically literate individual has a positive attitude toward engaging in physical activity and sustains the habit and responsibility of exercise (Dudley, 2015; Green et al., 2018). Students or children can develop motor skills and become competent in the concept of physical literacy during sports practices to retain motivation and confidence to participate in physical activity (Roetert and MacDonald, 2015).

In addition to different topics, a variety of studies have been developed to examine motivation in sports for different age groups of learners. De Bruijn et al. (2021) examined whether the satisfaction of children's psychological needs (autonomy, relatedness, competence) directly or indirectly predicted basic motor skills (running, jumping, and object control skills) and motor-related skills (skills developed during participation) from the perspective of children. It is important to note that feelings of competence, peer relationships, and teacher relationships can directly or indirectly influence children's physical and motor skill development. The motivation of children to learn in PE involves multiple factors. In recent years, contextual interest has become one of the ways to measure students' motivation for PE class to understand children's and adolescents' motivation and incentives for PE, including challenge, attention demand, instant enjoyment, and exploration intention (Chen et al., 2001, 2012).

For measuring motivation, Burgueño et al. (2019) predicted students' frustration in PE classes through the Basic Psychological Need Frustration Scale (BPNFS-PE) and showed that a high level of satisfaction with the BPNFS-PE contributed to an increase in intrinsic motivation to promote environmental maladaptation. Huescar Hernandez et al. (2020) suggest that teacher-directed supportive behaviors reduce students' fear of failure. At the same time, students can also create an ideal learning atmosphere. In a study of teachers, the scale was used to measure teachers' emotional engagement and behavioral performance in the workplace, including the importance of partner teacher motivation and the impact of psychological support and beliefs on performance and climate (Cheon et al., 2012; Shen et al., 2015).

Owen et al. (2014) suggested in a meta-analysis study that a broader and more comprehensive analysis could be used to generalize a larger sample (journal articles) to capture the development of knowledge in the field if more diverse variables are to be explored in future. From the above research on PE in motivation, it is evident that the literature in this field has been rapidly evolving due to the number of papers that have been written from different perspectives.

Due to the rapid increase in the number of academic publications in recent years, it is difficult for researchers to keep up with the latest academic trends and update their knowledge at the same time (Briner and Denyer, 2012). As a result, this study evaluates the state of PE in motivation-related research using Bibliometric characteristics in order to summarize and predict diverse subjects for future researchers' reference.

BIBLIOMETRIC METHODS

Academic journals are the primary means by which knowledge is transmitted, and "Bibliometrics" is becoming an increasingly important component of research methodology. The use of mathematical and statistical methods in books and other media was originally defined as bibliometric (Abramo and D'Angelo, 2011). Unique variables, co-citation links, relevant

topics, co-occurrence, and co-authorship, keywords, publication countries/regions, organizations, and the effect of specific articles, journals, and authors may all be classified and presented using bibliometrics (De Battisti et al., 2015).

Simple methods are used to organize the current data on a group of study objects. More complex techniques can also be used to create, visualize, and explore maps based on network data (Cobo et al., 2015). This type of analysis not only helps researchers analyze the evolution of literature and research models, but also provides productivity metrics as well as research goals and publication preferences (Abramo and D'Angelo, 2011). Furthermore, bibliometric map analysis software such as VOSviewer, a program for building and examining bibliometric maps (Van Eck and Waltman, 2010, 2017), has arisen, which is characterized by a simple and thorough grouping of subjects.

Co-citation analysis, on the contrary, is a variation of normal citation analysis (Zupic and Cater, 2015). It is a pioneer in the field of bibliometrics, defined co-citation as the frequency with which two units (e.g., authors, documents, journals) are cited together (Cobo et al., 2015). Co-citation can also be used to explain hot trends and is commonly used in computer science, information science, and medicine (Chang et al., 2020; Goksu, 2021). In this research, bibliometric visualizing methods have been applied through VOSviewer to visualize further analysis results. It defined co-citation as the frequency with which two units (e.g., authors, documents, and journals) are referenced together. It is a pioneer in the field of bibliometrics. Co-citation is extensively used in computer science, information science, and medicine to explain current events. To visualize the results of this study, bibliometric visualizing approaches were used in combination with VOSviewer.

As we know from the above, there is a wide range of topics and perspectives in the extensive literature on motivation in PE. Ryan and Deci (2020) review the last 20 years of motivation in PE research and also suggest supporting metrics and network analysis techniques to provide subsequent researchers and practitioners with a knowledge structure and experience in the field. Therefore, this study used a bibliometric method to search through the Scopus electronic database to try to grasp the motivational issues and trends related to school PE. For this purpose, the following five questions have been developed for the study:

(1) What is the status of annual publications for 2016–2020?

(2) Which countries/regions are the 10 countries/regions with the most publications?

(3) What are the top 10 journals that published the most motivation for PE research?

(4) Who are the 10 most frequently published authors?

(5) What are the co-occurrences that were explored in motivation at PE research?

METHODS

Ethics Statement

This study was a retrospective bibliometric analysis focusing on analyzing the published articles. No clinical trials were conducted in this study. Approval from an institutional review board was not applicable.

Study Design

It is a bibliometric examination of a specific topic based on the Scopus literature databases. Based on the bibliometric methodology literature, Zupic and Cater (2015) offered process guidelines for science mapping analysis using bibliometric methodologies. For the five-step approach for doing science mapping, the authors followed the preferred reporting items including study design, data collection, data analysis, data visualization, and interpretation.

Data Collection

Data related to the present study were retrieved from Scopus on September 7, 2021. Two terms "Motivation" and "Physical Education" were used as the keywords for searching journal articles. Only those publications published in the years ranging from 2016 to 2020 were considered to retrieve related data from the past. In addition, this study only covers the study of motivation in the field of PE, including school PE classes and other related learning activities, and therefore does not include the concept of terms such as exercise or sport. In line with the main purpose of identifying this research, Scopus is selected as the database for the following bibliometric analysis. Initially, 870 articles were obtained by searching the above two keywords. After manual coding, 67 non-empirical studies and 180 journal articles not presented in English were removed. In the end, 623 journal articles were used as the analysis data.

Data Analysis

To begin, bibliographic data for 623 publications were acquired from the Scopus website and saved as.csv (comma-separated values) files. The saved data contained author names, organizations, article titles, keywords, abstracts, and various citation data. A copy of the.csv file with the identical information was also stored in Excel. Second, the data collected from the Scopus database were imported into VOSviewer software and the Bibliometrix R package to draw a network map and visualize it.

Visualization

A bibliographic visualization tool was created by Leiden University's center for science and technology studies (CWTS). The correlation strength of measurement was used to evaluate network visualization, overlay visualization, and density visualization of cluster normalization (Van Eck and Waltman, 2010). The web of science, Scopus, PubMed, and RIS databases are among the file types that can be analyzed. Author relationship, keyword co-occurrence, citation, and literature coupling are examples of analytical types. VOSviewer is a useful tool for mapping scientific information, and it is well-suited to displaying big bibliometric maps. The maps are very simple to understand (Van Eck and Waltman, 2017). When using VOSviewer to process data, the software will examine the items based on their frequency of occurrence or threshold size. The data will be too huge if the threshold is set too low; otherwise, the data will be too sparse. As a result, the author will establish

the visualization map size barrier based on readability and literature analysis.

The Bibliometrix R software package is also an important research tool for literature metrics, containing a range of tools for quantitative literature metrics and scientific metrics research. It is written in R, a tool for developing programming languages and ecosystems (https://www.bibliometrix.org/), and is even available to researchers who are new to coding (Aria and Cuccurullo, 2017). R is a pairwise-oriented functional programming language, so it is easier to simplify the analysis and add new functions.

Interpretation

The final step in the study of bibliometrics is to interpret the visualization results, but there are two points that need special attention here. First, bibliometric methodologies are different from previous literature reviews, meta-analyses, or systematic reviews. It is mainly a big-picture approach to interpreting the structure of various types of academic literature, finding interrelationships and influences, and providing new perspectives to improve knowledge in the field. Second, the interpretation of bibliometric methodologies cannot be trusted too much to match past research but must be interpreted objectively. However, it is still possible to reconcile the results of retrospective articles in the field to understand the past and even predict future developments, so special care should be taken at this stage.

RESULTS

Annual Publications

From the number of publications, it can be understood that the research in the field of motivation in PE has been growing rapidly in the last 20 years, and scholars in various fields have been updating and exploring the knowledge in the field. **Figure 1** shows the number of articles published and cited on motivation in PE in the last 5 years. Between 2016 and 2020, no <93 articles per year will be published on motivation in PE. Since 2017, the number of articles has been increasing year by year, and the number will be no <100 in 2018, with the highest number of 190 articles published in 2020.

In **Figure 2**, we can see the top 10 articles on sports motivation cited by other scholars from 2016 to 2020. Martin S. Hagger and Nikos L. D. Chatzisarantis, authors from Curtin University in Australia, published the most-cited article in the Review of Educational Research in 2016. The study is entitled, "The Trans-Contextual Model of Autonomous Motivation in Education: Conceptual and Empirical Issues and Meta-Analysis." The article focuses on the transfer of motivational forms of the trans-contextual model from the school PE classroom to the out-of-school environment and confirms that the theoretical model can help students develop autonomous motivation. The article has been cited nearly 120 times, which is a significant difference from other articles. The reason is that the authors based on Deci and Ryan (1985) self-determination theory and extended the trans-contextual model, which emphasizes the emerging model of autonomous motivation, and therefore is widely discussed and cited by scholars. It is also worth noting that the top three cited articles were all published in 2016, with the number of citations ranging from 80 to 110, echoing **Figure 1**, which was cited 315 times in 2016, the most-cited year in the last 5 years.

Publication Countries/Regions

Figure 3 shows the visualization of the density of country publications, showing the distribution of research on PE motivation in 32 countries/regions between 2016 and 2020. Each dot has a layer of color, ranging from blue to green, then from yellow to red, from the outside to the inside, and from low to high density. The more articles are published, the higher the density of the area, the more the color tends to be red.

Figure 4 shows the top 10 countries/regions, among which Spain has the highest number of published articles with 156, followed by the United States with 125, Australia in third, the United Kingdom in fourth, followed by China, Brazil, Ukraine, Canada, Finland, and Belgium. In particular, the top two countries/regions, Spain and the United States, have a total of 281 articles, accounting for 45.1% of the total 623 articles in the last 5 years. The total number of articles is higher than the total number of articles from the other eight countries (279), which shows the importance of Spain and the United States in the study of PE motivation and their leading role in this field. The distribution of the top 10 shows that Europe is the most represented, including Spain, the United Kingdom, Ukraine, Finland, and Belgium, North America includes the United States and Canada, and the rest of South America, Australia, and Asia each have one country/region in the top 10. The rest of the countries/regions in South America, Australia, and Asia have one country/region in the top 10. This shows that the issue of motivation in PE is widely discussed in European countries/regions. In addition, Asian countries/regions, including China, Taiwan, Hong Kong, Korea, and Singapore, are also involved in the research of motives in PE.

PUBLICATION JOURNALS

Figure 5 shows that the top journal was the *International Journal of Environmental Research and Public Health* with 56 articles, exceeding the number of articles published by many journals. Of these 251 articles, 72 are in the area of public health. The reason may be that the World Health Organization has pointed out that physical inactivity is one of the causes of increased mortality in recent years, with an annual mortality rate of up to 6%, making it the fourth most important risk factor for global mortality. The abovementioned statement forms the beginning of the introductory remarks of most of the articles. Matthews et al. (2012) suggest that physical inactivity increases the development of cardiovascular disease and metabolic syndrome, leading to premature death. Therefore, scholars in the field of public health are actively working to understand the motivation of physical activity in various ethnic groups and to develop strategies to increase physical activity in countries/regions to reduce chronic diseases and related mortality factors.

Next, the second to fifth place is sport pedagogy-related journals, with 117 articles, accounting for 46.6% of the total

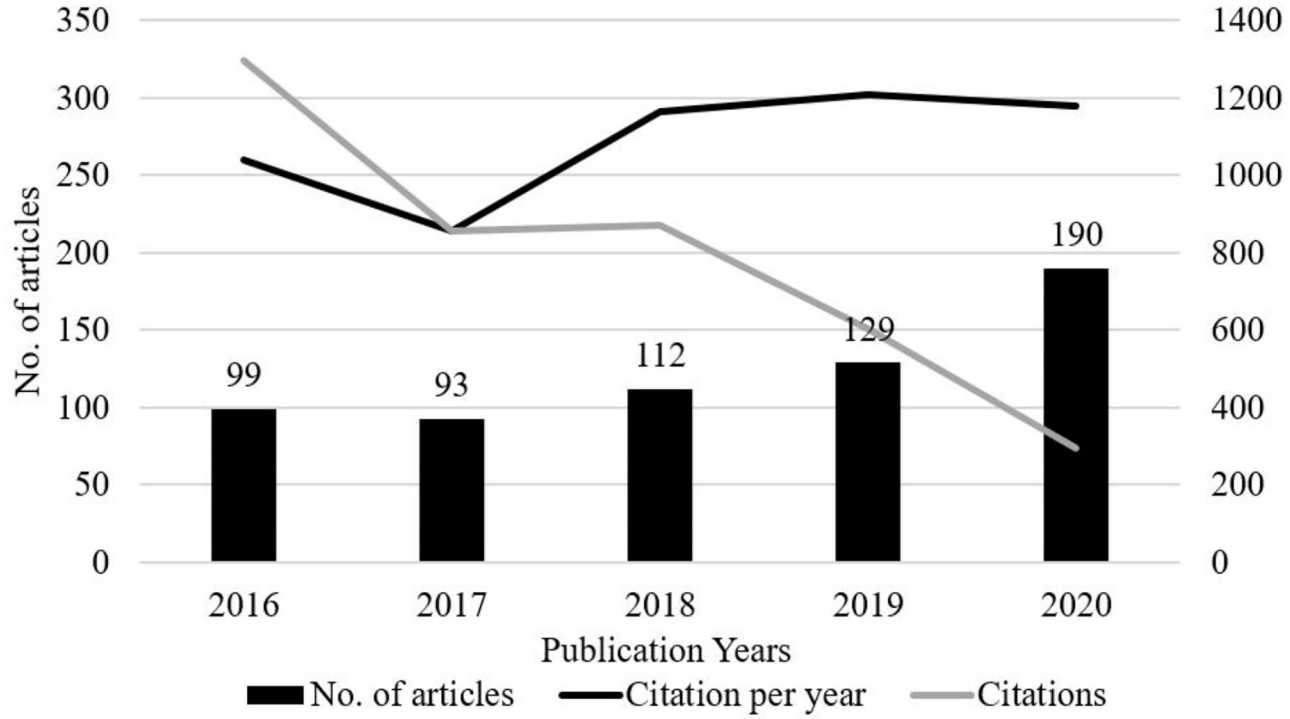

FIGURE 1 | Distribution of annual publications.

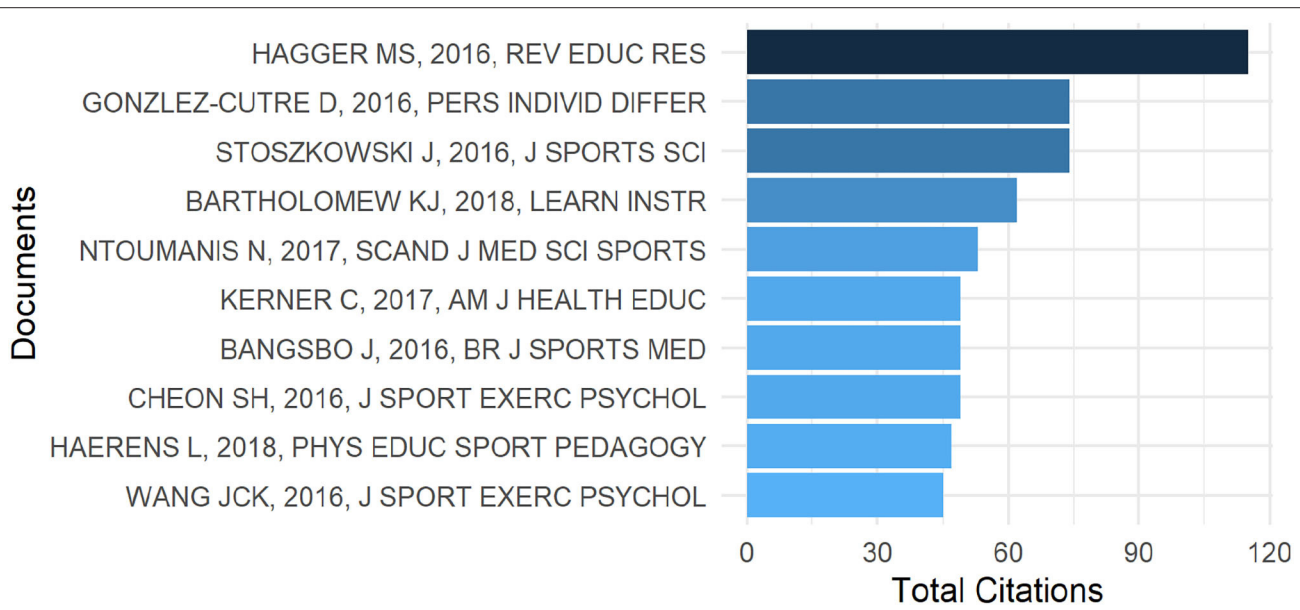

FIGURE 2 | Top 10 most-cited articles.

number of articles. The number of articles in the field of sport pedagogy surpassed that of public health (30.3%). From a long-term perspective, sport pedagogy continues to be the leading PE-related study in motivation and is more thoroughly researched in both theory and practice, as can be seen from the high number of cited articles in **Figure 2**. From another perspective, both sport pedagogy and public health continue to focus on motivation-related issues, which is a positive thing and means that this issue is continuously being advanced.

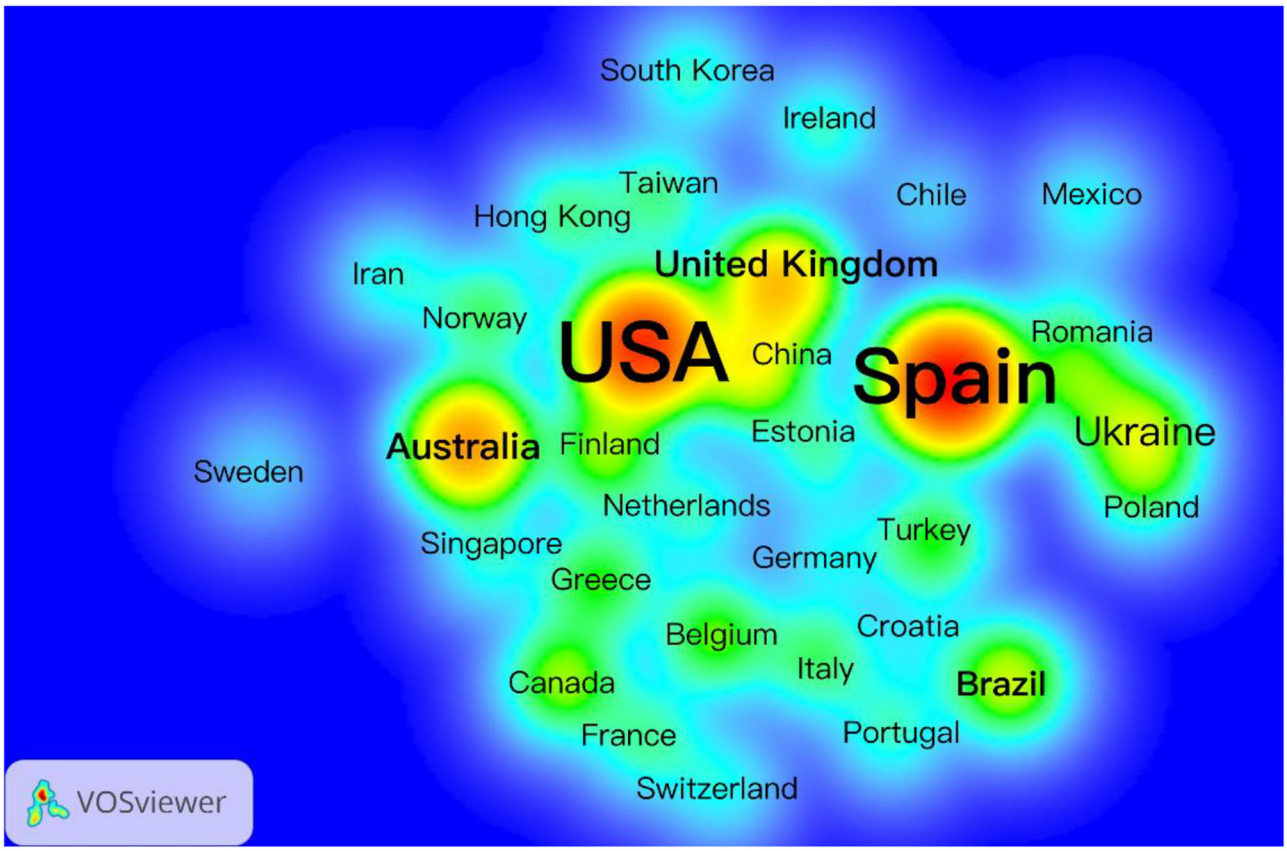

FIGURE 3 | Country/region publication density visualization.

PUBLICATION AUTHORS

Figure 6 shows the top 10 articles published between 2016 and 2020, with Prof. Leen Haerens of Ghent University in the first place, whose research focuses on PE classes, PE teachers, and student motivation, with 13 publications in the last 5 years. Her most-cited article is "*Do perceived autonomy-supportive and controlling teaching relate to physical education students' motivational experiences through unique pathways? Distinguishing between the bright and dark side of motivation.*" The article explains that controlling teaching (and subsequent experiences of need frustration) does not simply reflect an absence of autonomy support (and subsequent experiences of low need satisfaction). Finally, it was emphasized that effective teacher training in terms of motivational style may involve more than training teachers to become more autonomy supportive toward their students it may also involve raising awareness among teachers about the motivational risks associated with controlling practices.

Next, the second-place winner is Professor Chris Lonsdale from Australian Catholic University. His research focuses on motivation, behavior, education, and physical activity, and he has published a total of 12 studies on motivation in PE in the last 5 years. His most-cited article is "*The Behavioral Regulation in Sport Questionnaire (BRSQ): Instrument development and initial validity evidence.*" The study develops and tests a new measure of competitive sports participants' intrinsic motivation, extrinsic motivation, and amotivation. And the BRSQ finally has good information in terms of reliability and validity, which also has a stable foundation for subsequent researchers to use.

The third is Martin Hagger, currently a professor at the University of California Merced, and formerly a professor of health psychology at the University of Jyväskylä. His primary focus is on applying social psychological theory to predict, understand, and change health behaviors. His most-cited article is "*A meta-analytic review of the theories of reasoned action and planned behavior in physical activity: Predictive validity and the contribution of additional variables.*" The study was to examine relations between behavior, intentions, attitudes, subjective norms, perceived behavioral control, self-efficacy, and past behavior across studies using the theories of reasoned action (TRA) and planned behavior (TPB) in a physical activity context. The major relationships of the TRA/TPB were determined to be supported in this quantitative integration of the physical activity literature, and the addition of self-efficacy and past behavior to the model is an essential contribution.

The fourth-place winner is Professor David Lubans, who works at the University of Newcastle, where he is involved in

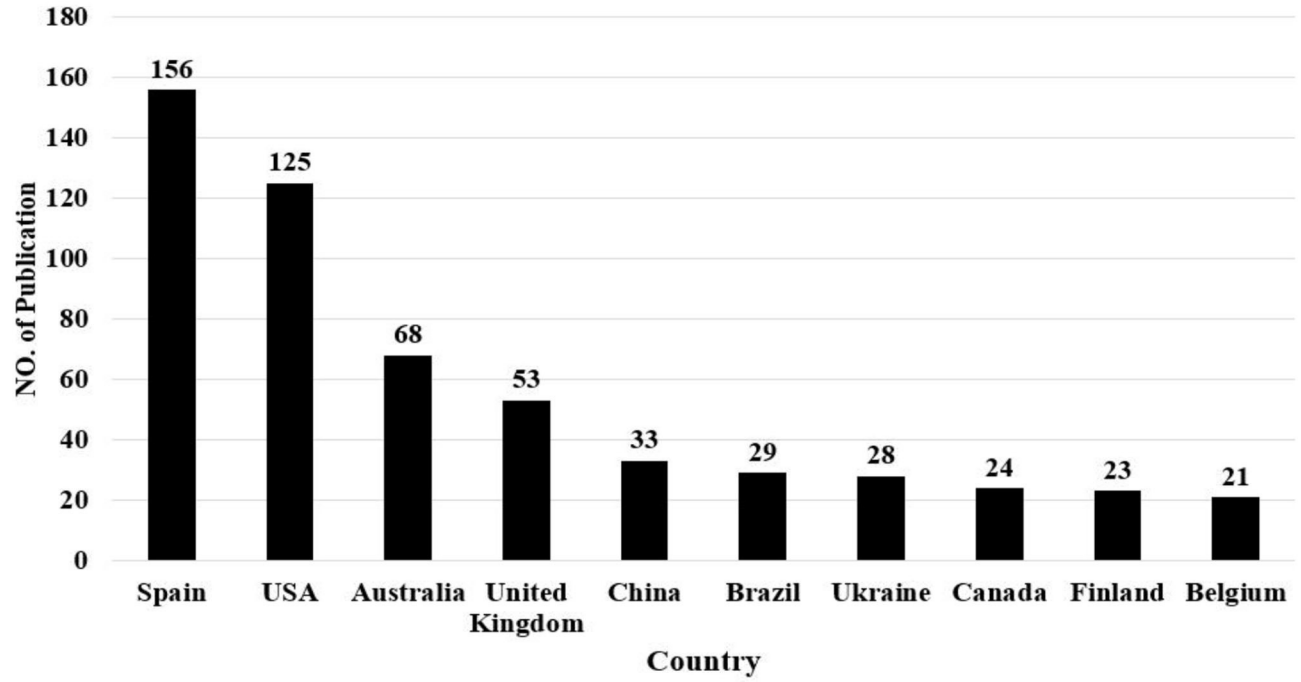

FIGURE 4 | Top 10 countries/regions of publications.

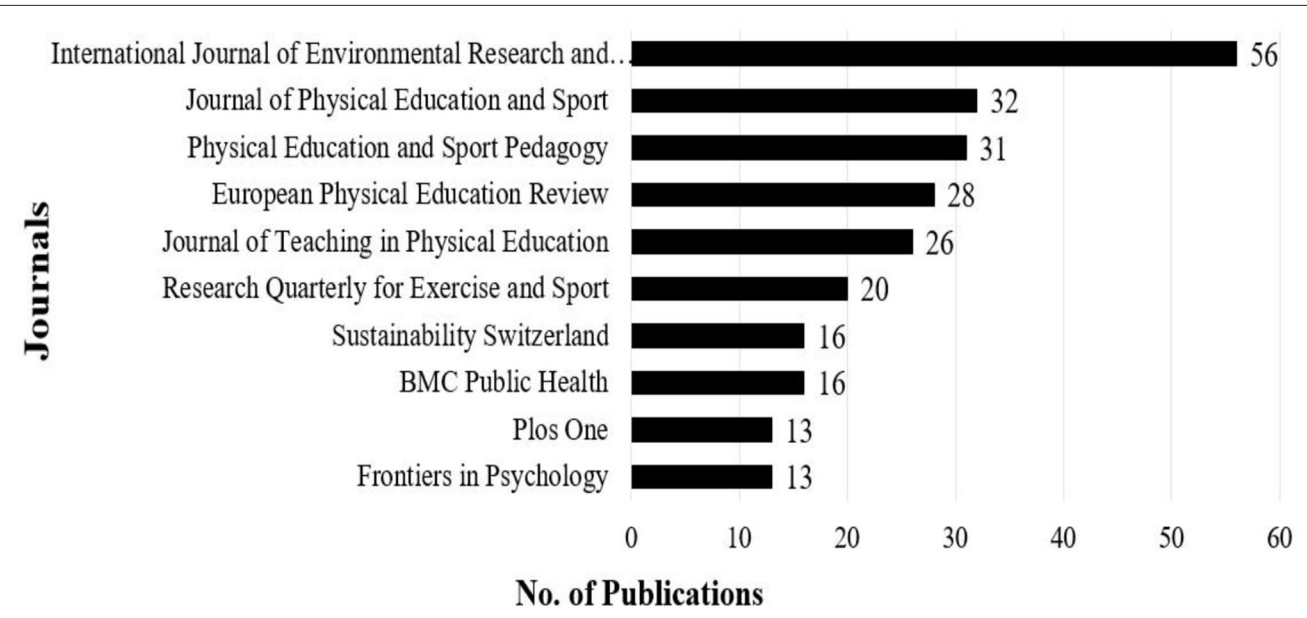

FIGURE 5 | Top 10 leading journals with publications.

motor skills and physical activity in children and adolescents. His most-cited article associated with motivation is "*Self-determined motivation and physical activity in children and adolescents: A systematic review and meta-analysis.*" The study was to assess the association between self-determined motivation and physical activity levels in children and adolescents. The result indicated that overall levels of self-determined motivation had weak-to-moderate, positive associations with physical activity. Autonomous forms of motivation had moderate, positive associations with physical activity, whereas controlled forms of introjection and external regulation had weak, negative associations with physical activity.

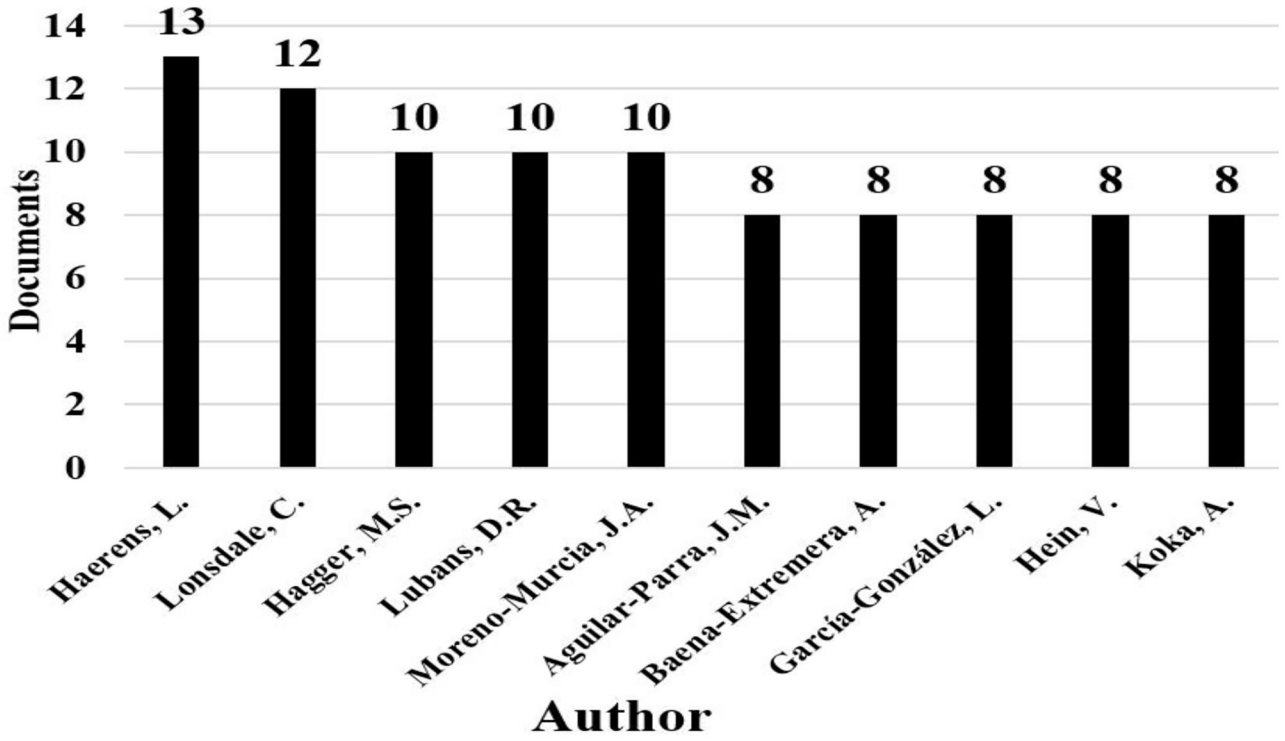

FIGURE 6 | Top 10 authors.

Fifth place went to Professor Juan Antonio Moreno Murcia at Miguel Hernández University, who has done a lot of research on motivation and PE and has also developed the Spanish PE Motivation Questionnaire. His most-cited article is "*Importance of the Self-Determination Theory in physical-sports practice: Foundations and practical implications.*" The study was to review the fundamentals, research, measurement instruments, and practical applications of the SDT in physical activity and sport.

The third to fifth places have published 10 articles, while the remaining six to ten places have published eight articles each. Among the top 10, three Spanish scholars (5, 7, and 8), two from Australia (2 and 4), two from the United States (3 and 6), two from Estonia (9 and 10), and one from Belgium (1) are found, with European scholars accounting for the largest number of six. The results echo **Figure 4**, with a total of 55 publications, indicating that European scholars are relatively more often motivated to publish research related to the field of PE.

In the density visualization in **Figure 7**, it can be seen that the collaborative relationships can be divided into three clusters. In addition to collaborative writing and publishing, it is also possible to distinguish by country/region. Among the three scholars in the middle cluster, only Dr. González-Cutre is Spanish, while the other two are American, and all three have published with each other for 5 years. The cluster on the left is a collaboration of professors and researchers from the University of Tartu who wrote the article together. The five people in the right cluster are all Finnish, all colleagues from the University of Jyväskylä, and have published together during the past 5 years. The results show that scholars from European and South American countries are more interactive and collaborative and that scholars from the same country write and publish together on topics related to motivation and self-determination theory motivation, physical activity, health, and physical education teachers and students.

CO-OCCURRENCE

This study searched for keywords in motivation and PE, followed by an analysis of co-occurrence. When words appear frequently together in the journal literature, it means that the concepts of these words are closely related. Co-occurrence analysis is a network of interrelationships between topics, reflecting other word concepts that can be linked in this domain. Therefore, co-occurrence analysis provides a more detailed knowledge base than co-citation analysis (Hallinger and Kovačević, 2019).

Figure 8 shows the co-occurrence network visualization, in which there are three colors for different clusters. The larger the dot means more articles list it as a keyword, and the line between words is the connection between themes, which means two themes are related to each other. The larger the correlation, the larger the dot, which means that the topics are related to it. In general, the red cluster occupies a larger area and covers 21 words (education, activity, goal, child, sport, health, goal, theme, knowledge, student motivation, performance, use, exercise, quality, process, development, training, change, program, intervention, control group, application, and effectiveness),

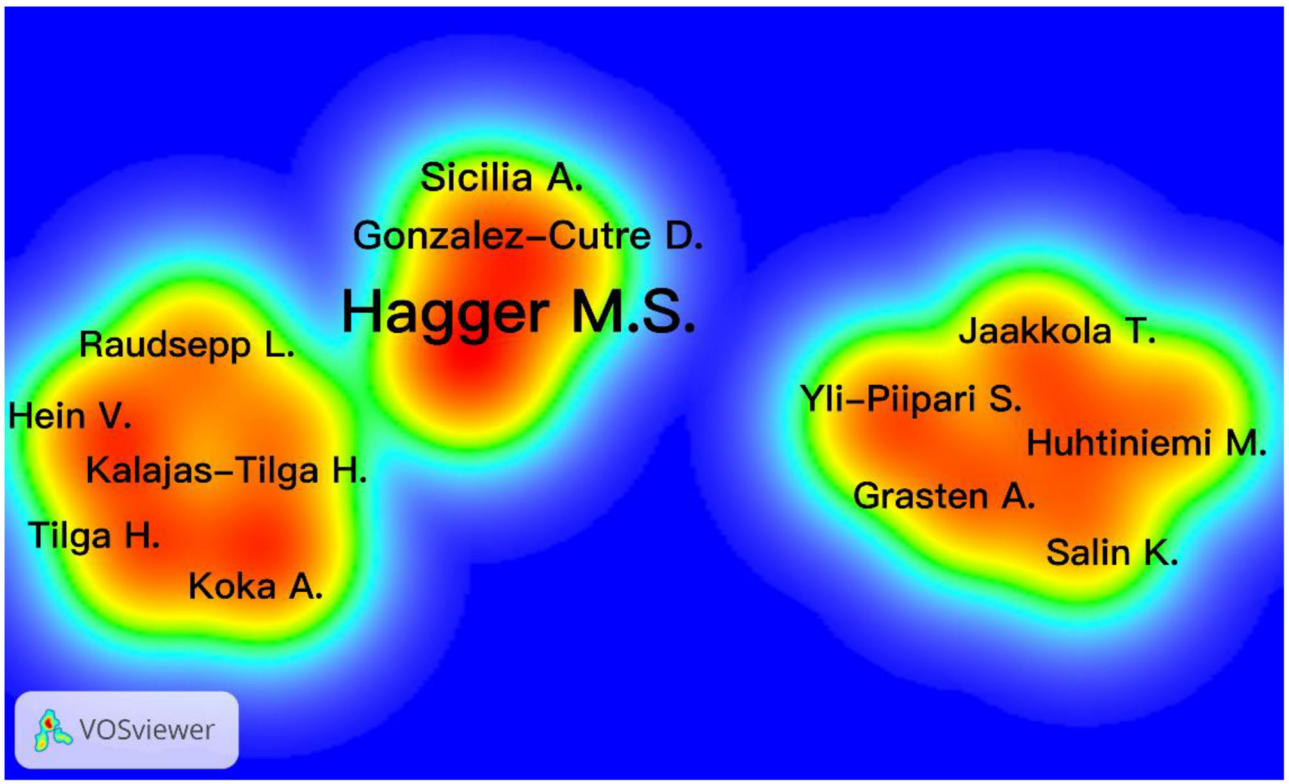

FIGURE 7 | Author's published density visualization.

which are more thematic issues and belong to the theme of operational variables. Education and activity are the largest themes in the dots and represent the most relevant words in the study of PE in motivation.

The green cluster consisted of nine words (role, self-determination theory, behavior, satisfaction, autonomy motivation, physical education teacher, support, competence, and autonomy), and these words were more associated with self-determined human factors. The last blue part has five main words that belong to the basic demographic variables (gender, female, relationship, adolescent, and scale). It is interesting to note that the background variables do not show the words male or boy, but rather the results are more likely to be significant for females or girls.

Next, we refer to Cobo et al. (2011) who identified a bibliometric approach that evaluates a research field and detects and visualizes its conceptual subdomains (specific topics/themes or general thematic areas) and thematic evolution using both performance analysis and science mapping tools. Using the Bibliometrix R package's functions, a research area can be viewed as a collection of Research Topics, mapped in a two-dimensional strategic diagram (**Figure 9**), and split into four categories. Centrality represents the strength of the external links to other themes, which is a measure of the importance of the development of a theme in the field. Density represents the strength of the association between keywords within the themes, and the larger the circle the more proportional the relevance to the theme (number of publications, citations, etc.).

(a) Motor themes: Themes in the upper-right quadrant are well-developed and crucial to the structure of a research field. They are known as the specialty's motor themes because of their high centrality and density. (b) Niche themes: Themes in the upper-left quadrant have well-developed internal relationships but minimal exterior linkages, making them of just marginal regional significance. These are highly specialized and ancillary topics. (c) Emerging or declining themes: Themes in the lower-left quadrant are both marginal and underdeveloped. The themes in this quadrant have a low density and centrality, and they frequently reflect fresh or vanishing motifs. (d) Basic and transversal themes: Themes in the lower-right quadrant are important for a Research Topic, although they are still evolving. This quadrant contains both transversal and general themes.

The themes developed in the four quadrants, as shown in **Figure 9**, provide a clear picture of the focus and future trends of scholarly research on PE motivation over the past 5 years. Among the motor themes, the adult questionnaire and the children's PE program have been well-developed. In the second quadrant on the top left, highly developed and isolated themes are gender, factor analysis, and psychometrics. The third quadrant contains sport, achievement goals, students, psychology, and physical education and training, which have recently been discussed extensively in the field of PE motivation and are relatively new

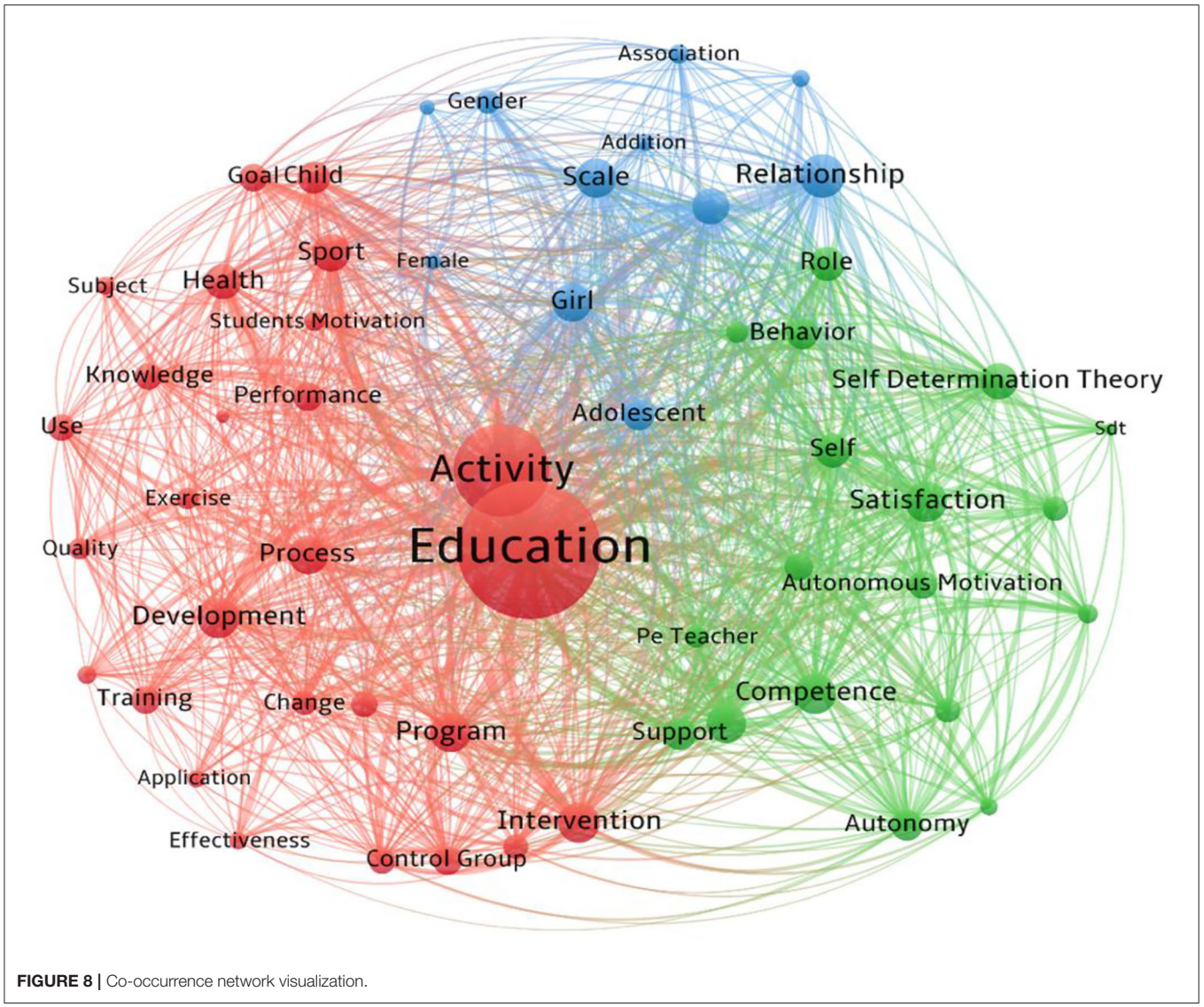

FIGURE 8 | Co-occurrence network visualization.

topics. Finally, the fourth quadrant is human, physical education, and motivation. The scope of human motivation to participate in PE is relatively broad. Even so far, there are still many studies worth exploring.

DISCUSSION AND CONCLUSION

Reviewing and examining the 623 articles published in 2016–2020, motivation research is rapidly evolving. Motivation is a popular topic in psychology and has a long history of research contributions. In the field of PE, sports psychologists Deci and Ryan (1985) self-determination theory has had a profound impact on motivation research, and subsequent scholars have begun to use self-determination theory as a basis for exploring other variables. Ryan and Deci (2020) review nearly 20 years of internal and external motivation research to illustrate the rapid maturation of the field, particularly the application of SDT in education with a focus on promoting basic psychological needs satisfaction for students and teachers. The framework of motivation thus provides much of the evidence base for education in the 21st century and has even led to changes in several educational policies.

For school PE, the field of sport pedagogy is the most explored issue related to motivation. The results of Chu and Zhang (2018), who examined the changes in motivation in students' learning through the sports education model, also showed that motivation plays an important role in PE lessons. However, in the past, studies on motivation in P.E. have mostly examined the development of motivation in the P.E. curriculum from the students' perspective. Nowadays, scholars are more interested in the perceptions of physical education teachers to understand the development of students' motivation in physical education lessons through teachers' leadership and teaching styles (White et al., 2021).

Among the journals searched for in this study, sports psychology, educational psychology, and some public health journals were included. However, sport pedagogy was the most

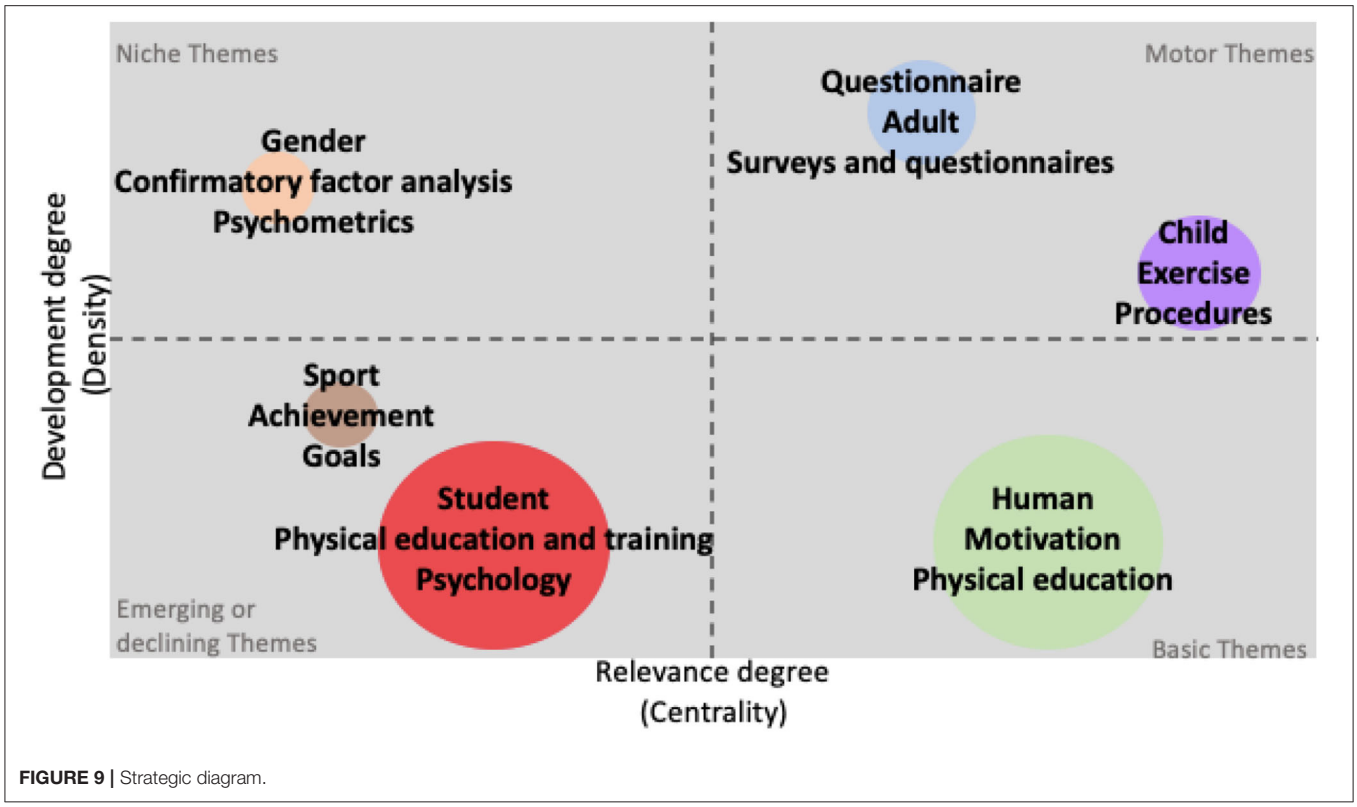

FIGURE 9 | Strategic diagram.

popular, and the reason for this may be that most of the studies were focused on physical education courses or PE-related activities, with teachers or students as the test subjects. Interestingly, the study design of Timken et al. (2019) compared single-sex and mixed-sex studies to understand the differences in student participation and ability levels in PE classes. The results indicated that participation was higher in all-female PE classes, and the greatest health benefits were achieved through higher levels of exercise performance. More importantly, a lack of physical activity, regardless of the reason, may lead to future health problems. As a result, adolescent girls have become the primary target group for motivational research in PE classes (Okely et al., 2017). In recent years, the literature on motivation in PE has begun to change, as not only the fields of sport pedagogy and public health but also other related fields have begun to explore the effects of motivation and PE on human health, increasing the number of submissions each year.

From the results of the number of articles in 2016–2020, European countries (Spain, UK, Ukraine, Canada, Finland, Belgium, etc.) are quite concerned about the research related to motivation in PE, followed by the United States. The number of articles from these countries is significantly higher than that of other countries, and one of the reasons for this is the frequent exchange and cooperation among scholars.

Figures 3, **4** are similar to the findings of White et al. (2021) in that Spain, the United States, and Australia have continued to develop new motivation-related issues in recent years, as well as continuing the relationship between motivation and PE in the past. The research team from the Department of Integrated Didactics, Faculty of Education, Psychology and Sports Sciences, Universidad de Huelva, Spain, also emphasized the satisfaction of basic psychological needs and more self-motivated students. Basic psychological needs and more self-determined motivational forms are related to positive behavioral consequences and that will increase the intention to be physically active in PE students (Fernández-Espínola et al., 2020). In addition, Ryan and Deci pioneered an important direction in motivation-related research in the United States, which has had a significant impact and has led to a large output in motivational research in PE in the United States.

As can be seen in the visualization of the words co-occurrence in this study, "Understanding the need for novelty from the perspective of self-determination theory," published by five authors from the same cluster, González-Cutre et al. (2016), is a classic collaborative study that includes scholars from Spain, the United States, and Australia. The article, based on self-determination theory, explores the satisfaction of novelty needs and examines the validity and reliability of the Novelty Need Satisfaction Scale (NNSS), with 211 citations (as of 2022.03.01), indicating a breakthrough in reference for subsequent researchers. Later, González-Cutre and Sicilia (2019) applied novelty demand satisfaction and motivation to the PE class and identified novelty satisfaction as intrinsic motivation. Finally, three important predictors of vitality, personality flow, and satisfaction with PE were identified. Moreover, in recent years, scholars in this field have continued to focus on the

relationship between novelty needs and motivations in PE activities, including the leadership style of PE teachers or innovative teaching (Hernández et al, 2019).

Aibar et al. (2021) also examined the novelty of teaching and learning satisfaction in school physical education programs, and their results also suggest that a supportive environment is currently associated with novelty satisfaction, including the intention of satisfaction to participation in physical activity. There is a positive correlation between satisfaction and the intention to participate in physical activity. This implies that the design of the physical education curriculum affects the psychological motivation of youth to participate in physical activities. This also reflects that the relationship between physical education curriculum design and student interactions should include strategies that support novelty, enthusiasm for teaching, and personal characteristics that can positively contribute to students' motivation to develop autonomy (Timken et al., 2019).

The Organization for Economic Co-operation and Development (OECD) has taken a whole-person education, calling for schools to be more than just a place to pursue academic achievement. Rather, requires a holistic education that Rather, it is a holistic education that promotes the social, emotional, physical, and psychological wellbeing of students. Therefore, it is also recommended that physical education classes should emphasize students as the main learning subjects and try to improve the quality of teaching to promote students' motivation and interest in PE classes and even cultivate the habit of lifelong participation in sports. Based on this, this study found that the word "education" has been the most relevant core word for learning motivation from the co-word in **Figure 8**. It is also found from the journals in which the articles are published that the field of PE has the highest number of publications. Accordingly, PE or sport pedagogy has a part in exploring the relationship between physical education lessons and students' motivation to learn (Sun et al., 2017).

In addition, support for students' basic psychological needs positively influences motivation, and teacher support can also help students improve their internal motivation, perceptual skills, and self-esteem (Deci et al., 1981). As a result, teachers' pedagogically relevant knowledge is important, and therefore, teacher training has been emphasized in recent years, echoing the results in **Figures 8**, **9**. This result has also led to an increase in related research on teacher self-support. The reason is that whether teachers' teaching strategies and situational atmosphere can meet students' internal needs are the key factors affecting students' self-directed learning motivation. At the same time, recent research on teacher support has focused on student achievement goals and has illustrated the need for teachers to satisfy autonomy, competence, and relatedness in the learning environment. Therefore, the issue of teacher autonomy support has been followed by a meta-analysis of research on self-determination, and finally, the importance and impact of teacher support on students have been further emphasized and clarified (Vasconcellos et al., 2019).

In addition, from the analysis of previous studies and the results of this study, it is evident that self-determination theory has become a widely used model by researchers, mostly using questionnaires and scales as measurement tools (Ryan and Deci, 2017). In other words, the model of self-determination theory has been an important and central Research Topic for motivation and has pioneered and developed directions in the field for nearly 30 years. Among them, Ryan and Deci (2020) indicated that past research findings have demonstrated that good intrinsic motivation predicts positive outcomes across educational levels and cultural contexts and supports the basic psychological need for students to develop autonomy, which helps to enhance learning outcomes.

It is important to note that student motivation and autonomy are often directly related to teacher motivation, which, like student motivation, is also accompanied by autonomy or psychological needs satisfaction. In other words, PE teachers themselves are controlled by school pressures and leadership styles and are even pulled from above (new policy and decision makers) and below (students and parents with multiple personalities) to influence their teaching (Nie et al., 2015; Guay et al., 2016).

Accordingly, this study has obtained the results of the analysis of multiple bibliographic data through bibliometrics and to found that school PE has focused on motivational studies in the past. These include innovations and developments in education, as well as the rise of student-centered teaching and learning, which has led researchers to look back at the factors associated with teachers' motivation to influence student learning. White et al. (2021) suggested that qualitative research can be used to understand teachers' perspectives in future, to further explore what ideas teachers adopt to accept internal and external factors in the teaching field, and to promote students' learning motivation. Therefore, this study also highlights the research in the field of PE in motivation for teachers to better understand its development trends and contexts.

The limitations of this study are 2-fold, and analysis was conducted only on the Scopus with a limited timeframe of 2016–2020 which may limit the generalizability of findings to the category in general. Second, limitations in the Scopus database may have some unidentified issues; however, the findings shared here for the leading contributors were manually verified. In addition, continuous changes and updates may show different publication data to be analyzed depending upon the date of search and timeframe. Metadata from other sources might be beneficial to complement this study and provide comprehensive context on the subject.

Finally, as academics who have published scientific studies based on bibliometric analysis, we would want to emphasize the importance of science mapping. This strategy takes advantage of quantitative approaches' accuracy, and it is often surprising how much "numbers explain a rich story." This is due, at least in part, to the approach's concentration on "visualizing relations" between different aspects of the literature. Therefore, after the end of the study, we hope that other academics or databases, such as WOS, will continue with this review study, which could be an alternative for future research. The findings of this fast scoping analysis provided valuable insight into the wide range of publications in the PE motivation field that grasp the past and predict the future.

AUTHOR CONTRIBUTIONS

C-JC and H-YL: conceptualization. H-YL and J-KF: methodology. C-JC and R-JL: writing—original draft preparation. C-JC, H-YL and J-KF: writing—review and editing. 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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Assessing the Association Between Pakistani Women's Religious Beliefs and Sports Participation

Rizwan Ahmed Laar[1], Muhammad Azeem Ashraf[2], Shu Zhou[1], Lei Zhang[3] and Zhengliang Zhong[1]*

[1]College of Physical Education, Hubei Normal University, Huangshi, China, [2]Research Institute of Educational Science, Hunan University, Changsha, China, [3]School of Marxism, Hubei Normal University, Huangshi, China

Women's participation in physical activities has been discouraged for a variety of reasons, especially in Muslim countries. This study aims to highlight Pakistani women's religious beliefs about sports. It focuses on whether their religion contradicts their participation in sporting activities, and it does so by using an adapted version of the Santa Clara Strength of Religious Faith Questionnaire (SCSRFQ) in the theoretical context of feminism in sports. The snowball sampling method was used to select women ($n = 357$) from the Sindh province of Pakistan, who completed a questionnaire incorporating the SCSRFQ that was specially designed for the current study. The results were unexpected, revealing that religious beliefs have no negative impact on Pakistani women's participation in sports. Few participants (14 out of 357, 3.9%) believe that religion is an obstacle to their participation in sports. The results of the study challenge the traditional view by most of the previous studies that Islam is against women's sports. It also challenges cultural limitations, such as some unwritten rules in Pakistani culture according to which women cannot participate in sports. These efforts should lead to enhanced female sports participation in the Pakistani context.

Keywords: religious beliefs, sports participation, Pakistan, women sport, SCSRFQ

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Bilal Ahmed Usmani, Aga Khan University, Pakistan
Hans Van Eyghen, VU Amsterdam, Netherlands

****Correspondence:***
Rizwan Ahmed Laar
rizwan_laar@yahoo.com

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BACKGROUND OF THE STUDY

Taking part in sports is helpful for the vitality of the body and mind. "A sound mind in a sound body" is a common saying. Regular participation in physical activity and exercise is beneficial for a variety of physiological systems and improves people's quality of life (Lim and Taylor, 2005; Forkan et al., 2006; King et al., 2007). It is recommended that adults engage in an average of 30 min of moderate-intensity activity daily to maintain health and prevent chronic disease (Nelson et al., 2007). For senior citizens, it is recommended that individuals engage in moderate physical activity with an average of 3–6 metabolic equivalent tasks (METs) daily, the equivalent of walking fast at 3–4 mph (Patte et al., 1995). Despite such suggestions, many people prefer to live a more sedentary lifestyle for many reasons (Manaf, 2013).

Pakistan began to establish sports support federations in the year following its independence in 1947. In 1948 alone, the Pakistan Cricket Board (PCB), Pakistan Hockey Federation (PHF), Pakistan Tennis Federation (PTF), Pakistan Tenpin Bowling Federation (PTBF), and Pakistan

Swimming Federation (PSF) were established. At present, 40 national sports federations are affiliated with the ministry and the board [that is, the Inter Provincial Coordination (IPC) and the Pakistan Sports Board (PSB)]. Each federation is responsible for the promotion and development of its own games/sports; some function well, while others need to be improved in many ways. Despite these supportive federations, the participation and performance of Pakistani athletes, especially women, in the national and international arena need to enhance right away. Almost 90% of women and girls do not participate in sports or physical activities (Cailliau, 2013; Laar et al., 2019a). Although Pakistan's female athletes have participated in the summer Olympics since 1996 (six summer Olympics), they have won no medals (Laar, 2019).

This quantitative study describes the religious beliefs of Pakistani women, focusing on whether their beliefs inhibit their participation in physical activities (PAs). It does so by using an adapted version of the Santa Clara Strength of Religious Faith Questionnaire (SCSRFQ) and through the theoretical lens of feminism in sports. This study adds to the literature examining women's levels of participation in sports in Muslim countries and the influence of religious beliefs on those levels. It specifically asks whether religious beliefs impact Pakistani women's participation in sports since there is a gap in the literature related to assessing Pakistani women's sports participation and their religious beliefs, and in particular, it answers this question with the help of the SCSRFQ (Coakley and Pike, 2014). This study supports much of the previous sports literature and is consistent with the findings from other Muslim countries. This comparison enables us to become some of the first researchers in this field. While a few books and articles have been written from this perspective, especially regarding the validity of the SCSRFQ (see Sherman et al., 2001; Plante, 2010; Dianni et al., 2014; Pakpour et al., 2014) and women's participation in Muslim countries, the list is by no means exhaustive, and the existing literature may oversimplify the relationship between religious faith and female sports participation by using the SCSRFQ in Muslim countries, especially Pakistan (Laar, 2019; Laar et al., 2019a,b, 2020). However, it is also important to study the religious faith of women by using an adapted version of the SCSRFQ in a Muslim country (in this case, Pakistan) to explore whether such faith contradicts sports participation. This research has the potential to open a new understanding of the links between women's religious beliefs and their level of sports participation and to serve as a basis for constructive suggestions regarding the development of women's sports in Pakistan.

Religion and Sports in Islam and the Interpretation of This Relationship in the Pakistani Context

In Pakistan, religion has a greater influence on most aspects of people's lives than in other Islamic countries (Ida and Saud, 2020) since more than 90% of the population is Muslim (Ashraf, 2018; Laar et al., 2019a). An understanding of the basics of Islam is therefore important for this study. Islam, from the Arabic root word "Salam," which means "peace," is a faith held by one-fifth of the world's population. Muslims believe in one Allah (God) who revealed the holy Quran to Muhammad, the final prophet, ~1,400 years ago. According to Kahan (2003), in Islam, activities of daily life are governed by the Quran and the Hadith (Mohammed's maxims and practices). Islam prohibits dishonesty, gambling, murder, suicide, bribery, theft, forgery, interest, the consumption of alcohol and pork, hoarding, cruelty to animals, public nudity, and adultery. Instead, Islam promotes tolerance for non-Muslims, eating clean food, respect for parents and family units, generosity, marriage and a stable family life, assistance for poor individuals, the decent treatment of women, and engagement in healthy recreation (Kahan, 2003).

Regarding sports in Islam, horse riding, swimming, shooting, hunting, fencing, wrestling, and running are referred to in the Quran and the Hadith (Kahan, 2003). It is well known that women take part in wars and activities to obtain 'an adequate level of physical health and military trainings' (Kahan, 2003). Mohammed's 55-year-old wife, Khadijah, is said to have climbed mountains to provide food to her husband (Kahan, 2003). The original form of Islam was inherently concerned with the development and maintenance of the spirit and physical strength, regardless of gender (De Knop et al., 1996; Adamczyk and Felson, 2012; Khan et al., 2020). However, previous studies of religious beliefs about sports in the Pakistani context reveal that modern Muslim women's participation in physical activities is subject to religious and cultural constraints (Fazal et al., 2019), the ethos of college physical education (PE) and sports facilities (Laar et al., 2019b). Despite these constraints, Muslim women in Pakistan show a positive attitude toward sports, and religion is considered less of a constraint than other social and economic factors by the respondents of the study conducted by Laar et al. (2019b). However, very limited research is available about the issues that influence women's participation in physical activities in the Pakistani context (Nanayakkara, 2012; Laar et al., 2019a).

In Pakistan, the interpretation of Islam is mainly reserved for religious scholars, i.e., imams (officiating priests of a mosque), rather than people directly referring to the Quran themselves. In many cases, the Quran is misinterpreted, creating serious consequences in many fields, including women's outdoor activities and sports. There are some unwritten rules that are followed; for example, women cannot participate in sporting activities. Women's participation in sports is often viewed as bad in religious terms. However, as discussed above, the Quran promotes high-quality health and encourages men and women to participate in PE to maintain a healthy lifestyle (Qureshi and Ghouri, 2011). As Miles and Benn (2016) point out, it is not the religion that is against sporting activities; rather, 'the cultural requirements of the western and Islamic sports related environment conflicts with each other.'

Scenario of PE (as an Academic Subject) in Pakistan

If someone wants to understand the value of physical activity in any society, a consideration of PE in the society's schooling system is very important. PE is an educational process that

uses physical activities as a resource to help individuals acquire skills, health, knowledge, and attitudes that contribute to their best development and well-being. As mentioned above, physical activity on a daily basis during childhood and adolescence is very important for well-being and the prevention of various health conditions. According to Fatima (2019), the school environment is one of the most effective zones for planning and implementing interventions to encourage PE. However, there is not a single university/college in Pakistan fully dedicated to PE, although there are some universities and colleges that offer PE as a subject. Games (cricket, badminton, football, hockey, squash, snooker, and traditional games such as Kabaddi "wrestling") and athletics are the main activities in Pakistani institutions (Kamal and Khan, 2014).

In Pakistan, sports have not been given the attention they deserve (Fatima, 2011), and for some, they are still considered an extracurricular activity or hobby. Sports science is a vast field, but in Pakistan, it is not been given the actual meaning (Yasmeen, 1997). According to Fatima (2011), in Pakistan, the subject is considered a waste of time, and people who choose it are ridiculed. There is a lack of understanding of the importance, necessity, and scope of PE in Pakistan, despite its potential positive contribution to many social issues. Since a healthy body has a healthy mind, which actually helps to stay healthy (Kamal and Khan, 2014), sports have the potential to improve psychological behavior. This paper begins with an overview of sports and Islam in general and in the Pakistani context in particular. The focus then shifts to the current situation of PE as an academic subject in Pakistan. This is followed by a review of the relevant literature that has used the SCSRFQ, and then, the methodology and findings are described.

Santa Clara Strength of Religious Faith Questionnaire

According to Fetzer Institute/National Institute on Aging Working Group (1999), Sherman et al. (2001), and Hill et al. (2007), both empirical research and clinical practice need to use reliable, effective, and practical tools to evaluate spiritual and religious behavior, ideas, and practice. Sherman et al. (2001) and Hill et al. (2007) state that with the development of research in recent years, there are a large number of self-report instruments on behaviors, practices, and spiritual and religious beliefs. However, many of these tools are very lengthy and unsuitable for specific research environments, while others have little empirical research to support their reliability and validity. The SCSRFQ was developed and published in 1997 in the *Journal of Pastoral Psychology* and has since been reprinted several times (Avants et al., 2003; Batson and Shwalb, 2006; Plante, 2009). It is a short self-report measure using 10 items (or a short version of five items) to assess the intensity of and participation in religious beliefs. The original version of the scale consists of 10 items that use a four-point Likert scale from strongly disagree to strongly agree. The following are example items: "I pray daily," "My religious faith is extremely important to me," and "I look to my faith as a source of inspiration." According to previous studies (Plante and Boccaccini, 1997, 1997a), the SCSRFQ assesses participants' strength of religious faith regardless of their religious affiliation or denomination. It is applicable to people with no interest in or connection with religious organizations, traditions, and views (Plante and Boccaccini, 1997; Plante et al., 1999, 2002; Sherman et al., 1999, 2001; Storch et al., 2004). The SCSRFQ is valid and has also been found by Plante and Boccaccini (1997) to have high internal reliability (Cronbach's alpha = 0.95) and split-half reliability ($r = 0.92$). In addition, the SCSRFQ is easy to obtain free of cost.

Studies of the internal consistency of the scale have found a correlation ranging from 0.94 to 0.97, whereas based on a split-half reliability score and Cronbach's alpha score, the range is from 0.90 to 0.96 (Plante and Boccaccini, 1997; Plante et al., 1999, 2002; Sherman et al., 1999). The SCSRFQ is correlated with other quality religious faith instruments, such as the Age Universal Religious Orientation Scale (AUROS), $r = 0.70$ to 0.90, and the Religious Life Inventory (RLI), $r = 0.76$ to 0.90. The SCSRFQ is also correlated with the Duke Religious Index (DRI), $r = 0.71$ to 0.85 (Cronbach, 1951; Schmitt, 1996; Plante and Boccaccini, 1997; Plante et al., 1999, 2002; Sherman et al., 1999). Therefore, existing research shows that the SCSRFQ is a highly reliable instrument for measuring religious beliefs and their impact on other social aspects of life (Plante and Boccaccini, 1997; Hu and Bentler, 1999; Plante et al., 1999, 2002; Sherman et al., 1999). The main purpose of the current research is to highlight the religious beliefs of Pakistani women about sports by using an adapted version of the SCSRFQ based on the theoretical perspective of feminism in sports and to focus on whether their religious beliefs contradict their participation in sporting activities, while keeping the hypothesis that religious believes may impact the women sport participation and the age and marital status of the respondents have the different attitude towards sports participation.

METHODS

This study was conducted in the Muslim country of Pakistan in August 2019. It is part of a larger project investigating women's participation in sports and physical activities and its influence on various factors, including religion, socioeconomics, culture, and family (see Laar, 2019; Laar et al., 2019a,b, 2020). All participants were female Suni Muslims and were selected from the Sindh province (2nd largest province of Pakistan) using snowball sampling (Laar et al., 2019b, 2021). As in previous research (Young et al., 2003; Mirsafian et al., 2014; Laar et al., 2019a), this study also conducted a survey to gain quantitative data. In the first stage, a sample of 400 participants was selected. The final sample size of valid responses, after data collection and using AMOS, was 357, yielding a response rate of 89.2% (**Table 1**). Notable, the sample was calculated with the help of Sample Size Calculator (SSC). The data collection process was completed in 5 weeks. The major characteristics of the sample ($n = 357$) are as follows: age—16–19 ($n = 60$, 16.8%), 20–23 ($n = 155$, 43.4%), and 23 and above ($n = 142$, 39.8%); participating in sport ($n = 186$, 52.1%); education—intermediate ($n = 52$, 14.5%), bachelor's ($n = 122$, 34.2%), master's ($n = 157$, 44%), and PhD ($n = 26$, 7.3%); school campus—girls' campus ($n = 118$, 33.1%)

and coeducation ($n = 239$, 66.9%); marital status—unmarried ($n = 257$, 72%) and married ($n = 100$, 28%); and school type—public ($n = 267$, 74.8%) and private ($n = 90$, 25.2%; see **Table 1**).

Based on the aim of the study, a two-part questionnaire was created based on the previous literature (Qureshi and Ghouri, 2011; Mirsafian, 2014; Mirsafian et al., 2014; Zvan et al., 2017; Laar et al., 2019a). The first part requested background- and sports-related information from the participants; the second part addressed their Islamic beliefs using the SCSRFQ, which is based on a Likert scale (Jackson, 1983; Henderson et al., 1988; Sherman et al., 2001; Plante, 2010; Dianni et al., 2014; Laar et al., 2019a) ranging from (1) strongly disagree to (4) strongly agree. The questionnaire was designed in the English language, which is the second most commonly spoken language and the official language of Pakistan. In the current study, the standard procedure for developing and establishing the psychometric characteristics of the scale was followed. These measures are generally designed for scales, especially for the development of religious and/or spiritual (R/S) scales. The authors acknowledge that they are not scale psychometrics or translation experts (readers may wish to review Boateng et al., 2018, and Koenig and Al Zaben, 2021 for a more in-depth description and definition).

Before the survey, the participants were informed of the purpose of the current research and that participation was voluntary. Their affiliations and identity are not revealed to ensure the confidentiality and privacy of their data. Current research provides opportunities to understand the current status of women's participation in sports in Pakistan and whether their religious beliefs are inconsistent with their participation in sports. It is worth noting that these types of data (especially about women) are often difficult to obtain in Pakistani society, making it extremely important and valuable; thus, confidentiality was essential. Notably, a one-sample *t*-test, independent sample *t*-test and multivariate analysis (MANOVA) were used to analyze the data. The results of the survey then underwent a Pearson correlation test, with the primary focus on the following question: does the strength of their religious beliefs influence the sports participation of Pakistani women?

TABLE 1 | Background information of the participants.

Elements	Frequency	Percentage
Sample distribution		
Total female students	400	100
Valid responses (after data collection and using AMOS)	357	89.2
Participating in sport	186	52.1
Age (Mean = 2.23 ± SD = 0.71)		
16–19 years	60	16.8
20–23 years	155	43.4
Over 23 years	142	39.8
Education		
Intermediate	52	14.5
Bachelor's	122	34.2
Master's	157	44.0
PhD	26	7.3
School campus		
Girls' campus	118	33.1
Coeducation	239	66.9
Marital Status		
Unmarried	257	72.0
Married	100	28.0
School type		
Public	267	74.8
Private	90	25.2

Statistical Analyses

First, normality test was conducted to ensure the data is approximately normally distributed, followed by one-sample *t*-test of the SCSRFQ items to determine the participants' religious beliefs. All the items were analyzed through test variable(s). On

TABLE 2 | SCSRFQ items *t*-tests: Differences between sports participating and non-participating women with factor loadings and h^2.

SCSRFQ items	Q8. Do you participate in sports?	Mean	±SD	*t*	Value of *p*	Factor Loadings	h^2
Q13. My religion faith is extremely important to me.	Yes	3.35	0.69	3.438	0.001	0.67	0.75
	No	3.08	0.81				
Q14. I pray daily.	Yes	3.06	0.79	0.823	0.411	0.91	0.58
	No	2.99	0.84				
Q15. I look to my faith as a source of inspiration.	Yes	3.26	0.73	3.330	0.001	0.82	0.66
	No	2.99	0.77				
Q16. I look my faith as providing meaning and purpose in my life.	Yes	2.21	1.03	−1.676	0.095	0.76	0.71
	No	2.40	1.09				
Q17. I consider myself active in my faith.	Yes	3.06	0.77	−0.842	0.400	0.78	0.49
	No	3.13	0.79				
Q18. My faith is an important part of who I am as a person.	Yes	3.25	0.79	2.600	0.010	0.82	0.53
	No	3.02	0.84				
Q19. My relationship with God is extremely important to me.	Yes	3.40	0.79	1.057	0.291	0.59	0.65
	No	3.30	0.88				
Q20. I enjoy being around others who share my faith.	Yes	3.02	0.78	0.189	0.850	0.83	0.51
	No	3.00	0.83				
Q21. I look my faith as a source of comfort.	Yes	3.24	0.71	2.857	0.005	0.72	0.63
	No	3.02	0.77				
Q22. My faith impacts many of my decisions.	Yes	3.08	0.80	0.555	0.579	0.58	0.71
	No	3.03	0.77				

the other hand, to analyze the participants' level of participation in sports, *t*-tests were applied to sports participation items and to the unmarried and married variables. "Marital status" was assigned as "grouping variable," whereas the rest of the items were categorized as "test variables" (see **Table 3**). Moreover, multiple regression model including marital status and age as predictors, with attitudes toward sports participation as the dependent variable was conducted to examine the relationship of the variances (see **Table 4**). In addition, to analyze the question "do religious beliefs affect participants" participation in sports?, the interrelations among the items (questions) were measured, and bivariate correlation analyses were run to obtain the results (see **Table 5**). Notably, a one-factor model was postulated. The models were tested using confirmatory maximum likelihood (ML) factor analysis parameter estimates in AMOS 24. Data were filtered by eliminating all defective samples.

TABLE 3 | Sports played by Pakistani women.

Sport	n	%
Badminton	65	34.95
Cricket	122	65.59
Yoga	12	6.45
Table tennis	27	14.52
Gymnastic	18	9.68
Swimming	15	8.06
Shooting	11	5.91
Running	7	3.76
Aerobics/Dance	6	3.23
Basketball	12	6.45
Football	21	11.29
Volleyball	12	6.45
Tennis	32	17.20
Bike	45	24.19
Hockey	8	4.30

Only 186 female students are enabling to respond to this question rest of the female students do not participate in any sports.

FINDINGS

The aim of the study was to assess the impact of religious beliefs on sports participation using a questionnaire incorporating the SCSRFQ. Notably, skewness and kurtosis *z*-values of data is in between −1.96 and +1.96 and the Shapiro–Wilk test value of p is above 0.05 ($p > 0.05$) in most of the cases. Hence, example data of this study are a little skewed and kurtotic, but it does not differ significantly from normality. It can be assumed that data are approximately normally distributed, in terms of skewness and kurtosis. The results reflect three steps: measuring religious beliefs and sports participation, conducting confirmatory factor analysis (CFA), and determining internal consistency reliability, which mainly pertain to the SCSRFQ (Sherman et al., 2001; Plante, 2010; Dianni et al., 2014; Pakpour et al., 2014). Descriptive statistics established that the mean strength of religious faith score, as assessed by the SCSRFQ, was 30.40 (SD = 8.10). Judging by the authors of the SCSRFQ questionnaire, this score seems to be relatively high while having alpha coefficient = 0.82.

TABLE 4 | Sports participation item *t*-tests: Differences between unmarried and married participants with factor loadings and h^2.

Dimension	Marital status	Mean	±SD	*t*	*Value of p*	Factor loadings	h^2
Q7. Physical activity is important to me.	Unmarried	3.36	0.75	−1.302	0.194	0.69	0.69
	Married	3.47	0.56				
Q8. Do you participate in sports?	Unmarried	1.44	0.497	−2.637	0.009	0.81	0.58
	Married	1.59	0.494				
Q9. Do you think that, according to the teachings of Islam, males/females should not do sports?	Unmarried	2.17	1.039	0.010	0.992	0.58	0.73
	Married	2.17	0.965				
Q11.7. Religion does not allow	Unmarried	1.97	0.174	1.261	0.208	0.55	0.64
	Married	1.94	0.239				
Q12.2. Control religious and cultural restrictions	Unmarried	1.77	0.424	−0.271	0.787	0.69	0.77
	Married	1.78	0.416				

TABLE 5 | Multiple regression model (age and Marital status as predictors with attitudes toward sports participation).

Regression weights		Beta coefficient	R2	F	*t*-value	Value of *p*	Sig. (Model)
Attitudes toward sports participation (Q7)	Age	0.03	0.06	1.03	0.60	0.546	0.36
	Marital status	0.10			1.18	0.241	
Attitudes toward sports participation (Q8)	Age	−0.15	0.06	12.62	−4.24	0.000	0.00
	Marital status	0.20			3.40	0.001	
Attitudes toward sports participation (Q9)	Age	−0.21	0.02	3.99	−2.82	0.005	0.02
	Marital status	0.06			0.48	0.630	
Attitudes toward sports participation (Q10)	Age	0.03	0.01	0.126	0.44	0.659	0.88
	Marital status	−0.03			−0.31	0.754	

Q7, Physical activity is important to me. Q8, Do you participate in sports? Q9, Do you think that, according to the teachings of Islam, males/females should not do sports? Q10, Participation in physical activities is mainly not encouraged by my own family members and by society and culture.

Measuring Religious Beliefs and Sports Participation

The main purpose of this study is to observe whether religious beliefs inhibit women's sports participation in Pakistan. To answer the research question, the data were analyzed in three sub-steps.

Religious Beliefs

The results of the women who practice sports and those who do not regarding the SCSRFQ items shows that the responses of 6 item out of 10 are significantly different with a *p*-value of <0.05 ($p < 0.01$; see **Table 2**). Whereas, rest of the four items such as: Q14, Q19, Q20, Q22 show the similarity in responses ($p > 0.05$). In addition, **Table 2** highlights the validity and factor loading of all items in both instruments with h^2. The results indicate that factor analysis of both instruments, adapted to the SCSRFQ and other items (**Table 4**), was appropriate for the data (Stevens, 1996). Items with a factor loading of more than 0.40 were considered to have loaded onto one factor (Hinkin, 1995; Stevens, 2012).

Sports Participation

Table 3 illustrated the type of sport generally participated by the female participants. The ratio of participating in Cricket is high followed by badminton 65.59% and 34.94%, respectively. **Table 4** shows that married and unmarried participants did not demonstrate a large difference in their sports participation (Q8, "Do you participate in sports?"). This result reveals that compared with unmarried women, married women participate slightly more in sporting activities. For all the remaining sporting-related items, married and unmarried participants showed similar responses indicating that sports are important to them. However, some of women still did not participate for different reasons (Q7). On the other hand, both groups disagree that Islam restricts sports participation (Q9). The ratio of married to unmarried participants saying that Islam does not allow women to participate in PE is also almost the same (Q11.7), and the rate of married and unmarried women suggesting that controlling religious and cultural restrictions can enhance female sports participation in Pakistan also does not show a large difference (Q12.2; see **Table 4**). The validity and communalities of all items in both instruments with h^2 are highlighted in **Table 4**.

To examine the relationship between attitudes toward sports participation (dependent variable) and participant characteristics, such as marital status and age, multiple regression model was designed. The results show that the attitude of young and unmarried participants toward sports participation or importance is more positive (**Table 5**). Notably, the observed covariance matrices of the dependent variables are equal across groups ($p > 0.05$). The Age and Marital status significantly predicted only one dependent variable (attitudes toward sports participation Q8) $F = 12.62$, and $p < 0.005$ (**Table 5**). Whereas, there is no difference in responses based on age or marital status of the participants in rest of variables. Hence, author reject hypothesis which says there is significant difference between the age and marital status towards attitude of sports participation.

Correlation Between the Strength of Religious Beliefs and Sports Participation

Pearson product correlation of total score for the SCSRFQ and each of the sports participation items was found to be very low positive and negative correlation ($r = 0.06$, -0.13, -0.06, 0.03, respectively and $p > 0.05$ except the correlation of total score of SCSRFQ with Q8; see **Table 6**). This shows that there is no difference in responses regarding the attitudes toward sports participation based on age or marital status. In other words, it can be narrated that, religion believes of the participants of current study does not impact their attitudes towards sports participation.

DISCUSSION AND CONCLUSION

This study provides a complete understanding of religious beliefs and the sports participation of Pakistani women, mainly focusing on the question of "do religious beliefs influence the participation of Pakistani women in sports?" According to the results, most participants have religious beliefs (with an average value of 3.05 out of 4), mainly Islam. They practice their faith regularly, and it influences many of their decisions in life. These findings match the results of other studies, such as Laar et al. (2019b) and Ashraf (2018), who argue that religion has a greater impact on most of the aspects of life in Pakistan than in other Islamic nations. In Pakistan, more than 90% of the population practices Islam. The results of this study reveal that although almost 50% of the participants do not participate in sporting activities, the majority believe that it is very important to participate in sporting activities and that Islam does not have any conflict with sports participation (Miles and Benn, 2016; Oates, 2016; Laar et al., 2019a,b). These results can be explained such as: in Pakistan, many people perform the cultural (including traditional sports) and ritual activities together which can normally see in national media too, which proofs the good image of religion and does not leave a conflict nature of religion with sports for the people of Pakistan. This study shows that the sports participation rate of unmarried women is higher than that of married women. These results may be explained by the tendency of men to restrict their wives' outside activities. As Laar et al. (2019b) and Hakim and Aziz (1998) observe that, in Pakistan, patriarchy is widespread, with men mainly (but not exclusively) controlling their wives' external activities.

TABLE 6 | Pearson correlation of total score for the SCSRFQ with each of the sports participation items.

	Total score of SCSRFQ&Q7	Total score of SCSRFQ&Q8	Total score of SCSRFQ&Q9	Total score of SCSRFQ&Q10
Pearson correlation	0.06	−0.13*	−0.06	0.03
Value of p	0.21	0.02	0.22	0.55

**Correlation is significant at the 0.05 level (two-tailed). Q7, Physical activity is important to me. Q8, Do you participate in sports? Q9, Do you think that, according to the teachings of Islam, males/females should not do sports? Q10, Participation in physical activities is mainly not encouraged by my own family members and by society and culture.*

The main objective of the current study is to assess the impact of religious beliefs on sports participation among Pakistani women from the theoretical perspective of feminism in sports and using the SCSRFQ. According to the results shown in **Table 6**, individuals' religious beliefs do not have any negative impact on Pakistani women's participation in sports. The correlation of the variables related to the religious believes and not practicing sports is significantly low. These results were unexpected and surprising (alternative hypothesis H_a). Because much of the previous literature (e.g., Haley et al., 2001; Fitzgibbons, 2015) claims that religion can reduce sports participation, especially among women. These results make this study relevant and unique in the field of measuring the religious believes and sports participation especial in Pakistani women context. However, there are some exceptional studies that highlight that religion (mainly Islam) does not prevent women's participation in sports (Miles and Benn, 2016; Oates, 2016; Laar et al., 2019b). In addition, Miles and Benn (2016) note that any reduction is not a consequence of religion *per se* but of the conflict between the cultural requirements of Islamic and Western sports-related environments, such as the wearing of sporting clothes and the intermingling of the sexes during sports participation. However, very few participants in this study (14 out of 357, 3.9%) thought religion was an obstacle to their sports participation, whereas 82 participants (23%) suggested that controlling religious and cultural limitations could enhance women's sports participation. This study was based on women in only one province of Pakistan; thus, there might be a difference of opinion if men in Pakistani society are surveyed. However, our study focused only on women's religious beliefs and the impact of their beliefs on their sports participation. The majority of the participants had religious beliefs, but according to the participants of this study, these religious beliefs did not reject women's sports participation in Pakistan.

This study has many implications that could contribute to Pakistan in different ways. First, although the results of this study show that religious beliefs do not have any strong influence on Pakistani women's sports participation, the levels in Pakistan are low (Klein, 2007; Mirsafian et al., 2014; Laar et al., 2019a,b, 2020). To tackle this problem, unwritten and misleading rules regarding Islam should be vigorously challenged: Islam is not an anti-sports religion (Benn and Ahmed, 2006; Benn et al., 2010). Second, according to Laar et al. (2019b), the media should represent images of real sportswomen who would surely impress many of their fans. This would be helpful in enhancing women's sports participation in Pakistan. Finally, and most importantly, women themselves should learn from feminist theory that they should stand up for their rights in this male-dominated society. They should stand firm and not let themselves be oppressed by the tactics of other society members.

Discovering the underlying reasons for these unwritten and misleading rules could be a challenge for future studies with larger samples. However, these perceptions might be explained by the fact that, as a religion, Islam is open for individual interpretation. Pakistan has great talent in sports, but there is a lack of opportunities and facilities that hold the country back in this field (Laar et al., 2019b, 2020). If we can bring physical activities back to educational institutions, Pakistan can surely enhance sports participation and performance in sporting events, especially for women. Furthermore, an internal shift in the traditional view that Islam is against women's sports and the corresponding cultural limitations should increase participation in sports and society. Programs demonstrating the benefits of sports for parents and women can also help in better understanding the topic. The reasons for the lack of participation of Pakistani athletes, especially in international events such as the Olympics, may represent another fascinating question for future research. Future research could also focus on using the SCSRFQ with more participants (especially interviewing husbands) and study populations. Sports educators who use the scale are encouraged to publish their findings in a journal.

Study Limitations

This study has some limitations. First, the participants were female only, and the responses of male participants may be different. Second, the study was conducted in one province only; thus, it may not represent the entire population. Third, all participants belonged to one sector of Islam (Sunni Muslims), and the responses of the Shia sector of Islam may show different opinions. Fourth, asking female respondents whether religious beliefs inhibit women's participation in sports may have caused some endogeneity issues. Fifth, the geographical, sociocultural, and religious elements of the selected population were similar, which may have led to bias. The investigators ensured that any bias and endogeneity issues were addressed to avoid such an outcome.

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 conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the School of Sports Science and Physical Education Hubei Normal University. We completely followed the relevant ethical considerations. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

RL: conceptualization, methodology, and writing-original draft preparation. MA, SZ, LZ, and ZZ: writing-review and editing. All authors contributed to the article and approved the submitted version.

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Development and Validation of Parental Support Scale of Children's Sports Training in China: Socio-Ecological Approach

Nan Zheng[1]* *and Ye Yang*[2]*

[1]School of Physical Education and Sport Training, Shanghai University of Sport, Shanghai, China, [2]School of Continuing Education, Shanghai University of Sport, Shanghai, China

Objectives: To promote Chinese children participation in sports training and acquisition of sports skills, we combined a social ecological research framework with parental support to develop the Parental Support for Children's Sports Training Scale (PSCSTS).

Methods: The scale was initially developed based on literature review, group interviews, and expert evaluations. A complete reliability and validity test was conducted on 1,594 parents of primary and secondary schools in Shanghai.

Results: The PSCSTS has 37 questions, and exploratory factor analysis has formed 10 factors: policy support, parents' financial support, community support, media support, sports development, school activity participation, parents' exercise habits, training quality support, development of school sports activities, learning skills. The higher-order models constructed by validated factor analysis fit well ($\chi^2/df = 2.130$, RMSEA = 0.038, SRMR = 0.042, GFI = 0.911, CFI = 0.928). The Parents of children of different sexes have measurement invariance in the PSCSTS.

Conclusion: The PSCSTS developed in this study based on a social-ecological framework has high reliability and validity, and can be used as a comprehensive measure of parental support for their children's sports training.

Keywords: scale development, parent support, children, sports training, socio-ecological

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Instituto Politécnico de Castelo Branco, Portugal

***Correspondence:**
Nan Zheng
zn0209@163.com
Ye Yang
yangye69@sus.edu.cn

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INTRODUCTION

A better level of sports skills is an important factor in promoting individuals to maintain lifelong sports behavior. The current situation of Chinese children's mastery of sports skills is not promising; they are still not proficient in a sports skill after years of physical education courses, which is an important reason for the lack of physical activity and the increase of obesity among Chinese children (Mao, 2019). Aside from physical education classes, various forms of sports training (school sports clubs, social sports training institutions, etc.) are important ways to help children's master sports skills. Children's participation in such organized sports training activities may require more support from their parents.

Parental support is an important factor in children's successful participation in organized sports training (Rittsteiger et al., 2021). Parental encouragement, behavioral support, and financial support are important factors in maintaining youth participation in a sport over time (Desroches et al., 2022). Existing research has measured parental support for their children's physical activity more along one dimension or a few items (Kirk et al., 1997; King et al., 2008; Hosseini et al., 2013). But parental support may include a variety of different behaviors, such as cheering on the sidelines, providing training funds, providing transportation, etc. (Knight et al., 2016). Thus, measuring parental support for sports training with a single question or a small number of items, while convenient, may not be sufficiently valid. In addition, the simple form of the measure only captures differences in overall parental support and does not reflect differences in different aspects of parental support.

Currently available instruments for measuring social support in sport such as the Perceived Available Support in Sport Questionnaire (PASS-Q; Freeman et al., 2011), and the Social Support Survey (SSS; Rees et al., 2000). Although these scales have a multidimensional structure, they are more suitable for evaluating the social support received by sport participants rather than how to promote supporter support. Specifically for example, the four-dimensional structure of the PASS-Q (emotional, Esteem, information, and tangible) can effectively evaluate the degree of support received by exercise participants on the corresponding dimensions, but cannot provide suggestions for improving supporter support. Therefore, we believe there is a need to develop a measurement tool to measure Chinese parents' total support for their children's participation in sports training and where this support originates.

Parents' support for their children's participation in sports training comes from a variety of sources. At the level of individual motivation, participation in sports contributes to mental health, emotional development, and physical health (Biddle et al., 2011; Warburton and Bredin, 2017; Brière et al., 2020), organized sports activities are more beneficial for children to acquire sports skills (Vandorpe et al., 2012), and some parents may see supporting their children's participation in sports training activities as an investment in the hope that their children will receive scholarships or become professional athletes in the future (Bean et al., 2014). Beyond the individual level, family support, socioeconomic status, and parental sports behaviors may influence children sports behaviors (Eime et al., 2013; Brown et al., 2020), the physical activity climate in the community may influence children physical activity levels (Cohen et al., 2017), and even more macroscopically, mass media and policies may influence children physical activity (Pate et al., 2011). It can be seen that parental support can come from several levels. Clearly, a comprehensive theoretical framework is needed to identify those influences that can drive parents to support their children's participation in sports training.

In recent years, social ecology has provided a new perspective for sports scholars to analyze the influencing factors of children sports behavior. This theory has a certain superiority over health belief theory and planned behavior theory, which intervene in individual sports behavior from internal factors, and social ecology emphasizes the core influence of the environment on sports behavior change, which provides ideas for establishing a long-term mechanism of children sports behavior intervention. The ecological model was first proposed by Professor Bronfenbrenner (1979) who believed that the interaction between individual behavior and the environment should be understood at different levels, such as micro, meso, and macro, and then Mcleroy et al. (1988) applied the ecological model to the field of health promotion by analyzing and developing health promotion programs at five levels: intrinsic factors, interpersonal, institutional, community, and policy.

The social ecology model is a valid analytical model for promoting individual behavior. The model is a multilevel structure, and influences that can promote children's physical activity behaviors exist at different levels (e.g., family level, school level, community level, etc.). Interventions at multiple levels are more effective than interventions at only the psychological level of the individual, so it is more effective to develop behavioral intervention programs based on multiple levels of influences. This model is highly adaptable and can be applied to interventions for other individuals who do not use sports behaviors (Sallis et al., 2015). In addition, the different socio-ecological levels do not exist in isolation from each other. The policy level may influence children's sports behavior by influencing the school level (Langille and Rodgers, 2010). The socio-ecological model can also be applied to health behavior interventions for adults, confirming that the environmental level and policy level can promote physical activity behavior and healthy eating among rural community residents (Barnidge et al., 2013). Therefore, we believe that it is reasonable and innovative to apply the social ecological model to the analysis of the division of parental support factors for their children's participation in sports training.

In summary, we believe that the multilevel structure of the social ecological model is an effective analytical model for exploring parental support factors. Therefore, we innovatively combined the social ecological model with parental support factors and combined it with the Chinese cultural context to develop the Parental Support for Children's Sports Training Scale (PSCSTS). It aims to effectively and comprehensively measure Chinese parents' support for their children's participation in sports training.

MATERIALS AND METHODS

Scale Construction

The PSCSTS was constructed mainly through literature review, interviews, and expert evaluation.

The specific question items at each level were primarily based on the social-ecological scale of children physical activity developed in recent years in the Chinese cultural context by Huang and Zhang (2020), Xiang (2019), and Chen and Sun (2014), and the expressions were modified according to the context of sports training while ensuring that the core concepts of the question items remained unchanged.

We interviewed 21 parents whose children were participating in sports training. The interviews were conducted on a telephone basis, and we stated that all information from the conversations would be used for academic research only, no personal information would be disclosed, all subjects participated voluntarily, and the interview time was limited to 5 min. All information is organized, categorized and used to expand the question items. It is worth noting that during preliminary discussions with the parents of children, some of them believed that "it does not matter where to train, but it mostly depends on whether the coach is professional enough" and that "the conditions of school venues and facilities are poor, so they participate in off-campus training institutions." In order to fully reflect the characteristics of reflecting children physical activity, this study designed the training quality support dimension in the ecological model.

Finally, we sent all the questions to six professors at Shanghai University of Sport, and the questions and categories that were considered unreasonable would be deleted.

The initial scale had seven dimensions in all. There were 16 items in the internal motivation dimension, 17 items in the family support dimension, 6 items in the training quality support dimension, 9 items in the school support dimension, 7 items in the community support dimension, 7 items in the policy support dimension, and 7 items in the media support dimension, for a total of 69 items, using a 5-point Likert scale, including "totally disagree," "disagree," "average," "agree" and "totally agree" with scores of 1, 2, 3, 4, and 5, respectively.

Calibration Tools

The Physical Activity Rating Scale (PARS-3; Liang, 1994) was used to evaluate parents' physical activity behaviors using three topics: single duration, frequency, and intensity of participation in physical activity activities in the last 3 months, scored on a five-point Likert scale, and considered to have good school standard association validity if there was a positive correlation between support scores for each dimension and parental exercise behavior scores.

Distribution and Collection of Questionnaires

We conducted the survey from October to December 2021. We selected 16 schools in 16 districts in Shanghai, including 12 elementary school and four secondary schools, making the sample as representative of Shanghai as possible. The survey was conducted among the parents of some students in these schools. In the preparation phase of the survey, the initial questionnaire was created electronically and completed by online responses. A teacher from each school was contacted to assist in the delivery of the study questionnaire, and the QR code and web link to the electronic questionnaire were sent by the teacher to a parent communication group.

All surveys were voluntary, and respondents read the informed consent form before starting to respond. We declare that all information will be kept confidential and can be withdrawn at any time during the filling process. In addition, to ensure the validity of the questionnaires, the questionnaires were considered invalid if they contained a large number of identical responses, if they were incomplete, or if they were completed too quickly (at least 3 s for each item).

The final sample consisted of 1,594 parents of students, and we called back 25 parents of students, 23 of whom were willing to be retested at 15-day intervals. The age range of the respondents' children was between 6 and 17 years old, Media = 9.00, Mean (M) = 9.77, and SD = 2.64. The gender of the survey respondents' children was 46.55% male (n = 742), 33.06% female (n = 527), and 20.39% both male and female (n = 325).

The 1,594 samples will be randomly divided into two separate groups in SPSS, Sample A (N = 797) and Sample B (N = 797), with Sample A undergoing exploratory factor analysis and Sample B undergoing confirmatory factor analysis. The recommended requirement for conducting factor analysis is that the sample size be greater than five times the number of items (Hair et al., 2011), and the initial number of scale items in this study was 69, and both Samples A and B were able to meet the recommended criteria.

Statistical Analysis

In exploratory factor analysis (EFA), this study used principal component analysis to extract factors with eigenvalues greater than 1, the optimal oblique intersection method was used for factor rotation, and the existence of a certain correlation among the factors was more in line with theoretical reality.

In the confirmatory factor analysis (CFA), we examined the common method variance (CMV) and measurement invariance of the model. The final attempt to construct a higher-order model based on the first-order model.

The analysis was performed using SPSS 26.0 with AMOS 24.0.

RESULTS

In SPSS, we randomly selected 50% of the 1,594 samples as Sample A (n = 797) for item analysis and exploratory factor analysis (EFA), and the remaining 50% as Sample B (n = 797) for confirmatory factor analysis (CFA).

Exploratory Factor Analysis

After removing two polygraph questions, the remaining 69 questions were included in the factor analysis and the Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were as follows.

Table 1 shows that the KMO value reached 0.929, representing an excellent score, indicating the presence of partial correlation between the variables (Kaiser, 1974). Bartlett's test reached the

TABLE 1 | KMO and Bartlett's test.

Number of items	Kaiser-Meyer-Olkin	Bartlett	χ^2	*df*	Sig.
69	0.929	0.000	20233.580	2,346	0.000

significance level, indicating that linear combinations existed and variables within the population correlation matrix were uncorrelated (Watson, 2017). This indicates that the data is suitable for EFA.

The extraction method in EFA in SPSS was the principal component method, and the rotation method was Promax. The criteria for removing items in EFA are (1) factor loadings below 0.45, (2) the number of items under a single dimension less than 3, (3) cross-loadings greater than 0.40, and (4) items that cannot be explained by theory. Only one question item was deleted each time, and then EFA was performed. After several operations, 13 question items were finally deleted and 56 question items were retained, with 12 factors with eigenvalues greater than 1, which cumulatively explained 55.655% of the total variance, and the factor loadings of each question item were between 0.488 and 0.839. In the remaining 56 items, the Skewness of each variable was less than 2 and the Kurtosis was less than 5, so each variable can be considered to follow a normal distribution (Curran et al., 1996), as shown in **Table 2**.

TABLE 2 | Descriptive statistics and factor loading of items.

Items	Mean	SD	Skewness	Kurtosis	Factor loading
Q58	3.536	0.933	−0.407	−0.124	0.809
Q59	3.184	1.022	−0.121	−0.485	0.797
Q60	3.986	0.826	−0.726	0.572	0.606
Q61	3.699	0.972	−0.463	−0.198	0.758
Q62	3.459	1.039	−0.480	−0.258	0.744
Q63	3.657	1.031	−0.589	−0.221	0.728
Q64	3.380	1.075	−0.259	−0.534	0.828
Q50	3.980	0.781	−0.520	0.093	0.595
Q52	3.346	1.029	−0.197	−0.525	0.708
Q53	2.974	1.136	0.036	−0.759	0.763
Q54	2.908	1.103	0.125	−0.679	0.761
Q55	3.546	1.001	−0.616	0.012	0.768
Q56	3.567	0.978	−0.403	−0.207	0.771
Q11	2.947	1.044	0.099	−0.380	0.710
Q13	2.349	1.063	0.673	−0.037	0.749
Q14	2.780	1.081	0.038	−0.667	0.816
Q15	3.069	1.092	−0.096	−0.592	0.760
Q16	3.862	0.848	−0.662	0.502	0.597
Q65	3.912	0.760	−0.574	0.411	0.681
Q66	3.817	0.994	−0.695	0.070	0.617
Q67	3.353	1.083	−0.253	−0.561	0.669
Q68	3.706	0.969	−0.722	0.285	0.737
Q69	3.838	0.822	−0.563	0.382	0.635
Q70	3.858	0.859	−0.631	0.434	0.598
Q41	4.034	0.698	−0.401	0.274	0.746
Q42	4.325	0.824	−1.258	1.576	0.764
Q45	3.846	0.904	−0.541	0.056	0.570
Q47	4.099	0.809	−0.867	0.942	0.733
Q17	3.746	0.896	−0.589	0.153	0.633
Q18	3.541	1.005	−0.354	−0.456	0.773
Q19	4.271	0.698	−0.782	0.811	0.601
Q22	3.734	0.967	−0.502	−0.224	0.783
Q23	3.844	0.945	−0.626	0.027	0.644
Q36	4.327	0.809	−1.205	1.349	0.720
Q37	4.286	0.777	−1.189	2.137	0.718
Q38	4.276	0.758	−0.959	1.032	0.649
Q40	4.523	0.609	−1.649	3.620	0.677
Q1	4.641	0.560	−1.628	4.117	0.690
Q3	4.463	0.628	−0.866	0.499	0.586
Q5	4.592	0.574	−1.303	2.246	0.642
Q7	4.408	0.697	−1.131	1.601	0.634
Q9	4.349	0.720	−1.038	1.401	0.516
Q25	3.524	1.071	−0.418	−0.586	0.759
Q26	3.344	1.130	−0.358	−0.712	0.803
Q27	3.412	1.128	−0.411	−0.562	0.782
Q2	4.168	0.726	−0.643	0.533	0.622
Q4	4.077	0.831	−0.670	0.244	0.735
Q6	4.156	0.752	−0.619	0.141	0.547
Q8	3.858	0.893	−0.408	−0.339	0.711
Q43	3.737	0.892	−0.269	−0.420	0.704
Q46	3.906	0.867	−0.479	−0.239	0.674
Q48	3.897	0.849	−0.396	−0.236	0.763
Q29	3.345	1.107	−0.290	−0.586	0.593
Q30	3.512	1.034	−0.401	−0.416	0.694
Q31	4.072	0.832	−0.869	0.931	0.626
Q33	3.577	1.120	−0.452	−0.505	0.714

Confirmatory Factor Analysis

The remaining 56 question items were included in AMOS for first-order oblique CFA using the maximum likelihood estimation. Before the CFA, we used an online calculator to calculate the required sample size for the CFA, using a date of May 4, 2022 (Soper, 2022). We entered the results given by the EFA (12 latent variables and 56 observed variables) into the calculator, with the Anticipated effect size set to 0.3 and the desired statistical power level designed to 0.8. The probability level is designed to be 0.05. The results suggest that the minimum sample for the model structure is 89, and the recommended minimum sample size is 200, so Sample B ($n = 797$) can be subjected to CFA.

Referring to the suggestion of Hooper et al. (2008), the rules for CFA include: (1) rejecting inter-residual correlations and eliminating questions with high residual MI correction indices; (2) standardized factor loadings < 0.50; and (3) the number of variables within dimensions < 3. A total of 19 questions were removed in CFA, of which Q3 was eliminated due to low factor loadings, Q1 and Q9 were difficult to form a dimension, so they were both removed. The final first-order oblique model includes 37 observed variables with a total of 10 dimensions. We used χ^2/df, RMSEA, SRMR, GFI, and CFI to evaluate the fit of this model. χ^2/df should be less than 5, RMSEA should be less than 0.1, SRMR should be less than 0.05, GFI should be greater than 0.8, and CFI should be greater than 0.9 (Bentler, 1990; Browne and Cudeck, 1993; Seyal et al., 2002; Schumacker and Lomax, 2004; see **Table 3**).

The fit index of the first-order oblique factor model in this study were able to meet the recommended criteria.

The remaining 10 dimensions were named by the common characteristics of the question items within each dimension, see **Table 4**.

Model Structural Validity

Reliability and Convergent Validity

In this study, average variance extracted (AVE) was used to evaluate the convergent validity of the dimensions, and composite reliability (CR) were used to evaluate the consistency of the dimensions. The recommended value for CR is greater than 0.7 (Raykov, 1997; Hair et al., 2019), AVE ≥ 0.50 is ideal (at this time the average of standardized factor loadings within

TABLE 3 | Fit index of first-order oblique factor model.

Model	χ^2	χ^2/df	RMSEA	SRMR	GFI	CFI
First-order oblique factor model	1198.167	2.052	0.036	0.038	0.921	0.937

TABLE 4 | Items and dimensions of PSCSTS (translated from the Chinese version).

Items	Factor
59: Familiar with children sports policies in recent years	Policy support
60: Enactment of children sports policies can promote my support for my children's participation in sports training	
61: Interested in children sports policies	
62: Know where to check children sports policies	
63: Often see children' sports policies promoted	
64: Often check children sports policies voluntarily	
52: Sports activities are well built near my community	Community support
53: Children sports activities are often organized near my community	
55: Children often exercise near my community	
56: Good atmosphere for physical exercise near the community	
25: I have a fixed activity content for each sports meeting	Parents' exercise habits
26: I have a fixed time for each sports meeting	
27: I have a fixed exercise area for each sports meeting	
17: I support my child to go to a paid gym to exercise	Parents' financial support
19: I support my child to buy sports equipment	
22: I am able to provide my child with various fitness and recreational protection	
23: I support my child to spend money on sports training	
11: Participation in training is good for getting competition rankings	Sports development
13: Participation in training is good for realizing parents' sports dreams	
14: Participation in training facilitates entry into professional sports teams	
2: Children's participation in sports training facilitates the acquisition of a sports skill	Learning skills
4: Mastery of a sports skill is important	
8: Mastery of a sports skill is indispensable for lifelong growth	
43: The school has abundant after-school sports competitions	Development of school sports activities
46: The school's sports games are well developed	
48: The school often conducts various sports competitions and training activities	
41: Children like to play sports at school	School activity participation
42: Children like to take physical education classes	
45: Children like physical education teachers	
47: Children like to participate in various sports activities at school	
36: I value the training quality of the training institution	Training quality support
37: I value the professional knowledge of the trainer	
38: I value the professional skills of the trainer	
65: Broadcast of exciting events can increase my support for my children's participation in training	Media support
66: My children will want to go to sports training if they have a sports star they admire	
67: I have a favorite sports star that can increase my support for my children's participation in training	
68: High profile media coverage of athletes is good for increasing my support	

the dimension should be greater than 0.71), $0.50 > AVE \geq 0.36$ is acceptable (at this time the average of standardized factor loadings within the dimension is 0.71 ~ 0.60; Fornell and Larcker, 1981).

According to **Table 5**, the standardized factor loadings of all retained question items in this study's CFA were greater than 0.50 ($p < 0.001$), the CR values of each dimension were 0.640–0.861, with most dimensions able to reach the recommended values, except for LS (CR = 0.658) and TQS (CR = 0.641), which were slightly below the recommended values. The AVE values for each dimension ranged from 0.373 to 0.511, with lower AVE values for some dimensions, probably due to the wide range of ecological factors that make it difficult to have high internal consistency, but all met acceptable criteria. This suggests that the first-order oblique intersection CFA in this study has strong convergent validity and reliability. This indicates that the convergence validity and reliability of the first-order oblique CFA in this study can be achieved.

Discriminant Validity

The discriminant validity of the model was tested by comparing the square root of AVE of each dimension to the correlation coefficients of other dimensions. If the square root of AVE is greater than the dimension's correlation coefficient with other dimensions, it means that each dimension in the model has some internal convergent validity while also having some discriminant validity with other dimensions (Fornell and Larcker, 1981).

As shown in **Table 6**, the square root of AVE for each dimension of the first-order CFA model was greater than the

TABLE 5 | Table of reliability and convergent validity.

Variables	Items	S.E.	*T*-value	*P*	Estimate	SMC	CR	AVE
PS	Q59				0.755	0.570	0.860	0.509
	Q60	0.040	14.944	***	0.547	0.299		
	Q61	0.045	18.680	***	0.675	0.456		
	Q62	0.051	20.308	***	0.729	0.531		
	Q63	0.051	19.825	***	0.713	0.508		
	Q64	0.052	23.269	***	0.830	0.689		
CS	Q52				0.612	0.375	0.789	0.484
	Q53	0.090	15.206	***	0.725	0.526		
	Q55	0.081	14.901	***	0.702	0.493		
	Q56	0.077	15.349	***	0.737	0.543		
SD	Q11				0.611	0.373	0.755	0.511
	Q13	0.096	14.597	***	0.816	0.666		
	Q14	0.085	14.347	***	0.702	0.493		
LS	Q2				0.564	0.318	0.658	0.393
	Q4	0.118	11.092	***	0.685	0.469		
	Q8	0.126	10.924	***	0.625	0.391		
PEH	Q25				0.770	0.593	0.755	0.508
	Q26	0.058	16.489	***	0.721	0.520		
	Q27	0.054	15.318	***	0.641	0.411		
PFS	Q17				0.661	0.437	0.755	0.437
	Q19	0.054	13.693	***	0.592	0.351		
	Q22	0.076	14.717	***	0.649	0.421		
	Q23	0.073	16.005	***	0.734	0.539		
DSA	Q43				0.677	0.458	0.736	0.481
	Q46	0.062	14.685	***	0.674	0.454		
	Q48	0.065	15.267	***	0.729	0.531		
SAP	Q41				0.709	0.503	0.774	0.464
	Q42	0.064	16.582	***	0.701	0.491		
	Q45	0.068	13.340	***	0.545	0.297		
	Q47	0.070	17.371	***	0.752	0.566		
TQS	Q36				0.607	0.368	0.641	0.373
	Q37	0.092	10.998	***	0.613	0.376		
	Q38	0.091	10.999	***	0.613	0.376		
MS	Q65				0.628	0.394	0.752	0.431
	Q66	0.091	14.275	***	0.650	0.423		
	Q67	0.094	14.882	***	0.690	0.476		
	Q68	0.081	14.396	***	0.657	0.432		

****p* <0.001.

TABLE 6 | A list of discriminant validity.

Factors	1	2	3	4	5	6	7	8	9	10
1. DSA	**0.694**									
2. MS	0.456	**0.657**								
3. TQS	0.267	0.487	**0.611**							
4. SAP	0.555	0.486	0.395	**0.681**						
5. PFS	0.377	0.648	0.499	0.448	**0.661**					
6. PEH	0.403	0.473	0.387	0.316	0.524	**0.713**				
7. LS	0.345	0.389	0.302	0.321	0.354	0.257	**0.627**			
8. SD	0.268	0.357	0.117	0.128	0.283	0.297	0.417	**0.715**		
9. CS	0.532	0.519	0.203	0.381	0.445	0.437	0.278	0.330	**0.696**	
10. PS	0.440	0.651	0.385	0.440	0.571	0.473	0.368	0.406	0.577	**0.713**

The bolded part is the square root of the corresponding dimension AVE.

correlations between the other dimensions in this investigation, showing that the model had high validity.

Content Validity and Retest Reliability

Content validity refers to the extent to which test items reflect the subject (Devellis and Thorpe, 2021).

Six physical education professors from Shanghai universities of sport were asked to analyze the questionnaire's content, and all six professors found the material to be acceptable or extremely reasonable in 100% of the cases, which indicated that the content of the questionnaire reflected the subject of the study.

The scale was distributed to 23 parents of primary and secondary school students in Shanghai and retested after an interval of 15 days. The Pearson correlation coefficient of the total score of the two results $r = 0.875$ ($p < 0.01$) indicates good reliability of the retest of the questionnaire and stable results.

Common Method Bias Test

Common method variance (CMV) refers to some kind of covariance introduced to all question items by the design of the measurement instrument, the selection of the subject population, and the measurement environment in the study of self-statement scales, and is a kind of systematic error (Richardson et al., 2009). The consequences brought about by CMV are called "common method bias" (CMB), which may have a large negative impact on the accuracy of experimental results, and have gradually been taken seriously by scientific researchers in sociology and psychology in recent years.

We used the Unmeasured Latent Method Construct (ULMC) method and the Harman's Singer-factor test to examine the CMB of this study.

The first-order CFA model was used as the baseline model to measure the CMB of this study using a control unmeasured potential method factor by adding a common method factor as a global factor in AMOS to construct a ULMC model, and if the model fit index improved substantially, it indicates the existence of serious common method bias (Richardson et al., 2009). The fit indices of the baseline model in this study were not significantly improved compared to the ULMC model (ΔRMSEA = 0.007, ΔSRMR = 0.01, ΔGFI = 0.021, ΔCFI = 0.026; **Table 7**).

Harman's Singer-factor test was performed in EFA and the results showed that the single factor without rotation explained 21.743% of the variance, which is less than the 50% criterion (Podsakoff and Organ, 1986). Therefore, it was concluded that there was no serious common method bias in this study.

Calibrated Correlation Validity

The results of Pearson correlation analysis indicated that the scores of each dimension of the children Physical Training Support Scale were positively correlated with the scores of the Parental Physical Activity Behavior Scale, indicating that this questionnaire has high correlation validity (**Table 8**).

Invariance Test for Different Child Genders

We tested for invariance between the sexes of the children using the sample B ($n = 797$) with male children ($n = 363$) versus the sample with female children ($n = 280$). Because χ^2 is susceptible to sample size, this study used RMSEA, SRMR, and CFI to assess measurement equivalence (Cheung and Rensvold, 2002). For testing loading invariance, a change in CFI ≥ -0.010, a change in RMSEA ≥ 0.015, or a change in SRMR ≥ 0.030 was considered not to have invariance. For testing intercept or residual invariance, a CFI change ≥ -0.010, RMSEA change ≥ 0.015, or SRMR ≥ 0.010 is considered not invariant (Chen, 2007). Model 1 is the baseline model with each parameter freely estimated; Model 2 restricts the factor loadings to be equal between groups based on Model 1; Model 3 restricts the covariance to be equal between groups based on Model 2; and Model 4 restricts the residuals to be equal between groups based on Model 3. The results indicated that the changes in ΔRMSEA, ΔSRMR, and ΔCFI were smaller than the cut-off values for each group, as the PSCSTS can be considered to be measurement invariant for parents with children of different genders (**Table 9**).

Higher-Order Model Building and Evaluation

Higher-order factor modelling requires theoretical interpretability and correlation between factors. In the model construction, the original dimension of "family support" (FS) in the scale design of this study was decomposed into "parent's exercise

TABLE 7 | A list of models fit.

Model	χ^2	χ^2/df	RMSEA	SRMR	GFI	CFI	TF[a]
Baseline model	1198.167	2.052	0.036	0.038	0.921	0.937	/
ULMC model	906.576	1.657	0.029	0.028	0.942	0.963	/
Second-order model	1262.980	2.098	0.037	0.040	0.915	0.932	0.949
Third-order model	1311.773	2.130	0.038	0.042	0.911	0.928	0.913

[a]*Target coefficient.*

TABLE 8 | Correlation between PSCSTS and PARS-3.

Factors	$\bar{x} \pm s$	1	2	3	4	5	6	7	8
1. PS	3.541 ± 0.769	1							
2. CS	3.328 ± 0.817	0.473	1						
3. FS	3.541 ± 0.769	0.505	0.390	1					
4. IM	3.339 ± 0.606	0.369	0.324	0.358	1				
5. SS	3.960 ± 0.564	0.444	0.420	0.444	0.314	1			
6. TQS	4.300 ± 0.600	0.269	0.138	0.370	0.171	0.295	1		
7. MS	3.693 ± 0.724	0.522	0.382	0.508	0.338	0.405	0.318	1	
8. PRS-3	3.692 ± 0.863	0.491	0.423	0.564	0.263	0.392	0.255	0.400	1

TABLE 9 | Test for child gender invariance.

	Model fit			Comparison of model *k* and model *k*–1		
	RMSEA	**SRMR**	**CFI**	**ΔRMSEA**	**ΔSRMR**	**ΔCFI**
Model 1	0.030	0.055	0.915	–	–	–
Model 2	0.030	0.056	0.916	0.000	0.001	0.001
Model 3	0.030	0.056	0.914	0.000	0.001	−0.001
Model 4	0.030	0.057	0.913	0.000	0.002	−0.002

habits" and "parent's financial support" in EFA, and the $r = 0.524$ for both. Consequently, it was considered necessary to construct a second-order factor named "family support" (FS). Similarly, the original "internal motivation" dimension was decomposed into "sports development" and "learning skills" with $r = 0.417$ to construct a second-order factor named "Internal motivation" (IM). The original "school support" dimension was decomposed into "development of school activities" and "school activity participation," with $r = 0.555$. Therefore, the second-order factor, named "school support" (SS), was constructed, and the first-order 10-factor model was streamlined into a second-order seven-factor model, which is consistent with the assumptions made at the beginning of the scale. And the fit index of this second-order model can meet the recommended criteria (**Table 7**).

In addition, theoretically, the second-order factors all belong to the ecological perspective of the influence of children sports training activities, which may be influenced by a common factor, and the dimensions have different degrees of correlation, $r = 0.200–0.801$. The study tried to construct a third-order factor model based on the second-order factor model, and finally named the third-order factor as "parental support for children's sports training" (PSCST), and the fit index of the third-order model met the recommended criteria (**Table 7**), and the loadings of the second-order factor on the third-order factor ranged from 0.53 to 0.93 ($p < 0.001$), as shown in **Figure 1**.

The evaluation method for higher-order model building often uses the target coefficient (Marsh and Hocevar, 1985) to the Chi-square of the first-order model and the higher-order model, and the closer its value to 1, represents the higher-order model is more representative. As shown in **Table 8**, the target coefficient of the second-order model and first-order model is 0.949 and the target coefficient of the third-order model and first-order model is 0.913. Therefore, following the principles of model parsimony and theoretical interpretability, we consider the third-order factor model to be the best model, as shown in **Figure 1**.

DISCUSSION

Parental support for children's participation in sports training is an important factor in children's successful participation in sports training, but the complexity of factors influencing this parental support means that measurement needs to be done at multiple levels. This study attempts to integrate a social ecological model with parental support for their children's sports training, aiming to develop a measurement tool that can comprehensively measure parental support for their children's training. We initially identified a seven-level structured scale (policy support, community support, family support, internal motivation, school support, media support, and training quality support) through literature compilation and interviews. We explored and validated the internal structure of the model through factor analysis. A higher-order factor model was constructed based on theoretical drivers, while also taking into account model fitting (e.g., RMSEA, CFI, GFI, etc.). There is no serious common method bias in this study and the calibration validity is good. The invariance test further illustrates the applicability of the PSCSTS to parents of gender diverse children. It provides a measurement tool to comprehensively measure Chinese parents' support for their children's participation in sports training.

The Framework of Measurement

Parental Support for Children's Sports Training Scale is a multi-level structure that includes seven dimensions (internal motivation, family support, school support, community support, training quality support, media support, and policy support). As the systemic concept emphasized by social ecology, these seven dimensions do not exist in isolation from each other, but are interrelated (Langille and Rodgers, 2010). **Table 6** demonstrates a degree of positive correlation among the dimensions.

Motivation explains why people think and act the way they do (Weiner, 1992). In the present study, the motivation dimension included mastery of sports skills and sports development. The acquisition of sports skills is an important way to maintain regular physical behavior of children and thus promote physical and mental health. Sports development is also important, as mastery of sports skills can help children achieve scholarships in school or higher earnings as professional athletes (Bean et al., 2014). Therefore, the PSCSTS uses these two motives to measure the internal motivational dimension of parental support.

The family is an important place for children to grow and also to receive education. Good sporting habits of parents are a behavioral model that can increase children's participation in sporting behavior (Sanz-Arazuri et al., 2012). In addition, financial support from parents is an important factor for children's participation in sports (Kirk et al., 1997), especially for participation in a sport training (requiring coaching costs, venue costs, equipment costs, etc.). Therefore, we used parental support in action and financial support to represent the family support dimension in PSCSTS.

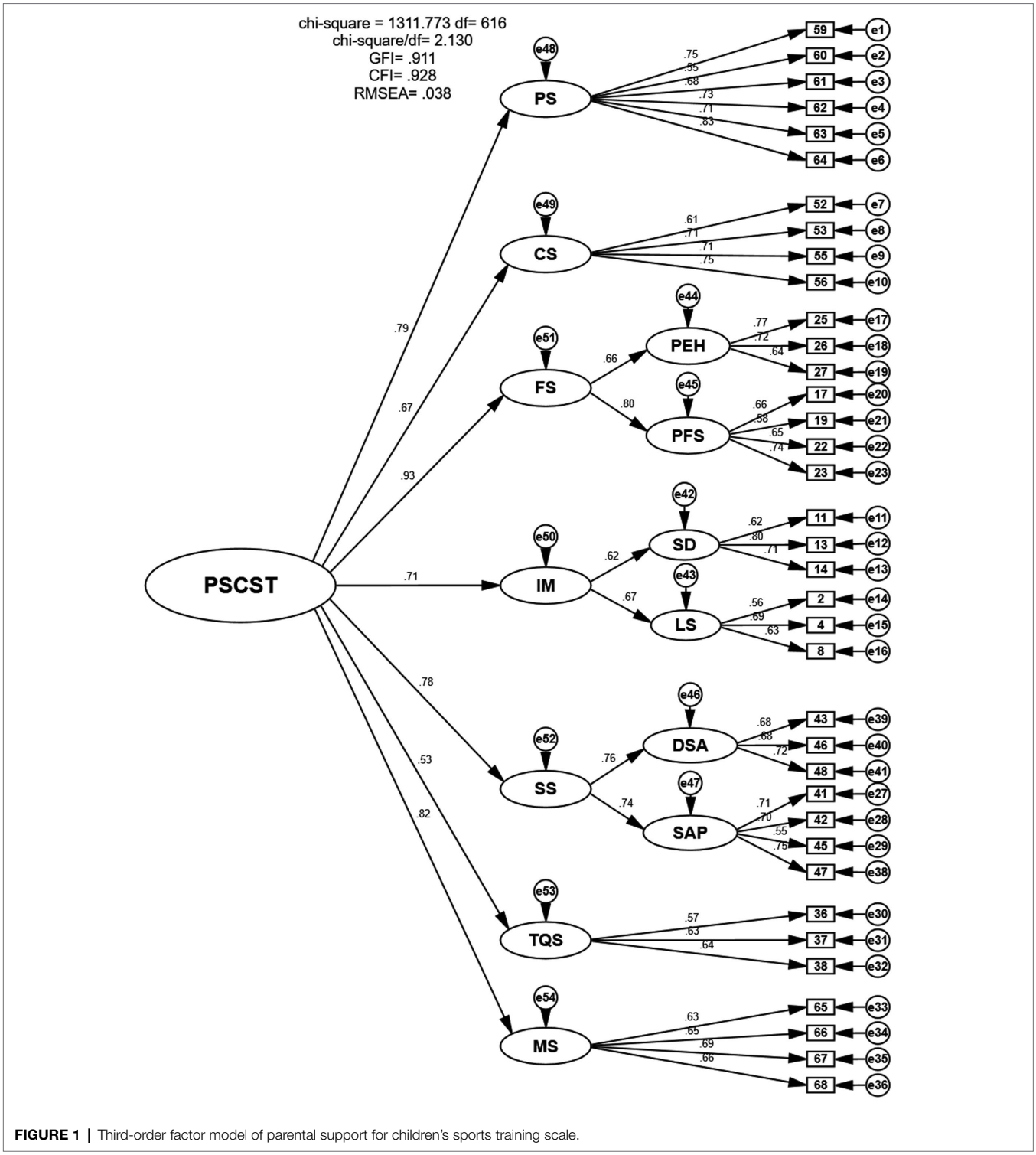

FIGURE 1 | Third-order factor model of parental support for children's sports training scale.

Schools are the main place where Chinese school-age children participate in physical activities and physical education classes (Guan, 2005). The school support dimension consists of the various types of sports activities (sports competitions and school sports clubs) conducted at school and the children's sports participation behaviors. In this sense, it covers the subject and object of school physical activity as one of the potential factors to improve parental support.

The community is the primary place where children engage in physical activity outside of school versus at home. A good community sport environment can improve the level of physical activity of individuals (Slater et al., 2010), and the community

support dimension of this study includes the construction of community sport facilities and the sporting atmosphere in the neighborhood, which should be one of the sources of parental support for their children's participation in sport training.

The training quality support dimension was derived from interviews with parents. This dimension cannot be categorized under other socio-ecological dimensions, but training quality is an important influence on parental support for their children's sports training, so we designed this dimension separately as an important factor reflecting the characteristics of sports training activities. It also reflects the main difference between physical training activity and general physical activity, namely that this activity requires more professional coaching organization and a range of venue facilities to support it.

The media support level mainly includes the influence of the broadcast of sports events and the effect of sports stars. Today's professional sporting events have a strong appeal to both parents and children. For parents who are keen watchers of sports events, the performance of athletes may be an important factor in promoting support for their children's sports training. As one interesting Chinese study notes, children who dream of becoming sports stars attend sports training schools (a type of school in China that specializes in sports training) and begin to receive professional sports training (Liu and Li, 2014).

Policy supports mainly refers to the policies issued by the Chinese government in recent years to promote various sports training activities for youth and children (e.g., integration of sports and education policy). Government policies that call for social attention to youth sports activities may directly increase parental support. In addition, policies may increase parental support for youth sport training by influencing school sport training efforts and social sport environments (Langille and Rodgers, 2010), suggesting interactions between different levels of social ecology, but this is beyond the scope of this study and will not be discussed in depth. In summary, policy is also an important factor in increasing parental support. Therefore, in this dimension we use some questions that measure the extent to which parents are concerned about Chinese youth sports policies in recent years to reflect policy support.

Theoretical Implications

Relative to other similar studies (Langille and Rodgers, 2010; Barnidge et al., 2013; Chen and Sun, 2014; Sallis et al., 2015; Xiang, 2019; Huang and Zhang, 2020), this study further expands the application of social ecology in the field of sport behavior field, proving the adaptability of social ecology theory combined with different subject studies, which also provides a basis for future studies to continue exploring the theoretical implications of social ecology in sport behavior research. On the other hand, we provide a comprehensive research perspective on the study of parental support for children and adolescents' physical activity. Both in terms of measurement instruments and theoretical research, we argue that the sources of parental support are multidimensional. Analysis, measurement, and intervention of parental support for children should begin at multiple levels, and any single level of intervention or measurement may be one-sided.

In terms of measurement instrument development, it is clear that the PSCSTS is a new measurement instrument that can be used to measure Chinese parents' support for their children's sports training, filling a gap in localized measurement instruments. Compared to the PASS-Q (Freeman et al., 2011) and the SSS (Rees et al., 2000), the PSCSTS developed in this study focuses more on the supporter than the supported, placing the supporter in the context and examining the influences that can increase parental support.

PRACTICAL IMPLICATIONS

The PSCSTS, constructed and validated in this study based on a Chinese cultural context, can be used to measure parental support for their children's participation in sports training in China. The validated seven dimensions can assess the role of each dimension in improving parental support. Government organizations and departments can use this measurement tool to measure the overall level of parental support for sports training in a region, analyze the differences in scores across dimensions, and develop appropriate measures to improve parental support to support various forms of sports training efforts. In addition, a unified measurement tool can be used to compare differences in parental support for sports training among Chinese youth and children in different regions.

CONCLUSION

This study further extends the application of social ecology theory and develops an instrument based on social ecology to measure parental support for their children's training. The results show that the PSCSTS includes 37 items and was validated for content validity, structural validity, calibration validity, and internal consistency reliability. The scale can be used to measure the extent to which parents of Chinese primary and secondary school students support their children's participation in training, providing a usable tool for government departments and institutions to analyze and intervene in parental support for their children's sports training.

Future Research

First, it may be more useful to examine differences in parental support for children's participation in sports training across family situations, for example, by conducting further research on parents with different incomes, parents with different occupations, parents with different sports habits, and parents living in different regions.

Second, this study set up seven dimensions to reflect parental support in physical training activities, and social ecological

theory also emphasizes the existence of interaction between different dimensions, so how the dimensions interact with each other remains to be further revealed by longitudinal studies (e.g., whether such effects further increase parental support through the school level, community level, or media level sometime after the policy is released).

Finally, this study developed a research framework based on the social ecology model, which also further demonstrates the applicability and superiority of this theory for research in the field of sport behavior science, which has yet to be extended to more sport research.

Limitations

First, this study can only be considered as a preliminary development and validation for PSCSTS. A good measurement tool needs to be developed in continuous practice, and although the model fit index of this study was able to meet the recommended standard, the CR and AVE of some dimensions could only be said to barely meet the acceptable standard, specifically because the social ecology perspective is too broad leading to insufficient internal consistency of some dimensions, or because online questionnaires are more difficult to control errors than paper-and-pencil tests.

Second, the measurement invariance of PSCSTS parental gender was not tested in this study and must be tested in more depth with future parents of different genders to test the applicability of PSCSTS.

Finally, the PSCSTS developed in social ecology is more comprehensive but also longer, which may lead to subjects feeling bored in the process of filling it out. Continued revision of the PSCSTS to make it more concise and focused may be more applicable to different contexts.

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 were not required for the study in accordance with the national legislation and institutional requirements. Written informed consent was not required for this study in accordance with national legislation and institutional requirements.

AUTHOR CONTRIBUTIONS

YY and NZ conceived the idea and organized the study. NZ conducted the study, analyzed the data, and wrote the manuscript. YY revised the manuscript. All authors contributed to the article and approved the submitted version.

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The Perception of Teaching, Learning Styles and Commitment to Learning and Their Influence on the Practice of Physical Activity and Eating Habits Related to the Mediterranean Diet in Physical Education Students

Carmen Fernandez-Ortega[1], Jeronimo González-Bernal[1], Sergio Gonzalez-Bernal[1], Ruben Trigueros[2], José M. Aguilar-Parra[2], Luis A. Minguez-Minguez[1], Ana I. Obregon[3] and Raquel De La Fuente Anuncibay[1]*

[1] Department of Psychology, University of Burgos, Burgos, Spain, [2] Department of Psychology, University of Almería, Almería, Spain, [3] Department of Mathematics, University of Burgos, Burgos, Spain

Childhood obesity, linked to a sedentary lifestyle and an unbalanced diet, is one of the main problems in today's Western societies. In this sense, the aim of the study was to analyze students' perceived satisfaction in physical education classes with learning strategies and engagement in learning and critical thinking as determinants of healthy lifestyle habits. The study involved 2,439 high school students aged 12–18 years (M = 14.66, SD = 1.78). Structural equation modeling was conducted to analyze the predictive relationships between the study variables. The results showed that teaching, teaching mastery, and cognitive development are precursors to deep thinking on the part of students, indicators of the adoption of healthy lifestyle habits. These results reflect the importance of the methodology adopted by the teacher in order to positively influence the students' habits.

Keywords: teaching, physical education, critical thinking, metacognitive strategies, healthy lifestyle habits

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***Correspondence:**
Ruben Trigueros
rtr088@ual.es

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INTRODUCTION

There is currently a growing concern about unhealthy eating habits and lack of physical activity in the adolescent population (Jonsson et al., 2017). In this regard, a recent survey conducted in Spain revealed that 5.1% of adolescents suffer from obesity and 21.4% are overweight (Moreno et al., 2020). This is due to the abandonment of the Mediterranean diet, with adolescents' diets being unbalanced and tending toward a high fat intake (35–50% of total calorie content), with a low polyunsaturated/saturated fatty acid index. In addition, the lack of physical activity among adolescents, with only 39.5% of young people engaging in regular physical activity, increases the health risk situation of young people, who are more prone to suffer from coronary heart disease, hepatitis, metabolic diseases, etc. (Tucker et al., 2011). Therefore, Physical Education (PE) classes have been shown to be a key factor in raising awareness and consolidating healthy habits in adolescents (Dudley et al., 2011; Trigueros et al., 2019a), both in terms of sports practice and the benefits of eating a balanced diet, given their ability to generalize beyond the academic context

(Hagger and Chatzisarantis, 2007; Ward, 2013). Furthermore, physical activity is one of the main protectors of childhood obesity (Heerman et al., 2022), and its benefits in improving health have been documented (Janssen et al., 2011; Sigmund et al., 2012), which is why it has been repeatedly included in the academic curriculum in different European countries (Eurydice, 2013).

Studies to date have shown that the motivational climate generated by the teacher and classmates has a significant influence on student engagement and participation during PE lessons (Newland et al., 2017; Zach et al., 2020). However, it is necessary to take into consideration students' perceived satisfaction with the teacher's teaching methodology and its influence on the students' learning process (Kosiba et al., 2019). In this sense, a study by Trigueros et al. (2019b) highlights the presence of three essential components with teaching satisfaction: teaching, which refers to the student's assessment of the pedagogical quality of the teaching staff, their attitude and their explanations; cognitive development, which refers to satisfaction with the perceived improvement of learning, both in mental strategies and basic concepts of the subject; and mastery teaching, which refers to learning and improvements in the mastery of physical and motor skills related to sports practice. In short, satisfaction would reflect the effect that the context, methodology and experiences in the PE class have on the students (Ramírez et al., 2019; Korina et al., 2021). This construct has been closely related to performance as it involves procedural learning aimed at perfecting physical skills, as well as effort, the desire to excel, motivation for the activity, the importance given to PE and the intention to remain physically active (Ruiz-Juan et al., 2010; Baena-Extremera et al., 2012), reflecting the effect that the environments, methods and experiences in the PE class have on students (Cid et al., 2019).

On the other hand, it is essential to consider the importance of learning strategies, critical thinking and commitment to learning toward the achievement of academic goals (Ibrahim et al., 2017). In this sense, it is important to encourage students' autonomy in planning and managing their own learning in order to become aware of their own mistakes in their teaching-learning process, which prevent them from achieving academic goals (Colomer et al., 2018). In addition, young people in today's society are subjected to a constant flow of information, most of the time untruthful, so it is important to develop in our students an open mind, but with a deep critical spirit, being necessary the acquisition of higher levels of thinking (Radulović and Stanèić, 2017). However, for students to be able to manage their learning and to develop a critical spirit, engagement in learning is an important mediator in determining learning outcomes, as greater student engagement can improve academic outcomes and commitment to set goals (Wu et al., 2020).

These three psychological elements related to the management and organization of information can have a substantial influence in facilitating the study and/or predicting the consolidation of future behaviors related to a balanced diet, typical of the Mediterranean diet, and the practice of physical activity, which are the one of didactic objective of the area of PE according to the Secondary Education Curriculum (Real Decreto 217/2022). In this sense, the use of deep learning strategies (metacognition) requires effort on the part of the learner that not only means commitment to the goal, but also regulates the continued use that can be maintained over time (Ulstad et al., 2016). Similarly, students' engagement and involvement in classes is positively associated with intrinsic motivation and leads to greater dedication and enjoyment toward physical activity practice (Gorely et al., 2009). In relation to adherence to these healthy habits and PE classes, previous research studies show that the PE teacher himself, in addition to the didactic contents of the subject itself, are an important element in achieving these habits (Tobar et al., 2019). It is highlighted that the content blocks of games and sports, health, and physical fitness play a fundamental role in students' likes and desires for physical activity in PE classes. In most cases, this is reflected in pupils' lifestyles. That is, their attachment to the PE subject and their subsequent success is directly related to their engagement in physical activity outside the classroom (Valencia-Peris and Mora, 2018). Furthermore, clear improvements are observed in students' self-esteem, self-concept and perceptions, while enhancing values related to effort, respect and teamwork, key values for the promotion of physical activity and health at school. Similarly, nutritional habits constitute one of the objectives of the new educational law in Spain (*LOMLOE; Ley Orgánica por la que se Modifica la Ley Orgánica 2/2006*), which is related to the acceptance of one's own body, that of others and using PE as a way of consolidating healthy eating habits and the practice of physical activity. In this sense, Vaquero-Solís et al. (2021) highlighted that, in addition to adequate levels of physical activity, aspects such as regular consumption of fruit and vegetables, fish and healthy breakfast habits, typical of the Mediterranean diet, should be considered as protective factors in relation to health. However, content related to food is hardly worked on in the area of PE, despite the fact that, as detailed above, it is an objective of the area.

Thus, the aim of this study is to analyze students' perceived satisfaction in PE classes with strategies and commitment to learning and critical thinking as determinants of healthy lifestyle habits. To this end, the following hypotheses are put forward: (1) teaching, mastery teaching and cognitive development will correlate positively with each other; (2) teaching, mastery teaching and cognitive development will be positively related to metacognitive strategies, engagement in learning and critical thinking; (3) engagement in learning will correlate positively with critical thinking and metacognitive strategies; (4) metacognitive strategies, engagement in learning and critical thinking will correlate positively with physical activity and healthy eating related to the Mediterranean diet.

MATERIALS AND METHODS

Participants

The secondary school students who participated in the study were 2,439, of which 1,331 were boys and 1,108 girls. These students were studying in different schools in the provinces of Almeria and Granada.

The age of the participants ranged from 12 to 18 years (M = 14.66; SD = 1.78). 54.44% were in Compulsory Secondary Education and 45.56% were in Post-Compulsory Secondary Education.

The sampling method for the student population was non-probabilistic inferential, based on those educational centers to which access was available. The criteria for participation in the study were the submission of a signed authorization from the parents or legal guardians and the full completion of each of the questionnaires described below.

Measurement

Perceived Structured Physical Education Teaching Environment

The scale used was the Spanish version of the Physical Activity Class Satisfaction Questionnaire (Cunningham, 2007) by Sicilia et al. (2014). The scale is made up of 9 factors and 45 items. However, to measure students' satisfaction with theoretical knowledge, learning skills and teaching methodology, only three factors were used: cognitive development, teaching mastery and teaching. The Likert scale that students had to fill in ranged from 1 (strongly disagree) to 8 (strongly agree).

Metacognitive Strategies and Critical Thinking

The Spanish version of the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1993) by Roces et al. (1995) was used. This questionnaire is made up of 81 items distributed among 15 factors. However, only the 12 items referring to metacognition strategies and the 5 critical thinking items were used. Students were asked to respond on a Likert scale ranging from 1 (not true at all) to 5 (completely true).

Engagement With Learning

The Spanish version of the Achievement Motivation in Physical Education Test (Nishida, 1988) of Ruiz et al. (2004) was used. This questionnaire is made up of 32 items spread over 4 dimensions. However, only the 9 items referring to engagement with learning were used. The Likert scale that students had to fill in ranged from 1 = strongly disagree to 5 = strongly agree.

Balanced Diet

The Spanish version of the scale linked to the Mediterranean diet (Serra-Majem et al., 2004) was used. This scale consists of 16 items, with an overall score ranging from 0 to 12. Items denoting a negative connotation with regard to the Mediterranean diet were assigned a value of -1, and those with a positive aspect were assigned a value of + 1.

Intentionality of Being Physically Active

The Spanish version of the Intention to be physically active scale (Hein et al., 2004) by Moreno et al. (2007) was used. This scale consists of five items to measure a single factor. The items are preceded by the phrase "Regarding your intention to practice some physical/sports activity." The Likert scale that students had to fill in ranged from 1 (totally disagree) to 5 (totally agree).

Procedure

To initiate the study, it was necessary to establish contact with the management teams of several educational centers so that they would grant us their authorization to access the students. Both the students and the management team were explained to them and any doubts about the study were resolved.

Those students who wished to participate voluntarily in the study were asked to sign an authorization form signed by their parents or legal guardians. After obtaining permission from the management team, the questionnaires were administered. The students completed the questionnaire individually with pen and paper at the beginning of PE lessons, stressing the anonymity of their answers and respect for all ethical procedures. During this phase, a member of the research group was present to answer any questions that might arise. The estimated time to complete the questionnaires was around 20 min.

The study obtained the approval of the bioethics committee of the University of Almería (Ref. UALBIO 2020/014) and respected the procedures established by the Declaration of Helsinki.

Data Analysis

The analyses used in the present study were descriptive statistics, represented by the mean, standard deviation and bivariate correlations. In addition, Cronbach's alpha reliability analyses were calculated. For each of these analyses, the SPSS 25 statistical package was used.

To analyze the objective and hypotheses of the study, a hypothesized model was established using structural equation modeling (SEM). For this purpose, the maximum likelihood method was used, which is the most appropriate in studies using Likert scales as it takes into account the non-normal distribution of the data (Beauducel and Herzberg, 2006). Furthermore, in the SEM model, 95% bias-corrected bootstrap CIs (95% CIBC) were calculated with a bootstrapping of 6,000 interactions (Hayes and Scharkow, 2013).

The model fit indices were used to define good models: the chi-square/degree freedom, the Root Mean Square Error of Approximation (RMSEA) with its 90% confidence interval (CI), the Comparative Fit Index (CFI), Incremental Fit Index (IFI) and Tucker–Lewis Index (TLI). The adjustment rates taken into account for the previous CFAs and SEM were those considered by Hair et al. (2006) (**Table 1**).

TABLE 1 | Adjustment indexes.

Estadístics	Good indexes
Chi square/degree freedom	Between 2 and 3
Comparative fit index (CFI)	Greater than 0.95
Incremental fit index (IFI)	Greater than 0.95
Tucker lewis index (TLI)	Greater than 0.95
Root mean square error of approximation (RMSEA) y su intervalo de confianza al 90%	Equal or less than 0.06
Standardized root mean square residual (SRMR)	Equal or less than 0.08

TABLE 2 | Descriptive statistics and correlations between all variables.

Factors	*M*	*SD*	α	1	2	3	4	5	6	7	8
1. Cognitive development	5.65	0.93	0.80	–	0.31**	0.33**	0.54***	0.35**	0.37***	0.45***	0.31**
2. Mastery teaching	6.04	0.68	0.83		–	0.49**	0.48***	0.42**	0.42**	0.31**	0.30*
3. Teaching	6.18	0.71	0.85			–	0.56**	0.36**	0.35***	0.44***	0.26***
4. Metacognitive strategies	3.63	1.12	0.82				–	0.58***	0.46**	0.32**	0.22*
5. Learning engagement	3.83	1.07	0.86					–	0.31**	0.56***	0.31***
6. Critical thinking	3.53	1.14	0.83						–	0.66***	0.59**
7. Intention to be Physically active	5.35	0.78	0.80							–	0.64***
8. Mediterranean diet	8.22	0.69	0.79								–

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$.

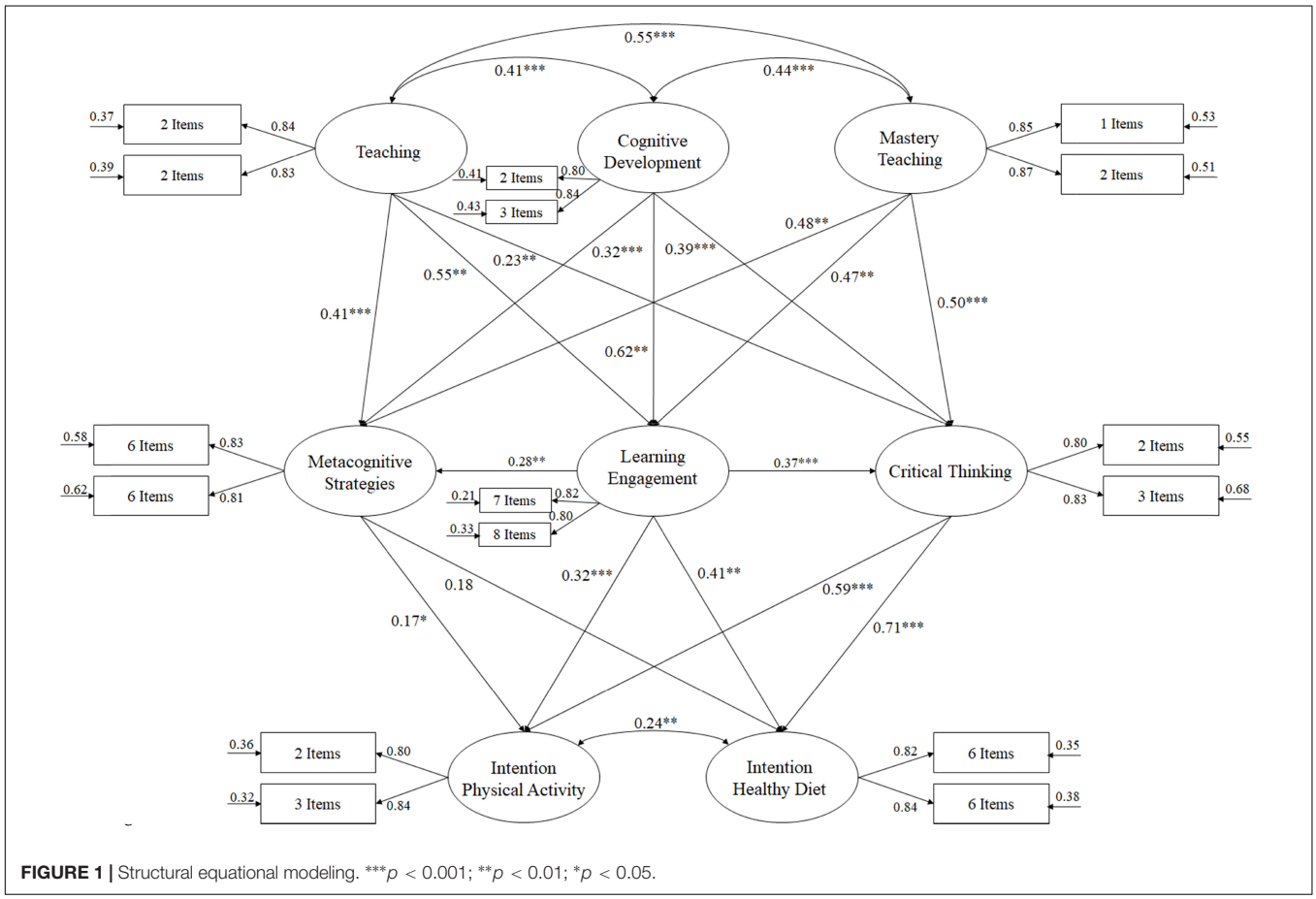

FIGURE 1 | Structural equational modeling. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$.

It should be noted that these adjustment indices should be interpreted with caution, as they prove to be too stringent or too complicated to achieve in complex models (Marsh et al., 2004).

RESULTS

Preliminary Analysis

The bivariate correlations, as shown in **Table 2**, were positive between each of the study variables. Finally, the reliability analysis showed a score above 0.70, so each of the factors were considered reliable (Taber, 2018).

Structural Equation Model

The fit indices of the hypothesized model, through structural equation analysis (**Figure 1**), to analyze the predictive relationships were adequate: $\chi^2(84, N = 3{,}415) = 254.38$, $\chi^2/df = 3.03$, $p < 0.001$, IFI = 0.94, TLI = 0.94, CFI = 0.94, RMSEA = 0.061 (CI 90% = 0.055–0.065), SRMR = 0.041. These indices reflect that the model has had an acceptable fit and should therefore be considered adequate. Standardized regression tests were used to analyze the relationships between the study variables.

The relationships obtained between the different factors that make up the model (**Figure 1**) are described as follows:

a) The correlations were positive, being β = 0.41 ($p < 0.001$) between teaching and cognitive development; β = 0.55 ($p < 0.001$) between teaching and mastery experiences; β = 0.44 ($p < 0.001$) between cognitive development and mastery experiences.
b) The relationship between teaching and metacognitive strategies (β = 0.41, $p < 0.001$), engagement in learning (β = 0.55, $p < 0.01$) and critical thinking (β = 0.23, $p < 0.01$), was positive.
c) The relationship between cognitive development and metacognitive strategies (β = 0.32, $p < 0.001$), engagement in learning (β = 0.62, $p < 0.01$) and critical thinking (β = 0.39, $p < 0.001$), was positive.
d) The relationship between mastery experiences and metacognitive strategies (β = 0.48, $p < 0.01$), engagement in learning (β = 0.47, $p < 0.01$) and critical thinking (β = 0.50, $p < 0.001$) was positive.
e) The relationship between commitment to learning and metacognitive strategies (β = 0.28, $p < 0.01$) and critical thinking (β = 0.37, $p < 0.001$) was positive.
f) The relationship between metacognitive strategies and intention to be physically active (β = 0.17, $p < 0.05$) and Mediterranean diet (β = 0.18, $p < 0.06$) was positive.
g) The relationship between engagement in learning and intention to be physically active (β = 0.32, $p < 0.001$) and Mediterranean diet (β = 0.41, $p < 0.01$) was positive.
g) The relationship between critical thinking and intention to be physically active (β = 0.59, $p < 0.001$) and Mediterranean diet (β = 0.71, $p < 0.001$) was positive.
h) The correlation was positive between intention to be physically active and intention to maintain a healthy diet (β = 0.24, $p < 0.01$).

DISCUSSION

The aim of the present study was to analyze the satisfaction perceived by students in PE classes on strategies and commitment to learning and critical thinking as determinants of PE academic objectives related to healthy lifestyle habits related to the practice of physical activity and balanced eating. This study presents for the first time a direct relationship between students' perceived mastery experiences of their own learning processes present during PE lessons and the achievement of academic goals related to the adoption of healthy lifestyle habits. So far, studies have focused on students' motivation toward PE classes (Behzadnia and Ryan, 2018; Bechter et al., 2018; Trigueros et al., 2019b; Mastagli et al., 2021) and its relationship with respect to the adoption of future behaviors. In this sense, more than motivation and its relationship with adaptive behaviors, it is necessary to analyze how students process and understand the information that comes to them during PE classes in order to adapt methodologies to make it easier to understand and assimilate the information and the importance of achieving academic goals (Goodyear and Dudley, 2015; Mannino et al., 2019).

Results have revealed how cognitive development, mastery experiences and teaching directly influence metacognitive strategies, engagement in learning and critical thinking. These results cannot be contrasted with previous studies in either the setting of the PE classroom or the educational context. However, a study by Ferriz et al. (2016) and Trigueros et al. (2019b) revealed that cognitive development, mastery experiences and teaching were predictors of the satisfaction of basic psychological needs (competence, relatedness to others, autonomy, and novelty). These psychological needs have in turn been linked to students' search for new experiences culminating in the development of critical thinking, metacognition and students' engagement during lessons due to the development of their motor skills (Zhang et al., 2019). Similarly, a study by Ulstad et al. (2016) showed how teachers' autonomy support was important in meeting basic psychological needs that mediated their relationships with motivational constructs. It was also important for teachers to encourage students to use learning strategies and to teach them how to use them in order to participate and perform better in school, achieving academic goals. Therefore, this study highlights the need to work on aspects that will subsequently influence student satisfaction, such as the structure of lessons, the promotion of innovative learning or the need to provide an appropriate adjustment to the learning pace of each student. Thus, teachers should foster student motivation through the development of a sense of competence, positive interpersonal relationships, or the design of innovative activities (Casey and MacPhail, 2018; Cheon et al., 2019; Trigueros and Navarro, 2019). In addition, content should have maximum meaning and significance for students and should be appropriate to their motivational needs and interests, in order to achieve greater commitment and involvement in learning (Moreno-Doña et al., 2016).

In addition, results showed that metacognitive strategies, engagement in learning and critical thinking were positively related to intention to be physically active and the consumption of a healthy diet. These results were similar to previous studies, although in isolation. In this sense, different studies showed that metacognitive strategies have been positively related to healthy habits such as physical activity practice (Theodosiou et al., 2008; Liu et al., 2019; Coimbra et al., 2021), similarly, previous studies showed how critical thinking has been positively related to habits related to physical activity practice (Pill and SueSee, 2017). However, engagement in learning has not been found to be related to healthy lifestyle habits, although there are studies that have shown a positive relationship between commitment and motivation toward classes with respect to physical activity and healthy diet (Ulstad et al., 2016; Hastie et al., 2022). In this way, the use of metacognitive strategies, critical thinking and engagement in learning constitute a number of variables that can foster students' commitment to not only academic achievement, but also greater wellbeing related to their quality of life. In this sense, the most engaged students are those who strategically self-regulate their learning processes, making use of planning strategies, monitoring the completion of their tasks and maintaining intense critical judgment (Sperling et al., 2016; Rigo, 2017), improving their motor skills and ultimately gaining a self-perception of improved health (Sicilia et al., 2014). Furthermore, previous studies have shown that engagement in PE classes is

directly related to the adoption of healthy routines outside this context (Jiménez-Castuera et al., 2007), with this commitment and involvement of students being malleable and sensitive to the variables of the context, with critical thinking being an indispensable tool in the transfer of knowledge and its application in problem solving.

Despite the relevance of the results obtained, it is necessary to bear in mind some limitations. Firstly, in terms of methodological issues, as this is a correlational study, it is not possible to determine cause-effect relationships, so the model presented is one possibility, in this case the one that best fits the literature reviewed, as other variables (e.g., motivation, emotions, etc.) could have been included, but due to the complexity of the model it was not possible to do so. It would be interesting for future research to design applied research to explore other possible relationships between the variables considered, with the aim of optimizing the benefits provided by the PE classes.

Finally, this work can help to consolidate a teaching model that allows the reorganization of the teacher's thinking, generating new educational practices such as gamification and/or game-based learning that help to gain internal coherence in the curriculum itself so that the information to be transmitted to students is close to them, enjoyable and in line with their interests.

CONCLUSION

The present study confirms the findings of previous studies (Trigueros et al., 2019b) that support the importance of PE classes in influencing and providing a series of resources and skills that are crucial for the adoption of positive health-related behaviors (Ekblom-Bak et al., 2018). To this end, teacher-generated learning experiences are essential to foster student engagement and thus achieve the academic objectives of the PE subject. In this way, PE should be considered as an area of great importance and interest in the development of values and attitudes through a climate that fosters student learning, involvement and commitment (Errisuriz et al., 2018). This would go some way to resolving the existing gaps in the literature on these relationships, opening up an interesting line of work whose results can be of great use in the field of teaching.

DATA AVAILABILITY STATEMENT

The datasets generated during and/or analyzed during the current study are not publicly available because we do not have the consent of the study participants but are available from the corresponding author on reasonable request.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Bioethics Committee of the University of Almería (Ref. UALBIO 2020/014) and respected the procedures established by the 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 listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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Activity Workstations in High Schools: Decreasing Sedentary Behavior Without Negatively Impacting Schoolwork

June J. Pilcher, Timothy L. Hulett, Paige S. Harrill, Jessie M. Cashman, G. Lawson Hamilton and Eva Diaz*

Department of Psychology, Clemson University, Clemson, SC, United States

High school students are at risk for increased sedentary behavior due in part to a decrease in physical activity throughout adolescence and to required sedentary behavior during much of the school day. The purpose of the current study is to examine the impact of using activity workstations in a high school English class for struggling readers. Twenty high school students participated in the study. The participants completed a 16-week study where each participant used an activity workstation for 8 weeks and a traditional desk for 8 weeks in a crossover design for a 40-min period during normal class. They responded to a series of subjective questions about reading and schoolwork at the beginning and end of each 8-week session and followed the READ 180 program designed to help struggling readers during the study. The results indicated that academic performance increased in both desk conditions during the study and from the beginning to the end of the study. In addition, there was a significant improvement in items in the subjective survey related to reading, motivation, and schoolwork in both desk conditions across the study. The current results suggest that using an activity workstation in the classroom did not negatively affect academic performance or students' perceptions of working on academic assignments compared to the traditional desk condition. These results indicate that activity workstations could be implemented in classrooms to provide students with a non-sedentary option during the school day thus increasing physical activity in students.

Keywords: sedentary behavior, physical activity, high school, READ 180 program, academic performance, school-related subjective measures

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Marcos Mecías-Calvo, University of Santiago de Compostela, Spain

****Correspondence:***
June J. Pilcher
jpilche@clemson.edu

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INTRODUCTION

Many school-age children do not meet the recommended 60 min of physical activity each day (World Health Organization, 2016). Furthermore, the number of children meeting the recommendations for daily activity decreases throughout adolescence (Cornelius et al., 2020). As such, adolescents are at particular risk of increased sedentary behavior which increases their likelihood of becoming overweight and obese (Ogden et al., 2012) as well as increasing their long-term health risk (Kohl and Cook, 2013). Given that adolescents spend many hours each day during the school year in a classroom setting, it is important to consider how the classroom environment could contribute to sedentary behavior as well as opportunities for physical activity. The traditional desk in most classroom settings requires sedentary behavior from students. One way to reduce sedentary behavior in the classroom and to increase light physical activity is through incorporating

activity workstations allowing students to engage in classroom activities or to complete desk-based tasks while being physically active.

Some studies have investigated the potential impact of activity workstations in a classroom setting on physical activity and classroom behavior in students. Activity workstations increase low-intensity physical activity (Fedewa et al., 2017) and energy expenditure (Torbeyns et al., 2017) when compared to traditional classroom seating. Similar results were found when placing standing desks in a classroom setting (Pickens et al., 2016), suggesting that students could benefit from the opportunity to use a classroom desk arrangement that encourages some type of physical activity other than simply being seated. Fedewa et al. (2017, 2018) also found that on-task behavior was not negatively affected by activity workstations in high school English classes and high school special education classes. In addition, in a meta-analysis examining the impact of standing desks in a classroom on student behavior such as concentration and inattention, there were no significant changes due to the use of standing desks (Minges et al., 2016).

Although a number of studies have suggested that moderate-to-vigorous physical activity during the school day can improve academic performance (Fedewa and Ahn, 2011; Donnelly et al., 2016; Alvarez-Bueno et al., 2017), there is less information on the potential impact of light physical activity on academic achievement. One study with young adolescents using bike desks in a classroom found no significant change in academic performance (Torbeyns et al., 2017). Similarly, a systematic review of dynamic seating interventions in classrooms found that none of the interventions had a detrimental effect on academic outcomes (Rollo et al., 2019), whereas a meta-analysis examining the impact of a variety of types of physical activity interventions in the classroom found a moderate improvement in language skills but no change in mathematics or grade point average (Haverkamp et al., 2020).

It is also important to consider the potential impact of using activity workstations in the classroom on meta-cognitive variables. For example, if using workstations results in some type of positive outcome or feeling, this could encourage individuals to engage in physical activity in the future and across the lifespan (Pilcher and Baker, 2016). Unfortunately, little research has examined the potential effect of using activity workstations on meta-cognitive variables (Rhodes et al., 2012). One study found that using activity workstations in a work setting positively impacts stress and affect (Sliter and Yuan, 2015). In other studies, when college students used workstations while completing laboratory-based tasks, there was an improvement in positive affect, motivation, and morale (Pilcher and Baker, 2016) as well as a decrease in sympathetic reactivity during stressful tasks (Pilcher et al., 2022). In addition, it is important to note that performance on the laboratory-based tasks in these studies did not suffer due to using the activity workstations.

The potential impact of using activity workstations in classes designed for high school students who are struggling to meet the academic demands of their grade level has not yet been investigated. One group of particular concern is students who are struggling readers since the ability to read and understand technical documents is essential for success in many workplaces (Friedman, 2006). Research suggests that 90–95% of struggling readers can improve their reading skills if they receive appropriate interventions (Drummond, 2005). One type of reading intervention is Scholastic's READ 180 program which can be used in students reading below expected proficiency levels in grades 4 through 12. The READ 180 program provides class and small group instruction as well as structured reading practice and has been shown to significantly improve measures of reading comprehension (Hasselbring and Glaser, 2000).

The purpose of the current study is to examine the potential impact of using a stationary bike with a desktop (FitDesk) in comparison to a traditional desk in a high school English class using the READ 180 program. We hypothesize that the students' performance scores on the READ 180 program will not differ between the two desk types. We also examine the potential impact of using the FitDesk on subjective measures related to reading and schoolwork. Due to the paucity of literature in this area, we are unable to develop hypotheses for these measures.

METHODS

Participants

The study took place in an urban secondary school in a large city in southeastern United States. The participants were students in a ninth-grade basic English class designed for below average readers to help the students improve their reading skills. Twenty students, 13 males and 7 females with an average age of 14.55 (SD = 0.67), completed the study. The participants self-identified as 70% African American, 15% White, 10% Hispanic, and 5% other. Participants were recruited by their teacher who used documentation from the researchers to explain the study to the students and parents. Consent forms were signed by both the parents and student volunteers. All participants were in good health and able to pedal a stationary bicycle continuously for 40 min. The study was approved by the university's institutional review board.

Procedures

This study compared the use of an active workstation (FitDesk) and a traditional school desk during a normal literature/reading class period. A FitDesk is a stationary bike with a desktop that allows students to read or do schoolwork during class while pedaling at a comfortable pace. A crossover research design was used across 16 weeks resulting in each student using a FitDesk for 8 weeks and a traditional desk for 8 weeks. Half of the students were randomly assigned to the FitDesk group for the first 8 weeks of the study and then reassigned to the traditional desk group for the second 8 weeks of the study and vice versa. The first 8-week session took place between October and December of the school year. The second 8-week session took place between January and March of the school year. This resulted in a 4 week break between the two 8-week sessions during the Christmas holidays.

The participants completed all measures (see below) at the beginning and end of each 8-week session resulting in a pre

and post measure for each desk condition. All measures were completed at a traditional desk under teacher supervision.

The students followed a READ 180 program and completed their normal classroom activities in a 90-min literature/reading class for the duration of the research study. READ 180 is a learning intervention program designed for students to improve reading comprehension, vocabulary, and writing skills. The FitDesk group worked for 40 min on the FitDesks for the reading assignments and small group instruction portions of the READ 180 program and then worked for the remaining 50 min of the class period seated at standard classroom desks. The traditional desk group worked the entire 90-min class period seated at standard classroom desks.

Measures

Scholastic Reading Inventory

The READ 180 program includes the Scholastic Reading Inventory (SRI), a computerized assessment of reading comprehension and proficiency. The SRI requires students to answer multiple choice and fill-in-the-blank questions after reading a short passage and is administered as part of the normal class assessment procedure multiple times during the year to evaluate student progress. Lexile scores are produced based on each student's performance on the SRI and are used to determine each student's current reading level. For reference, the 25th–75th percentile Lexile score range for students in the ninth grade is 1,040L–1,350L.

The SRI has been validated with students with disabilities using the Stanford Diagnostic Reading Test and with all types of students using the Stanford Achievement Tests (Stebbins et al., 2012). A correlation of 0.65 was found between the SRI and the Stanford Diagnostic Reading Test while correlations between 0.79 and 0.82 were found between the SRI and the Stanford Achievement Test (Scholastic Inc, 2007).

Subjective Measures

The subjective survey included a 38-item Visual Analog Scale (VAS) assessing factors related to reading and schoolwork (e.g., positiveness, commitment, motivation) as well as physiological reactions (e.g., feelings of restlessness). The VAS was administered on a computer screen and used the standard scale from 0 (not at all) to 100 (extremely). The students could slide a marker across the scale to provide a visual and numerical answer to each question. For example, for the question "How motivated to read were you?" the student could move the marker on the scale from 0 (indicating not motivated to read at all) to 100 (indicating extremely motivated to read).

Data Analysis

All data were analyzed using the IBM SPSS statistical analysis program (SPSS 27; SPSS Inc., Chicago, IL). An exploratory factor analysis was completed to determine if the VAS items were measuring similar constructs. The factor analysis used principal components extraction with direct oblimin rotation with Kaiser Normalization. The VAS items within each factor were averaged to create one component score for each factor. Significant differences in the SRI Lexile scores, and the component scores for each factor were examined using 2 (Desk type) × 2 (Pre-post) repeated measures ANOVAs. The Wilks' Lambda results are presented for these analyses. To ensure that the study did not negatively impact reading skills in the students, a one-way ANOVA was used to examine the four SRI Lexile scores from October to March. Because the assumption of sphericity was not met, the Greenhouse-Geisser results are reported.

RESULTS

As shown in **Table 1**, the SRI Lexile scores increased in both desk conditions during the study and from the beginning to the end of the study. The 2 × 2 repeated measures ANOVA found a significant difference in Lexile scores from pre to post [$F(1, 19) = 6.608$, $p = 0.019$, $\eta_p^2 = 0.258$]. There was no significant difference in desk type [$F(1, 19) = 0.2$, $p = 0.659$, $\eta_p^2 = 0.01$] nor was there a significant interaction effect [$F(1, 19) = 0.375$, $p = 0.548$, $\eta_p^2 = 0.019$]. In addition, there was a significant difference in Lexile scores across the four testing times (October, December, January, March), [$F(1.54, 57) = 4.758$, $p = 0.023$, $\eta_p^2 = 0.20$].

The factor analysis resulted in a 4-factor solution that explains 76.72% of the variance. The four factors include a reading factor explaining 42.14% of the variance, a physiological factor explaining 15.85% of the variance, a motivation factor explaining 11.38% of the variance, and a schoolwork factor explaining 7.35% of the variance. The reading and schoolwork factors included a range of concepts related to students' perception of reading and schoolwork during the study (**Table 2**). The other items in the VAS survey did not load significantly into these four factors and did not merge into other factors.

The descriptive data for each of the four factors and each item within each factor are shown in **Table 3**. The VAS responses for the reading, motivation, and schoolwork factors generally increased from the pre-test to the post-test. In contrast the VAS responses for the physiological factor were more mixed showing an average of no change for the FitDesk condition and a slight decrease for the traditional desk condition from the pre-test to the post-test.

For the reading factor, there was a significant difference from pre to post [$F(1, 19) = 11.625$, $p = 0.003$, $\eta_p^2 = 0.380$], but there was no significant difference by desk type [$F(1, 19) = 0.193$, $p = 0.666$, $\eta_p^2 = 0.010$] nor was there a significant interaction effect

TABLE 1 | Lexile scores from the scholastic reading inventory (SRI).

		Test period	Mean	*SD*
SRI score (Lexile) by desk condition	FitDesk	Pre-test	603.05	233.59
		Post-test	639.95	245.07
	Traditional desk	Pre-test	620.80	238.83
		Post-test	644.70	229.67
Overall SRI scores (Lexile) by month		October	592.60	242.24
		December	611.40	243.66
		January	631.25	228.70
		March	673.25	226.79

TABLE 2 | Factor matrix after direct oblimin rotation.

Items	Reading factor	Physiological factor	Motivation factor	Schoolwork factor
How well did you pay attention while doing schoolwork?	0.851			
How positive did you feel while reading?	0.945			
How clearly were you able to think while reading?	0.976			
How relaxed did you feel while reading?	0.814			
How much did you enjoy reading?	0.879			
How committed were you to reading?	0.842			
How do you rate your reading ability?	0.697			
How much effort did it take to concentrate while reading?	0.848			
How tired did you become while reading?		0.872		
How restless did you feel while doing schoolwork?		0.755		
How restless did you feel while reading?		0.756		
How motivated to learn were you?			–0.588	
How committed were you to schoolwork?			–0.641	
How much did you understand while doing schoolwork?				–0.807
How positive did you feel while doing schoolwork?				–0.716
How do you rate your learning ability?				–0.816
How much did you focus while doing schoolwork?				–0.899
How much effort did it take to concentrate while doing schoolwork?				–0.907
How much did you enjoy doing schoolwork?				–0.783

[$F(1, 19) = 1.400$, $p = 0.251$, $\eta_p^2 = 0.069$]. For the physiological factor, there was no significant difference from pre to post, [$F(1, 19) = 0.413$, $p = 0.528$, $\eta_p^2 = 0.021$] or desk type [$F(1, 19) = 0.038$, $p = 0.847$, $\eta_p^2 = 0.002$] nor was there a significant interaction effect [$F(1, 19) = 0.824$, $p = 0.375$, $\eta_p^2 = 0.042$]. For the motivation factor, there was a significant difference from pre to post, [$F(1, 19) = 8.084$, $p = 0.010$, $\eta_p^2 = 0.298$], but there was no significant difference by desk type [$F(1, 19) = 1.166$, $p = 0.294$, $\eta_p^2 = 0.058$] nor was there a significant interaction effect [$F(1, 19) = 0.173$, $p = 0.682$, $\eta_p^2 = 0.009$]. For the schoolwork factor, there was a significant difference from pre to post, [$F(1, 19) = 6.322$, $p = 0.021$, $\eta_p^2 = 0.250$], but there was no significant difference by desk type [$F(1, 19) = 0.004$, $p = 0.953$, $\eta_p^2 = 0.000$] nor was there a significant interaction effect [$F(1, 19) = 0.186$, $p = 0.671$, $\eta_p^2 = 0.010$].

DISCUSSION

The current results indicate that allowing students to use an activity workstation, such as the FitDesk, in a high school classroom does not negatively impact reading-related performance in a class designed for students who are struggling

TABLE 3 | Factors and items descriptive statistics.

Factors/VAS question	Desk	Test period	Mean	*SD*
Reading factor	FitDesk	Pre-test	63.10	22.85
		Post-test	72.64	18.13
	Traditional desk	Pre-test	66.69	17.94
		Post-test	72.05	17.63
How well did you pay attention while doing schoolwork?	FitDesk	Pre-test	66.90	21.07
		Post-test	73.35	18.86
	Traditional desk	Pre-test	65.70	21.15
		Post-test	71.00	20.69
How positive did you feel while reading?	FitDesk	Pre-test	63.15	29.75
		Post-test	70.95	20.01
	Traditional desk	Pre-test	67.80	22.89
		Post-test	73.10	21.26
How clearly were you able to think while reading?	FitDesk	Pre-test	64.45	24.67
		Post-test	68.95	23.12
	Traditional desk	Pre-test	66.65	18.05
		Post-test	74.00	21.76
How relaxed did you feel while reading?	FitDesk	Pre-test	60.75	25.94
		Post-test	72.65	21.73
	Traditional desk	Pre-test	63.80	24.56
		Post-test	71.20	19.68
How much did you enjoy reading?	FitDesk	Pre-test	58.75	31.05
		Post-test	77.85	19.77
	Traditional desk	Pre-test	66.55	25.22
		Post-test	70.05	21.74
How committed were you to reading?	FitDesk	Pre-test	60.45	23.73
		Post-test	69.30	23.21
	Traditional desk	Pre-test	66.85	22.72
		Post-test	68.75	19.86
How do you rate your reading ability?	FitDesk	Pre-test	64.95	22.02
		Post-test	76.00	19.79
	Traditional desk	Pre-test	68.25	15.26
		Post-test	76.20	15.59
How much effort did it take to concentrate while reading?	FitDesk	Pre-test	65.40	25.11
		Post-test	72.10	20.22
	Traditional desk	Pre-test	67.90	17.36
		Post-test	72.10	17.39
Physiological factor	FitDesk	Pre-test	60.52	25.58
		Post-test	60.67	23.25
	Traditional desk	Pre-test	63.72	17.01
		Post-test	59.12	21.26
How tired did you become while reading?	FitDesk	Pre-test	63.75	25.69
		Post-test	65.95	25.00
	Traditional desk	Pre-test	69.00	19.15
		Post-test	62.35	28.56
How restless did you feel while doing schoolwork?	FitDesk	Pre-test	58.25	29.40
		Post-test	59.75	24.07
	Traditional desk	Pre-test	58.55	21.52
		Post-test	58.95	21.50
How restless did you feel while reading?	FitDesk	Pre-test	59.55	30.13
		Post-test	56.30	28.38
	Traditional desk	Pre-test	63.60	22.96
		Post-test	56.05	25.34
Motivation Factor	FitDesk	Pre-test	66.73	18.15
		Post-test	73.20	17.53

(Continued)

TABLE 3 | (Continued)

Factors/VAS question	Desk	Test period	Mean	*SD*
	Traditional desk	Pre-test	64.90	18.39
		Post-test	68.75	16.82
How motivated to learn were you?	FitDesk	Pre-test	66.50	24.39
		Post-test	75.50	18.72
	Traditional desk	Pre-test	65.15	20.16
		Post-test	66.30	20.69
How committed were you to schoolwork?	FitDesk	Pre-test	66.95	16.19
		Post-test	70.90	18.98
	Traditional desk	Pre-test	64.65	20.32
		Post-test	71.20	17.91
Schoolwork factor	FitDesk	Pre-test	66.63	21.67
		Post-test	72.53	16.67
	Traditional desk	Pre-test	68.03	17.28
		Post-test	71.52	16.08
How much did you understand while doing schoolwork?	FitDesk	Pre-test	67.30	27.13
		Post-test	73.40	18.68
	Traditional desk	Pre-test	64.55	18.26
		Post-test	71.20	19.46
How positive did you feel while doing schoolwork?	FitDesk	Pre-test	67.25	23.67
		Post-test	74.85	18.09
	Traditional desk	Pre-test	69.20	19.21
		Post-test	69.95	16.53
How do you rate your learning ability?	FitDesk	Pre-test	68.85	24.71
		Post-test	75.40	17.34
	Traditional desk	Pre-test	69.75	18.78
		Post-test	76.95	12.31
How much did you focus while doing schoolwork?	FitDesk	Pre-test	69.70	22.54
		Post-test	71.75	19.80
	Traditional desk	Pre-test	68.75	21.76
		Post-test	71.30	22.88
How much effort did it take to concentrate while doing schoolwork?	FitDesk	Pre-test	69.80	20.64
		Post-test	67.10	19.92
	Traditional desk	Pre-test	71.15	17.91
		Post-test	73.60	16.67
How much did you enjoy doing schoolwork?	FitDesk	Pre-test	59.85	27.19
		Post-test	72.65	19.49
	Traditional desk	Pre-test	64.75	22.42
		Post-test	66.10	23.03

to meet the academic standards of their grade level. These results support our hypothesis that performance on the READ 180 program would not differ between desk conditions and are consistent with previous findings (Pilcher and Baker, 2016; Fedewa et al., 2017, 2018; Pilcher et al., 2017; Magnon et al., 2018; Chim et al., 2021). This suggests that activity workstations could be used in educational settings where students are required to sit for extended periods of time to help reduce sedentary behavior in children and adolescents.

Assessing students' perception of schoolwork is a complex undertaking. For example, engagement in schoolwork is a multidimensional construct which includes academic, affective, cognitive, and behavioral components (Fredricks et al., 2004; Appleton et al., 2006; Salmela-Aro and Upadaya, 2012). The VAS items used in the current study provide a means for students to assess a number of items, including motivation/engagement as well as their perceived accomplishments related to reading and schoolwork. Although there were no significant differences based on the type of desk used, there were improvements across the study in subjective assessments related to reading, schoolwork, and motivation as indicated by the factors derived from the VAS items. This suggests that the students in this class had a positive reaction to their educational experience in a class designed for students performing below their grade level. Many factors could have contributed to this outcome including the READ 180 method, the teacher, and the opportunity to have activity workstations in the classroom. Future research can be designed to examine the impact of different aspects of the class to better delineate what may have contributed to the positive change in VAS factors shown in this study. However, it is important that the students in the current study experienced this type of positive outcome when participating in the study suggesting that they found positive aspects to their education experience.

It is not surprising that the VAS factors did not differ based on desk condition. Student effort in schoolwork as well as their motivation to complete the required tasks are related to many aspects of their lives including gender, social economic status, and teacher standards (Brookhart, 1998) and can be particularly problematical when transitioning from middle school to high school (Niehaus et al., 2012). Students' feelings toward schoolwork, in general, are unlikely to be altered by something as simple as pedaling on a FitDesk for 40 min during one required class period. It is possible that more voluntary use of an activity workstation may have a positive benefit on students. Future studies could be designed to assess this possibility. In this study, students volunteered to be participants; however, they did not volunteer to be in that class or to complete the assignments made by the teacher, thus limiting how much choice the students actually had.

We did not expect reading performance to significantly improve based on the desk condition. Many factors contribute to the ability to maintain task performance (Hancock and Warm, 1989). Adding 40 min of light physical activity during one class is not likely to have a profound effect on academic performance. It is important to note that there was improvement in reading skills across each testing session; however, there was a decrease in reading skills during the holiday season before returning to school in January. The teachers at the school noted that this was a normal pattern for their students. Future research can more fully examine how reading skills may change across and between academic years. It is also interesting to note that although there was no significant difference in Lexile scores between the desk conditions, the students on the FitDesk showed a slightly better improvement in reading performance across the study. Although we cannot conclude that using the FitDesk improved reading performance, it is encouraging to recognize that there was no decrement in performance while using the activity workstations. Future studies could be designed to use activity workstations in multiple classes or across longer periods of time to assess whether a more prolonged experience with the workstations could improve performance across time.

Interventions that help reduce sedentary behavior are needed in many environments in developed societies (Proper et al., 2011). This is particularly important when considering the typical school setting which requires children and teenagers to be sedentary for 5–6 h (or more) each school day. The possibility of increasing physical activity in a classroom is particularly important given that many adolescents show decreasing interest in physical activity (Lubans et al., 2010). Some studies have addressed how to implement and study the potential impact of physical activity in a classroom setting; however, more research is needed (Polo-Recuero et al., 2021). The current study is one part of this over-all effort to examine how workstations can be implemented in educational settings.

The current study has some limitations. The limitations of this study are largely a side effect of doing research in a high school classroom. One limitation is the number of participants. This was determined by the classes that were available for the study. Because we were using an actual classroom setting, we were limited to the number of students in the class. There was also no control class of reading-challenged students either with the same teacher or a different teacher who did not use the READ 180 program. The crossover design used here allowed us to test the subjects under both desk conditions; however, we could not control how the students were assigned to the class, the teacher assigned to teach the class, or the use of the READ 180 program. As noted earlier in the discussion, this limits our ability to draw conclusions about the potential impact of the teacher and the READ 180 program. Future studies are needed in high school classroom settings to more fully document the potential impact of activity workstations using control classes and different performance measures. There were also some issues common in high school students, such as one student was disruptive and removed from school during the study. Finally, we had access only to students that were assigned to the class, limiting our subject pool. Additional studies are needed with more participants and using other types of academic classrooms to expand on the current results. Although the current study cannot fully address all potential questions related to using activity workstations in classroom settings it provides necessary information to help teachers and education administrators decide on how activity workstations can be implemented in a classroom setting.

CONCLUSION

The current study suggests that activity workstations can be implemented in secondary education settings without negatively impacting academic performance. The current study examined reading skills in students struggling to reach grade level performance. In these students, reading skills improved across the academic year in both desk conditions. In addition, the finding that subjective assessments related to reading, schoolwork, and motivation improved during the study is encouraging. Although we cannot draw definitive conclusions based on the current study about the cause of this change in the students' perspective related to their classes, any positive change in terms of student perceptions is promising. Finally, it is important to note that the teacher reported that the class was easier to manage and that many of the students looked forward to using the activity workstations during their assigned period. Future studies can be designed to further evaluate how activity workstations impact the classroom dynamics that could positively impact student engagement. The present findings suggest a feasible intervention that could provide a means to increase activity in students who are expected to remain seated for most of the school day. Activity workstations in the classroom provides one mechanism for students to increase their physical activity during the school day which may have long-term positive benefits on physical fitness, health, and wellbeing in the students.

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 Clemson University Institutional Review Board. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

JP conceived and designed the study, involved in all aspects of the study and writing the manuscript, and completed the final drafts of the manuscript. GH assisted with designing the study and establishing the methodology. JC and ED assisted with data gathering, data management, and initial data analyses. TH and PH assisted with final data management, final data analysis, and worked on earlier drafts of the manuscript. All authors contributed to the article and approved the submitted version.

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EDITED BY
Víctor Arufe Giráldez,
University of A Coruña, Spain

REVIEWED BY
Wen Xuan Fang,
Shanghai University of Sport, China
Yulong Tang,
Zhejiang University of Technology, China
Wen Lu,
Zhejiang Sci-Tech University, China

*CORRESPONDENCE
Ti Hu
11112016028@bnu.edu.cn
Lei Cui
cuilei@bnu.edu.cn

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The influence of "small private online course + flipped classroom" teaching on physical education students' learning motivation from the perspective of self-determination theory

Ti Hu[1]*, Meng-long Zhang[1,2], Hong Liu[1], Jun-cheng Liu[1], Si-jia Pan[1], Jiang-hao Guo[1], Zong-en Tian[1,3] and Lei Cui[1]*

[1]College of Physical Education and Sports, Beijing Normal University, Zhuhai, China, [2]Zhengzhou No. 17 Senior Middle School, Zhengzhou, China, [3]Shenzhen Senior High School Group, Shenzhen, China

Objective: The study aimed to enhance the learning motivation of college physical education students and improve their learning outcomes. Based on the perspective of the self-determination theory, this study explores the influence of "Small Private Online Course (SPOC) + flipped classroom" teaching on the learning motivation of students majoring in physical education and profoundly analyzes the influencing factors and promotion paths of learning motivation using this model.

Materials and methods: A total of four classes (64 students) of physical education majors in a university were selected and randomly divided into an experimental group (34 students) and a control group (30 students). The experimental group received "SPOC + flipped classroom" teaching, the control group received traditional teaching. Before and after the 16-week intervention, learning motivation, teacher support perception, basic psychological need satisfaction, and academic emotions of the 64 students were measured, and the data were analyzed by repeated-measures analysis of variance and partial least square regression.

Results: (1) The instructional intervention reduced non-regulation, external regulation, and introjected regulation, while increased identified regulation, intrinsic regulation, and self-determination levels in the students. The levels of non-regulation, external regulation, identified regulation, and self-determination were also significantly different from those of the control group. (2) After the intervention, the scores of support for autonomy, support for competence, support for relatedness, and need for relatedness in the experimental group were significantly higher than those in the control group. (3) Support for autonomy, support for competence, support for relatedness, need for competence and need for relatedness positively predicted the self-determination level, and intrinsic regulation and identified

regulation negatively predicted non-regulation, external regulation, and introjected regulation.

Conclusion: "SPOC + flipped classroom" teaching has a positive impact on students' learning motivation of basketball skills and promotes students' motivation autonomy. The improvement of support for autonomy, support for competence, support for relatedness, need for competence, and need for relatedness may be related to the improvement of learning motivation of college students majoring in Physical Education (PE). "SPOC + flipped classroom" teaching enables students to obtain more demand satisfaction by giving them more demand support, while demand support and demand satisfaction can promote the internalization of learning motivation so that students can maintain high autonomy motivation.

KEYWORDS

"SPOC + flipped classroom" teaching, self-determination theory, learning motivation, influencing factors, internalization, physical education student

Introduction

Since the beginning of the 21st century, with the rapid development of information technology, an increasing number of countries have embarked on educational informatization (Yang et al., 2014). Network teaching arises at this historic moment, and flipped classrooms have developed rapidly and attracted global attention. In 2012, MOOC prompted intense discussions around the world, and a large number of high-quality open online courses emerged, further promoting the rapid development of online education and blended teaching. Xu et al. (2014) proposed small private online course (SPOC), considered "post-MOOC", to give full play to the role of online courses more efficiently. Small Private Online Course (SPOC), supported by advanced education and information technology, changes the time and space limitations of the traditional teaching model, provides rich learning materials for students to communicate and collaborate anytime and anywhere, realizes an open educational environment, and brings together the advantages of online courses and face-to-face teaching, which also provides a strong guarantee of flipped classroom knowledge acquisition (De La Croix and Egerstedt, 2014). The combination of flipped classrooms and SPOC will bring new vitality to course teaching (Gu et al., 2017). In terms of "SPOC + flipped classroom" teaching design, the primary forms in other disciplines are self-study teaching videos before class to absorb knowledge, diverse teaching activities in class to help students complete the internalization of knowledge, and consolidation and feedback through an online platform after class (Li and Li, 2015; Peng and Long, 2020). The design of physical education is essentially the same as that of other subjects, but due to the physical activity-based nature of the physical education classroom, the specific implementation forms are different, with classroom activities primarily based on group cooperation, demonstration, and intergroup competition (Hinojo-Lucena et al., 2018; Peng and Long, 2020). In addition, due to the more difficult mastery of motor skills and the longer learning cycle, consolidation exercises and feedback on questions in the post-class phase have been emphasized (Wang et al., 2019). In the teaching practice "SPOC + flipped classroom" model, it has been found that it helps students master technical actions and relevant theoretical knowledge and significantly promotes learning attitudes, learning efficiency, enthusiasm, motivation, and self-efficacy (Wang et al., 2019; Liu, 2020), but there are relatively few studies on students' learning motivation, and only simple comparisons are made at a superficial level (Kurt, 2017; Wang, 2021), and there is a lack of detailed discussion on the factors and mechanisms influencing learning motivation.

Motivation is the internal psychological tendency that causes and maintains individual behavior to meet its needs and is the power source of individual behavior. Learning motivation is the psychological tendency and motivation source of individuals to produce and continue learning behavior, cause the individuals' learning behavior and maintain and continue it, and is the internal motivation of the individuals to participate in learning (Pi et al., 2009). Relevant studies have shown that insufficient motivation to learn can hinder the improvement of the teaching effectiveness of physical education courses (Su, 2007), while greater motivation promotes the improvement of the learning effect (Yang, 2021). At present, college students majoring in physical education are in a state of high cognition and low desire for professional learning (Zhou, 2010), with weak learning motivation and engagement (Luo et al., 2017; Mao,

2020); as the grades increase, learning burnout is becoming an increasingly serious problem, which reduces the learning effect (Zhang, 2010; Liu et al., 2016). Therefore, it is crucial to explore new teaching modes and enhance the learning motivation of physical education students in order to improve the teaching effect and the quality of talent training.

The self-determination theory (SDT), developed by Deci and Ryan (1985), systematically explains the continuous structure, regulation model, influencing factors, and mechanism of motivation and puts forward the main viewpoints of *basic psychological needs*, organic integration, causal orientation, and *cognitive evaluation*. In exploring learning motivation, the self-determination theory states that individual motivation is on the continuum of *no motivation*, *external motivation* (multiple adjustment methods), and *internal motivation* (**Table 1**) and that the higher the degree of self-determination of motivation, the greater the autonomy of motivation (Deci and Ryan, 2000). In terms of exploring the factors affecting learning motivation, the SDT holds that the social environment influences the internalization of motivation by influencing the satisfaction of three basic psychological needs (*need for competence*, *need for autonomy*, and *need for relatedness*) of individuals. Relevant research shows that the satisfaction of basic psychological needs significantly predicts the internalization of *internal motivation* and *external motivation* (Joe et al., 2017), and the task of meeting individual basic psychological needs can significantly affect *internal motivation*. Second, the SDT holds that the outside world affects motivation through individuals' cognitive evaluation of external events, that is, the external support (*support for autonomy*, *support for relatedness*, and *support for competence*) felt by students impacts motivation. Reeve (2002) uses the SDT to explain the process of learning motivation that when teachers provide *support for autonomy*, students can benefit from it, and it improves students' learning motivation. Another study shows that *support for autonomy* can promote the development of *identified regulation* and *intrinsic regulation* (Deci and Ryan, 2000). In addition, emotions (*positive activity orientation*, *positive outcome orientation*, *negative activity orientation*, and *negative outcome orientation*) are the source of motivation for self-determination, which plays a vital role in learning motivation (Qiao and Li, 1995; Li et al., 2004). Studies have shown a significant positive correlation between positive emotions and learning motivation variables, and a significant inverse correlation between negative emotions and learning motivation variables (Jin, 2021). Therefore, this study measures the degree of self-psychological needs, external support, and academic emotions that students feel and explores their connection to learning motivation.

Based on this, from the perspective of the self-determination theory, this study explores the influence of "SPOC + flipped classroom" teaching on the learning motivation of students majoring in physical education and profoundly analyzes the influencing factors and promotion paths of learning motivation under this model. The research is mainly carried out from the following three aspects:

1. The impact of "SPOC + flipped classroom" teaching on the learning motivation of physical education students.

2. Factors influencing the learning motivation of physical education students under the teaching of "SPOC + flipped classroom."

3. The "SPOC + flipped classroom" teaching affects the promotion paths of the learning motivation of physical education students.

Materials and methods

Subjects and study design

In the autumn semester of 2020, four classes (64 students in total) of physical education majors in a university in Beijing were selected for the basketball teaching experiment, and the four classes were randomly divided into an experimental group (34 students) and a control group (30 students). A mixed experimental design of 2 (experimental group and control group) × 2 (pretest and posttest) was used. The experimental group adopted "SPOC + flipped classroom" teaching, while the control group adopted the traditional teaching approach; the experiment lasted for one semester (16 weeks). Before and after the experiment, students' learning motivation and teachers' perceptions of support, basic psychological need satisfaction, and academic emotions were measured in both groups.

"SPOC + flipped classroom" teaching design

This study is based on the following aspects: three dimensions of basketball course teaching objectives, learner characteristics, and model characteristics; two platforms of SPOC and classroom; two perspectives of teacher and student; three stages, namely before class (knowledge transfer), in class (knowledge internalization), and after class (knowledge consolidation), to carry out the "SPOC + flipped classroom" basketball teaching design. In the before class stage, teachers publish the learning resources of this class on the SPOC platform. Students learn relevant theoretical knowledge about basketball skills and tactics by themselves (action methods, tactics, rules, etc.) and complete online tests. Then, through cognitive imitation of skills and tactics and peer training, the visual representation was initially established. Finally, a real-time communication channel is established through the online platform to feed back problems that are difficult to solve for teachers. In the class stage, teachers target guidance

TABLE 1 Explanation of different forms of motivation regulation.

	Adjust the way	Meaning
Amotivation	Non-Regulation	Individuals cannot be motivated when they do not recognize the connection between their behavior and the desired outcome;
Extrinsic motivation	External Regulation	Reflects that the individual is under the control of external events (such as rewards and punishments) to take a certain behavior, has the lowest autonomy.
	Introjected Regulation	Individuals adjust their own behaviors through the perceived values and reflect external motivation to begin to internalize and have a certain degree of autonomy.
	Identified Regulation	Individuals evaluate events or behaviors, recognize their value to themselves, and then decide whether to take action; However, there is no spontaneous pleasure or satisfaction.
Intrinsic motivation	Intrinsic Regulation	Internal motivation is derived from the tendency to grow and develop mentally and is caused by the satisfaction generated by the behavior itself, without the involvement of external conditions.
	Self-determination level	The comprehensive expression of motivation level represents students' self-determination level, and the higher the score, the more independent it is.

TABLE 2 Motivation levels of the experimental group and the control group before and after intervention.

Learning motivation	The experimental group				The control group			
	Before the test		After the test		Before the test		After the test	
	M	SD	M	SD	M	SD	M	SD
Self-determination level	8.5200	4.97092	9.9021	4.81957	7.5887	4.87984	6.4333	5.06685
Non-regulation	2.0588	1.24644	1.7844	1.23039	2.6893	1.58061	2.7773	1.71609
External regulation	2.8526	1.60206	2.5294	1.11049	3.2780	1.51396	3.3557	1.61886
Introjected regulation	3.8732	1.70758	3.6668	1.76412	4.2787	1.51399	4.1443	1.58696
Identified regulation	5.8426	1.24790	6.1176	0.94901	6.0670	1.12227	5.6450	1.16111
Intrinsic regulation	6.1279	1.20581	6.2553	0.90605	6.1777	0.98913	5.8223	1.23698

in doubts and difficulties in students before class learning, solving students' questioning and corrective technical actions, thereby shortening the time of explaining the primary content. Through the organization, collaboration, dialog, competition, and other organizations, students' enthusiasm for learning is fully mobilized so that students will continue to internalize and consolidate the content of the learning in the process of high-density "learning," "practice," and "competition." At the after class stage, the teachers arranged the after-school learning tasks through the SPOC platform, answered doubts for students, and completed the tracking and evaluation of students' learning effects in the process. Students have practiced autonomous exercises, group exercises, and practical applications and jointly completed after-class tasks. At the same time, after class feedback also provides reference and guidance for before class teaching to achieve an adequate grasp and comprehensive application of knowledge and skills.

Data collection

Measurement of learning motivation

The Perceived Locus of Causality Scale was used to estimate students' learning motivation level. The scale, developed by Goudas et al. (1994), is suitable for measuring the motivation and behavioral regulation of middle school students in physical education and sports, and it was later revised and introduced in China by Pak-Kwong et al. (2014) and has good reliability and validity with five dimensions: *intrinsic regulation*, *identified regulation*, *introjected regulation*, *external regulation*, and *non-regulation*. In this study, Cronbach's α coefficients were 0.81, 0.73, 0.64, 0.71, and 0.77, respectively, and the total table coefficients were 0.82. The self-determination index (SDI) is calculated in the form of weighting as follows: 2 × *intrinsic regulation* + *identified regulation* - *introjected regulation* - 2 × *external regulation*; the higher the score, the more autonomous it is, and the more inclined the learning behavior is

toward a *self-determination level*. This index does not include the dimension of *amotivation* because the SDI represents the *self-determination level* of individual motivation, while *amotivation* represents that individuals have no motivation to stimulate, and its effectiveness has been verified in many studies (Grolnick and Ryan, 1987; Vallerand et al., 1997; Standage et al., 2006).

Measurement of physical education needs support

The Perceived Need Support Scale in physical education was used to evaluate students' perceived need for support. This questionnaire, which was compiled by Yin et al. (2018), is suitable for measuring the perception of demand support in PE teaching. It contains three dimensions, *support for autonomy*, *support for competence*, and *support for relatedness*, and has high reliability and validity. Cronbach's α coefficients in this study were 0.97, 0.93, and 0.96, respectively, and the total table coefficient was 0.99.

Measurement of academic emotion

The General Academic Emotion Questionnaire for College Students (GAEQ) was used to evaluate students' academic emotion. This questionnaire, compiled by Xu and Gong (2011), is suitable for evaluating college students' academic emotions, and it contains four subscales of *positive activity orientation*, *positive outcome orientation*, *negative activity orientation*, and *negative outcome orientation* and has good reliability and validity. Cronbach's α coefficients of each subscale in this study were 0.92, 0.94, 0.95, and 0.85, respectively, and the coefficient of the total scale was 0.94.

Measurement of basic psychological needs

Basic psychological needs were measured by the questionnaire used by (Zhu et al., 2011) in this questionnaire, *need for autonomy* was measured by the relevant scale in Hollembeak and Amorose (2005), *need for competence* was measured using the relevant scale in the *intrinsic motivation inventory* (IMI) of McAuley et al. (1989); and *need for relatedness* was measured using the relevant scale in *the Need for Relatedness Scale* (NRS) developed by Richer and Vallerand (1998). The three subscales have been widely used and certified in the field of sports. Through confirmatory factor analysis, Zhu Xiaona showed that the reliability and validity of the three questionnaires were good. In this study, Cronbach's α coefficients of the three subscales of competence, autonomy, and relationship were 0.86, 0.71, and 0.98, respectively, and the total coefficient was 0.96.

Data analysis

In this study, SPSS 22.0 and SIMCA-P 11.5 software were used to conduct *analysis of variance* (ANOVA) and *partial least square regression* (PLSR) analyses to explore the influence of different models on students' motivation, as well as their influencing factors and mechanisms. PLSR analysis with principal component analysis, canonical correlation analysis, and multiple linear regression of some of the common characteristics are able to analyze large numbers of variables in small sample sizes. Thus, considering the small number of samples and a large number of variables in this study, we performed the PLSR analysis. PLSR analysis mainly includes the following two steps: first, identify the number of principal components; second, after setting the number of principal components for specific analysis, (1) analyze the relationship expression, correlation coefficient, and accuracy between principal components and research items; (2) analyze the influence relationship between independent variables and dependent variables; and (3) projection importance analysis.

Research results

Influence of "SPOC + flipped classroom" on learning motivation

Table 2 shows the descriptive statistical results of the motivation level and *self-determination level* of each dimension of the experimental group and the control group before and after the teaching intervention. Compared with before the intervention, the overall level of the experimental group increased after the intervention, while that of the control group decreased. A one-way ANOVA results showed that there was no significant difference between the pretest group and the control *group (self-determination level* ($F_{(1,\ 62)}$ = 0.569, p = 0.453 > 0.05, *partial* η^2 = 0.009); *non-regulation* ($F_{(1,\ 62)}$ = 3.175, p = 0.080 > 0.05, *partial* η^2 = 0.049); *external regulation* ($F_{(1,\ 62)}$ = 1.183, p = 0.281 > 0.05, *partial* η^2 = 0.019); *introjected regulation* ($F_{(1,\ 62)}$ = 0.998, p = 0.322 > 0.05, *partial* η^2 = 0.016); *identified regulation* ($F_{(1,\ 62)}$ = 0.566, p = 0.455 > 0.05, *partial* η^2 = 0.009); and *intrinsic regulation* ($F_{(1,62)}$ = 0.032, p > 0.05, *partial* η^2 = 0.001). Next, the influence of teaching intervention on students' motivation is analyzed.

In the dimension of self-determination level, a repeated-measures ANOVA was conducted for intra- and intrasubject effect tests (**Table 3**), indicating that the main effect of time was not significant ($F_{(1,62)}$ = 0.018, p = 0.894 > 0.05, *partial* η^2 = 0.000), that is, there was no significant difference in the *self-determination level* of each group over time. The interaction effect of time * group was not significant ($F_{(1,62)}$ = 2.243, p = 0.139 > 0.05, *partial* η^2 = 0.035), indicating that there was no significant difference in the change in the s*elf-determination level* between the experimental group and the control group before and after intervention. Further post-analysis of the group's main effect showed that there was no significant difference between the experimental group and the control group, and the *self-determination level* of the experimental

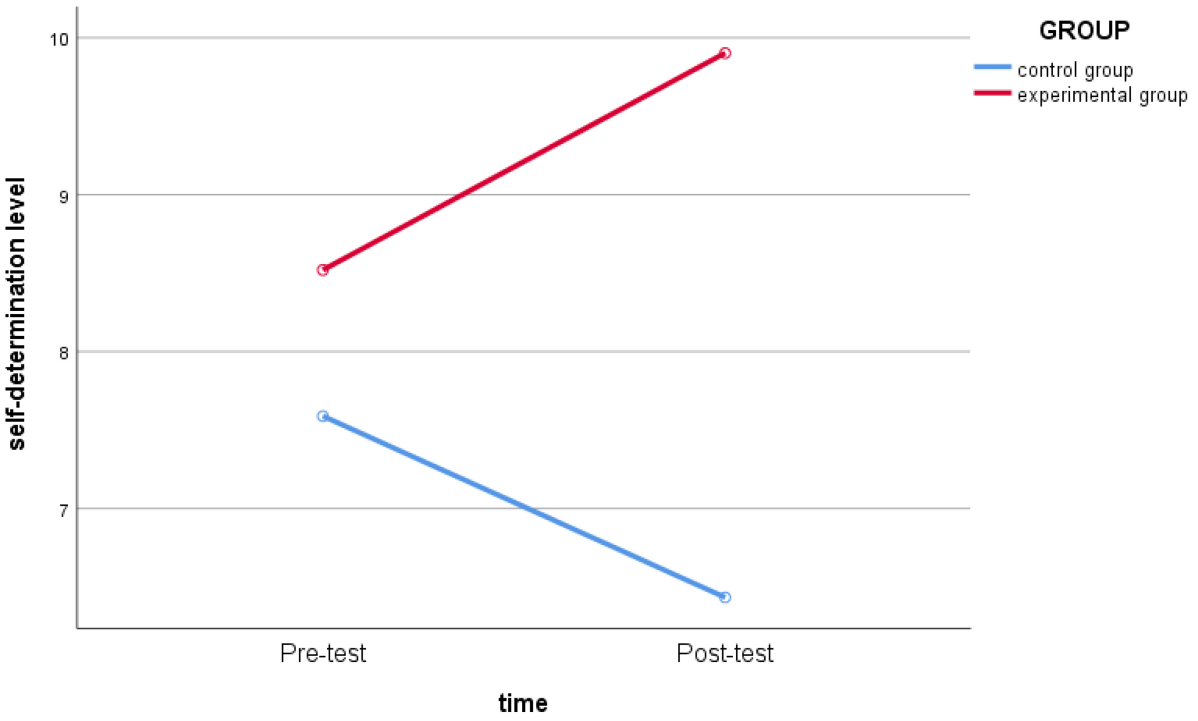

FIGURE 1
Schematic diagram of the changes in *self-determination level* between the experimental group and the control group before and after intervention.

TABLE 3 Detection of intra- and intersubject effects.

Measure: MEASURE_1

The source	Class III sum of squares	Degrees of freedom	The mean square	F	Significant
Time	0.410	1	0.410	0.018	0.894
Time * group	51.306	1	51.306	2.243	0.139
Group	154.279	1	154.279	5.982	0.017*

*$p < 0.05$.

group was significantly higher than that of the control group ($F_{(1,62)} = 5.982$, $p = 0.017 < 0.05$, *partial* $\eta^2 = 0.088$) (Figure 1).

Then, the repeated measures ANOVA on the five dimensions of non-regulation, external regulation, introjected regulation, identified regulation, and intrinsic regulation. The repeated-measures ANOVA results showed *non-regulation* ($F_{(1,62)} = 10.533$, $p = 0.002 < 0.05$, *partial* $\eta 2 = 0.145$) (Figure 2) and *external regulation* ($F_{(1,62)} = 5.244$, $p = 0.025 < 0.05$, *partial* $\eta 2 = 0.078$) (Figure 3); the main effect of the two-dimensional group was significant, indicating that teaching intervention had a significant impact. The group effects of *introjected regulation* ($F_{(1,62)} = 1.584$, $p = 0.213 > 0.05$, *partial* $\eta 2 = 0.025$) (Figure 4) and *intrinsic regulation* ($F_{(1,62)} = 0.806$, $p = 0.373 > 0.05$, *partial* $\eta 2 = 0.013$) (Figure 5) were not significant, indicating that there was no significant difference in the level of different groups. Among them, the group effect of *identified regulation* was not significant, but the interaction effect of time* group was significant ($F_{(1,62)} = 4.137$, $p = 0.046 < 0.05$, *partial* $\eta 2 = 0.063$) (Figure 6). Further analysis showed that there were significant differences in the degree of change in the *identity regulation* level before and after intervention for different groups, and the experimental group had a positive influence on the identity regulation level, while the control group experienced the opposite effect.

Next, we conducted a *post hoc* power analysis using software G*Power (version 3.1.9.2; Kiel University, Kiel, Germany) to confirm the sample sizes. We used a power analysis with an effect size f = 0.2592 or 0.4118 (*partial* $\eta 2 = 0.063$ or 0.145), α error of probability = 0.05, total sample size = 64, number of groups = 2, number of measurements = 2, correlation = 0.5, and power (1-β) = 0.98 or 0.99.

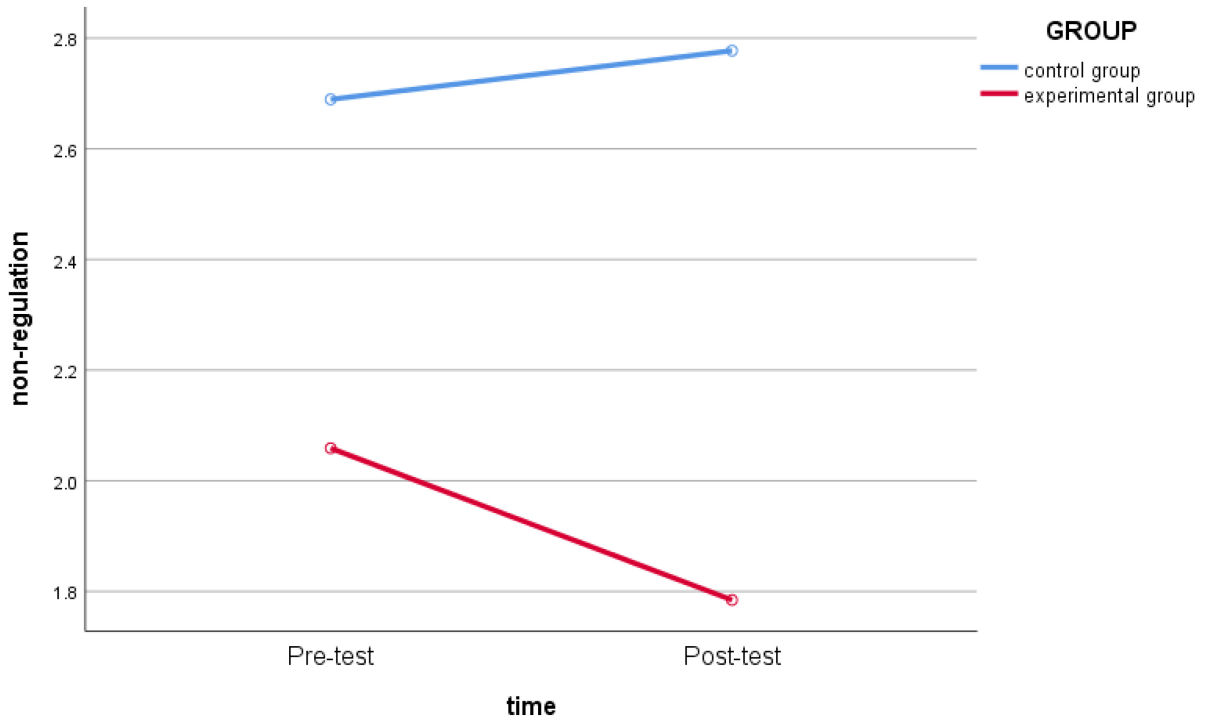

FIGURE 2
Schematic diagram of the changes in *non-regulation* between the experimental group and the control group before and after intervention.

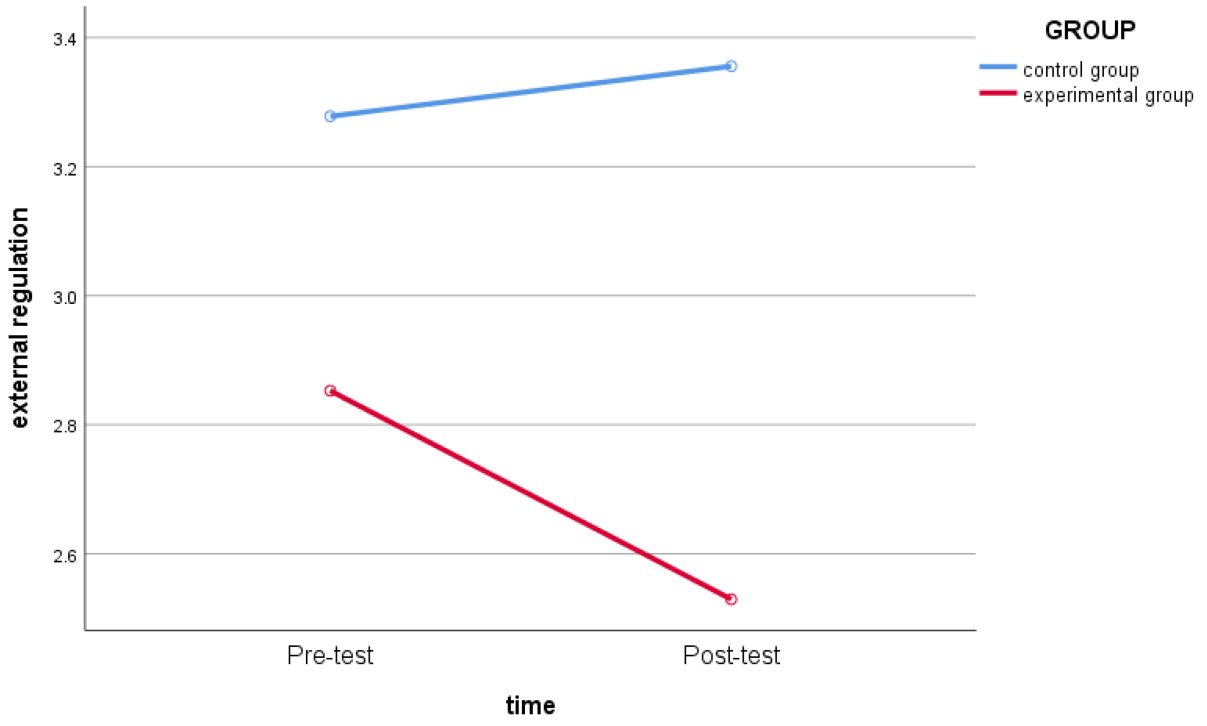

FIGURE 3
Schematic diagram of the changes in *external regulation* between the experimental group and the control group before and after intervention.

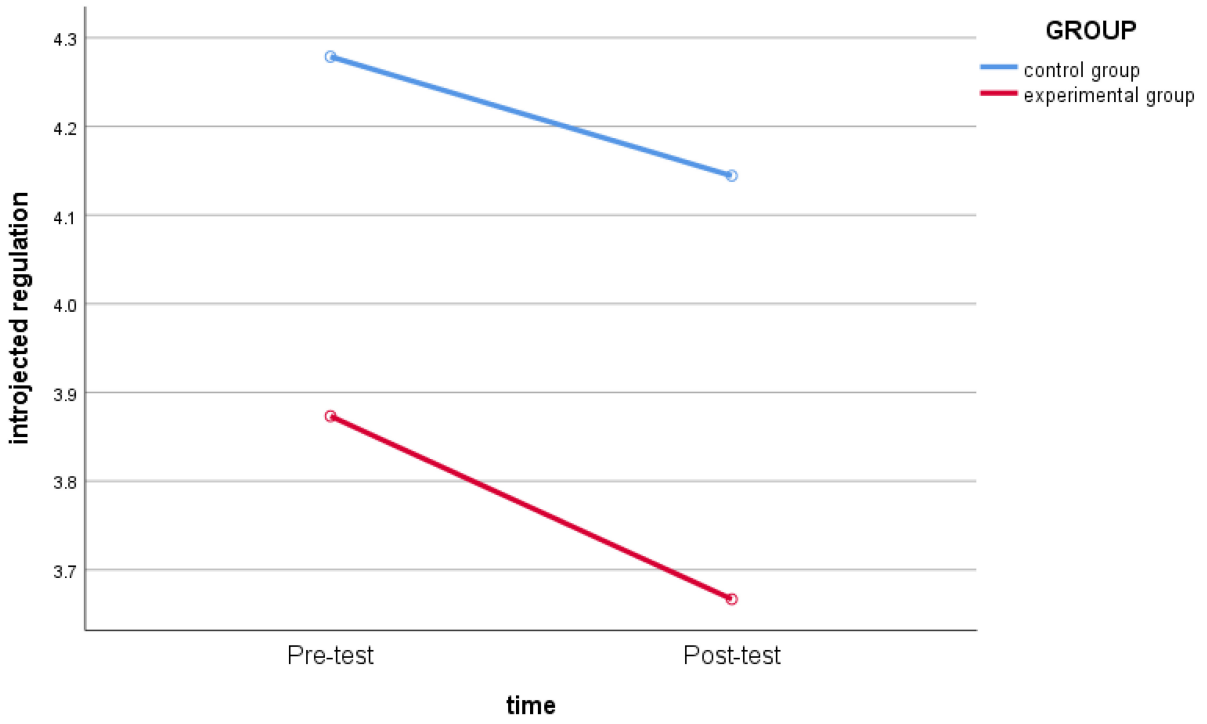

FIGURE 4
Schematic diagram of the changes in *introjected regulation* between the experimental group and the control group before and after intervention.

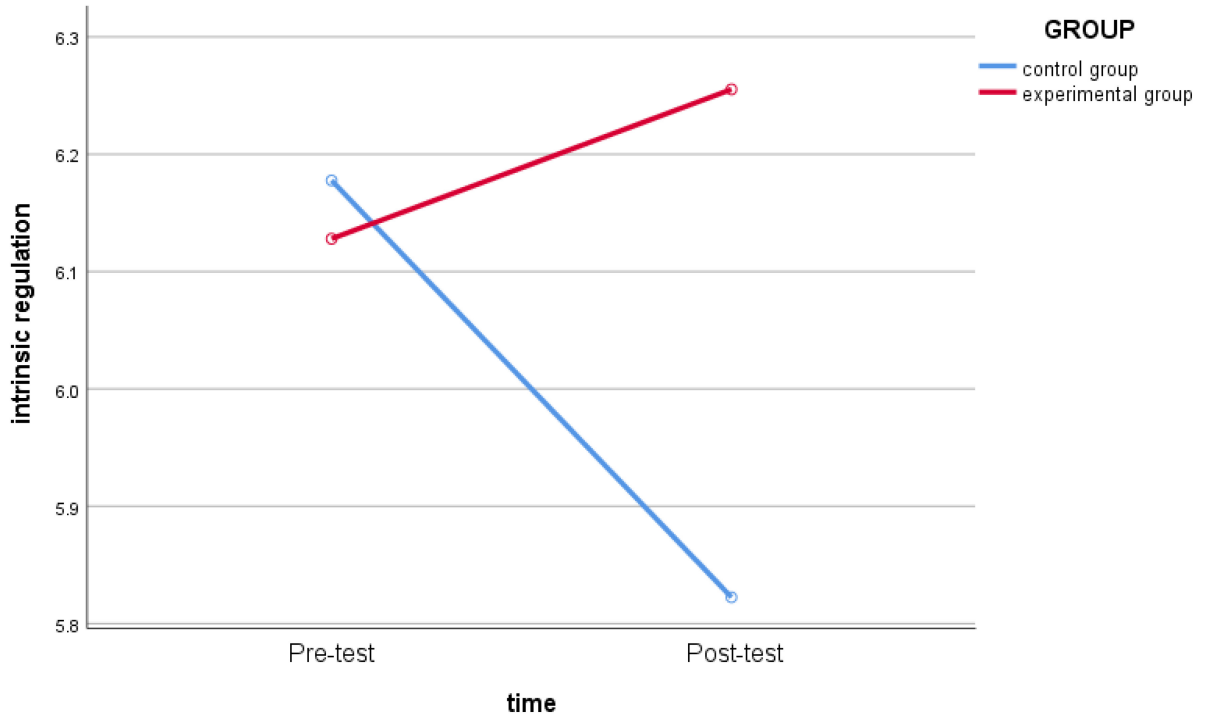

FIGURE 5
Schematic diagram of changes in *intrinsic regulation* between the experimental group and the control group before and after intervention.

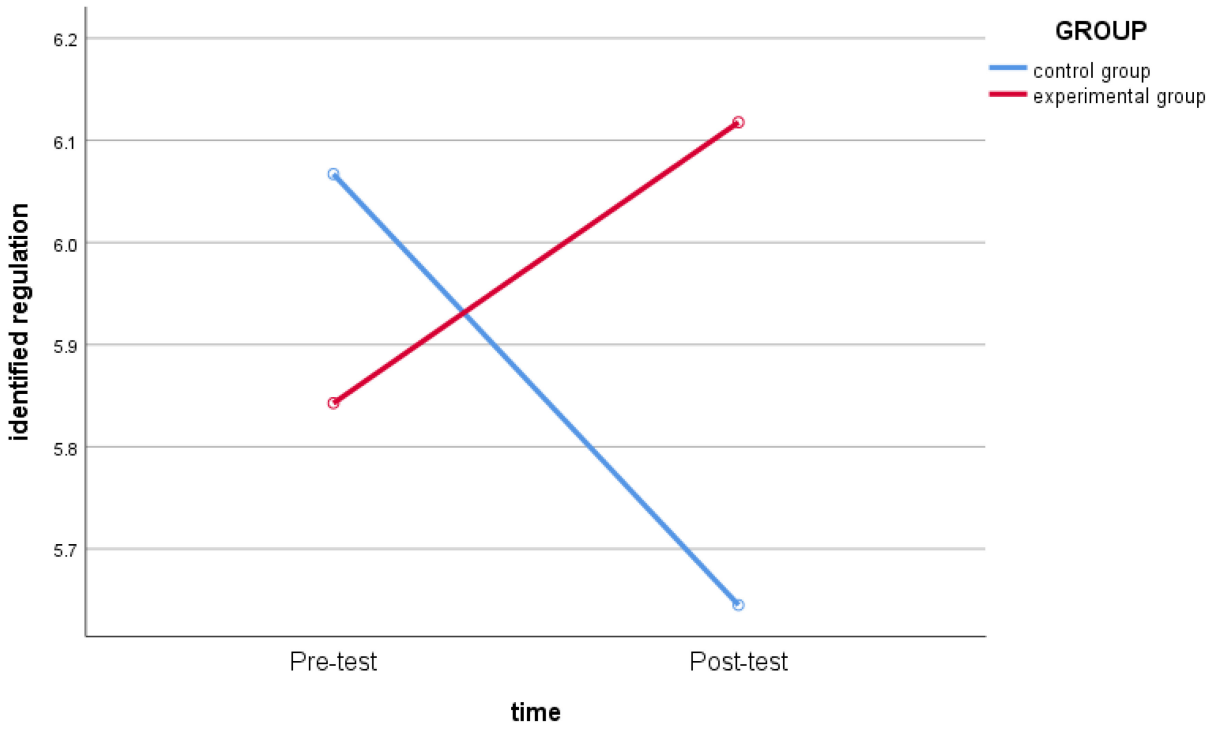

FIGURE 6
Schematic diagram of the changes in *identified regulation* between the experimental group and the control group before and after intervention.

As a result, the instructional intervention reduced *non-regulation*, *external regulation*, and *introjected regulation*, while increased *identified regulation*, *intrinsic regulation*, and *self-determination levels* in the students. The levels of *non-regulation*, *external regulation*, *identified regulation*, and *self-determination* were also significantly different from those of the control group.

Partial least square regression analysis of the influencing factors of "SPOC + flipped classroom" teaching to improve learning motivation

Determine the number of principal components

In this study, cross-validity analysis was used to determine the number of principal components, supplemented by importance in projection Variable Importance in Projection (VIP) value analysis. Crossover validity can be used to analyze the optimal number of components. If Qh2 $\leq$ 0.0975, it is meaningless to increase the number of principal components further, that is, the number of components corresponding to this point (or the upper point) is the optimal number of principal components. When h = 1, Qh2 = 1.000 > 0.0975; therefore, it is suitable to extract one principal component (Table 4).

The VIP value was further analyzed. By comparing the VIP values of the projected importance of principal components with different numbers, it was found that there was no significant difference between the VIP values of each variable when there were one principal component and multiple principal components. Combined with the results of the cross-validity analysis, the number of principal components was finally determined to be 1.

TABLE 4 Results of cross-validation analysis.

Composition h	SS	PRESS	Qh^2
1	494.728	562.397	1.000
2	474.789	595.170	−0.203
3	466.268	596.233	−0.256
4	455.139	702.616	−0.507
5	449.329	719.839	−0.582
6	427.953	753.313	−0.677
7	423.360	753.947	−0.762
8	420.341	984.184	−1.325
9	383.388	958.450	−1.280
10	381.861	956.701	−1.495

Partial least square regression analysis

In PLSR analysis, multiple independent variables and dependent variables will be concentrated to represent the principal component U and principal component V, which are then used as bridges for research. Through analysis, the relationship expression between principal components U and V and the variables is obtained as follows: (1) U1 = 0.427**support for autonomy* + 0.407* *support for relatedness* + 0.429* *support for competence* + 0.347* *need for competence* + 0.186* *need for autonomy* + 0.404* *need for relatedness* + 0.267* *positive activity orientation* + 0.261* *positive outcome orientation* −0.038* *negative activity orientation* + 0.096* *negative outcome orientation.* (2) V1 = −0.571* *non-regulation* −0.544* *external regulation* −0.167* *introjected regulation* + 0.663**identified regulation* + 0.755* *intrinsic regulation* + 0.726* *self-determination level.*

The factor loading value between principal components and research items is used to analyze the correlation between the principal components and analysis items, the value is between -1 and 1, and the larger the absolute value, the stronger the correlation. Table 5 shows that there is a positive correlation between the principal component U1 and the respective variables. The principal component V1 was negatively correlated with *non-regulation*, *external regulation*, and *introjected regulation* and positively correlated with *identified regulation*, *intrinsic regulation*, and *self-determination levels.* Further analysis of principal components U1 and V1 and the accuracy of the research item shows that the extracting ratio of principal component U to the information of the 10 independent variables is 0.546 (i.e., the variance explanation rate is 54.6%), which is acceptable. Among them, the information extraction proportion of *support for autonomy*, *support for relatedness*, *support for competence*, *need for competence*, *need for competence*, and *need for autonomy* was very high (0.906, 0.820, 0.861, 0.719, and 0.837, respectively), while the information extraction proportion of *need for autonomy*, *positive activity orientation*, and *positive outcome orientation* was low (0.333, 0.406, and 0.432, respectively); the proportion of information extraction *for negative activity orientation* and *negative outcome orientation* was very low (0.004 and 0.141, respectively). The extraction ratio of principal component V1 to the six dependent variables was 0.597 (i.e., the variance explanation rate was 59.7%), which was acceptable. Among them, the proportion of information extraction of *non-regulation*, *external regulation*, *identified regulation*, *intrinsic regulation*, and *self-determination* level was very high (0.558, 0.648, 0.616, 0.745, 0.924), while the proportion of information extraction of *introjected regulation* was very low (0.092).

Table 6 shows the standardized regression expression between the dependent variable Y and independent variable X, without motivation: (1) *non-regulation* = -0.111**support for autonomy*-0.106* *support for relatedness* -0.112**support for competence*-0.091**need for competence*-0.049**need for autonomy* −0.106**need for relatedness*-0.070**positive activity orientation*-0.068**positive outcome orientation* + 0.010**negative activity orientation* −0.025**negative outcome orientation.* The other five dimensions are the same. The result shows that the *self-determination level*, *intrinsic regulation*, and *identified regulation*, in addition to *negative activity orientation*, have a negative impact. *Support for autonomy*, *support for relatedness*, *support for competence*, *need for competence*, *need for autonomy*, *need for relatedness*, *positive activity orientation*, *positive outcome orientation*, and *negative outcome orientation* have a positive influence on the results. Among them, the influence of *support for autonomy*, *support for relatedness*, *support for competence*, *need for competence*, and *need for relatedness* is larger, followed by the influence of *positive activity orientation* and *positive outcome orientation*, and the impact of *need for autonomy*, *negative activity orientation*, and *negative outcome orientation* is smaller. *Non-regulation* and *external regulation*, in addition to *negative outcome orientation*, have a positive impact. *Support for autonomy*, *support for relatedness*, *support for competence*, *need for competence*, *need for autonomy*, *need for relatedness*, *positive activity orientation*, *positive outcome orientation*, and *negative outcome orientation* all have a negative impact on them. Among them, *support for autonomy*, *support for relatedness*, *support for competence*, and *need for relatedness* have a greater impact, followed by the influence of *need for competence*, *positive activity orientation*, and *positive outcome orientation*, and the impact of *need for autonomy*, *negative activity orientation*, and *negative outcome orientation* is small. I*ntrojected regulation*, in addition to *negative outcome orientation*, has a positive impact. *Support for*

TABLE 5 Correlation analysis between principal components and research items (loading value).

	Principal component U1
Support for autonomy	0.410
Support for relatedness	0.390
Support for competence	0.400
Need for competence	0.366
Need for autonomy	0.249
Need for relatedness	0.395
positive activity orientation	0.275
Positive outcome orientation	0.284
Negative activity orientation	0.029
Negative outcome orientation	0.162
	Principal component V1
Non-regulation	−0.261
External regulation	−0.249
Introjected Regulation	−0.076
Identified Regulation	0.303
Intrinsic regulation	0.345
Self-determination level	0.332

autonomy, *support for relatedness*, *support for competence*, *need for competence*, *need for autonomy*, *need for relatedness*, *positive activity orientation*, *positive outcome orientation*, and *negative outcome orientation* all have a negative impact, but the impact of all independent variables is less.

The projected importance index VIP is used to explain the overall importance of the independent variable X to the dependent variable Y (Table 7). *Support for autonomy*, *support for relatedness*, *support for competence*, *need for competence*, and *need for relatedness* have greater explanatory power for students' learning motivation (VIP value > 1.0), followed by *positive activity orientation* and *positive outcome orientation* (0.844 and 0.825, respectively). *Need for autonomy*, *negative activity orientation*, and *negative outcome orientation* had low explanatory power for students' learning motivation (0.589, 0.121, and 0.303, respectively). Some variables contribute less to the regression model and need to be adjusted. To further determine the variables that need to be adjusted, combined with the regression coefficient test of the original data, the influence of individual independent variables on the dependent variables is not significant. Finally, the regression model was adjusted based on the standardized regression coefficient, VIP value, and regression coefficient test results.

Partial least square regression model after adjustment

Through multiple variable adjustments, this study found that the model was ideal after removing the items *positive activity orientation*, *positive outcome orientation*, *negative activity orientation*, *negative outcome orientation*, and n*eed for autonomy*. The following is the adjusted analytical regression result.

The mathematical relationship between the adjusted principal components and the research items was as follows: (1) principal component U1 = 0.472* *support for autonomy* + 0.452* *support for relatedness* + 0.475* *support for competence* + 0.384* *need for competence* + 0.446* *need for relatedness*; (2) principal component V1 = −0.547* *non-regulation* −0.515* *external regulation* −0.167* *introjected regulation* + 0.542* *identified regulation* + 0.656* *intrinsic regulation* + 0.652* *self-determination level*. There is a positive correlation between the adjusted principal component U1 and the respective variables. Principal component V1 was negatively correlated with *non-regulation*, *external regulation*, and *introjected regulation* and positively correlated with *identified regulation*, *intrinsic regulation*, and *self-determination level*. After adjustment, the loading value is higher, and the correlation is stronger. The information extraction ratio of the adjusted principal component U1 to the respective variables reached 0.869 (i.e., the variance explanation rate was 86.9%), which was significantly higher than the previous rate of accuracy, and the extraction effect was ideal. The extraction ratio of principal component V1 to the information of each

TABLE 6 Regression coefficients between dependent variable Y and independent variable X.

	Not standardized						Standardized					
	Non-regulation	External regulation	Introjected regulation	Identified regulation	Intrinsic regulation	Self-determination level	Non-regulation	External regulation	Introjected regulation	Identified regulation	Intrinsic regulation	Self-determination level
Constant	7.854	7.723	6.406	1.363	0.832	−18.825	0.000	0.000	0.000	0.000	0.000	0.000
Support for autonomy	−0.169	−0.145	−0.071	0.151	0.164	0.841	−0.111	−0.106	−0.033	0.129	0.147	0.142
Support for relatedness	−0.165	−0.142	−0.069	0.148	0.160	0.821	−0.106	−0.101	−0.031	0.124	0.141	0.135
Support for competence	−0.150	−0.129	−0.063	0.135	0.146	0.749	−0.112	−0.107	−0.033	0.130	0.148	0.142
Need for competence	−0.094	−0.081	−0.040	0.085	0.092	0.470	−0.091	−0.086	−0.027	0.105	0.120	0.115
Need for autonomy	−0.047	−0.040	−0.020	0.042	0.046	0.234	−0.049	−0.046	−0.014	0.056	0.064	0.062
Need for relatedness	−0.140	−0.121	−0.059	0.126	0.136	0.698	−0.106	−0.101	−0.031	0.123	0.140	0.134
Positive activity orientation	−0.008	−0.006	−0.003	0.007	0.007	0.038	−0.070	−0.066	−0.020	0.081	0.092	0.089
Positive outcome orientation	−0.015	−0.013	−0.006	0.014	0.015	0.077	−0.068	−0.065	−0.020	0.079	0.090	0.087
Negative activity orientation	0.001	0.001	0.000	−0.001	−0.001	−0.004	0.010	0.010	0.003	−0.012	−0.013	−0.013
Negative outcome orientation	−0.003	−0.002	−0.001	0.002	0.003	0.013	−0.025	−0.024	−0.007	0.029	0.033	0.032

variable reached 0.599 (i.e., the variance explanation rate was 59.9%), which was relatively ideal.

Table 8 shows the regression expression between the dependent variable Y and independent variable X, including the relationship expression between each dependent variable Y and all independent variables, as explained later without motivation. The other five dimensions are the same: (1) *non-regulation* = −0.148**support for autonomy*−0.142**support for relatedness* −0.149* *support for competence* −0.121**need for competence*−0.140**need for relatedness*. The normalized values of the adjusted regression coefficients showed that *support for autonomy*, *support for relatedness*, *support for competence*, *need for competence*, and *need for relatedness* had positive effects on the *self-determination level*, *intrinsic regulation*, and *identified regulation*. In terms of *non-regulation* and *external regulation*, *support for autonomy*, *support for relatedness*, *support for competence*, *need for competence*, and *need for relatedness* all had negative effects. In terms of introjected *regulation*, *support for autonomy*, *support for relatedness*, *support for competence*, *need for competence*, and *need for relatedness* all had negative effects. However, all the independent variables have little influence. After adjustment, the VIP values of each variable are all greater than 0.8, which indicates a great influence on the dependent variable set, namely, learning motivation. Among them, the VIP value of *support for autonomy*, *support for relatedness*, and *support for competence* is greater than 1, which has a more important effect on learning motivation, while the effect of *need for competence* and *need for* relatedness on students' motivation is relatively small.

To further test the fitting degree of the model, it can be seen from Table 9 that R^2 = 0.438, that is, the set of independent variables can explain 42.8% of the reasons for the unmotivated changes. The other five dimensions are the same. The aforementioned results indicate that *non-regulation*, *external regulation*, *identified regulation*, *intrinsic regulation*, and *self-determination level* are good; *introjected regulation* is poor. On the one hand, this is related to the weak correlation between introjected regulation and other variables; on the other hand, it

TABLE 7 Summary of important indicators for projection (VIP).

Variable	VIP value
Support for autonomy	1.349
Support for relatedness	1.289
Support for competence	1.355
Need for competence	1.097
Need for autonomy	0.589
Need for relatedness	1.279
Positive activity orientation	0.844
Positive outcome orientation	0.825
Negative activity orientation	0.121
Negative outcome orientation	0.303

TABLE 8 Adjusted regression coefficients between the dependent variable Y and independent variable X.

	Not standardized						Standardized					
	Non-regulation	External regulation	introjected regulation	identified regulation	Intrinsic regulation	Self-determination level	Non-regulation	External regulation	introjected regulation	identified regulation	Intrinsic regulation	Self-determination level
Constant	7.897	7.719	6.321	1.452	0.862	−18.584	0.000	0.000	0.000	0.000	0.000	0.000
Support for autonomy	−0.225	−0.191	−0.098	0.172	0.199	1.049	−0.148	−0.140	−0.045	0.147	0.178	0.177
Support for relatedness	−0.220	−0.187	−0.096	0.168	0.194	1.026	−0.142	−0.134	−0.043	0.141	0.170	0.169
Support for competence	−0.201	−0.170	−0.088	0.153	0.177	0.936	−0.149	−0.141	−0.045	0.148	0.179	0.178
Need for competence	−0.126	−0.107	−0.055	0.096	0.111	0.587	−0.121	−0.114	−0.037	0.120	0.145	0.144
Need for relatedness	−0.186	−0.158	−0.081	0.142	0.164	0.868	−0.140	−0.132	−0.043	0.139	0.168	0.167

TABLE 9 Summary of R-square model.

The regression model	R^2
Non-regulation	0.428
External regulation	0.380
Introjected Regulation	0.040
Identified Regulation	0.420
Intrinsic regulation	0.616
Self-determination level	0.608

is also related to the information extraction ratio of principal component to introjected regulation is low.

Discussion

In terms of exploring the impact of "SPOC + flipped classroom" teaching on sports majors, the instructional intervention reduced *non-regulation*, *external regulation*, and *introjected regulation*, while increased *identified regulation*, *intrinsic regulation*, and *self-determination level* in the students. The levels of *non-regulation*, *external regulation*, *identified regulation*, and *self-determination* were also significantly different from those of the control group. This result is corroborated by many studies (Vallerand and Losier, 1999; Standage et al., 2006; Lonsdale et al., 2009; Alsancak Sirakaya and Ozdemir, 2018; Chuang et al., 2018), and some studies have suggested the promotion of "SPOC + flipped classroom" teaching in Russian higher education to improve motivational autonomy (Datsun, 2019). The aforementioned results show that "SPOC + flipped classroom" teaching promotes the transformation of motivation to internal motivation, that is, it promotes the internalization of motivation and improves the autonomy of motivation. This is related to the teaching design of the "SPOC + flipped classroom". It provides an online SPOC platform for students to preview independently at any time before class, and in class, teachers answer the problems encountered by students' self-study before class and carry out rich student-centered learning activities such as collaborative learning and group competition (Strayer, 2012). Students are in a learning environment that can meet their basic psychological needs, have a stronger sense of participation and identification with learning activities, and feel more attention and help from teachers and classmates. In addition, students are vulnerable to the influence of surrounding people when they engage in sports activities; the design of autonomous learning, group exploration, and teacher question answering of "SPOC + flipped classroom" teaching makes students pay less attention to the surrounding people and begin to pay attention to their own actual situation. Sports become an internal satisfaction and further promote the internalization of learning motivation. In addition, diversified teaching activities after class can further stimulate learning motivation and improve motivation autonomy (Botella et al., 2021; Faridah et al., 2021).

In terms of exploring the influencing factors and promotion paths of "SPOC + flipped classroom" teaching on sports students' learning motivation, PLSR analysis results show that *demand for support* (*support for autonomy*, *support for relatedness*, and *support for competence*) and *basic psychological need satisfaction* (*need for competence* and *need for relatedness*) have a larger influence on learning motivation, and these variables can positively predict students' *self-determination level*, *intrinsic regulation*, and *identified regulation*, and can negatively predict students' *non-regulation*, *external regulation*, and *introjected regulation*. Emotion (*positive activity orientation*, *positive outcome orientation*, *negative activity orientation*, and *negative outcome orientation*) and the *need for autonomy* are the factors that have a great impact on learning motivation.

According to the *self-determination theory*, favorable external factors can have a positive effect on the internalization of motivation. When the external environment is more supportive of students' autonomy, it will promote the development of students' *intrinsic regulation* and *identified regulation*; otherwise, it will weaken the development of students' autonomy regulation and may promote the development of *external regulation* and *introjected regulation* (Ryan, 1995; Ryan and Deci, 2000). Specifically, the "SPOC + flipped classroom" teaching method emphasizes student-centered teaching and combines online and offline teaching activities with information technology to provide a personalized learning environment for students, which is conducive to the internalization of students' motivation to a certain extent. The model uses information technology to expand the time and space of teaching so that teaching has a greater space to play and provides richer learning activities, including after-the-class video learning, theoretical testing, video explanations, and other theoretical content; in-class exercises include competitions, displays, role plays, and other practical content so that students have more choices, which is conducive to reducing behavior control, developing autonomy adjustment, and improving motivation (Deci and Ryan, 1990; Vallerand and Losier, 1999). At the same time, the combination of online and offline learning links the inside and outside of class and gives timely feedback to each teaching activity. Sufficient before class preparation and positive feedback make students feel competent (Khayat et al., 2021). In addition, the model establishes a stable communication channel between teachers and students and provides a premise for enhancing the relationship between teachers and students. The process of this interactive cycle and the environment that includes online and offline integration inside and outside can make students perceive more needs for support (Long et al., 2017; Unal and Unal, 2017; Atkins, 2018) and further facilitates the adjustment and internalization of students' learning motivation. Sanchez-Oliva et al. (2014) and Standage et al. (2006) found that the

perception of teacher support predicts students' autonomous motivation. The research of Sun and Ji (2010) also supports this conclusion and points out that teacher support can negatively predict *external regulation* and *non-regulation*, which strongly supports the practical results of this study.

Basic psychological need satisfaction is an important aspect of the *self-determination theory*, to achieve the high-quality development of motivation and the realization of optimal individual functions; three basic needs of individuals must be satisfied: *need for autonomy*, *need for competence*, and *need for relatedness* (Ryan and Deci, 2000; Garn et al., 2012). In the learning process, when the learning content is beyond the cognitive ability of students, students have a great cognitive load, and it is difficult to achieve a good learning effect, which may easily lead to frustration. This situation is changed in the teaching mode of "SPOC + flipped classroom" (Muir, 2021). Under the teaching mode of "SPOC + flipped classroom", great changes have taken place in the teaching process and students' cognitive process. Basic theoretical knowledge and the establishment of movement representation do not happen in class but are completed by students through video learning before class. While in class, concentrated physical practice is carried out based on the learning that took place before class. Learners' previous knowledge reserves and various learning materials can reduce cognitive load (Paas and Van Merriënboer, 1994; Pollock et al., 2002), making students feel that the class content is "easier" and enhancing students' sense of ability. In addition, before class learning will also provide a preview of the learning activities in class so that students are skilled in the exercise activities in class, and their sense of competence in learning activities is improved, which is beneficial to enhancing students' autonomous motivation. Online platforms also provide a second place for communication between teachers and students, improving the frequency of interaction between teachers and students and making the teacher–student relationship closer so that students can be in a relaxed and pleasant psychological environment in the process of learning (Velde et al., 2021); these changes can better meet the psychological needs of students, thereby promoting the optimization of students' learning motivation (Sergis et al., 2018; Zainuddin and Perera, 2019). The results of this study show that the *need for competence* and *need for relatedness* has a positive predictive effect on students' autonomic motivation and negative prediction of students' *non-regulation*, *external regulation*, and *introjected regulation*. Vasconcellos et al. (2020) conducted a meta-analysis of data from 265 related studies in the field of sports, and the results showed that *need for competence*, *need for autonomy*, and nee*d for relatedness* were significantly correlated with *intrinsic motivation*. Standage et al. (2005)'s research also highly supports this result. In addition, this study believes that there is a weak negative correlation between demand satisfaction and *introjected regulation*, which may be caused by different research scenarios and samples.

In summary, the teaching mode of "SPOC + flipped classroom" positively impacts the indicators of students' motivation and promotes the level of autonomy of students' motivation. "SPOC + flipped classroom" teaching enables students to obtain greater satisfaction by providing them more support, both of which promote the internalization of learning motivation so that students maintain a high level of autonomous motivation.

Conclusion

Compared with traditional teaching, "SPOC + flipped classroom" teaching has a positive impact on students' learning motivation of basketball skills and promotes students' motivation autonomy. The improvement of *support for autonomy*, *support for competence*, *support for relatedness*, *need for competence*, and *need for relatedness* may be related to the mechanism of "SPOC + flipped classroom" teaching to improve the learning motivation of college students majoring in Physical Education (PE). "SPOC + flipped classroom" teaching enables students to obtain more demand satisfaction by giving them more demand support, while demand support and demand satisfaction can promote the internalization of learning motivation so that students can maintain high autonomy motivation.

Limitations and prospects

From the perspective of the self-determination theory, this study analyzed and discussed the influence of "SPOC + flipped classroom" teaching on students' motivation and its influence mechanism. After a semester of the teaching intervention, this research has made some achievements, but there are still some shortcomings, mainly reflected in the following aspects:

(1) During the research process, the COVID-19 epidemic interrupted the teaching intervention and disrupted the implementation of the research plan. The first teaching intervention was forced to be suspended, and the second teaching intervention was conducted after the pandemic ended; according to that, the research objectives and teaching objectives had to be adjusted, resulting in a smaller sample size.

(2) Due to the limitation of the number of research objects, the planned research methods (such as structural equation modeling) were not fully adopted in this study, and the analysis of the motivation influencing mechanism is still insufficient, which requires further research.

In future research, the aforementioned deficiencies should be addressed and improved. In addition, this study only analyzes technical courses in physical education. Future research can be carried out on theoretical courses of physical education and public physical education courses to analyze the similarities

and differences and provide references and suggestions for improving the teaching of "SPOC + flipped classroom".

Data availability statement

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Author contributions

TH: overall study design, and writing and revising manuscript. M-lZ: data collection and analysis, and manuscript writing. LC and HL: manuscript revision. All authors reviewed the manuscript, contributed to the article, and approved the submitted 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.

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EDITED BY
Víctor Arufe Giráldez,
University of A Coruña, Spain

REVIEWED BY
Javier Rico Díaz,
University of Santiago de Compostela, Spain
Marcos Mecías-Calvo,
University of Santiago de Compostela, Spain

*CORRESPONDENCE
Liping Liu
llp@mail.xjtu.edu.cn

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Analysis of the anomie behavior and external motivation of college students in sports: A cross-sectional study among gender

Liping Liu[1,2]*, Shanping Chen[2] and Xueyan Yang[1]

[1]School of Public Policy and Administration, Xi'an Jiaotong University, Xi'an, China, [2]Department of Physical Education, Xi'an Jiaotong University, Xi'an, China

Objective: In the context of Healthy China, the effect of external motivation on sports anomie behavior from the perspective of gender among Chinese college students was investigated.

Participants: In total, 2,340 college students were involved in this study.

Methods: The self-made scales were used, which were about anomie behavior and external motivation in sports. The independent sample *T*-test was used to compare the sports anomie behavior between male and female students. Then, multiple linear regression analysis was adopted to examine the effects of external motivation on sports anomie behavior.

Results: Girls' sports anomie behavior was lower than boys. There were significant gender differences in honor motivation, obedience motivation, and economic motivation; girls' motivations were lower than boys. The academic motivation was negatively correlated with the sports anomie behavior of college students of both genders. The economic motivation was positively correlated with their sports anomie behavior. The honor motivation was negatively correlated with the sports anomie behavior of female college students.

Conclusion: Female college students' sports anomie behavior and external motivation are lower than that of male college students. External motivation had a significant influence on college students' sports anomie behavior.

KEYWORDS

external motivation, gender, undergraduate, anomie behavior, sports

Introduction

The outline of "Healthy China 2030" clearly proposes that school and health education should be strengthened, and the health literacy of citizens should be improved. It also proposes that the national fitness campaign should be widely implemented and that self-discipline should be promoted to foster healthy behavior. In recent years, the anomie behavior of college students in their sports activities has attracted the attention of scholars, as this has seriously impeded the cultivation of healthy behavior among college students (Chen et al., 2018). Studies have shown that male and female college students had great differences in sports attitudes, motivations, and sports behavior (Liu et al., 2017). Some studies have posited that there are significant differences in the sports behavior of male and female college students, specifically in their thoughts, consciousness, and self-exercise habits. Given all of this, determining how to foster healthy sports behavior among male and female college students and reduce sports anomie is an urgent task.

Anomie behavior, which is also known as deviant behavior and differential behavior, is proposed by Durkheim and refers to behavior that deviates from the norms that members of society abide by. In Durkheim's view, anomie is a kind of irregularity or lack of social norms and confusion (Anthony and Philip, 2019). In essence, it is when behavior violates existing standards and norms of a society or group that relate to morality and law. It is when behavior deviates from the established "normal operation track" (Zhou, 2011). According to Douglas and Waxler (1987), deviant behavior refers to a subject's behavior when he/she deviates from the established track or to the behavior of social members when they deviate or violate norms to varying degrees. Deviant behavior is also called "improper behavior" or "differential behavior." According to sociology, there are five levels of deviant behavior in sports, namely, behavior against customs, behavior against discipline, behavior against morality, illegal behavior, and criminal behavior (Luo and Zhou, 2011). Zhang and Wang (2021) proposed in their research that sports anomie refers to sports participation behavior in which the subject violates laws, ethics, and rules in the process of sports participation, and sports anomie behavior and compliance behavior can be regarded as a mirror of behavioral norms front and back sides. Following this classification, this study defined the sports anomie behavior of college students as the behavior wherein college students violate social norms in sports, such as morality, rules and regulations, competition rules and laws, and regulations in activities.

During the peak period of physical and mental development, adolescents are highly curious and inquiring, but have poor self-control and low self-discipline, and are prone to anomie behavior (Liu and Shi, 2016). From the analysis of existing literature, scholars have already conducted research on the behavior of athletes, coaches, and other sports workers in competitive sports (Zhou, 2021). A small amount of research has been carried out on the phenomenon of negative sports behavior, while the research on sports behavior of college students mainly focuses on the positive impact of sports on physical and mental health. Quantitative research, its formation mechanism, and intervention methods are still theoretical gaps.

Based on the behavioral motivation research of SDT, exercise motivation has a psychological orientation effect on sports persistence (Edmunds et al., 2006; Ma, 2014). Good motivation can drive students to take the initiative to participate in sports activities and then develop the habit of exercise (Chen and Li, 2007). Motivation is divided into internal motivation and external motivation. Psychology defines internal motivation as participation in an activity for the satisfaction of the behavior itself, and external motivation is participating in activities due to external pressure, rewards, and returns (Richard and Ryan, 2000). Existing internal motivation measures include five dimensions, namely, health motivation, appearance motivation, fun motivation, ability motivation, and social motivation; extrinsic motivation measures include two dimensions, namely, academic motivation and obedience motivation. The needs involved in internal motivation can only be met by normal exercise behavior itself. It has been proved that internal motivation and sports behavior have a positive correlation, while external motivation and sports behavior have a negative correlation (Shang, 2017). With the development of the market economy, the values of sports people are also quietly changing, and people's pursuit of money and honor is getting stronger and stronger, causing some athletes to lose their sportsmanship and obtain competition rankings through various improper means, seek the satisfaction of vanity (Pan, 2019). From the perspective of behavior motivational conflict, individuals intend to resist external temptations before making a behavioral decision (Arkinson and Birch, 1970; Gollwitzer et al., 2004). However, this intention depends on the difficulty of the motivational goal (Kruglanski et al., 2002). Needs related to external motivation may be met by exercising the above-described normal behavior or others. When these external needs cannot be met by normal sports behavior (or when it is difficult or inconvenient to implement the normal behavior), the needs of the score and award are likely to be met by improper means (Ryan and Deci, 2000). These improper means are against the norms of sports behavior and as such may be classified as anomie behavior. Therefore, the external motivation to exercise may lead to sports anomie behavior (Chen and Li, 2007). Based on the data of Chinese college students, this study analyzes the differences between male and female college students' exercise motivation and the influence of sports anomie behavior, which shows a certain theoretical and practical significance for China and other countries to study students' sports behavior and motivation theory.

In the existing research on physical exercise behavior, not only the demography factor is used as a regulating variable to

investigate physical exercise behavior but also the psychological variable is used as a factor to explain behavior occurrence (Miao and Qin, 2006; Taymoor and Lubans, 2008). Existing studies have incorporated individual characteristic variables, such as age, an only child, and a cadre of the class and group into the research fields, and believe that these characteristic variables will also affect college students' sports behavior and psychological factors (Yan et al., 2016; Chen, 2022).

Consequently, the purpose of this study was to analyze the sports anomie behavior, the external motivation, and its influencing factors of male and female college students to improve their behavior regarding sports health. It proposes strategies to specifically intervene in the external motivation of college students to exercise, standardize, and prevent sports anomie behavior of male and female students to promote healthy sports behavior of male and female college students.

Materials and methods

Data collection and sample

This research is divided into three phases. The first phase of qualitative research uses stratified random sampling to select 63 college students from 3 universities in Northwestern China for qualitative interviews and related theoretical research, using Likert's 5-level scale to design measurement questions for exercise external motivation and sports anomie behavior items. In the second phase of the pre-survey phase, stratified random sampling from 10 May to 30 July 2018, 360 copies were distributed to 3 colleges and universities in the northwest region, and 338 valid samples were recovered with an effective rate of 93.8%. The internal consistency of this scale was found to be adequate for this study. In the third phase, a national formal questionnaire survey was conducted. From 1 October 2018 to 19 December 2019, 12 universities (5 in North China, 2 in Northeast China, and 5 in East China) and 8 colleges (3 colleges in central and southern regions, 3 colleges in southwest regions, and 2 colleges in northwest regions) were selected by stratified random sampling. The college students were issued 2,400 questionnaires (120 questionnaires per college, 30 questionnaires for each grade, and 15 for men and women), and 2,340 valid questionnaires were returned. The response rate reached 97.5%.

The research objects are college students. The 2,340 valid questionnaires included 1,145 females and 1,195 males; 1,187 undergraduates from key colleges and universities, 1,153 undergraduates from ordinary colleges and universities; 598 first-year college students, 603 second-year college students, 572 third-year college students, 567 fourth-year college students; 975 only child students, 1,364 non-only child students; 936 class leaders, 1,404 non-class leaders (see **Table 1**).

TABLE 1 Descriptive statistics of sample characteristics (n = 2,340).

Variable name	Code/definition	Percent/mean (SD)
Gender	0 = female; 1 = male	51.07%; 48.93%
School level	0 = ordinary colleges and universities; 1 = key colleges and universities	49.27%; 50.73%
Grade	1 = first grade; 2 = second grade; 3 = third grade; 4 = fourth grade	25.56%; 25.77%; 24.44%; 24.23%
Is it an only child	0 = non-only child; 1 = only child	58.32%; 41.68%
Is it a class leader	0 = non-class leaders; 1 = class leader	60.00%; 40.00%
Sports anomie	1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = always	1.12 (0.24)
Academic motivation	1 = no; 2 = a little; 3 = strong; 4 = stronger; 5 = very strong	4.44 (0.80)
Obey motivation	1 = no; 2 = a little; 3 = strong; 4 = stronger; 5 = very strong	3.83 (1.15)
Economic motivation	1 = no; 2 = a little; 3 = strong; 4 = stronger; 5 = very strong	3.28 (1.42)
Honor motivation	1 = no; 2 = a little; 3 = strong; 4 = stronger; 5 = very strong	4.04 (1.05)

Measurement

At present, there is no mature measurement tool for college students' sports anomie behavior. According to the five major sports activities of college students, namely, physical education class, National Physical Health Standard Test for Students (hereinafter referred to as the Standard), sports competition, sports associations, and independent exercise, combined with the interview with students, a measurement scale with 55 questions was compiled by the research team. This included 1–16 questions regarding physical education class, such as "late in physical education class" and "early leave." Regarding Standard, there were 17–29 questions, such as "cheating." Regarding sports competition, there were 30–40 questions, such as "intentional foul in extracurricular sports

competition." Regarding sports association, there were 41–49 questions, such as "failing to complete related tasks in sports association" and "shirking responsibility." Regarding self-exercise, there were 50–55 questions, such as "intentionally damaging sports equipment and facilities in extracurricular independent exercise." The number of times this kind of behavior happened was asked. The mean value of 55 questions indicated the score of sports anomie behavior, which had a range from 1 to 5 representing "never," "rarely," "sometimes," "often," and "always," respectively (for the value assignment method, see Table 1). This article used Cronbach's coefficient to test the reliability of the scale. Reliability analysis results showed that the Cronbach's coefficients of the five subscales of sports anomie behavior were 0.726, 0.695, 0.726, 0.745, and 0.574, and most of them were above 0.7. Although two were lower, they were also close to 0.7, indicating that the questionnaire had a good reliability level.

The external motivation scale is revised based on the existing external motivation scale (Chen et al., 2008). Existing external motivation includes two dimensions of academic motivation and obedience motivation, namely, "I want to meet the attendance requirements of sports activities," "I want to pass the physical education exam," "I want to get sport-related scores," and "I hear the opinions of my friends." Opinions, "I want to hear the opinions of my classmates" and "I want to hear the opinions of my family." Based on the theory of external motivation and combined with the interview with college students, two dimensions of economic motivation and honor motivation were added based on the original score motivation and obedience motivation, namely, "I want to meet the attendance requirements of sports activities," "I want to pass the sports examination," "I want to get sport-related scores," "I want to listen to friends' opinions," "I want to listen to classmates' opinions," and "I want to listen to family members' opinions." Second, economic motivation included "I want to use sports activities to get scholarships," "I want to use sports activities to get some economic benefits," and "I want to get excellent, research and exchange opportunities." Finally, under honor motivation, three items included, namely, "I want to win in the competition," "I want our team to win," and "I want to get other people's praise in sports activities." The score ranged from 1 to 5, indicating "no," "a little," "strong," "stronger," and "very strong," respectively. The average value of three questions indicated the score of one dimension. A higher score represented higher motivation in the individual (for the value assignment method, see Table 1). This article used Cronbach's α coefficient to test the reliability of the scale. Reliability analysis showed that the Cronbach's α coefficients of academic motivation, obedience motivation, economic motivation, and honor motivation of sports anomie behavior motivation were 0.918, 0.955, 0.879, and 0.880, respectively, which were all above 0.7, indicating that the questionnaire had a good level of reliability.

Statistical analysis

Statistical data were processed by SPSS 22.0 programs. First, the independent sample *T*-test was adopted to compare and analyze the sports anomie behavior and external motivations of college students of different genders domestically. On this basis, the sports anomie behavior was selected as the dependent variable, and a multiple linear regression analysis method was adopted to investigate the impacting factors of sports anomie behavior between different genders. Among them, Model 1 and Model 1*(1′) take four external motivations (academic motivation, obedience motivation, economic motivation, and honor motivation) as independent variables; in model 2 and Model 2*, school ranking, grade, only-child status, and class leader status were added as control variables.

Results

Descriptive statistics

Table 2 showed the analysis results of gender differences in sports anomie behavior and the external motivation scores of college students in China. The results of the independent sample *T*-test showed that in addition to academic motivation, there were also significant gender differences in sports anomie behavior ($P < 0.001$), obedience motivation ($P < 0.01$), economic motivation ($P < 0.05$), and honor motivation ($P < 0.001$). The score of the sports anomie of boys was 1.150, while that of girls was 1.101. The obedience motivation score was 3.908, while that of girls was 3.760. These indicated that the sports anomie and obedience motivation of girls were significantly lower than that of boys, thus showing that girls were less affected by their friends, classmates and family in sports activities than boys were. Furthermore, the score of economic motivation of boys was 3.342, while that of girls was 3.220. The honor motivation score of boys was 4.180, while that of girls was 3.901. These showed that the economic motivation and honor motivation of girls were significantly lower than that of boys.

TABLE 2 Descriptive statistics.

Variables	Male (N = 1,145)		Female (N = 1,195)		*T*
	Mean value	SD	Mean value	SD	
Sports anomie	1.150	0.278	1.101	0.185	−4.961***
Academic motivation	4.423	0.818	4.460	0.775	1.114
Obedience motivation	3.908	1.114	3.760	1.179	−3.140**
Economic motivation	3.342	1.445	3.220	1.390	−2.091*
Honor motivation	4.180	0.988	3.901	1.090	−6.483***

*$P < 0.1$, **$P < 0.05$, ***$P < 0.001$.

Analysis of influencing factors

Table 3 showed the regression analysis results of the influencing factors of sports anomie behavior of male college students in China. In Model 1, obedience motivation and honor motivation had no significant effect on the sports anomie behavior of male college students, but academic motivation and economic motivation did. Among them, academic motivation and sports anomie had a negative significant impact. To meet the requirements of physical attendance, pass the physical examination, and obtain physical credits, stronger academic motivation of male college students was needed because then they would be less likely to adopt anomie behavior (−0.211, $P < 0.001$). Economic motivation and sports anomie had a positive significant impact. However, the stronger motivation of male college students to obtain scholarships and economic benefits meant that they were more likely to adopt anomie behavior (0.071, $P < 0.1$). Following Model 1, Model 2 further included school level, grade, whether the individual was an only child and class cadres as control variables. Then, it was seen that the influence of academic motivation on sports anomie behavior of college students became significant and that the direction of the regression coefficient did not change, but the regression coefficient itself slightly decreased (−0.200, $P < 0.001$). The same thing was seen for economic motivation (0.064, $P < 0.1$). Furthermore, it was seen the hat school level had a significant negative impact on the anomie behavior of male college students. This indicated that the higher the school level, the less the anomie behavior among male college students, which further indicated that grades had a significant positive impact on their anomie behavior. With the increase in grade, there would be a consequent significant increase in the anomie behavior of male college students in junior and senior years. Other control variables had no significant effect on the anomie behavior of male college students. Model 1 and Model 2 were significant; R^2 increased with the increase of variables, which indicated that the model setting was effective.

Table 4 shows the results of regression analysis on the factors that affect the behavior of female college students in China. As seen in Model 1*, while obedience motivation had no significant effect on the sports anomie behavior of female college students, academic motivation had a significant negative effect. To meet the requirements of sports attendance, pass the sports examination and obtain sports credits, stronger institutional motivation for female college students was needed because would be less likely to adopt anomie behavior (−0.137, $P < 0.001$). Economic motivation and sports anomie had a positive and significant impact. However, the stronger economic motivation of female college students to obtain scholarships and economic benefits meant that the possibility of adopting anomie behavior was higher (0.150, $P < 0.001$). Honor motivation and sports anomie had a negatively significant influence. The stronger the economic motivation of female college students to obtain scholarships and economic benefits, the less likely they were to adopt anomie behavior (−0.098, $P < 0.1$). Following Model 1*, Model 2* further introduced school grade, grade, whether the individual was an only child, and whether there were class and league cadres as control variables. Then, it was seen that the influence of academic motivation on the sports anomie of female college students was significant and that the direction of the regression coefficient did not change, but the

TABLE 3 Multiple linear regression of sports anomie behavior of male college students.

Dependent variable: sports anomie	Model 1	Model 2
Independent variables		
Academic motivation	−0.211***	−0.200***
Obedience motivation	−0.032	0.036
Economic motivation	0.071*	0.064*
Honor motivation	−0.021	−0.027
Control variables		
School level		−0.056*
Sophomore		0.057
Junior		0.076*
Senior		0.074*
Only child or not		−0.045
Class and league cadres or not		−0.024
df	1144	1143
R^2	0.036	0.047
ΔR^2	0.033	0.039
F	10.740***	5.597***

*$P < 0.1$, **$P < 0.05$, ***$P < 0.001$.

TABLE 4 Multiple linear regression of sports anomie behavior of female college students.

Dependent variable: sports anomie	Model 1*	Model 2*
Independent variables		
Academic motivation	−0.137***	−0.116***
Obedience motivation	0.009	0.008
Economic motivation	0.150***	0.147***
Honor motivation	−0.098*	−0.107*
Control variables		
School level		−0.019
Sophomore		0.028
Junior		0.058
Senior		0.104**
Only child or not		−0.029
Class and league cadres or not		0.013
df	1194	1194
R^2	0.027	0.037
ΔR^2	0.024	0.029
F	8.343***	4.508***

*$P < 0.1$, **$P < 0.05$, ***$P < 0.001$.

regression coefficient itself decreased (−0.116, $P < 0.001$). The same thing was observed for economic motivation; however, the regression coefficient only slightly decreased (0.147, $P < 0.001$). What happened for economic motivation was also observed for honor motivation (−0.107, $P < 0.1$). Grade had a significant positive effect on the anomie behavior of female college students. As their grade increased, the anomie behavior of senior female college students also significantly increased (0.104, $P < 0.1$). Other control variables had no significant effect on the sports anomie behavior of female college students. Model 1 and Model 2 were significant; R^2 increased with the increase of variables, which indicated that the model setting was effective.

Discussion

Difference between sports anomie behavior and external motivation between male and female college students

This study found that the sports anomie behavior of female college students was significantly lower than that of the male students. First, from the analysis of the difference in the sports behavior between male and female students, it was seen that the difference in the sports behavior of male students was higher than that of female students and that the enthusiasm of male students to participate in vigorous sports was significantly higher than that of female students, making the probability of developing sports anomie higher (Zhu and Shu, 2022). Second, it was also related to the personality of the girls. Women are more docile with external regulations (Fleming and Agnew-Brune, 2015; Chen et al., 2017).

All the academic motivation scores of male and female students were above "strong," and there was no gender difference. Foreign scholars believe that academic expectation and achievement factors are some of the causes of anxiety among college students (Armeli et al., 2001). Wang and Yao's (2012) research has proved that academic pressure is the first source of pressure for contemporary college students, especially for those in China who have attached great importance to achievement and credit evaluation since childhood. Studies have shown that there is no gender difference in anxiety test among college students (Ang, 2022). In obedience motivation, economic motivation, and honor motivation, there were significant gender differences. The motivation of female students was weaker than that of male students. Ranking from the highest to the lowest, it was honor motivation, obedience motivation, and economic motivation. From the perspective of gender role analysis, a prescribed thinking mode was formed for expected behavioral norms among male and female students (Bern, 1975; Liu, 2011). Under traditional social culture, sports were generally considered as a symbol of solemnity and periodicity. It was considered as a display of the sports spirit of male students, while female students shouted and cheered for the men.

Influence of external motivation on sports anomie behavior of male and female college students

There was a negative relationship between academic motivation and sports anomie behavior of male and female college students. Under oriented education and traditional Chinese culture, academic achievement was the most important pursuit of Chinese teenagers (Fuligni and Zhang, 2004). Students with strong academic motivation had higher academic goals. As such, they would not deter from their normal activities and develop anomie behavior for the sake of sports attendance, physical examination, credit, and other related systems. There was a positive relationship between the economic motivation and sports anomie behavior of male and female college students. Because female college students have lower physical fitness and physical exercise behavior than male students, they also have more economic motivation than male college students. Economic motivation referred to the desire to gain financial benefits through behavior in sports activities affected by adverse economic and social conditions. Under the background of the current era, college students are not ashamed to talk about "making money," and when acknowledging the important role of money, they do not exaggerate its value (Hu, 2020). For example, to obtain scholarships, the hope was to help other students get rewards. This is narrated by students as such: "Students who agreed to help the test agent have good physical fitness, high test scores and generally have material benefits." During the interviews, some students said: "She spent 100 Yuan to get the physical test done, and didn't run at all. She also revealed to me that she was a student who was a middleman. Many students in our school contacted the runner through this student, and the student who was a middleman also made profits." There was a negative relationship between the honor motivation and sports anomie behavior of female college students. A female college student who wanted to win in sports, gave credit to her team, and was praised by others must have had good physical and moral qualities. She must have had higher requirements for her personal code of conduct and less anomie.

In addition, R^2 and the adjusted R^2 of Model 1* and Model 2* were smaller than those of Model 1 and Model 2, respectively, which showed that the explanatory power of external motivation to the sports anomie behavior of male college students was greater, while the explanatory power to the sports anomie behavior of female college students was limited. This showed that there may have been more important variables that affected the sports anomie behavior of female college students.

Other influencing factors of sports anomie behavior of male and female college students

Gender had a significant impact on the sports anomie behavior of college students, especially for boys. Existing literature showed that among the exercisers and non-exercisers, the scores of behavior habits, behavior intention and emotional experience of male college students were higher than that of their female counterparts, and the emphasis on gender was one of the important demographic factors (Wang, 2021). Multiple studies have shown that there are gender differences in adolescents' attitudes and intentions to physical activity, and girls are more likely to have negative physical activity attitudes (Sun et al., 2018; Burton et al., 2020). In the interview materials of this study, there were many expressions about gender anomie, for example: "The most common anomie of sports in the teaching process is the lack of interest of students, especially the lack of attention of girls to sports, the phenomenon of asking for leave at will in class is more frequent, requiring probation or refusing to practice with a slight excuse." "Boys are generally more likely to act impulsively, and may only win in the eyes of competition, losing will inevitably lead to anger, which will lead to quarrels or physical conflicts between the team or two teams. Different levels of schools have an impact on the anomie behavior of male college students".

Studies have shown that the tolerance of students in 985 and 211 colleges and universities for behaviors involving illegal and moral bottom lines is significantly lower than that of vocational colleges (Wei, 2020). Students phrased it in the following ways: "We are higher vocational colleges, compared with students in undergraduate colleges, we are less conscious. The most common way of thinking in physical education is that we are lazy, do not want to make progress, and muddle along is particularly serious," "Most vocational college students have poor self-study ability and less active practice," "Junior college students and art students are relatively free in class," "Private colleges and universities, most parents dote on their children," and so on. The sports anomie behavior of the students in different grades was also different. The male students in junior and senior high school and the female students in senior high school all had significant sports anomie behavior. In the materials, it was stated as follows: "A large number of students are involved in a large number of sports classroom irregularities, involving a wide range of aspects and students of different grades." "There are many students who take the place of the exam in the physical examination of the third and fourth grade of the undergraduate course just ended. As far as I know, most of these students take the place of the exam just because they don't have physical education classes, they usually have no community activities to participate in, and they are lazy and don't like activities very much. Every year, on the eve of college students' physique test, students always complain a lot, and the physique test of the fourth year is the most headache. Because of the particularity of the fourth year, students in this grade are in a critical period from school to society. They are faced with the pressure of graduation design, postgraduate entrance examination, difficulty in employment, etc., and are prone to realistic problems of anxiety (Zhai et al., 2022). We can see the behavior of the fourth-year students kneeling in the circle of friends and asking for running for others, even paying for running for them to protect themselves, and there are not a few students willing to run for them." Therefore, in the study of sports anomie, gender, different grades, and different schools were very critical factors.

Limitations and prospects

Of course, there are some limitations to this research. First of all, as it is a cross-sectional research path, it is impossible to analyze the causality of the variables involved in the research. It is more scientific to use tracing research to further explore the mechanism of action between variables. Second, the college students' sports anomie behavior and external motivation measurement scales are still not mature and complete. The scales of sports anomie behavior and exercise external motivation should be further supplemented and improved in follow-up research. Third, due to different regions, there are some differences in the implementation of school sports policies, which will have a certain impact on different college students' sports behavior and external motivation. In the future, we will conduct more detailed exploration from the perspective of the region. Finally, the anomie behavior of sport is a complex concept because of the different types of sports, so it would be better to focus on one specific type of sports activities, due to multiple intervention strategies and studies.

Conclusion and implications

Based on the previous research, several conclusions were drawn as follows: First, female college students' sports anomie behavior is lower than that of male students. With the increase in grades, the sports anomie behavior of male and female students is on the rise. Second, the external motivation of female students is lower than that of male students. Third, academic motivation and economic motivation have a significant influence on college students' sports anomie behavior.

The conclusion of this study has important implications for practice. First, physical education classes and extracurricular sports activities should be offered to juniors and seniors, especially to cultivate sports behavior as per norms. Second, physical education in ordinary schools should be examined specifically to strengthen the education of male college students'

anomie. Third, future research should target intervention studies to provide a theoretical reference for schools to better perform physical education. Research from the perspective of gender differences is conducive to targeted interventions on college students' sports anomie behavior. The conclusions and suggestions drawn from the research provide theoretical support for health and education administrative departments to intervene in college students' sports health behavior and health literacy and can improve school sports policies, the rationality of formulation, and the quality of sports management.

Data availability statement

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

Author contributions

LL and SC: formal analysis and writing—original draft preparation. XY: investigation, writing—review and editing, and supervision. All authors have read and agreed to the published version of the manuscript.

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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.

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EDITED BY
Rui Matos,
Quality of Life Research Center (CIEQV), Portugal

REVIEWED BY
Novita Intan Arovah,
Yogyakarta State University, Indonesia
Angelita Bautista Cruz,
Keimyung University, South Korea

*CORRESPONDENCE
Meida Sofyana
meidasofyana@mail.ugm.ac.id

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Applying the behavior change wheel to identify pandemic-related attitudes and feelings about physical activity as predictors of physical activity level among university students in Indonesia during the COVID-19 pandemic

Rakhmat Ari Wibowo, Meida Sofyana* and Denny Agustiningsih

Department of Physiology, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia

A recent systematic review found a significant drop in physical activity (PA) among university students during the coronavirus disease 2019 (COVID-19) pandemic. Identifying students' attitudes and feelings about PA and coronavirus, which could facilitate or hinder PA, is essential to guide intervention planning. Therefore, this study aimed to examine attitudes and feelings about PA and coronavirus as predictors of PA levels. We conducted a cross-sectional study among undergraduate university students in Indonesia to collect their PA levels using the global PA questionnaire version 2 and their attitudes and feelings about PA in pandemic situations. A binomial logistic regression has been conducted to predict whether students will sufficiently engage in PA based on their attitudes and feelings related to PA, coronavirus, and demographic characteristics. Results from 588 undergraduate students (75% female) showed that students perceived the health benefits of PA, perceived feeling guilty about wanting to do PA during the pandemic, body mass index (BMI), and field of study were statistically significant predictors of PA levels. An increase of one unit of perceived health benefits of PA increases the odds of meeting the PA guidelines by 2.313 (95% confidence interval 1.708–3.132, $p < 0.001$). On the other hand, raising one point of feeling guilty about conducting PA was associated with 1.285 times lower odds

(95% confidence interval 1.062–1.558, p = 0.01) of meeting the PA guidelines. Thus, intervention should increase students' awareness of the physical health benefits of PA during the pandemic and reduce their feeling of guilty about conducting the PA.

KEYWORDS

attitude, COVID-19, exercise, pandemic, students, universities

Introduction

The college period is a transition to adulthood which is a critical moment that can determine a person's lifestyle (Carney et al., 2000; Naudeau et al., 2008). Although an active lifestyle has an essential role in maintaining fitness, physical and mental health, as well as academic achievement, almost half of the student population is classified as lacking physical activity (PA) (Keating et al., 2005; Anuar et al., 2021). In addition, the novel coronavirus disease 2019 (COVID-19) pandemic exacerbated the physical inactivity among university students. A recent systematic review showed that the level of PA in college students decreased to half of their level of PA before the pandemic (López-Valenciano et al., 2021). In that systematic review, several studies conducted in the United States, Mexico, Australia, and several European countries consistently showed decreased PA levels in university students. Therefore, PA promotion among students is an urgent need.

Effective PA promotion should address factors influencing PA engagement in its target population. Physical activity engagement can be affected by several factors, including the environment, social support, and personal factors, such as knowledge, motivation, and attitude toward PA (Treiber et al., 1991; Sallis et al., 2008; Howlett et al., 2019). The behavior change wheel (BCW) framework, a comprehensive theoretical model to create a change in behavior, suggested that individual, social and environmental factors could equally contribute to influencing behavior through changing capacity, opportunity, and motivation (COM-B) components (Michie et al., 2011; Biddle et al., 2021). Universities can play a role in promoting an active lifestyle among students by providing support through all three factors.

In order for universities to provide effective and efficient support for establishing an active lifestyle among students, identification of PA predictors among students is required (Michie et al., 2011; Atkin et al., 2016). The COVID-19 pandemic changed social and environmental factors, which could influence students' attitudes and feelings toward PA (Yon et al., 2022). A longitudinal study suggests that pandemic-related attitudes and feelings could be a predictor factor influencing PA levels (Sport England, 2020). While recent studies showed that general individual and environmental factors, such as perceived general benefits of PA and field of study, and pandemic-related individual and social factors, such as self-efficacy in being physically active despite barriers during the COVID-19 pandemic, were strong correlates of PA during the COVID-19 pandemic among university students in Indonesia, there was no study examined the comprehensive pandemic-related attitudes and feelings toward PA which including individual, social and environmental factors (López-Valenciano et al., 2021; Rizal and Wibowo, 2021; Ruhayati et al., 2021; Arovah, 2022; Cruz et al., 2022). Also, the two studies in Indonesia resulted from a majority sample of sport science students, which limit their generalizability to university students (Ruhayati et al., 2021; Arovah, 2022). Thus, our study aimed to examine university students' attitudes and feelings related to PA and coronavirus as predictors of their PA level in a representative sample of university students.

Materials and methods

Study design and setting

We conducted a cross-sectional survey among Universitas Gadjah Mada (UGM) students for 1 week in the second semester of the academic year 2020/2021 (11–17 April 2021), following the ethical principles of the Declaration of Helsinki. This study is a part of the ASEAN University Network Health Promoting Network (AUN-HPN) Physical Activity in College Students (PACS) Project (Rahman et al., 2022), which collected PA data and its correlates in UGM on three-phase (28 March –3 April 2021; 4–10 April 2021, and 11–17 April 2021). The study protocol was approved by the Medical and Health Research Ethics Committee of the Faculty of Medicine, Public Health and Nursing UGM (approval number: KE/FK/1066/EC/2020). We wrote the manuscript following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for cross-sectional studies (**Supplementary Table 1**; von Elm et al., 2008). Universitas Gadjah Mada, located in Daerah Istimewa Yogyakarta Province, is the largest public university in Indonesia with 59,540 students in the second semester of academic year 2020/2021 (Sekretariat Direktorat

Jenderal Pendidikan Tinggi Kementerian Pendidikan dan Kebudayaan, 2022). While there was a social activity restriction called Pemberlakuan Pembatasan Kegiatan Masyarakat Berbasis Mikro (PPKM Mikro) during April to June 2021 in Java and Bali Island (Negeri, 2021), UGM was still not reopened the university yet. The majority of learning activities were conducted through online platforms, and only a minority of activities, such as practical skills and thesis, were allowed to be conducted on campus (Rektor Universitas Gadjah Mada, 2020).

Participants

All undergraduate students were eligible to participate in the study. Failure to complete the questionnaire and postgraduate students were excluded from the study. Using a convenient sampling method, we distributed an online questionnaire link to students *via* several social media groups in each faculty. A minimum sample size of 500 was suggested to derive statistics involving logistic regression that can represent the parameters in the population (Bujang et al., 2018). Therefore, this study required at least a total sample size of 625 subjects to anticipate a 20% missing value.

Outcome measures

We collected university students' demographic data, including age, academic year, gender, field of study, height and weight which then were calculated as body mass index (BMI).

Physical activity levels

Students were requested to fill out the Global Physical Activity Questionnaire (GPAQ), a reliable instrument for monitoring PA in population surveillance with an acceptable validity, through an online form Bull et al. (2009). Having cleaned the GPAQ data following the GPAQ Analysis Guide, we categorized students' PA levels to whether meeting the PA guidelines or not meeting the PA guidelines (World Health Organization, 2002, 2010). Students were categorized into meeting the guidelines if they were engaged in at least: 150 min of moderate-intensity PA a week or 75 min of vigorous-intensity PA a week, or a combination of moderate and vigorous-intensity PA reaching at least equivalent to 600 MET-min per week.

Attitudes and feelings about physical activity and coronavirus

We adopted a questionnaire from Sport England to capture students' attitudes and feelings related to PA and coronavirus (Sport England, 2020). The original questionnaire asked for agreement with 17 statements based on the COM-B model in the BCW framework (Michie et al., 2011). Having conducted expert consultations with three specialists in exercise physiology, education, and health promotion, we removed five items because of redundancy. Therefore, the adopted version consists of 12 statements to ask for respondents' agreement with a Likert scale from 1 for disagreeing to 5 for agreeing with the statement (**Table 1**). We also add a bogus item to minimize inattentive responses by asking them, "please choose option number 2 if you read this statement" (Meade and Craig, 2012; Maniaci and Rogge, 2014; Niessen et al., 2016). Our unpublished data showed that the adopted questionnaire with one bogus item had acceptable reliability ($W = 0.662–0.800$, $p < 0.05$).

Data analysis

We descriptively presented the demographic of our respondents, including their age, gender, BMI, academic year, and field of study. Students' BMI was categorized into underweight (<18.5), normoweight (18.5–22.9), overweight (23–24.9), and obese (≥25 kg) (World Health Organization, 2000). Students' field of study was categorized into health science, non-health natural science, and social science. Then, we presented the prevalence of students who did not meet the PA guidelines among our samples, proportion of gender, BMI, academic year, and field of study. Students' engagements in each PA domain were described using the median and interquartile range (IQR) (Lang and Altman, 2015). We also visually presented the proportion of the scale of the agreement to each attitude and feeling related to PA and coronavirus. We calculated the Pearson chi-square to examine the association of potential confounding, including gender, BMI, and field of study (Rejali and Mostajeran, 2013; Naim et al., 2016; Chung et al., 2018; Haynes et al., 2018; Rizal and Wibowo, 2021), using the SPSS v26 (SPSS Inc., Chicago, IL, US). Finally, a logistic regression using an alpha of $p < 0.05$ was conducted to examine the odds ratio of each theme of the attitudes and feelings related to PA and coronavirus as predictors of meeting the PA guidelines with and without controlling gender, BMI, and field of study as confounders. We treated each theme of attitudes and feelings about PA as a continuous variable, whereas confounders as categorical variables. We observed The Nagelkerke R^2 and receiver operating characteristic (ROC) curve to check the best model for predicting PA level (Steyerberg et al., 2010).

Results

Sixty hundred and thirty-nine students filled out the online questionnaire, but two of them did not fill the questionnaire completely, 32 (5%) of them filled in the wrong answer to the bogus question, and 17 (3%) of them had an implausible value of the GPAQ. Therefore, 588 subjects with a median age of 19 (IQR 1) years were included in the analysis. The sample consisted of first-year (43.9%), second-year (34.9%),

TABLE 1 Themes and statements asked in the attitudes and feelings questionnaire.

Theme	Statements
Physical health benefits	I exercise to help manage my physical health during the outbreak
Mental health benefits	I exercise to help manage my mental health during the outbreak
Knowledge of the physical activity recommendations	I have been encouraged to exercise by the University's recommendation
Time opportunities	I have more time now to be physically active
Lost of physical activity opportunities	I miss the types of physical activity I was able to do before the outbreak
New physical activity opportunities	Since the outbreak, I have found new ways to be active
Feeling worried about doing outdoor physical activities	I worry about leaving my home to exercise or be active
Feeling guilty about not exercising	I feel guilty about not exercising more during the outbreak
Feeling guilty about wanting to exercise	I feel guilty about wanting to exercise during the outbreak
Lost of enjoyable physical activities	I do not find exercising on my own enjoyable
Feeling that the pandemic did not impact physical activities	The current situation has not impacted my current exercise regime
Feeling that being active is more important at the moment	I felt that being active is more important at the moment

TABLE 2 Participants' demographic.

	n (%)
Physical activity level	
Met the PA guidelines	275 (47%)
Did not meet the PA guidelines	313 (53%)
Gender	
Female	441 (75%)
Male	147 (25%)
Field of study	
Health science	87 (15%)
Non-health natural science	331 (56%)
Social science	170 (29%)
Body mass index	
Underweight	140 (24%)
Normoweight	280 (48%)
Overweight	82 (14%)
Obese	86 (14%)

third-year (18.5%), fourth-year (1.9%), and fifth-year (0.9%) undergraduate students. Third-quarter of our samples were female. Most of our sample were studying non-health natural science (56%) and had a normoweight (48%). Our samples' prevalence of physical inactivity was 53% (Table 2).

Students' gender, field of study, and BMI were associated with their PA level with X^2 of 10.841, 10.329, and 8.681, respectively (Table 3). Male, non-health natural science, and obese students were more likely to meet the PA guidelines. Among students who met the guidelines, they had median academic-related PA, transport-related PA, and recreational PA of 0 (IQR 1800) MET.minutes/week, 0 (IQR 480) MET.minutes/week, and 900 (IQR 1560) MET.minutes/week respectively. In contrast, students who did not meet the guidelines had median academic-related PA, transport-related PA, and recreational PA of 0 (IQR 0), 0 (IQR 0), and 0 (IQR 20), respectively.

Our respondents tended to agree that they engaged in exercise to help manage their physical health and mental health, they had more time to be physically active, and they lost opportunities to do several types of PA. They also tend to agree that the importance of an active lifestyle is even greater during a pandemic. On the other hand, they tend to disagree with the statement that the pandemic did not impact their physical activities; they lost their enjoyable exercise, they felt guilty about wanting exercise, and they felt worried about doing outdoor physical activities (Figure 1).

Results from binomial logistic regression without adjusting confounding variables showed that the model was statistically significant, $\chi^2(12) = 130.710$, $p < 0.0001$. The unadjusted model explained 26.6% (Nagelkerke R^2) of the variance of students' PA level and had an area under the ROC curve of 0.759 [95% confidence interval (CI) 0.720–0.797]. Binomial logistic regression was performed to ascertain the effects of attitudes and feelings related to coronavirus on the likelihood that university students engage in recommended amounts of PA by controlling their gender, BMI, and field of study. The logistic regression model was statistically significant, $\chi^2(18) = 151.974$, $p < 0.0001$. The model explained 30.4% (Nagelkerke R^2) of the variance in PA levels, correctly classified 69.0% of cases, and had an acceptable level of discrimination by having an area under the ROC curve of 0.777 (95% CI 0.740–0.814), which was better than the unadjusted model. There were four of fifteen predictors that were statistically significant: physical health benefits, feeling guilty about wanting to exercise, the field of study, and BMI (Table 4). Each increase in one point of agreement that students engaged in PA to get physical health benefits was associated with 2.313 times higher odds (95% CI 1.708–3.132) of meeting the PA guideline. Having obesity and studying non-health natural science was also associated with an increased likelihood of engaging in a recommended amount of PA. On the other hand,

TABLE 3 Association between students' characteristics and their physical activity (PA) levels.

	Did not meet the guidelines *n* (%)	Met the guidelines *n* (%)	*P*-value	X^2
Gender			0.001	10.841
Female	252 (42.9%)	189 (32.1%)		
Male	61 (10.4%)	313 (14.6%)		
Field of study			0.006	10.329
Health science	54 (9.2%)	33 (5.6%)		
Non-health natural science	157 (26.7%)	174 (29.6%)		
Social science	102 (17.3%)	68 (11.6%)		
Body mass index			0.034	8.681
Underweight	85 (14.4%)	55 (9.4%)		
Normoweight	148 (25.2%)	132 (22.4%)		
Overweight	45 (7.7%)	37 (6.3%)		
Obese	35 (5.9%)	51 (8.7%)		

TABLE 4 Predictors of meeting the physical activity (PA) guidelines.

	B	SE	Wald	dF	*p*	Odds ratio (95% confidence interval)
Perceived physical health benefits	0.839	0.155	29.408	1	0.000	2.313 (1.708–3.132)
Feeling guilty about wanting to do physical activities	−0.251	0.098	6.638	1	0.010	0.778 (0.642–0.942)
Non-health natural science student	0.754	0.283	7.087	1	0.008	2.126 (1.220–3.705)
Obese student	0.684	0.301	5.177	1	0.025	1.982 (1.099–3.574)
Perceived mental health benefits	0.188	0.144	1.710	1	0.191	1.207 (0.910–1.600)
Time opportunities	−0.033	0.099	0.109	1	0.742	0.968 (0.797–1.175)
Lost of physical activity opportunities	0.108	0.094	1.313	1	0.252	1.114 (0.926–1.340)
New physical activity opportunities	0.210	0.119	3.140	1	0.076	1.234 (0.978–1.556)
Feeling worried about doing outdoor physical activities	−0.022	0.098	0.050	1	0.823	0.978 (0.807–1.186)
Feeling guilty about not exercising	0.031	0.096	0.100	1	0.752	1.031 (0.853–1.246)
Lost of enjoyable physical activities	0.009	0.100	0.007	1	0.932	1.009 (0.829–1.227)
Feeling that the pandemic did not impact physical activities	0.029	0.095	0.096	1	0.757	1.030 (0.855–1.240)
Feeling that being active is more important at the moment	−0.197	0.135	2.133	1	0.144	0.821 (0.631–1.070)

each one-point increase in feeling guilty about wanting to do PA was associated with 1.285 times lower odds (95% CI 1.062–1.558) of meeting the PA guideline.

Discussion

We found that university students' perceived physical health benefits as a motivation to do PA and their feeling guilty about wanting to do PA during the pandemic were the most consistent predictors of PA behavior among them. Our study results could help tailor PA promotion messages to fit the pandemic context and also choose the appropriate messaging framing for university students (Williamson et al., 2021). To increase university students' perceived physical health benefits of PA, it could be suggested that PA promotion targeting university students should use gain-framed persuasive strategies focused on the physical health benefits of PA, such as boosting immunity to protect them from severe infection (McCall et al., 2020; Chastin et al., 2021; Rahmati et al., 2022). Excessive fear, which was caused by the pandemic itself, several contingency measures to control the pandemic, or opinions on the negative effect of certain kinds of PA on immunity, could lead people to prefer to avoid losses of the PA benefits rather than gain the PA benefits (da Silveira et al., 2021). This loss aversion phenomenon could make students feel guilty about wanting to do PA (Wagner et al., 2012; Collier et al., 2020). Intervention using non-loss-framed strategies should also be implemented to countermeasure the loss aversion phenomenon during the pandemic, for example, by providing examples of PA, which could help students avoid their fear of contracting the infection or avoid their fear of immunity deprivation (Carfora and Catellani, 2021).

Our study is in line with several previous studies showing changes in PA motives during the pandemic. In general, intrinsic motivation is the most consistent motive for PA among university students (Teixeira et al., 2012; Ribeiro Nunes Lages et al., 2015; Valenzuela et al., 2021). However,

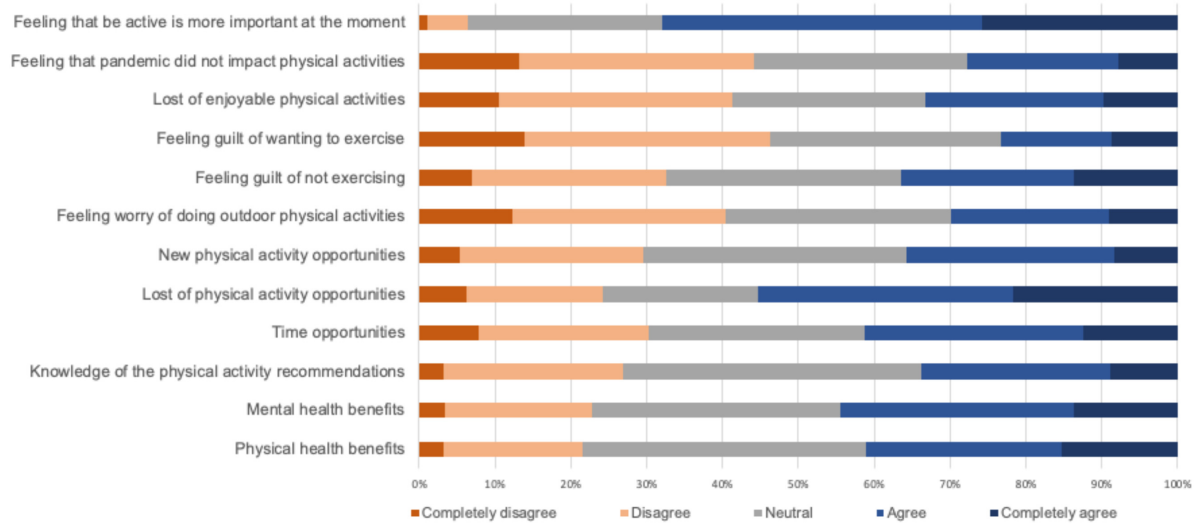

FIGURE 1
Participants attitudes and feelings about physical activity (PA) and coronavirus.

certain situations, such as a pandemic, could shift people's motivation by increasing the role of identified regulations of PA, which drive them to do PA because they consciously value the PA, for example, the health benefits of PA (Angosto et al., 2020; Al-Yaaribi, 2021; Gang et al., 2021; Spence et al., 2021; Wilczyńska et al., 2021). While two previous studies highlight the perceived mental health benefits as a strong motive for PA among the adult population during the pandemic (Angosto et al., 2020; Wilczyńska et al., 2021), our study indicated that perceived physical health benefits were stronger than perceived mental health benefits to influence university students' PA during the pandemic. This is surprising because university students are more prone to psychological distress during the pandemic than the other adult population (Xiong et al., 2020). Timely dissemination of accurate health information and social support from the university, which could reduce students' susceptibility to psychological distress, and also the sensitivity of university students to the PA promotion messages targeting physical health rather than psychological health could be the explanation for this discrepancy (Al-Eisa et al., 2016; Wang et al., 2020; Caso et al., 2021). In addition, a recent study in Indonesia also showed that students value physical performance as the highest perceived exercise benefits than the other subscales (Ruhayati et al., 2021). Another surprising result was that lost opportunities to do several kinds of PA did not associate with PA levels. However, it could be caused that the opportunity lost was compensated by the more available time to engage in PA since the majority of our samples felt that they had more time to be physically active (Yon et al., 2022). In addition, most of our samples also felt they did not lose their enjoyable PA types, which indicate they could engage in their favorite PA or find new PA routines even if they lost opportunities to engage in certain kind of PA, such as sports (Rizal and Wibowo, 2021; Yon et al., 2022).

Our study also strengthens that BMI and field of study are important predictors of PA among university students. This study strengthens our previous research on the early pandemic, which found an increase in PA among non-health natural sciences students compared to the other fields of study (Rizal and Wibowo, 2021). However, our current study contradicts the majority of previous studies showing that overweight and obese adults were associated with lower PA levels (Haynes et al., 2018). Pandemic situations could increase their awareness of the importance of PA during the pandemic since being overweight or obese is one of the important risk factors for COVID-19 severity (Pu et al., 2020; Robertson et al., 2022; Yang et al., 2022). In addition, their perception of having more spare time during the pandemic could also facilitate them to do more PA (Robertson et al., 2022).

The results of our study should be cautiously interpreted because of several limitations. First, the cross-sectional design of our study limits the causal inference of observed PA predictors. Second, we only captured our participants' PA levels using a subjective measurement tool prone to several biases. However, we used a validated tool and added a bogus item to minimize inattentive responses (Bull et al., 2009). The questionnaire used to examine participants' attitudes and feelings have also not been specifically validated in our study population. We anticipated this limitation by conducting a prior reliability study and adding a bogus item to our questionnaire to minimize inattentive responses (Meade and Craig, 2012; Maniaci and

Rogge, 2014; Niessen et al., 2016). Lastly, we only used a web-based survey as our data collection method, which was prone to sampling bias and resulted in a very high proportion of female students. Because the students were not on campus, remote data collection was the only way to collect data from research participants. This online-based data collection could also cause disproportionate gender representation since women are more likely to participate than men (Smith, 2008). The present study, which represented a high proportion of women, however, makes several noteworthy contributions to PA research since the proportion of female students in Indonesia is indeed more than male students (52 vs. 48%) (Sekretariat Direktorat Jenderal Pendidikan Tinggi Kementerian Pendidikan dan Kebudayaan, 2022). In addition, Mielke et al. (2018) also found that inactivity prevalence was higher in women (27%) than in men (20%), which advocated women as priority targets for PA research and intervention. Future research may need to consider the more heterogeneous remote data collection to avoid sampling bias. Future longitudinal studies using validated tools were also needed to examine solid causal inference of students' PA levels predictors.

Conclusion

During the COVID-19 pandemic, university students' motivation to do PA because of its physical health benefits and their barriers to PA because of feeling guilty about wanting to do it are consistent predictors which could be addressed with appropriate strategies. Appropriate messaging framing that fits the pandemic context could be suggested to increase students' perceived physical health benefits of PA and decrease their feeling guilty about wanting to do PA. Future longitudinal studies using validated tools and heterogeneous data collection methods could be suggested to establish strong evidence on predictors of university students' PA 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 the Medical and Health Research Ethics Committee of the Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada. The patients/participants provided their written informed consent to participate in this study.

Author contributions

RW: conceptualization, methodology, investigation, project administration, formal analysis, visualization, funding acquisition, and writing – original draft, review, and editing. MS: conceptualization, methodology, and writing–review and editing. DA: conceptualization, methodology, and supervision. All authors contributed to the article and approved the submitted 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.

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Pedro Morouço,
Polytechnic Institute of Leiria, Portugal

REVIEWED BY
María Luisa Zagalaz-Sánchez,
University of Jaén, Spain
Lidia Scifo,
Libera Università Maria SS. Assunta, Italy
José Eugenio Rodríguez-Fernández,
University of Santiago de Compostela, Spain

*CORRESPONDENCE
Oliver Ramos-Álvarez
oliver.ramos@unican.es

†PRESENT ADDRESS
Oliver Ramos-Álvarez,
Universidad de Cantabria, Santander, Spain

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Implications for balance in 11- and 12-year-old children in northern Spain during SARS-CoV-2 lockdown

Oliver Ramos-Álvarez[1,2*†], Víctor Arufe-Giráldez[3], Alberto Sanmiguel-Rodríguez[4] and Rubén Navarro-Patón[5]

[1]Education Faculty, University of A Coruña, A Coruña, Spain, [2]Departamento de Educación, Área de Educación Física y Deportiva, Universidad de Cantabria, Santander, Spain, [3]Research Unit of School Sports, Physical Education and Psychomotricity (UNIDEF), Specific Didactics Department, Research and Diagnostic Methods in Education, Education Faculty, University of A Coruña, A Coruña, Spain, [4]Faculty of Language and Education, University of Camilo José Cela, Madrid, Spain, [5]Facultad de Formación del Profesorado, Universidade de Santiago de Compostela, Lugo, Spain

Introduction: The home lockdown due to the appearance of SARS-CoV-2 in Spanish society led to changes in certain habits in children and adolescents. These habits were related to the practice of physical activity and the implications of higher rates of sedentary activities. This lockdown lasted from March to June 2020. The aim of this study was to determine the implication that lockdown in Spain due to the SARS-CoV-2 virus outbreak had on balance in 11–12 year-old schoolchildren.

Materials and methods: In total, 50 Spanish children aged 11–12 years (M = 11.40, SD = 0.50) participated, 33 (66%) boys and 17 (34%) girls. The Movement Assessment Battery for Children 2 (Movement ABC-2) and an *ad hoc* questionnaire for sociodemographic data and other relevant information were used for the three data collections.

Results: There are significant differences ($p < 0.05$) in the results for balance variables measured by static balance tests on supports in the total sample, in boys and girls. There are also significant differences in the total sample as well as in the boys in the heel-toe backward walking test. In addition, there are significant differences in mean, scalar and percentile dimension scores for balance between before and after lockdown in both boys and girls. No significant differences were found in the total sample or by gender in measurements related to the zigzag jumping test with dominant as well as non-dominant leg in girls (p = 0.317).

Conclusion: As a consequence of SARS-CoV-2 confinement, there was a worsening of balance values in children aged 11–12 years.

KEYWORDS

SARS-CoV-2, physical activity, children, MABC-2, balance

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Introduction

During the health crisis caused by COVID-19, many countries around the world opted for unusual measures to contain the virus that was spreading uncontrollably. Spain, like other neighbouring countries such as Italy, France and Portugal, opted to impose social measures of home lockdown to eradicate the transmission of the virus among the population. Spain by Royal Decree 463/2020 of 14 March declaring a state of alarm for the management of the health crisis caused by COVID-19 and restricting the movement of the entire Spanish population, except for essential workers (Agencia Estatal Boletín Oficial del Estado, 2020) began house confinement. These restrictions were in force for 98 days between 15 March and 21 June 2020. Educational establishments and sports schools were closed without a specific date for their reopening. During the course of this period of home confinement, the population in general and children and adolescents in particular modified their habits in relation to daily physical activity (PA), screen time, and eating habits (Arufe-Giráldez et al., 2020; Reina Prieto, 2020; Ramos Álvarez et al., 2021a). These changes resulted in changes in children's anthropometric averages, physical condition and psychological and emotional states (Quero et al., 2021; Ramos Álvarez et al., 2021a,b, 2022).

In this context, the development of motor competence is affected in children and young people. Motor competence is the implementation of a motor skill as a response in a given context (Fort-Vanmeerhaeghe et al., 2017). Balance is an important part of motor competence as an essential element of human movement as well as for body control. The good development of balance is fundamental for the correct development of general dynamic coordination and for the autonomy of the different body segments (Ruiz-Pérez, 2004). The development of motor competence is associated with the period of human growth and maturation, but there are certain life events that can create a worsening of human motor competence, such as ageing itself or the absence of physical activity (Fort-Vanmeerhaeghe et al., 2017).

Following the explanatory models of motor development of authors such as Gallahue, addressed in the work of Ruiz Perez (Ruiz-Pérez, 2004; Gallahue and Ozmun, 2006; Rigal, 2006; Ruiz-Pérez et al., 2014), or Clark and Metcalf (2002), the process of motor development is composed of different factors. These factors are individual factors (e.g., biological), task factors (e.g., physical characteristics or cognitive requirements). And finally, contextual factors, in which we find socio-cultural factors and which to a large extent can condition this motor development and as a consequence of the balance values. Through the active participation of the child, it promotes their motor development and therefore their balance, thus producing this social, affective, educational and ecological stimulation. In addition, motor experiences become essential to prevent possible deficiencies or impairments in motor development (Gardner, 1976; Young and Fujimoto Gómez, 2004). For example, disadvantaged socio-economic situations, living in small dwellings or without sufficient space, are considered limiting factors for the correct motor and physical development of the child development (Ruopp et al., 1979).

But if we look even more closely at the factors that influence the stability of balance, another series of factors can be identified: psychological and environmental factors, factors related to physical condition, physiological factors, and mechanical factors (García-López and Rodríguez-Marroyo, 2013). The combined work of these factors will enable the human body to achieve balance through its neuromuscular system. When the human body is in a bipedal position, it is in an unstable equilibrium, which is continuously restored by its neuromuscular system (García-López and Rodríguez-Marroyo, 2013).

Gallahue distinguishes five stages in human motor development (Gallahue and Ozmun, 2006): phase of reflex movements (0–1 years), phase of rudimentary movements (1–2 years), phase of basic motor skills (2–7 years), phase of specific motor skills (7–11 years), and phase of specialised motor skills (over 11 years). It is at the beginning of the third of the stages cited by this author, basic motor skills, that the development of balance becomes more important through changes of rhythm and turning. Included in the balance skills, balance, together with the development of strength and coordination, will enable the learning and development of other types of more complex movements.

Children of school age are characterised by a motor development in which perceptual-motor abilities begin to have a certain stability. This stability is a consequence of several factors: a greater maturation of the central nervous system and motor learning, the acquisition of the body schema and the acquisition of a greater functional autonomy of the body segments (Ruiz-Pérez et al., 2014). This period of motor stability is due to exogenous factors such as the practice of PA (Gutiérrez, 2008). However, fitness deficits and their most direct consequence, poor physical fitness, are related to motor development problems (Cairney et al., 2005; López-Gallego et al., 2016), among these are low levels of balance. By the age of 11–12 years, all coordination and balance skills should be fully defined and functionally efficient (Ruiz-Pérez et al., 2014). Practising regular PA or following a physical exercise training programme improves balance stability (García-López and Rodríguez-Marroyo, 2013). This improvement is a consequence of increasing the quality of the neuromuscular system (physiological factor) and the person's fitness levels. In addition, this increase in the quality of the neuromuscular system is associated with an improved emotional state (psychological factor).

One of the factors that has the greatest impact on proper motor development is the regular practice of PA. This regular PA practice is encouraged for the entire world population by the World Health Organisation (WHO), which has published

recommendations for PA practice by age group of the population. In the case of children, the WHO recommends at least 60 min of moderate to vigorous intensity PA (MVPA) daily. All the time a child spends in PA above this recommended time will lead to more health benefits (World Health Organization, 2010). It also states that children aged 5–12 should use technology devices and screens for no more than 60–90 min a day (World Health Organization, 2010, 2021), although the data are much higher (Cartanyà-Hueso et al., 2021). Similarly, there is also a preventive effect of regular PA practice with minimal exertional intensity on infectious diseases. Regular PA at least 30 min a day, 5 days a week can reduce the risk of contracting a virus, including COVID-19, by 31%, reduce the probability of death from infectious diseases by 37% and improve the effectiveness of vaccines by up to 40% (Chastin et al., 2021).

These WHO recommendations are far removed from the reality of Spanish children between 9 and 15 years of age, showing very negative data: the highest levels of sedentary lifestyles and abandonment of PA and sport outside the school context, with 85% of girls and 78% of boys. Spanish children in this age group do not spend the minimum number of minutes established by the WHO (World Health Organization, 2021). Also of concern is the population of children who seem to be more in need of regular PA practice, such as overweight or obese schoolchildren as opposed to schoolchildren with a body mass index (BMI) of normal weight (Wickel and Belton, 2016; Cartanyà-Hueso et al., 2021). Both elements, the decrease in the practice of PA and sport and the increase in the time spent using technological devices and screens, constitute the so-called technological sedentary lifestyle (Lozano-Sánchez et al., 2019; Arufe-Giráldez et al., 2020) and may be associated with other health problems (Díaz and Aladro, 2016).

Therefore, the main aim of this research is to determine the implication that lockdown in Spain due to the SARS-CoV-2 virus outbreak had on balance in 11–12 year-old schoolchildren. We investigated the possible relationships established between the balance tests assessed and certain socio-demographic variables (e.g., type of housing, place of residence, length of PA) in the context of school closures.

Materials and methods

Study design

In order to carry out this research, a descriptive and longitudinal observational study was conducted (Ato et al., 2013). Children's balance was the dependent variable used in the study. The independent variables of the research were defined on the basis of an *ad hoc* questionnaire. This questionnaire collected socio-demographic data of the children who participated in the study (e.g., age, gender, parents' educational level, employment status) as well as data related to the different variables under study (e.g., perception of tiredness, perception of self-esteem, perception of creativity).

Participants

Fifty-five children from a primary school in northern Spain were invited to take part in the research. These children were in the sixth grade at the time of the research. The school is located in a semi-urban residential area close to the city of Santander. Of the 55 children invited to participate in the study, 50 children finally participated, 33 (66%) boys and 17 (34%) girls (median age = 11.40, SD = 0.50). The other five children were excluded from the study because they did not provide informed consent from their parents or legal guardians or because they chose not to participate. The sample was distributed as follows: 56% resided in an urban setting, 38% in a semi-urban or residential setting and 6% resided in a rural setting during the SARS-CoV-2 closure period.

The participants in this study have contributed to a better understanding of the consequences of home lockdown in Spain due to SARS-CoV-2. In addition to the implications that such lockdown had on their balance, the implications for their manual dexterity are also known (Ramos Álvarez et al., 2022).

Instruments

The Spanish adaptation of the Movement Assessment Battery for Children 2 (MABC-2) was used for this research (Henderson et al., 2007; Ruiz Pérez and Graupera-Sanz, 2012). The MABC-2 is composed of three dimensions: Dimension 1, which assesses children's manual dexterity, Dimension 2, which assesses aiming and catching, and Dimension 3, which assesses balance. Each of these dimensions is made up of different tests. The test administered in this research were a static balance test and two dynamic balance test.

The static balance test (B1), balance on two supports, consists of the child standing on the narrow part of some supports and in a heel-toe position for a maximum of 30 s. In order to carry out this test, a wide space must be available where the child cannot lean on it. Specific supports are also required for the execution of this test. The researcher must also demonstrate the correct execution of the test. The investigator must emphasise the importance of a stable position, that it is not permitted to lift the feet off the supports, to touch the base of the supports with the edges of the feet and that they can use their arms to balance themselves. The time shall be counted when the child is perfectly balanced. Before the test is performed, the child has a 15-s trial and has two attempts to achieve the objective of this test.

The first dynamic balance test (B2), walking backward heel-toe, consisted of the child walking backward in a heel-toe pattern

along a line made with adhesive tape. The length of this line was 4.5 m. The child has 5 trial steps and two attempts to walk 15 steps or finish the line without mistakes. It is not possible to help the child, but a demonstration should be given, stressing that there should be no gaps between each step, that the child should not step off the line, that he/she should not touch the ground with the free foot to regain balance, and that the position of the foot should not be readjusted once it is on the line.

The last of the tests performed and the second dynamic balance test (B3 and B4 for dominant and non-dominant leg, respectively), is jumping on one leg in a zigzag. To perform this test, specific equipment is required. This material consists of mats: 3 yellow mats, 2 blue mats, and a blue mat with an orange circle (target mat). These mats will be arranged in a zigzag pattern over a distance of 4.5 m. The child must stand on the first mat on one leg and must jump from mat to mat with the same leg to the target mat. The test must be performed on both legs and the child can choose which leg he/she wants to start the test with. As in the other tests, the researcher must demonstrate the limits over which the child must jump on the mats, jumping one mat at a time and without stopping, avoiding the free foot touching the floor or another mat and finishing the jumps in balance and within the target mat. You will have one trial with each leg and two attempts with each leg during your evaluation. The maximum score (five points) is achieved if the child manages to perform all five zigzag jumps without error.

For the performance of the tests, their measurement and subsequent evaluation, the procedures established in the MABC-2 were followed, using specific test materials, as well as a digital hand-held stopwatch and adhesive tape. Likewise, for the interpretation of the research results, the reference values established in the MABC-2 were taken into account (Ruiz Pérez and Graupera-Sanz, 2012).

The data obtained by means of the MABC-2 were complemented by means of an *ad hoc* socio-demographic questionnaire. This questionnaire was completed by the parents or legal guardians and collected information on different variables: economic and educational information on the family, information on the time dedicated to the practice of PA, information on the time dedicated as well as the type of sedentary activities carried out and finally information on the time dedicated and the type of technologies used by the children before and during confinement. The designed questionnaire is composed of 50 dichotomous items, items rated on a Likert scale and open-ended questions. The questionnaire showed an acceptable Cronbach's alpha coefficient ($\alpha = 0{,}71$) (Nunnally and Bernstein, 1994; George and Mallery, 2003).

Procedure

The research was carried out during the 2019–2020 academic year. Three data collections were conducted: two pre-lockdown data collections and a third post-lockdown data collection. The pre-lockdown data collections were conducted in physical education classes, specifically during the weeks of 14 October 2019 and 2 March 2020. While the post-lockdown data collection took place in the so-called de-escalation period in Spain: during the week of 28 May 2020.

Spain closed its schools indefinitely from 15 March 2020 due to the outbreak of SARS-CoV-2 in Spain (Agencia Estatal Boletín Oficial del Estado, 2020). It is from this date that the national lockdown began in Spain as a result of the state of alarm decreed due to the health emergency caused by SARS-CoV-2. Following this event, all families of the children participating in the research were contacted and informed of the changes that were to be made to the study. These changes affected the post-lockdown data collection process. This new information, conveyed in writing, did not cause any participants to drop out of the study.

In the post-lockdown data collection, the same procedures used in the previous data collection were used and some modifications were introduced to ensure compliance with the health measures established by the Spanish government to prevent the spread of SARS-CoV-2. Firstly, as a consequence of the closure of primary schools, data collection was conducted outside physical education classes. Secondly, groups of six sampled children were convened in different time slots and in an outdoor space for data collection. In addition, in this post-lockdown data collection, data from the socio-demographic questionnaire were collected by means of a paper survey. This questionnaire was completed by the parents or legal guardians. With this third data collection, a statistical analysis was carried out between the results obtained between pre-lockdown 2 and post-lockdown.

Statistical analysis

The statistical software SPSS v. 26 (IBM Corporation, New York, NY, USA) was used to perform the statistical analyses of the research. Descriptive analyses of the main variables of the research were performed as well as normality tests of the quantitative variables for hypothesis testing. For normality analyses of the total sample, the Kolmogorov-Smirnov statistic was used ($n > 50$). In the case of normality tests by sex, the Shapiro–Wilk statistic was used ($n < 50$).

The Mann–Whitney *U* test for paired samples was also performed to check whether there were statistically significant differences ($p < 0.05$) between the data obtained in the different data collections for the research variables, both for the total sample and by sex. This test was performed on the two pre-lockdown data collections as well as on the post-lockdown data collection. This decision was based on having a sample of less than 25 female participants. The Mann–Whitney *U* test has been shown to be the most appropriate test for investigations with

samples similar to the one presented in this study. Numerous scientific articles have addressed the suitability of its use in similar circumstances in the paediatric population (Gómez-Gómez et al., 2003; Ramírez and Polack, 2020; Ortega et al., 2021).

Finally, the Kruskal–Wallis *H*-test was used in the case of three or more groups. This test was applied with the data collected in the family habits questionnaire.

Ethical aspects

The ethical and deontological principles established by the American Psychological Association have been followed in this research (American Psychological Association, 2020), as well as ethical recommendations for educational research (Paz, 2018).

The research protocol was approved by EDUCA's Ethics Committee under code 82019.

Results

Balance assessment tests and scores

Descriptive and functional analysis

To confirm the normality of the assessment scores as well as the balance tests performed, the Shapiro–Wilk test was performed. This test rejects the hypothesis of normality in the two pre-lockdown data collections in the balance dimension score, scalar score and balance percentile in both boys and girls. The results of the Shapiro–Wilk test in the post-lockdown data collection on these same scores also show the rejection of the normality hypothesis for both girls and boys. The exception is the boys' balance dimension score ($p = 0.113$).

Significant differences were found for the total balance score, the scalar score and the percentile (**Table 1**).

In tests for related samples when the *p*-value is significant ($p < 0.05$) the hypothesis is accepted with 95% confidence that there is a statistically significant difference in the mean value of the variable between the different data collections. This circumstance appears in the total sample between the three data collections in the balance dimension score, in the scalar score and the balance percentile ($p = 0.000$). Identical results are found for boys in these scores. In the case of girls, statistically non-significant data appear in the scores between the first pre-lockdown data collection and the post-lockdown data collection: balance dimension score ($p = 0.230$), scalar score ($p = 0.201$), and balance percentile ($p = 0.114$).

In relation to the different tests carried out, between the first and second data collection pre-lockdown, there are statistically significant differences in the balance test on supports. These results are obtained for the total sample, in boys and girls.

TABLE 1 The balance test results between pre-lockdown 1, pre-lockdown 2, and post-lockdown using descriptive analysis.

	Pre-lockdown 1			Pre-lockdown 2			Post-lockdown		
	***n* (Total)**	**Boys**	**Girls**	***n* (Total)**	**Boys**	**Girls**	***n* (Total)**	**Boys**	**Girls**
SD	30.96 ± 5.41*	31.06 ± 4.98*	30.76 ± 6.32	34.44 ± 2.12	34.15 ± 2.57	35.00 ± 0.00**	26.48 ± 7.11***	25.39 ± 7.18***	28.58 ± 6.67^{+}
SDS	10.56 ± 3.15*	10.57 ± 3.06*	10.52 ± 3.41	12.66 ± 1.28	12.48 ± 1.56	13.00 ± 0.00**	7.92 ± 4.12***	7.33 ± 4.10***	9.05 ± 4.03^{+}
BP	59.32 ± 29.71*	59.15 ± 30.09*	59.65 ± 29.86	80.46 ± 13.13	78.63 ± 15.93	84.00 ± 0.00**	36.84 ± 32.89***	32.02 ± 31.86***	46.20 ± 33.80^{+}
B1	23.36 ± 8.79*	23.78 ± 8.40*	22.52 ± 9.72	29.34 ± 3.42	29.00 ± 4.19	30.00 ± 0.00**	20.80 ± 10.52***	20.36 ± 10.27***	21.64 ± 11.27^{+}
B2	13.20 ± 3.73	12.81 ± 3.86	13.94 ± 3.47	14.66 ± 1.23**	14.48 ± 1.50**	15.00 ± 0.00	9.66 ± 4.80***	9.06 ± 4.78***	10.82 ± 4.77^{+}
B3	4.98 ± 0.14	5.00 ± 0.00	4.94 ± 0.24	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	4.96 ± 0.19	4.93 ± 0.24	5.00 ± 0.00
B4	4.94 ± 0.31	4.90 ± 0.38	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	4.74 ± 0.77^{+}	4.63 ± 0.92^{+}	4.94 ± 0.24

Data are presented as mean ± standard deviation. $n = 50$; boys = 33; girls = 17. Abbreviation: SD, score dimension balance; SDS, score dimension scaling balance; BP, balance percentile; B1, balance 1—static balance test; B2, balance 2—dynamic balancing test 1; B3, balance 3—dynamic balancing test 2 with dominant leg; B4, balance 4—dynamic balancing test 2 with non-dominant leg. $^{*}p < 0.001$ = significant for pre-lockdown 2. $^{**}p < 0.05$ = significant pre-lockdown 1. $^{***}p < 0.001$ = significant with pre-lockdown 2. $^{+}p < 0.05$ = significant with pre-lockdown 2.

There are also statistically significant differences in the heel-toe backward walking test in the total sample and in the boys, results that do not occur in the girls ($p = 0.180$). In the rest of the tests performed between the first and second pre-lockdown data collection (zigzag with dominant and non-dominant leg), there are no statistically significant results in the total sample, in the boys or in the girls. Therefore, there was an improvement in the results of the first two balance tests between the two pre-lockdown data collections.

The data analysed above are similar to those obtained between pre-lockdown 2 and post-lockdown. The results show statistically significant differences ($p < 0.05$) in the mean scores of the balance on supports assessment tests and the heel-toe backward walking test. These results are given for the total sample, boys and girls. Statistically significant results are also given in the zigzag test with non-dominant leg in the total sample ($p = 0.026$) and in the boys ($p = 0.039$). In the zigzag test with dominant leg the results are not significant for the total sample ($p = 0.157$), neither for boys ($p = 0.157$) nor for girls ($p = 1.000$).

The research showed a worsening of test scores between pre-lockdown 2 and post-lockdown, except in the zigzag jumping test with dominant leg in girls, which maintained the same score ($p = 5.00$). Likewise, this worsening showed significant differences in the scores of all the balance assessment tests performed, except in the zigzag jump test with dominant leg in the total sample ($p = 0.157$), in the boys ($p = 0.157$) and in the girls ($p = 1.000$), as well as in the jump with non-dominant leg in the girls ($p = 0.317$). The results obtained by gender do not show large differences between boys and girls in the tests performed, but girls obtain better results in the tests performed between pre-lockdown 2 and post-lockdown.

Evolution of the tests

The results obtained from the different balance tests performed according to the MABC-2 show improvements between the results of the pre-lockdown 1 and pre-lockdown 2 data collection. This improvement is smaller in the dynamic balance tests of zigzag jumps, which maintained stable results with small modifications between the different data collections.

However, this improvement was not reflected in the post-lockdown results. There was a negative evolution in all the post-lockdown results, even worsening the results obtained in the pre-lockdown data collection 1. This worsening occurs both in the mean values of the sample and by gender, although with less worsening in girls.

Table 1 and **Figure 1** show the results obtained for Dimension 3 of the MABC-2 in the three data collections carried out in this research (two pre-lockdown and one post-lockdown data collection). These results are broken down by the mean value of the total sample, as well as by gender, in the tests performed as well as in the total, scalar and percentile balance scores.

The MABC-2 (Henderson et al., 2007) establishes three classifications based on the total scores obtained. It classifies in the red zone if the total score is less than 62 points, associated with difficulty in the child's movement. A second zone is called amber. This Zone is between 63 and 69 points and establishes a certain risk of having movement problems. And finally, a green Zone is established for scores above 69 points and in which children do not present movement problems. According to this classification and the mean scores obtained by the sample in the first data collection, the sample was in the Green Zone: the whole sample ($M = 71.220$), the boys ($M = 70.636$) and the girls ($M = 72.352$).

In the second data collection and even without the sample being confined, the sample experienced a notable improvement in the results obtained in the different tests: 19.23% for the total sample, 19.60% for the boys and 18.53% for the girls. This enabled the sample to remain in the Green Zone: the total sample ($M = 84.920$), the boys ($M = 84.484$) and the girls ($M = 85.764$). The results showed a worsening as a consequence of the period of lockdown due to SARS-CoV-2 in Spain. This aspect was shown in that the means of the boys ($M = 62.636$) and the full sample ($M = 65.580$) both scored within the amber zone. It should be remembered that the amber zone may indicate a risk of movement problems. However, the girls in the sample obtained results that kept them in the green zone, although with worse values than the initial values ($M = 71.294$).

In the specific case of balance and the results obtained from the specific tests set out in the MABC-2, the same worsening occurs. According to the scores obtained in the different tests, specifically the scalar scores, it is observed that the sample starts from normal levels of balance: in the total sample ($M = 10.56$), in the boys ($M = 10.57$) and in the girls ($M = 10.52$). These balance levels undergo a significant improvement in the second pre-lockdown data collection, both in the total sample ($M = 12.66$), in the boys ($M = 12.48$) and in the girls ($M = 13.00$). These scores show no risk of movement in the sample.

However, and as a direct consequence of the lockdown, the balance scores suffer a significant deterioration: in the total sample ($M = 7.92$), in the boys ($M = 7.33$) and in the girls ($M = 9.05$). These scores are not yet within the MABC-2 reference values for movement risk, but the worsening of balance levels in the sample is significant as a consequence of the lockdown.

Family habits

Descriptive analysis

In relation to the data obtained from the questionnaire on family habits during lockdown and completed by the parents or legal guardians of the children, a basic descriptive analysis was carried out. Of note are the data in relation to exposure

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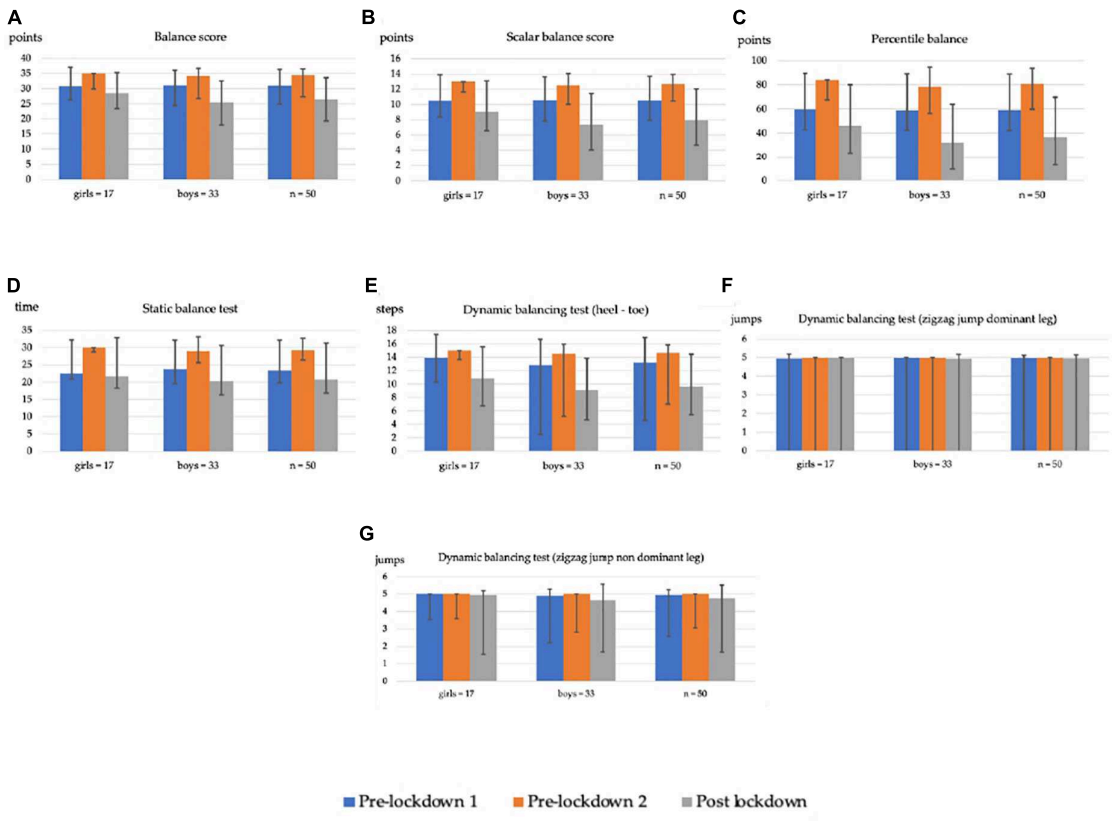

FIGURE 1
Columns of the evolution of mean balance scores and their different tests with standard deviation bars. **(A)** Balance dimension score; **(B)** Balance scalar score; **(C)** Balance percentile; **(D)** Static balance test–values in seconds; **(E)** Dynamic balance test 1–values in steps performed correctly; **(F)** Dynamic balance test 2 with dominant leg–values in jumps performed correctly; **(G)** Dynamic balance test 2 with non-dominant leg–values in jumps performed correctly.

to screens, educational and cultural activities carried out by the children, hours of rest, the practice of PA or the place and size of residence during lockdown (Ramos Álvarez et al., 2022).

In relation to the place and size of residence during lockdown, this was considered important information for the research as a limiting aspect for the practice of physical activity during confinement. The data show that 6% of the sample resided in a rural setting, 38% in a semi-urban or residential setting, and 56% in an urban setting. In terms of dwelling size, 36% of the sample resided in a house with a garden, 28% in a flat of between 91 and 120 m^2, 28% in a flat of between 61 and 90 m^2, and 8% of the sample in a flat of less than 60 m^2. However, there was no evidence in this study that place of residence and size of dwelling during the period of lockdown had a significant influence on differences in PA minutes or balance scores during lockdown. Two exceptions occurred around place of residence, which showed significant results in the static balance test on supports ($p = 0.023$) and in the dynamic balance test of zigzag jumping with non-dominant leg ($p = 0.009$).

On the practice of physical activity, there was an increase from 4 to 32% of the children in the sample who did not engage in any physical activity. However, during lockdown there was a decrease in the frequency of weekly PA practice. Children who practised PA 2–3 times a week suffered a decrease of 10%, 14% among children who practised between 4 and 5 days and from 10 to 6% among children who had practised between 6 and 7 days. In relation to the amount of rest time children spent during the lockdown period, 20% of the sample slept 8 h a day, 40% slept 9 h, and 38% slept 10 h a day.

In relation to sedentary activities carried out by the sample during lockdown, educational and cultural activities were taken into account in this study, as well as the time devoted by the children to the consumption of screens. Regarding educational and/or cultural activities, 82% of the sample spent more than 60 min doing homework and 30% spent more than 146 min. A total of 38% of the sample spent between 16 and 30 min a day reading, 2% playing musical instruments and 8% spent more than 60 min on artistic activities.

Finally, in relation to the time the children were exposed to screens, the entire sample had a daily exposure to screens of more than 60 min. A total of 52% used a video console, 50% watched TV, 48% used a computer, 30% used a tablet and 26% used a mobile phone.

Statistically significant differences

The Mann–Whitney *U*-test and the Kruskal–Wallis *H*-test were used, taking as a reference the recommendations established by the WHO (World Health Organization, 2022) to measure whether there were statistically significant differences between the equilibrium variables and the sociodemographic variables at pre- and post-lockdown. According to the items of interest for this research, these tests of independence showed no statistically significant differences ($p > 0.05$) between the post-lockdown balance variables and the sociodemographic variables, with some exceptions. These exceptions that showed statistically significant differences are: whether any parent is an athlete with respect to the static balance test on supports ($p = 0.010$), the place of residence with respect to the static balance test on supports ($p = 0.023$) and with the dynamic balance test of zigzag jumping with non-dominant leg ($p = 0.009$), the mean number of minutes/day that the child uses a video console with respect to the static balance test on supports ($p = 0.015$) and with the dynamic zigzag jumping balance test with non-dominant leg ($p = 0.014$) and finally the mean number of minutes/day that the child plays a musical instrument with the dynamic zigzag jumping balance test with dominant leg ($p = 0.000$).

Post-lockdown results

Once the analyses of the family habits questionnaire and the post-lockdown balance score and test variables had been carried out, a statistical analysis was performed between both types of variables. This analysis focused on the relationship between the results of the post-lockdown balance variables in relation to the frequency of PA practice in the sample.

This analysis shows worsening in three of the four balance tests performed in this study in children who did not practice PA during lockdown: decrease in balance time in the static balance test on supports (−5.68%) and in the dynamic balance tests of zigzag jumps with dominant (−1.4%) and non-dominant (−11.4%) leg. However, there is a maintenance or improvement of the pre-lockdown results after the lockdown period in children who have performed PA. There are three exceptions with notable worsening of results: decrease in the time of balance in the static balance test on supports (−3.59%) in children who performed between 2 and 3 days of PA during lockdown, as well as those who practised between 6 and 7 days a week (−13.91%). Finally, there were also worse post-lockdown results in children who performed 6–7 days of weekly physical activity in the dynamic balance test of zigzag jumping with non-dominant leg (−2.91%). A breakdown of the results can be found in **Table 2**.

Another important factor studied in this research is the increased exposure time to screens by the children in the sample. This event may have limited the practice of physical activity during the lockdown period. **Table 3** shows the results obtained for the variables analysed by means of the balance tests in relation to the time the sample spent using screens during the confinement period to the detriment of the practice of PA.

The results show that from 45 min of use of technological devices onward, worse results are produced in the balance assessment tests. It is also evident that the children who used the technological devices between 31 and 45 min compared to those who did not use them, improved the results of the balance tests carried out.

Similarly, and after analysing the time the sample spent on other sedentary activities during the lockdown period (homework, reading, using musical instruments and performing artistic activities), the results showed that the balance values did not worsen in relation to the daily minutes spent on these activities.

Discussion

The aim of this study was to determine the implication that lockdown in Spain due to the SARS-CoV-2 virus outbreak had on balance in 11–12 year-old schoolchildren.

TABLE 2 Pre- and post-lockdown balance test scores in relation to the frequency of children who were not physically active using descriptive analysis.

	PA practice			
	No PA	**2–3 times/week**	**4–5 times/week**	**6–7 times/week**
B1 pre-lockdown	21.00 ± 12.72	23.34 ± 9.59	17.05 ± 10.63	24.00 ± 12.32
B1 post-lockdown	19.87 ± 10.26	22.50 ± 11.14	19.61 ± 9.70	20.66 ± 16.16
B2 pre-lockdown	7.00 ± 1.41	10.69 ± 4.71	8.75 ± 4.94	9.60 ± 5.55
B2 post-lockdown	8.43 ± 5.11	11.22 ± 3.84	8.69 ± 5.61	11.00 ± 3.60
B3 pre-lockdown	5.00 ± 0.00	4.95 ± 0.20	4.95 ± 0.22	5.00 ± 0.00
B3 post-lockdown	4.93 ± 0.25	5.00 ± 0.00	4.92 ± 0.27	5.00 ± 0.00
B4 pre-lockdown	5.00 ± 0.00	4.69 ± 0.87	4.75 ± 0.78	4.80 ± 0.44
B4 post-lockdown	4.43 ± 1.20	4.94 ± 0.23	4.84 ± 0.55	4.66 ± 0.57

Data are presented as mean ± standard deviation. PA, physical activity; B1, balance 1—static balance test; B2, balance 2—dynamic balancing test 1; B3, balance 3—dynamic balancing test 2 with dominant leg; B4, balance 4—dynamic balancing test 2 with non-dominant leg.

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TABLE 3 The post-lockdown balance test results according to exposure to screens during lockdown using descriptive analysis.

	Average minutes/day of video game console use during lockdown								
Test	**0**	**1–15**	**16–30**	**46–60**	**61–75**	**76–100**	**101–115**	**116–130**	**+146**
B1	26.93 ± 7.62	11.00 ± 0.00	30.00 ± 0.00	10.60 ± 10.45	–	21.33 ± 11.86	–	18.33 ± 9.90	16.40 ± 10.78
B2	10.00 ± 5.25	3.00 ± 0.00	9.00 ± 0.00	12.20 ± 4.08	–	12.66 ± 4.08	–	7.00 ± 3.76	12.00 ± 2.82
B3	4.93 ± 0.25	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	–	5.00 ± 0.00	–	4.93 ± 0.25	5.00 ± 0.00
B4	5.00 ± 0.00	2.00 ± 0.00	5.00 ± 0.00	4.60 ± 0.54	–	5.00 ± 0.00	–	4.46 ± 1.12	5.00 ± 0.00
	Average minutes/day of television use during lockdown								
Test	**0**	**1–15**	**16–30**	**31–45**	**46–60**	**76–100**	**101–115**	**116–130**	**+146**
B1	20.25 ± 11.61	29.00 ± 1.41	10.75 ± 13.09	30.00 ± 0.00	22.00 ± 10.34	20.00 ± 14.14	25.00 ± 0.00	21.76 ± 10.14	15.40 ± 10.80
B2	9.25 ± 4.64	12.00 ± 4.24	5.50 ± 3.10	11.00 ± 5.65	10.38 ± 4.29	10.50 ± 6.36	15.00 ± 0.00	9.88 ± 5.40	7.80 ± 5.49
B3	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	4.94 ± 0.24	4.80 ± 0.44
B4	5.00 ± 0.00	5.00 ± 0.00	4.75 ± 0.50	5.00 ± 0.00	4.53 ± 1.12	5.00 ± 0.00	5.00 ± 0.00	4.70 ± 0.84	4.80 ± 0.44
	Average minutes/day of PC use during lockdown								
Test	**0**	**1–15**	**16–30**	**31–45**	**46–60**	**61–75**	**76–100**	**116–130**	**+146**
B1	21.20 ± 11.35	30.00 ± 0.00	15.80 ± 12.33	30.00 ± 0.00	21.77 ± 9.12	30.00 ± 0.00	22.75 ± 13.20	21.13 ± 11.38	13.75 ± 4.19
B2	10.20 ± 3.96	3.00 ± 0.00	7.40 ± 7.16	7.00 ± 0.00	10.55 ± 4.36	7.00 ± 0.00	12.75 ± 4.50	10.00 ± 5.16	7.75 ± 4.11
B3	5.00 ± 0.00	5.00 ± 0.00	4.80 ± 0.44	5.00 ± 0.00	4.88 ± 0.33	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00
B4	4.90 ± 0.31	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	4.66 ± 1.00	2.00 ± 0.00	4.75 ± 0.50	4.86 ± 0.51	4.25 ± 1.50
	Average minutes/day of tablet use during lockdown								
Test	**0**	**1–15**	**16–30**	**31–45**	**46–60**	**76–100**	**101–115**	**116–130**	**+146**
B1	22.29 ± 10.16	30.00 ± 0.00	17.90 ± 10.93	30.00 ± 0.00	17.80 ± 9.20	19.50 ± 14.84	–	21.55 ± 11.35	17.50 ± 14.52
B2	9.23 ± 4.63	9.00 ± 8.48	9.10 ± 5.46	7.00 ± 0.00	11.60 ± 5.27	10.50 ± 6.36	–	10.66 ± 4.77	8.75 ± 4.78
B3	4.94 ± 0.24	5.00 ± 0.00	4.90 ± 0.31	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	–	5.00 ± 0.00	5.00 ± 0.00
B4	4.58 ± 1.00	5.00 ± 0.00	4.60 ± 0.96	5.00 ± 0.00	4.60 ± 0.89	5.00 ± 0.00	–	5.00 ± 0.00	5.00 ± 0.00
	Average minutes/day of mobile phone use during lockdown								
Test	**0**	**1–15**	**16–30**	**31–45**	**46–60**	**61–75**	**101–115**	**116–130**	**+146**
B1	20.00 ± 10.49	16.50 ± 19.09	23.33 ± 11.54	28.00 ± 0.00	20.20 ± 10.78	30.00 ± 0.00	–	19.66 ± 12.50	23.33 ± 10.40
B2	9.50 ± 5.24	10.00 ± 7.07	12.00 ± 2.64	12.00 ± 0.00	7.00 ± 2.73	9.00 ± 0.00	–	8.50 ± 5.39	12.16 ± 4.49
B3	4.96 ± 0.19	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	4.80 ± 0.44	5.00 ± 0.00	–	5.00 ± 0.00	5.00 ± 0.00
B4	4.65 ± 0.89	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00	4.40 ± 1.34	5.00 ± 0.00	–	4.83 ± 0.40	5.00 ± 0.00

Data are presented as mean ± standard deviation. Abbreviation: PA, physical activity; B1, balance 1—static balance test; B2, balance 2—dynamic balancing test 1; B3, balance 3—dynamic balancing test 2 with dominant leg; B4, balance 4— dynamic balancing test 2 with non-dominant leg.

The results of this study show a negative evolution in the balance scores of a sample of 11- and 12-year-old boys and girls living in a region of northern Spain as a consequence of the SARS-CoV-2 lockdown. This deterioration occurs in the static equilibrium of the sample as well as in the dynamic equilibrium. Similarly, the deterioration in balance values occurs in boys as well as in girls. The research reinforces other studies of the negative impact that lockdown has had on different psychomotor domains in the paediatric age population, such as children's manual dexterity, and a generalised worsening in global motor coordination (Ramos Álvarez et al., 2022). This worsening is more important for boys than for girls. Research carried out in the province of Tungurahua (Ecuador), showed a slight and significant delay of 10.35% of the sample studied in both the gross and fine motor areas, as well as in coordination, factors of importance in the balance of the paediatric age population (Sánchez-Reyes et al., 2020).

Similar studies have shown the deterioration in children's motor skills, including stability and balance, during periods of restricted movement such as the COVID-19 lockdown (Pombo et al., 2021). In this research it was found that motor competence in Portuguese children worsened significantly overall as well as in individual tests after restraint. On this occasion the worsening was not significantly greater in boys than in girls, but worsened equally for both.

Events such as home lockdown are detrimental situations for children's physical activity behaviours that affect all spheres of human motor skills (Wang G. et al., 2020). As a consequence of this lockdown and the decrease in children's physical activity time, levels of overweight and obesity have also risen. These pathologies have become a global concern because of the emergence of associated diseases in adulthood (Wang H. et al., 2020). But also because overweight and obese children have poorer levels of balance and motor coordination, which has been accentuated during the COVID-19 lockdown period (Lizondo-Valencia et al., 2021).

Other research has shown that sedentary lifestyles have an important impact on some factors associated with balance. Low rates of regular PA in children and adolescents have negative repercussions on their mental and physical health, and lead to alterations in the musculoskeletal system, postural imbalances and the appearance of back, head, and neck pain. Psychological factors are also affected. These events are more prevalent in girls, who present a higher rate of clinical manifestations of pain related to sedentary lifestyles (Martínez-López et al., 2015). For this reason, strength training is particularly important for improving coordination and balance in children. In addition to preventing possible injuries during the practice of physical sports activities (Kordi et al., 2016; Comité Nacional de Medicina del Deporte Infantojuvenil, 2018).

In relation to this type of study, in Spain, children and adolescents do not meet the physical activity recommendations established by the WHO as optimal for an active and healthy life (Ventura et al., 2021; World Health Organization, 2022). These data have suffered a decrease due to home lockdown due to the outbreak of SARS-CoV-2, with the main consequences being the worsening of physical fitness values as well as anthropometric values in children and adolescents (Maltagliati et al., 2021; Ramos Álvarez et al., 2021a,b; Ventura et al., 2021). Balance has as a group of influencing factors in its development the levels of physical fitness (García-López and Rodríguez-Marroyo, 2013). Therefore, the decrease in the values of equilibrium evidenced in this research may have as one of its causes the loss of physical condition of the sample.

It should be noted that in this pandemic context, several studies have found (Chen et al., 2020; Ortiz and Villamil, 2020; Chastin et al., 2021) that good physical fitness and regular physical activity are preventive factors against SARS-CoV-2 infection. Likewise, optimal physical fitness resulting from regular PA reduces the suffering from the disease. This has the consequence that in case of infection with the virus, it may have lower health risks. This evidence is supported by some of the direct consequences that regular PA practice has on the body: anti-inflammatory, anti-fibrotic and antioxidant effects, which can mitigate the negative effects that COVID-19 can have on the body.

This research has also shown changes in certain habits of the sample that have a direct impact on physical fitness (Ramos Álvarez et al., 2021a), including their performance in balance tests. A change has occurred in the sample's rest and hours of sleep. For the age range of the sample in this study, the WHO recommends more than 11 h of rest per day, which the sample did not comply with (Ramos Álvarez et al., 2021a).

This research has also evidenced changes in habits between pre- and post-lockdown and that these changes influenced their equilibrium values: related to food and PA. These changes have been evidenced in different studies and with direct implications in different population settings (Arufe-Giráldez et al., 2020; Villaseñor et al., 2020; Santos-Miranda et al., 2021). Another habit that should be highlighted due to the significant changes in all age groups is related to the consumption of time spent with technological devices. There has been a significant increase in the amount of time spent on technology and screen time. This change in habits has a significant impact on the increase in time spent on sedentary activities and a significant loss of time and frequency spent on physical sports activities. This loss of time and frequency devoted to PA leaves values below the WHO's global recommendations (World Health Organization, 2021). These sedentary habits have become a concern for some States, issuing laws limiting the use of technology by children and adolescents to This, compounded by the SARS-CoV-2 health crisis, has led some governments to implement measures to limit the use of technology, prevent addiction and mitigate the high levels of sedentary behaviour among children and adolescents (Rtve, 2021).

This research, like any other similar study, has certain limitations. The main limitation of the research is the size of the sample and the difference between genders. This limitation prevents the results obtained in this research from being generalisable to the entire Spanish population aged 11–12 years.

Despite the limitations of this study, the research cited in this article shows profiles similar to the characteristics of the sample presented in this research. In addition to the research cited, other documents consulted (especially governmental) corroborate this assertion. The latest survey of the National Statistics Institute (INE) of 2020 (Instituto Nacional de Estadística, 2020) and EUROSTAT reports (Oecd/European Observatory on Health Systems and Policies, 2019) are some examples of government documents that show similar profiles to the sample presented in this research.

Conclusion

The main objective of this research was to determine the implication that lockdown in Spain due to the SARS-CoV-2 virus outbreak had on balance in 11–12 year-old schoolchildren. The results have shown that there has been an impact on balance as a consequence of this lockdown. This worsening in the equilibrium values of the sample studied may have a multifactorial origin (Ruiz Pérez and Graupera-Sanz, 2012). The

same conclusion has been reached in similar studies (Ramos Álvarez et al., 2021a, 2022). These factors are based on the decrease in time dedicated to the practice of PA, the increase in the use of electronic devices and the increase in daily time dedicated to other types of sedentary activities. This worsening of post-lockdown balance values is lower in girls than in boys. Despite this decrease in the balance values of the total sample as well as by gender, it does not imply that the sample is in balance-related movement difficulties according to the reference values of the MABC-2.

The research has two main limitations that prevent the results obtained in this study from being generalisable to the rest of the population of this age group. The first limitation is the size of the sample, as a larger sample would be needed to be able to generalise the results obtained. The second limitation, also related to the sample, is the difference in sample size between boys and girls. It would have been more desirable for the study to have a more gender-equitable sample. However, these limitations in relation to the sample do not prevent us from highlighting the deterioration that the sample has undergone in its static and dynamic equilibrium as a consequence of the SARS-CoV-2 confinement in Spain. This research is a complement to the research being carried out in different areas of knowledge on the impact of COVID-19 confinement on the paediatric population.

This research reinforces the findings of other research related to the impact of SARS-CoV-2 lockdown in this age group (Ramos Álvarez et al., 2021a, 2022): the need to reinforce and work on more effective strategies to promote the practice of healthy PA on a regular basis among Spanish children and adolescents is evident. To achieve these objectives, the promotion and development of effective strategies for adherence to the practice of PA among the children participating in this research should be addressed.

Likewise, the work proposed for the promotion of regular PA practice in children and adolescents must be complemented with other educational actions. These educational actions should be linked to the learning and use of effective strategies for the responsible use of new technologies, especially in exceptional situations such as this large-scale home lockdown due to SARS-CoV-2. However, these strategies will not only be useful for exceptional moments such as lockdown, but should also help them to lead a more active life from a motor point of view. This work must be approached in a collaborative way between the different social agents involved in the education of children and adolescents, such as the family, educational centres and local sports organisations.

The problems of Spanish children and adolescents, with low levels of PA, high rates of childhood overweight and obesity, and the worrying consequences of the great lockdown in Spain, seem to be powerful arguments to focus efforts on working on these strategies and solutions.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors upon request. Requests to access the datasets should be directed to OR-Á, oliver.ramos@unican.es.

Ethics statement

The research protocol was approved by EDUCA's Ethics Committee under code 82019. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

OR-Á, VA-G, AS-R, and RN-P: conceptualisation, validation, writing—review and editing, visualisation, and supervision. OR-Á and VA-G: methodology. OR-Á: software, formal analysis, investigation, resources, data curation, writing—original draft preparation, and project administration. All authors have read and agreed to the published version of the manuscript.

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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.

The reviewer JR-F declared a past co-authorship with the author RN-P to the handling editor.

Publisher's note

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EDITED BY
Alberto Sanmiguel-Rodríguez,
Camilo José Cela University, Spain

REVIEWED BY
Marc Lochbaum,
Texas Tech University,
United States
Marcos Mecías-Calvo,
University of Santiago de Compostela,
Spain

*CORRESPONDENCE
Shan Shan Zhu
zhuss548@nenu.edu.cn

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The influencing factors of individual interest in physical education based on decision tree model: A cross-sectional study

Jia Bin Lin[1] and Shan Shan Zhu[2]*

[1]School of Physical Education, Changchun Normal University, Changchun, China, [2]School of Physical Education, Northeast Normal University, Changchun, Jilin Province, China

To identify the key influencing factors and analyze the internal relationship among the factors of individual interest in PE, we conducted a cross-sectional survey of a large sample of Chinese young students based on the decision tree model. A total of 3,640 young students (M_{age}=14.16; 7–18 years; SD=2.66, 47% boys) were investigated by using six questionnaires, including individual interest in physical PE, self-efficacy, achievement goals, expectancy value in PE, PE knowledge and skills and PE learning environment. Results showed there were a total of seven variables entered into the decision tree model, which was 3 layers high, including 38 nodes. The root node was expectancy value which was divided by sports knowledge and skills and self-efficacy. The third layer included mastery-approach goal, family sports environment, performance-avoidance goal and gender. The results depict that expectancy value of PE was the most important influencing factors of adolescent students' individual interest in PE in this study, and the other important factors were sports knowledge and skills, self-efficacy, mastery-approach goal, family sports environment, performance-avoidance goal, and gender, respectively. The implications for PE are: (1) Improve the status of the PE curriculum and enhance students' recognition of the value of PE; (2) Strengthen the teaching of knowledge and skills to avoid low-level repetitive teaching; (3) Enhance success experience and foster sports self-efficacy; and (4) Establish reasonable sports goals to foster individual interest in sports learning.

KEYWORDS

adolescents, individual interest, influencing factors, decision tree, physical education

Introduction

To actively engage with and persist on a learning task, students need to be sufficiently motivated (Rotgans and Schmidt, 2017). Renninger and Hidi (2016) regarded interest as a powerful motivator variable that directs students' attention to specific objects and stimuli and guides their engagement towards specific activities. In educational research, researchers conceptualized interest as situational and individual (Chen and Darst, 2002). Situational

interest is a relatively transient reaction to highly stimulating factors in the immediate environment, whereas individual interest is a relatively long-term preference for a particular subject or activity (Palmer et al., 2017).

In physical education (PE), systematic research on interest has mainly investigated SI and evidence has been accumulated regarding its sources, motivational function, and relationship with learning (Chen and Wang, 2017). Researchers concluded that individual interest has an important effect on performance and cognitive functioning, as students who are interested in a domain or task have been shown to pay more attention, persist for longer periods of time, and acquire more and qualitatively different knowledge than individuals without such an interest (Hidi, 1990; Palmer et al., 2017). Despite the role of individual interest has been general accepted, it has been subjected to limited empirical testing in educational settings (Chen and Wang, 2017).

Given that the most recent global estimates show that more than three-quarters (81%) of adolescents do not meet the recommendations for aerobic exercise, as outlined in the 2010 Global Recommendations on Physical Activity for Health (Bull et al., 2020). More than about 60% of children and adolescents do not meet the recommended amount (Zhu, 2021). In the face of the problem of declining physical health and insufficient participation in physical activity among teenagers around the world, it is particularly important to deeply explore the influencing factors of individual interest. However, the influencing factors of individual interest in PE have rarely been studied. Consequently, it is not clear that to what extent each influencing factor will facilitate or hinder the development of individual interest in PE. And there is a lack of targeted strategies on how to improve students' individual interest in PE in different situations, which makes it difficult to explain and improve the reality of low individual interest in PE among young people in China.

Research showed that the decision tree model analysis method could not only obtain a more intuitive relationship diagram between various influencing factors, but also identify the most critical influencing factors of individual interest in PE, construct a clearer classification standard, and dig deeper into the role of each factor (Henrard et al., 2015; Zhao et al., 2020). This method has an in-depth theoretical basis and more targeted practical guidance significance for cultivating individual interest in youth sports participation. Therefore, in view of the practical background of low individual interest in youth sports and lack of targeted promotion strategies, this study adopted decision tree model analysis methods to analyze 3,640 people based on comprehensive consideration of ethical issues (voluntary rights, the right to know, and privacy protection, etc.). A survey of young students aged 7–18 was carried out to reveal the key factors influencing young students' individual interest in PE and the relationship among the factors, and to further explore the implications of the research results on the promotion of individual interest in young students, aiming to provide a useful reference for improving youth sports learning individual interest.

Social cognitive theory and individual interest

Bandura (1986) first proposed the social cognitive theory, then the theory was widely applied and carried out a large number of empirical studies. Social cognitive theory is widely used by researchers to analyze the influencing factors of individual behavior (Sumak et al., 2011; Zhou et al., 2020). This theory analyzes the influencing factors of individual behavior in detail and holds that the generation or change of individual behavior is not only affected by external environmental factors, but also influenced by their own internal psychological factors (Bandura, 1986; Li and Hua, 2022). The social cognitive theory explains human behavior using a three-way model in which environment, personal factors, and behavior interact continuously (Shamizadeh et al., 2019; Sebastian et al., 2021), and emphasize the role of self-efficacy, expectancy-value, achievement goals, knowledge and other factors.

The relationship between environment factors and interest

Traditional behavioral theory points out that individual behavior depends entirely on external environmental stimuli, despite being greatly questioned and criticized, the role of the environment cannot be ignored. From the perspective of space, environmental factors include three aspects: family environment, school environment, and social environment. Results showed that parents impacted the trajectory of participants' athletic careers and their general approach toward sport (Erickson et al., 2017). The local environment can affect an individual's interest, and the space available for sports, the distance to facilities, and quality of the equipment all naturally impact willingness to participate (Gomes et al., 2016). Participants who lived in rural settings were less interested in recreational sports than their urban counterparts (Chen et al., 2017). Existing evidence suggests that the influence of environmental factors on interest is mediated or modulated by other variables, such as self-efficacy (Halim et al., 2021), and the action effect of environmental factors still needs further research.

The relationship between expectancy-value and interest

Motivated behavior is characterized by voluntary choices, persistent effort, and achievement, which are directly associated with students' expectancy for success and perceived value in specific activities (Chen et al., 2008). The expectancy-value theory argued that students' expectancy-value motivation directly predicts their achievement and behavior choices, and that student achievement over time predicts their behavior choices (Eccles et al., 1983; Eccles and Wigfield, 1995).

Expectancy belief and task values have been identified as predictors for both physical activity participation intention (Xiang et al., 2003) and successful performances in physical education (Gao et al., 2009). Findings in other areas have shown that task value (Bai et al., 2020) and utility value (Hulleman et al., 2010; Akcaoglu et al., 2018) and interest are closely related.

The relationship between self-efficacy and interest

Self-efficacy is a positively focused ability belief that describes a person's perception of his ability to successfully complete a specific task (Bandura, 1977). It was found to be as important as value in educational settings and was an important predictor of achievement (Fryer and Ainley, 2019; Nuutila et al., 2021). While the majority of self-efficacy research focused on task-level outcomes, Bandura (2011) has clarified that self-efficacy are also related to long-term pursuits such as skill development have developed over time and are not limited to individual events. Increasing empirical evidence supports the important role of self-efficacy in benefits, with long-standing theories suggesting that the two are interconnected over time (Fryer and Ainley, 2019; Nuutila et al., 2020).

The relationship between achievement goals and individual interest

Researchers have identified two types of achievement goals that students adopt: mastery and performance goals (Nicholls, 1984; Dweck, 1986). Further studies subdivided these achievement goals into approach and avoidance components, presented four categories: mastery-approach goal, performance-approach goal, mastery-avoidance goal, and performance-avoidance goal (Elliot and McGregor, 2001). Numerous studies found a positive correlation between mastery-approach goal and individual interest, but the relationship between performance-approach goals and individual interest is still unclear (Hulleman et al., 2010; Linnenbrink-Garcia et al., 2013). Roure et al. (2021) found that the positive correlations between both mastery-approach and performance-approach and individual interest, and confirmed the key role played by students' mastery-approach goal when considering its relationship with students' individual interest (Roure and Lentillon-Kaestner, 2021). The meta-analysis results show that, relative to performance-approach and performance-avoidance goals and no-goals, induced mastery-approach goals enhanced performance (Huang, 2011, 2012), but not motivation (Noordzij et al., 2021). Overall, more research is needed to clearly understand the relationship between students' achievement goals and their individual interest.

The relationship between knowledge, skills and interest

Reviews have consistently pointed that prior knowledge is one of the most important individual difference brought to the learning experience (Lin and Chai, 2019; Fryer et al., 2021). Prior knowledge can account for 30–60% of the variance in future learning (Tobias, 1994). Knowledge refers to one's understanding of a given domain in either a declarative (factual) or procedural (skillful execution) form (Alexander et al., 1991). A majority of studies showed that the relationship between interest and knowledge may be two-way, students with high individual interest in a field are likely to continue to acquire additional knowledge in that field as they are naturally drawn to the subject and are willing to spend more time and effort to learn more about the subject (Tobias, 1994). And in return, increased knowledge is likely to strengthen the interest, because the expanded knowledge affords the individual to extend the knowledge base on which interest is developed and sustained. Prior knowledge determines interest in learning in physical education (Zhang et al., 2016), interest is a by-product of knowledge (Rotgans and Schmidt, 2017).

The present study

Based on previous research, the purpose of this study was to explore the influencing factors of individual interest in PE from three aspects: demographic factors, environmental factors, and individual factors. Variables investigated include gender, school location, sports environment, expectancy value, sports knowledge and skills, self-efficacy, and achievement goals. As Henrard et al. (2015) argued, the decision tree model was an important classification technique in data mining, and optimal segmentation for multiple types of variables was an important function of this method. Therefore, this study chose the decision tree model as the main method to analyze the importance and internal relationship of each influencing factor. These analyses have theoretical implications for how individual interest develops across the PE learning process, and they are of practical concern to educators seeking to enhance students' individual interest and sports participation independently.

Materials and methods

Participants

The present study sample consisted of 3,640 students (M_{age} = 14.16; 7–18 years; SD = 2.66, 47% boys) from 110 PE classes, taken from 11 cities located in the Northeast, East, Central, and West regions of China. Students were in grades 1–12. Class sizes ranged from 20 to 65 students per class. Permission to conduct the study was granted by the ethical board of the host

university, and agreement was also obtained from the principals of the participating schools.

Materials

Individual interest

The Chinese Individual Interest Scale in PE (Lin, 2019) was used to measure students' individual interest. As Rotgans (2015) argued, the instrument of individual interest should measure at least the following three key components of the definition: (a) willingness to reengage with specific content, (b) positive emotions, and (c) increased value for the topic. Take willingness to participate (e.g., 'I often take part in sports activities in my spare time'), emotional experience (e.g., 'Participating in sports activities brings me a lot of fun') and value embodiment (e.g., 'I want to work in sports or sports-related industries in the future') as three dimensions to compile the questionnaire of individual interest in PE. Each of these three dimensions consists of three items. These nine items were randomly arranged and each was rated on a five-point Likert scale, ranging from 1 = 'strongly disagree' to 5 = 'strongly agree'. Lin (2019) established the construct validity of the Chinese Individual Interest Scale in PE using exploratory and confirmatory factor analyses (χ^2/df = normed fit index (NFI) = 0.97, comparative fit index (CFI) = 0.99, Tacker-Lewis index (TLI) = 0.98, incremental fit index (IFI) = 0.99, and root mean squared error of approximation (RMSEA) = 0.045). The internal consistency (Cronbach's alpha) and test–retest reliability factor for willingness to participate (0.81, 0.87), emotional experience (0.86, 0.84), value embodiment (0.73, 0.82) and for the total scale (0.90, 0.85) among the grade 1–12 school students.

Environment factors for PE

Investigate the sports learning environment from three aspects: school sports environment (including school sports facilities, equipment, PE teachers, sports activities and sports curriculum development, etc.; e.g., 'How is your school's sports facilities?'), family sports environment (including family sports equipment, parents' support, family sports atmosphere, etc.; e.g., What is the atmosphere of your family sports activities?') and social sports environment (including social sports venues, social sports activities and clubs, etc.; e.g., How about the surrounding sports clubs and activity centers?'). The questionnaire consists of 16 randomly arranged items, and each was rated on a five-point Likert scale, ranging from 1 = 'very bad' to 5 = 'very good'. The construct validity of the questionnaire was established by means of exploratory and confirmatory factor analysis (Byrne, 2001), $\chi^2/df = 1.592$, NFI = 0.94, CFI = 0.98, TLI = 0.97, ILI = 0.98, RMSEA = 0.048. The internal consistency (Cronbach's alpha) and test–retest reliability factor for school sports environment (0.90, 0.92), family sports environment (0.86, 0.91), social sports environment (0.83, 0.88) and for the total scale (0.93, 0.90).

Expectancy-value

Students' expectancy beliefs and task values were measured using a modified Chinese Expectancy-Value Questionnaire for PE (Eccles and Wigfield, 1995; Chai and Lin, 2019). The questionnaire is a 5-point Likert scale of 11 items. Five items were designed to measure expectancy beliefs and six items to measure attainment (importance), intrinsic (interest), and utility (usefulness) values. In completing the questionnaire, students were asked to respond to the items by indicating their preference on the five-point scale attached to each item. For example, in responding to the item "How important do you think PE is for you?" the student can choose a number between 1 and 5, with 5 indicating "very important" and 1 indicating "not important." The descriptors "very important" and "not important" are printed explicitly on the EVQ to avoid confusion (Zhu et al., 2012). Chai and Lin (2019) confirmed its construct validity by means of confirmatory factor analysis and found that the measurement model of Chinese EVQ was well preserved with $\chi^2/df = 2.73$, NFI = 0.99, CFI = 0.99, TLI = 0.99, ILI = 0.99, RMSEA = 0.020. The internal consistency (Cronbach's alpha) and test–retest reliability factor for expectancy beliefs (0.89, 0.88), attainment values (0.78, 0.89), intrinsic values (0.84, 0.91), utility values (0.84, 0.85) and for the total scale (0.80, 0.87).

Self-efficacy

The Generalized Self-Efficacy Scale (GSES; Schwarzer and Jerusalem, 1995) was used to measure students' self-efficacy. The questionnaire consists of 10 randomly arranged items, and each was rated on a five-point Likert scale, ranging from 1 = 'strongly disagree' to 5 = 'strongly agree'. The internal consistency (Cronbach's alpha) and test–retest reliability factors in this investigation were 0.86 and 0.89.

Achievement goals

The 2 × 2 Achievement Goals Questionnaire (AFQ-PE) compiled by Guan (2004) was used to measure students' achievement goals. The scale includes four dimensions: master-approach goal, master-avoidance goal, performance-approach goal, and performance-avoidance goal. Each of these four dimensions consists of three items. These 12 items were randomly arranged and each was rated on a five-point Likert scale, ranging from 1 = 'strongly disagree' to 5 = 'strongly agree'. The internal consistency (Cronbach's alpha) and test–retest reliability factors in this investigation were 0.89 and 0.88.

Sports knowledge and skills

Use a self-reporting questionnaire to evaluate students' sports knowledge and skills. The questionnaire consists of six randomly arranged items, and each was rated on a five-point Likert scale, ranging from 1 = 'strongly disagree' to 5 = 'strongly agree'. The items are as follows: (1) 'I know more about sports knowledge than most of my classmates'; (2) 'I am familiar with many sports'; (3) 'I am familiar with many sports'; (4) 'I have many sports skills better than most of my classmates'; (5) 'At least one sports skill

I master better than most of my classmates'; (6) 'I have many sports skills better than most of my classmates'. The internal consistency (Cronbach's alpha) and test–retest reliability factors in this investigation were 0.89 and 0.91.

Procedure

Data came from a cross-sectional study investigating 7–18 year-old teenage students' individual interest in PE. Assessments were completed over two-month periods in spring 2019 and fall 2020. All questionnaires will be distributed, filled out, and collected by 11 graduate students who have undergone strict training immediately after the PE class. In order to ensure that all the students fully understand the meaning of the questions and options, the graduate students read the questions aloud to the first and second grade students in elementary school, making corresponding explanations. Then ask students to fill out the questionnaire and raise their hands whenever they encounter problems during the filling process. All in all, the testing of each child took about 20 min.

Statistical analyses

The data was analyzed using SPSS for Windows Version 22.0. Because all of the data in this study were gathered *via* questionnaires and all items were completed by young students, there may be common method bias in the research supporting this thesis (Gorrell et al., 2011; Mackenzie and Podsakoff, 2012). First, the Harman single factor test method was used to conduct common method bias. The specific method was to perform Principal Component Analysis (PCA) on all questionnaires and scale items. The results showed that there are 15 factors with a characteristic value greater than 1, and the variance explained by the first factor is 25.30%, which is less than the critical standard of 40% (Cao and Chi, 2016). The results showed that there was no serious common method bias problem in this study.

Subsequently, create a decision tree model. According to the characteristics of the large sample, multiple indicators, continuous variables, and categorical variables in this study were compared to the accuracy of each model, finally determining the optimized CHAID model for decision tree analysis (Henrard et al., 2015). Among all the variables, gender, grade, and school location were category variables. The two grades of the gender variable "male" and "female" were marked as 1 and 2 respectively, the 12 grades of grade variable "1 ~ 12" were marked as "1 ~ 12" respectively, and the variables of the city and village where the school is located were marked as 1 and 2 respectively; other variables are continuous variables, and the best cut-off point is identified and split by the decision tree model. The model parameters were set as follows: the maximum depth of the decision tree is 5, the minimum number of cases of influencing factor nodes is 200, the minimum number of cases of sub-nodes is 100, the minimum change value of the Gini coefficient is 0.0001, and the recognition accuracy rate of the 10-level cross-validation model is adopted (Cao and Chi, 2016).

The rules for ranking the importance of various factors affecting individual interest in PE are: (1) sort according to the position of the node where the variable is located, the closer the variable is to the root node, the greater the impact on the target variable; (2) At the same level of branches, we compared the value of p and Chi-square of each variable. The smaller the value of p, the greater the impact on the target variable. If the value of p is equal, compare the chi-square value; (3) At non-terminal nodes, if the sample size of the variable is less than 10, the variable is not regarded as an important one.

Result

Descriptive statistics

Table 1 shows the descriptive statistics as well as the correlation matrix between the measures of the study for the whole sample across different grade students. The results show that the correlation among each variable and between each variable and individual interest have reached a significant level ($p < 0.05$).

Construction of decision tree model

The decision tree model of the influencing factors on individual interest in PE created by this research has 3 layers and 38 leaf nodes (see Figure 1). The results showed that a total of seven variables entered the model, in order of importance. They are: (1) expectancy-value; (2) sports knowledge and skill mastery; (3) self-efficacy; (4) mastery-approach goal; (5) family sports environment; (6) performance-avoidance goal and (7) gender.

At the first layer of the decision tree structure, students' individual interest in PE was divided into 8 nodes according to "expectancy-value," and the difference between each node reached a significant level ($F = 393.07$; $p < 0.05$). The higher the students' expectancy-value, the greater their individual interest in PE. Students whose expectancy-value score ≥ 4.45 had the highest individual interest, and students whose score ≤ 2.55 had the lowest individual interest.

At the second layer of the decision tree structure, 8 nodes of students' expectancy-value in PE were divided into 20 nodes according to "sports knowledge and skills" and "self-efficacy" (see Figure 1). Students whose expectancy-value scores were ≥ 4.45 and were between 3.36 and 3.55 were divided into 3 (self-efficacy scores: < 3.57, 3.57–4.5, > 4.5; $F = 72.43$, $p < 0.05$; the node no longer grows) and 2 (self-efficacy scores: ≤ 3.10, > 3.10; $F = 58.98$, $p < 0.05$) nodes, respectively, according to their "self-efficacy." The higher the self-efficacy, the higher the expectancy-value score. In the self-efficacy score ≤ 3.10 group, there are gender differences in

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TABLE 1 Means (and SD), and intercorrelations between environment factors, expectancy-value, self-efficacy, sports knowledge and skills achievement goals and individual interest.

Variable	*M*	SD	1	2	3	4	5	6	7	8	9	10	11
1. Individual interest	3.31	0.86	1										
2. School environment factors	4.04	0.80	0.337	1									
3. Family environment factors	3.65	0.92	0.456	0.527	1								
4. Social environment factors	3.58	1.04	0.410	0.545	0.649	1							
5. Expectancy-value	3.52	0.72	0.669	0.341	0.369	0.336	1						
6. Self-efficacy	3.40	0.79	0.549	0.294	0.407	0.365	0.416	1					
7. Sports knowledge and skills	3.23	0.92	0.652	0.248	0.423	0.372	0.528	0.539	1				
8. Master-approach goal	3.74	0.96	0.596	0.426	0.386	0.353	0.525	0.491	0.507	1			
9. Master-avoidance goal	3.46	0.98	0.353	0.231	0.253	0.209	0.267	0.335	0.376	0.533	1		
10. Performance-approach goal	3.26	1.02	0.361	0.172	0.233	0.195	0.305	0.416	0.493	0.406	0.557	1	
11. Performance-avoidance goal	3.31	1.01	0.174	0.156	0.172	0.177	0.107	0.267	0.294	0.248	0.460	0.534	1

the self-efficacy scores of students, and boys' self-efficacy scores are higher than those of girls.

Students whose expectancy-value scores in the other six ranges were divided into 2 (sports knowledge and skills scores: ≤ 2.00, > 2.00, $F = 71.86$, $p < 0.05$), 2 (sports knowledge and skills scores: ≤ 2.83, > 2.83, $F = 82.04$, $p < 0.05$), 4 (sports knowledge and skills: ≤ 2.50, 2.50–2.83, 2.83–3.33, > 3.33, $F = 64.79$, $p < 0.05$), 2 (sports knowledge and skills: ≤ 2.83, > 2.83, $F = 53.65$, $p < 0.05$), 3 (sports knowledge and skills: ≤ 3.33, 3.33–4.00, > 4.00, $F = 111.07$, $p < 0.05$) and 2 (sports knowledge and skills: ≤ 3.67, > 3.67, $F = 91.11$, $p < 0.05$) nodes, respectively, according to their "sports knowledge and skills," the higher the sports knowledge and skills score of students, the higher the expectancy-value score. At the last layer of the decision tree structure, the sports knowledge and skills were divided into 8 nodes: (1) the sports knowledge and skills scores > 2.00 group were divided into 2 nodes (≤ 3.10, > 3.10, $F = 17.59$, $p < 0.05$) according to their family sports environment; (2) the scores between 2.83 and 3.33 group were divided into 2 nodes (≤ 3.47, > 3.47, $F = 14.20$, $p < 0.05$) according to their family sports environment; (3) the scores >2.83 were divided into 2 nodes (≤ 3.55, > 3.55, $F = 14.76$, $p < 0.05$) according to their performance-avoidance goal; (4) the scores ≤ 3.33 group were divided into 2 nodes (≤ 3.33, > 3.33, $F = 36.27$, $p < 0.05$) according to their mastery-approach goal. In each group, students' sports knowledge and skill scores increase with the increase of branch indicators.

Decision tree model evaluation

The accuracy recognition result of the 10-layer cross-validation model shows that the accuracy of the decision tree model of the factors affecting individual interest in PE of primary and middle school students constructed in this research was 90.88% (see Table 2).

Discussion

The purpose of the present study was to identify the key influencing factors of individual interest in PE among primary and middle school students in China. To rank the influencing factors according to their importance accurately, we selected a total of 13 variables as the influencing factors of individual interest in PE for decision tree analysis, including gender, grade, school location, school sports environment, family sports environment, social sports environment, expectancy-value, self-efficacy, sports knowledge and skills, master-approaching goal, master-avoidance goal, performance-approach goal, and performance-avoidance goal, and conducted a large sample of 3,640 students selected from 11 cities. The selected questionnaires and scales have been tested for reliability and validity and could be used as measurement tools for this study. There was no common method bias among all the questionnaires and scales.

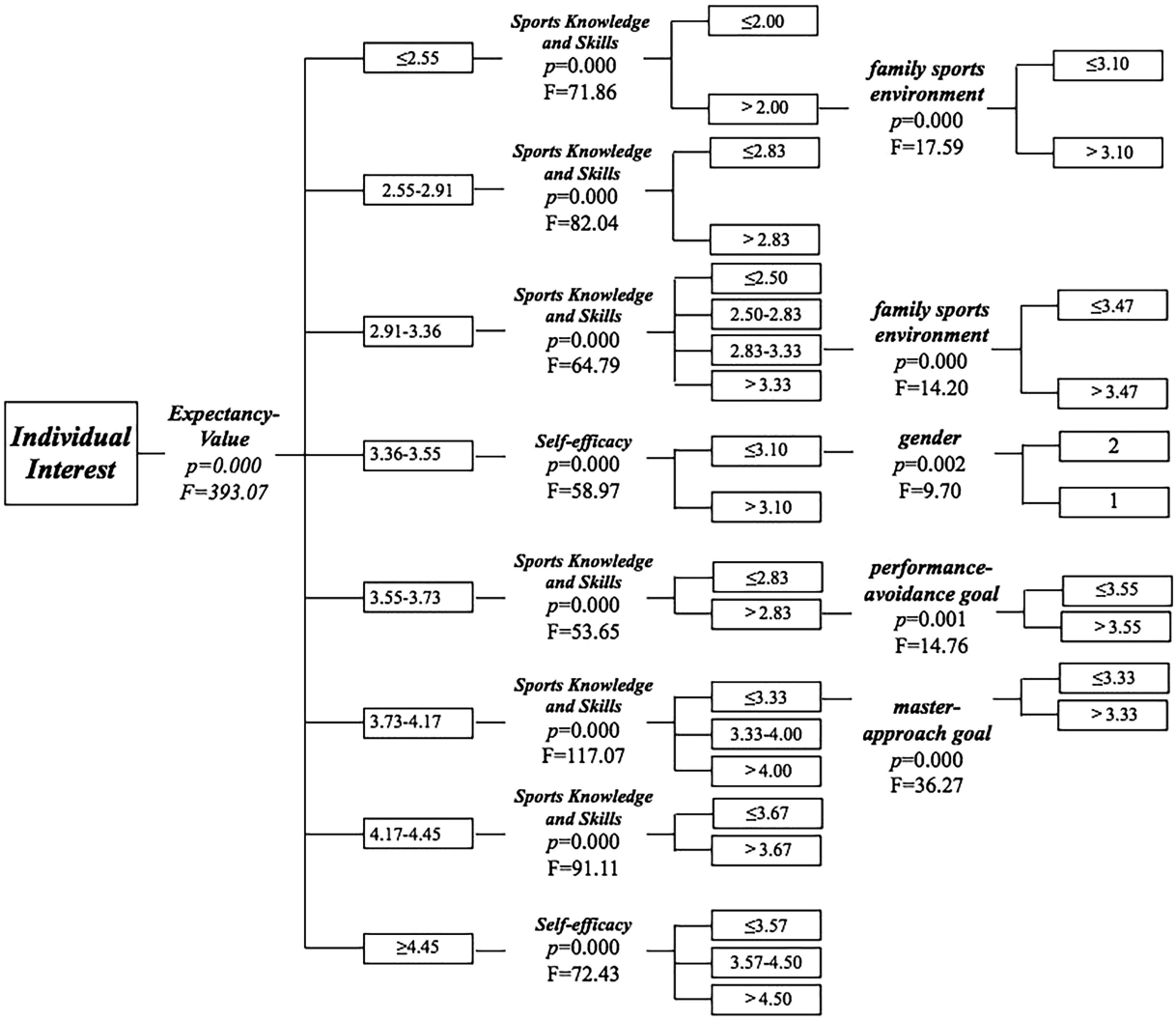

FIGURE 1
The decision tree model of the seven influencing factors, including expectancy-value, sports knowledge and skill mastery, self-efficacy, mastery-approach goal, family sports environment, performance–avoidance goal, and gender of individual interest. The asterisk indicates a statistically non-significant level of alpha. 05.

TABLE 2 Recognition accuracy rate of the model of factors affecting individual interest in PE of primary and middle school students.

	N	%
Accurate	3,380	90.88
Error	332	9.12
Total	3,640	100

The decision tree adopts a top-down recursive approach to compare and evaluate the attribute values of nodes within the decision tree and determine the branch down from the node based on the different attribute values (Zhang et al., 2020). The decision tree algorithm has been widely used in different fields since its introduction (Tao et al., 2016). Not only that, the decision tree analysis could also identify the key influencing factors of individual interest in PE of primary and middle school students in China, and make up for the shortcomings in the current research on many influencing factors of sports learning interests. Decision tree algorithm models include CHAID, C5.0, QUEST, and C&R. Combining the characteristics of the large sample, multiple indicators, and the simultaneous existence of continuous variables and categorical variables in this study, the accuracy of related models is compared, and the optimized CHAID model is selected (Zhao et al., 2020). The results show that the constructed decision tree model of the factors affecting individual interest in PE of primary and middle school students was 3 layers high, divided into 38 leaf nodes, and the decision tree model was lush and leafy. In addition, the accuracy of the model was as high as 90.88%, which is satisfactory for the needs of this research.

There was a total of seven variables entered into the decision tree model in this study. In order of importance, they

were: expectancy-value, sports knowledge and skills, self-efficacy, mastery-approach goal, family sports environment, performance-avoidance goal, and gender. Among them, except for the two variables of family sports environment and gender, the other variables are all individual factors, which is consistent with previous research conclusions (Chai and Lin, 2019). This result is in line with the ternary interactive determinism of social cognitive theory (Bandura, 1977), which argues that individual factors (expectancy value, self-efficacy, knowledge, and goals are important individual factors), environmental factors, and behavioral factors are dynamic interactions (Bandura, 1989, 2001; Chiu et al., 2007; Jeng et al., 2022).

Previous studies have suggested that expectancy beliefs and perceived task values, a source of situational interest, were positively related to after-school physical activity (Chen et al., 2014). In this study, expectancy value was located at the root node of the individual interest decision tree model, indicating that it was the most important factor affecting individual interest. Eccles et al. (1983) argues that students' learning interest stems from their expectancy beliefs and the value of the task, collectively referred to as "expectancy value." Expectancy beliefs are students' perceptions of the possibility of success in the upcoming learning task, and task value, including achievement value, intrinsic value, utility value, and cost, is the student's perception of the value of the learning task. Previous studies have suggested that expectancy is positively associated with interest (Xu et al., 2020), and task expectancy motivation could predict students' future interest in math at the individual and class level (Ruiz-Alfonso et al., 2021). This also appeared to be the case in the present study. Not only that, this research further proved that expectancy value was the most important influencing factor of individual interest in PE among all the factors of social cognition theory investigated in this study. It is not difficult to find that the current reality of the implementation of the physical education curriculum in primary and secondary schools in China makes it difficult to improve the life expectancy value of students: (1) Poor attendance rate of PE courses, according to the survey conducted by the State Sports General Administration (2014), 53.9% of the fourth graders have less than three sessions of PE per week, the serious over-standards of Chinese, mathematics, physics, and other courses were in sharp contrast with this; (2) Poor PE teachers' team. The number of full-time PE teachers is seriously insufficient, and part-time PE teachers account for a large proportion. And these teachers mostly adopt the "shepherd type," which makes it difficult to satisfy the students' interest in classroom sports (Mao et al., 2019); (3) Playground and ground equipment need to be further improved. All kinds of phenomena reveal that the attention paid to the PE curriculum of primary and middle school students in China is not up to standard, and still needs to be improved. Therefore, we appeal to improving students' expectancy value of PE by enhancing the attention of PE curriculum, teachers' literature, and teaching environment, so as to improve students' individual interest.

The relationship between knowledge and interest has always received widespread attention. Almost all researchers take interest as an independent variable and individual interest as a dependent variable, believing that interest is the reason for acquiring knowledge (Schraw and Lehman, 2001, 2009; Tomlinson et al., 2003). Rotgans and Schmidt (2017) examined the causal relationship between students' individual interest and knowledge acquisition using cross-lagged panel analysis; results showed that individual interest was not the cause but the consequence of the process of learning: individual interest as an affective by-product of learning. In this study, there were 6 groups of students' expectancy values classified according to their sports knowledge and skills. According to the findings, sports knowledge and skills were the second most important influencing factor of individual PE interests. At present, the phenomenon of low-level repetitive teaching in the PE curriculum is more common in China. After years of study, students still cannot master one or two sports skills proficiently, let alone form a stable individual interest (Mao et al., 2019). Therefore, we argue that while using novel teaching activities to stimulate students' situational interest, we should also teach students some sports knowledge and skills to cultivate their individual interest, which is obvious, but often overlooked.

At the second level of the decision tree structure, there were 2 groups of students' expectancy values classified according to their self-efficacy. The results showed that students' self-efficacy was the third important influencing factor of individual interest in PE. The results of previous studies show that individual interest and self-efficacy are positively correlated (Armstrong et al., 2009). This growing body of empirical evidence supporting the important role of self-efficacy within an interest is buttressed by long-standing theory suggesting that the two are reciprocally linked over time (Fryer et al., 2016, 2019; Nuutila et al., 2020, 2021). Fryer et al. (2021) used the potential curve to analyze the role of self-efficacy between knowledge development and individual interest, which lends further support to the critical role played by self-efficacy beliefs within the development not only of knowledge but also of individual interest as a learning outcome. The role of self-efficacy in determining individual interest has been confirmed by a large number of research results. The emotional experience of sports participation, especially a successful experience, is helpful to the establishment of self-efficacy. Therefore, we appeal to strive to enable each student to obtain successful experiences in the process of sports participation and cultivate their sports confidence so as to obtain a long-term and stable individual interest in PE.

There are five branches in the third layer of the decision tree model, and master-approaching goal is the most important variable in this layer, followed by the family sports environment, performance-avoidance goal, and gender. The research of Harackiewicz et al. (2000, 2008) showed that achievement goals can predict students' interest and academic achievement in the short term or long term. Among them, mastering goals can effectively predict students' interest, but there was no predictive effect on academic achievement; on the contrary, achievement goals can effectively predict students' academic performance, but

they cannot predict their learning interest. This research examines the influence of achievement goals on individual interest from four aspects: performance-approach goal, performance-avoidance goal, master-approach goal, and master-avoidance goal. The results showed that master-approach goal and performance-avoidance goal could predict students' individual interest in PE, and the effort of the master-approach goal was better than the performance-avoidance goal.

In addition, family sports environment and gender have also entered the decision tree model of students' individual interest in PE, but school sports environment, social sports environment, grade, and school location did not correspondingly. The results of this study confirmed the important role of the family sports environment in the development of students' individual interest in PE once again. Knight et al. (2016) identified a number of individual and environmental influences on parental involvement in youth sports, and the results showed that parents were involved as supporters, coaches and managers, and providers of opportunities. Parents' past experiences in sports and as a sport parent, their beliefs, goals, and values, the youth sport context, their concerns regarding others, and their own behavior can affect youth sports. Erickson et al. (2017) used a qualitative methodology to explore the role of significant others in this domain, and the results showed that the parent-athlete relationship influenced athletes' lives in and beyond sport and could shape athletes' attitudes, experiences, and behaviors toward doping. Parents are the most important part of the family sports environment for primary and middle school students, so we call on all children's parents to pay attention to their attitudes towards sports activities and establish a positive family sports environment for their children. At the same time, we have also discovered the weak role of gender in the decision tree model of individual interest influencing factors. This is consistent with the results of previous research and is a current development trend of Chinese students' individual interest in PE (Lin, 2019).

Conclusions, limitations and future directions

The current study investigates the factors affecting individual interest of primary and secondary school students based on social cognitive theory and ranks multiple influencing factors in order of importance using decision tree model analysis. It has been demonstrated that the most important factor influencing individual interest in PE is expectancy value, which is followed by sports knowledge and skills, self-efficacy, mastery-approach goal, family sports environment, performance-avoidance goal, and gender. The implications for PE are: (1) improve the status of the PE curriculum and enhance students' recognition of the value of PE; (2) strengthen the teaching of knowledge and skills to avoid low-level repetitive teaching; (3) improve success experience and cultivate sports self-efficacy; and (4) set reasonable sports goals to cultivate individual interest in sports learning.

This study adopted a large sample method to collect a total of 3,640 primary school students nationwide, but for China, with a population of 1.3 billion, the sample size was still slightly insufficient. In addition, this study did not analyze the differences in factors affecting students' individual interests in PE according to different grades or stages of learning. Future work might further expand the sample size to make the sampling more representative, and it might also analyze the differences in students' individual interests in stages.

The second limitation lies in the lack of data; data consisted solely of self-reported measures, and all questionnaires and scales were filled out by student groups. However, we focused on students' subjective motivational perceptions of individual interest, and self-report was the rule rather than the exception. Nonetheless, we recognize the methodological problems that are likely to occur when relying exclusively on self-reported measures (Knogler et al., 2015). Self-reported data potentially suffers from inaccuracy, especially at earlier stages of interest development, when people may lack meta-cognitive awareness of their interest (Renninger and Su, 2012). Therefore, we encourage future work to use multiple sources of information, and to further determine the importance of influencing factors on individual interest in PE.

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 Changchun Normal University work place. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

JL: conceptualization, methodology, software, investigation, formal analysis, and writing—original draft. SZ: data curation and writing—original draft. All authors contributed to the article and approved the submitted 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.

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Alberto Sanmiguel-Rodríguez,
Camilo José Cela University, Spain

REVIEWED BY
María Luisa Zagalaz-Sánchez,
University of Jaén, Spain
José Luis García Soidán,
University of Vigo, Spain

*CORRESPONDENCE
Xiao Fang Qian
869456868@qq.com

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Weight self-stigma and engagement among obese students in a physical education class

Bao Gen Zhang[1] and Xiao Fang Qian[2]*

[1]School of Physical Education and Health, Zhao Qing University, Zhao Qing, China, [2]Department of Physical Education, School of Humanities, Zhao Qing Medical College, Zhao Qing, China

Background: This is a cross-sectional in design. It involves the mediating effects of basic psychological need satisfaction in relation to the moderating effects of teacher autonomy support regarding weight self-stigma's effect on engagement among obese students in physical education classes.

Methods: This study includes 165 Chinese high school obese students [mean age, 16.84 (±0.147) years], comprising 93 males (56.63%) and 72 females (43.63%), with a mean body mass index (BMI) of 30.453 (SD = 2.426). Participants completed the weight self-stigma questionnaire, basic psychological need satisfaction questionnaire, teacher autonomy support questionnaire, and student engagement questionnaire.

Results: Weight self-stigma and engagement among obese students were mediated by basic psychological need satisfaction. Moreover, the mediated effect of basic psychological need satisfaction was moderated by teacher autonomy support.

Conclusion: Weight self-stigma and basic psychological need satisfaction are the antecedents influencing the engagement of obese students. Notably, weight self-stigma not only directly blocks the engagement of obese students but also their engagement by hindering the acquisition of basic psychological need satisfaction. Teacher autonomy support can significantly reduce the negative impact of weight self-stigma on basic psychological need satisfaction and significantly promote engagement. Therefore, by promoting their physical education engagement, physical education teachers should strengthen the application of their supportive autonomous teaching strategies to help obese students meet their basic psychological needs.

KEYWORDS

student engagement, obesity, weight self-stigma, self-determination theory, physical education

Introduction

In China, obesity rates have steadily increased in recent decades and are now a significant public health problem (Wang et al., 2007). Obesity has a tremendous impact on the health of adults, children, and adolescents (Jakab et al., 2020). It has many serious consequences, including some types of cancer (Altová, 2022), eating disorders (Bristow et al., 2022), cardiovascular diseases, type 2 diabetes (Stevens et al., 2012), thyroid dysfunction (Mahdavi et al., 2021), high blood pressure (Pileggi et al., 2021),

depression, and anxiety (Werner-Seidler et al., 2017). Therefore, to reduce the negative effects of obesity, a series of interventions were made: exercise (Lee, 2021) through lifestyle, environmental, behavioral, pharmacologic, or surgical interventions (Aceves-Martins et al., 2022). Furthermore, moderate physical activity is one of the best tools to alleviate the complications associated with obesity (Apovian et al., 2015). China's education system relies almost entirely on test scores to evaluate its progress, which leads to more reading, examinations, and/or homework for Chinese children and less time for physical activities (Yu et al., 2012). Thus, physical education classes can be an ideal context to encourage the acquisition of healthy lifestyles throughout a student's life development (Langford et al., 2015). As a matter of fact, it has become the primary method by which students engage in physical exercise. Despite this, some studies show that the participation of obese students in physical education is not high, leading to a lack of physical activity during class.

Student engagement is a three-dimensional concept involving behavioral, emotional, and cognitive engagement (Fredricks et al., 2004). Behavioral engagement includes effort, exertion, and persistence, as well as activities such as answering the teacher's questions, actively engaging in various exercises, and carefully listening to the teacher (Skinner et al., 2008). Emotional engagement involves students' relationship with their teachers and peers, whether they view physical education as enjoyable or like it (Asogwa et al., 2020). Finally, cognitive engagement refers to an investment in learning that requires motivation, strategic learning skills, and problem-solving abilities (Fredricks et al., 2004). Student engagement has emerged as an essential construct in predicting self-esteem, happiness, and performance (Skinner et al., 2008). As such, student engagement is an essential prerequisite for students to engage in physical activities. In particular, without student engagement, there is no physical activity level; thus, the effect of physical and mental health promotion in physical education teaching is difficult to achieve without a physical activity level. However, obese students are less likely to flourish and be academically engaged than their healthier peers with a normal weight (Mccoy and Rupp, 2021). Research shows that low engagement among obese students is strongly associated with weight self-stigma. Specifically, weight stigma can be defined as the experience of verbal or physical abuse resulting from being overweight or obese (Wu and Berry, 2018). Obese students are stigmatized by their teachers, peers, and even family members, which can have detrimental physiological and psychological consequences (Stojadinovic et al., 2018). They are usually thought of as unmotivated, physically unattractive, stupid, or lacking willpower and discipline with regard to their body weight (Li and Rukavina, 2009). Studies show that obese students who are teased during physical activities prefer isolated, sedentary activities (Hayden-Wade et al., 2005), enjoy sports less, and engage in less physical activity than their peers (Storch et al., 2007). Unfortunately, obese students tend to internalize these stigmas and biases (Durso and Latner, 2008; Lillis et al., 2010; Alberga et al., 2016). Subsequently, this internalization of weight stigma causes children and adolescents to self-stigmatize themselves, exhibit negative emotional reactions, and discriminate against themselves (Corrigan et al., 2006), thereby increasing their risk of being socially undervalued and/or rejected (Puhl and Heuer, 2009). In fact, those who suffer from weight self-stigma have negative beliefs about themselves, experience negative feelings, and isolate themselves as a result (Hilbert et al., 2015). If other students withdraw their social support, exclude them, and discriminate against obese students, these behaviors negatively affect their physical and mental health and hinder study engagement. They will lead to frustration, demotivation, and further withdrawal from athletic activity, and the joy of movement will be lost (Pont et al., 2017).

The essential features of the physical education teaching process are interpersonal interactions. However, few studies explore the relationship between self-stigma and engagement among obese students in physical education classes, especially those involving obese Chinese students. Accordingly, based on the above research, this study's first hypothesis (Hypothesis 1) is put forward: Weight stigma negatively affects engagement among obese students in physical education classes.

A study found a positive association between weight stigma and less engagement in current exercise behavior (Vartanian and Shaprow, 2008). At the same time, stigma also entails psychosocial effects such as social isolation and feelings of rejection (Jung and Luck-Sikorski, 2019). Several studies have examined the relationship between weight stigma and engagement through the lens of self-determination theory (SDT). Notably, SDT is a motivation theory about human social situations that emphasizes three fundamental needs that must be fulfilled: autonomy, competence, and relatedness needs for optimal motivational functioning to occur along with subsequent positive outcomes (Ryan and Deci, 2000). Autonomy can be defined as one's need to experience a sense of willingness in one's actions, without pressure from other people, which can be expressed as one's need to feel like the originator and not the pawn of their behaviors; competence refers to an individual's perception of their own need to experience effectiveness in their interactions to accomplish certain tasks, and relatedness is defined as the extent to which one is connected and accepted by significant others (Rm Ryan, 2017). A social situation has the dual effect of meeting basic psychological needs. SDT argues that the more students' basic psychological needs are met, the more autonomous they become (Maldonado et al., 2019). In contrast, when individuals' basic psychological needs are not met (or partially met), they feel controlled and have more extrinsic motivation. As such, autonomous motivation is associated with more desirable engagement (Taylor et al., 2010), but extrinsic motivation is associated with higher

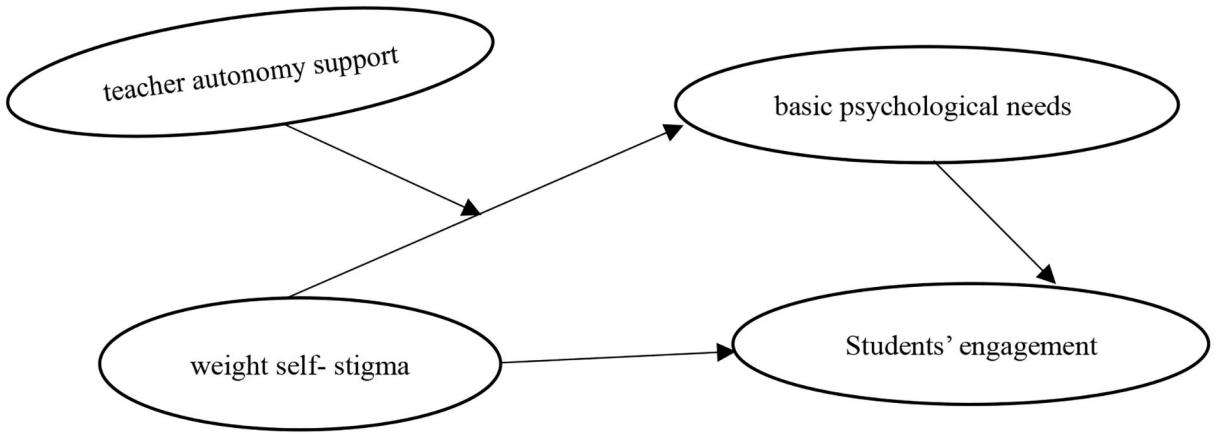

FIGURE 1
The hypothesized model.

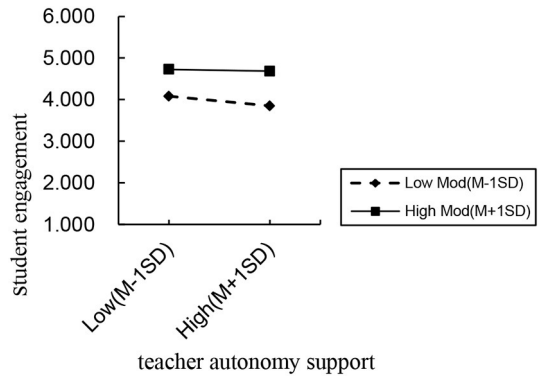

FIGURE 2
Simple slope analysis.

frustration levels with autonomy, competence, and relatedness needs (Haerens et al., 2015; Jang et al., 2016). These findings are consistent with SDT's basic hypothesis, which postulates that basic psychological needs are intermediary during social situations affecting individual behavior. Thus, it is safe to say that stigmatization is a negative social situation that is not conducive to meeting basic psychological needs and consequently hinders individual engagement. A study with bariatric patients revealed that participants who experienced stigmatization experienced a thwarting of their basic psychological needs for autonomy, competence, and relatedness (Megías et al., 2018). This is associated with a lack of commitment, quitting activity, and adopting negative behaviors (Standage et al., 2005). Based on the above, this study's second hypothesis (Hypothesis 2) is presented: Weight self-stigma affects engagement among obese students in physical education classes through the mediating effect of basic psychological needs.

The goal of the physical education teaching process is to get students to improve their interpersonal interactions. These interpersonal interactions mostly include teachers and students. At the same time, the obese student's perceived stigma mainly comes from teachers and peers. Relevant research shows that teachers' supportive teaching strategies not only reduce the perception of stigma among obese students but also compensate for the basic psychological needs and frustrations caused by the lack of peer support (Wentzel and Asher, 1995). In physical education classes, teacher autonomy support is one of the aspects of teachers' supportive teaching strategies, which includes nurturing their inner motivational resources by respecting students' attitudes and suggestions, recognizing students' feelings, providing students with opportunities for choice, displaying patience to allow students the time they need for self-paced learning to occur (Reeve, 2009). Some studies based on SDT have demonstrated that teacher autonomy support can meet students' basic psychological needs (Fin et al., 2019; Leyton-Román et al., 2020), which is associated with a higher level of self-determined motivation and engagement in physical education classes (Valero-Valenzuela et al., 2021). Therefore, our third hypothesis (Hypothesis 3) is proposed: The association between weight self-stigma and basic psychological needs is moderated by the level of perceived teacher autonomy support.

Broadly, to investigate the relationship between weight self-stigma and engagement among obese students in a physical education class, we built a moderated mediation model (Figure 1) and verified the following three hypotheses: (1) weight self-stigma negatively affects engagement among obese students in physical education class; (2) weight self-stigma affects engagement among obese students in a physical education class through the mediating effect of basic psychological needs;

TABLE 1 Basic information on obese students ($n = 165$).

	Senior one		Senior two		Senior three		Males		Females	
	n	*N* (%)	*N*	*N* (%)	*n*	*N* (%)	*n*	*N* (%)	*n*	*N* (%)
	61	36.96%	56	33.94%	48	29.09%	93	56.36%	72	43.63%
Age	15.14 ± 0.110		16.22 ± 0.175		17.19 ± 0.124		15.87 ± 0.776		15.91 ± 0.792	
BMI	29.221 ± 2.216		30.137 ± 2.394		30.341 ± 2.361		29.629 ± 1.350		31.199 ± 2.618	

and (3) the association between weight self-stigma and basic psychological needs is moderated by the level of perceived teacher autonomy support.

Materials and methods

Participants and procedures

Eight administrative districts in Shanghai were randomly selected as the survey areas. Six high schools were randomly selected from each administrative region, and a total of 48 schools were investigated. Each investigated school randomly selected a class called Senior One, Senior Two, and Senior Three. A total of 144 classes were surveyed, from which 2,583 students completed the questionnaire online. After screening invalid questionnaires for reasons such as missing data and non-conforming responses, a total of 2,217 valid questionnaires were finally retained. Among those 2,217 valid questionnaires, 165 students were defined as obese. Because their BMI was >28 (China, 2004), these 165 particularly obese students eventually became the research target of this study. Shanghai is an economically developed metropolis. All those obese students came from the city.

Table 1 presents the data of 165 obese students, comprising 93 males (56.63%) and 72 females (43.63%). Of them, 61 (36.96%), 56 (33.94%), and 48 (29.09%) were seniors, one, two, and three students, respectively, with a mean BMI of 30.453 (SD = 2.426), ranging from 28 to 39.12.

Ethical approval was obtained from the Ethics Committee of Zhao Qing University. This approval was administered through each district's education department, which then contacted each school. We asked for permission *via* informed consent, which the headmaster of each school signed before we collected the data. In addition, we also obtained signed informed consent from the student's parents. Subsequently, we trained the principals of physical education teaching at each school, who were then responsible for the questionnaire survey of their school. The training was intended to explain to the students that the questionnaire survey would only be used for the paper research work and that there were no right or wrong answers. Finally, the students were required to answer truthfully, and they had the right to choose whether to answer or not.

Measures

Weight stigma questionnaire

This study used the Chinese version of the Weight Self-Stigma Questionnaire (C-WSSQ) to assess stigma (Lin and Lee, 2017). The questionnaire included two dimensions in its assessment and comprised 12 items, which were scored on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Example items from the 12-item scale included "I feel guilty about my obesity" and "Because of my obesity, others think I lack self-control." In the present study, Cronbach's alpha was 0.927, and the split-half coefficient was 0.933.

Basic psychological need satisfaction in the physical education class

Psychological need satisfaction was measured using the Chinese version of the basic psychological needs in the physical education scale (Zhang Bao Gen, 2020). This 12-item scale assessed three dimensions: autonomy satisfaction ("I feel that the way classes are taught is a true expression of who I am"), competence satisfaction ("I feel that I improve even in the tasks considered difficult by most of the children"), and relatedness satisfaction ("My relationships with my classmates are very friendly"). Participants responded to items from 1 (strongly disagree) to 5 (strongly agree). In the present study, Cronbach's alpha was 0.936, and the split-half coefficient was 0.919.

Teacher autonomy and support in the physical education class

A teacher autonomy support scale was used to measure teacher autonomy support (Reeve et al., 2003). Example items from the 7-item scale include "My PE teacher allows me to choose between different exercises" and "My PE teacher answers me when I express my opinion." In the present study, the autonomy teacher support scale's Cronbach's alpha was 0.928, and the split-half coefficient was 0.925.

Student engagement

Student engagement was measured using the student engagement scale in physical education (Agbuga, 2015), which

TABLE 2 Confirmatory factor analysis of the whole set of measurement tools.

Variable	Confirmatory factor analysis							
	x^2/df	GFI	NFI	IFI	RFI	CFI	RMSEA	SRMR
Measurement tool	4.142	0.943	0.939	0.939	0.948	0.952	0.063	0.047

TABLE 3 Mean, standard deviation, and correlation coefficient of each variable.

	M ± SD	Range	1	2	3	4
1. Weight self-stigma	2.790 ± 0.882	1–5	1			
2. Basic psychological needs	4.338 ± 0.646	1–5	−0.237**	1		
3. Teacher autonomy support	4.355 ± 0.682	1–5	−0.220**	0.614**	1	
4. Student engagement	4.483 ± 0.635	1–5	−0.327**	0.675**	0.541**	1

** Significant correlation at the 0.01 level (Two-tailed test), $p < 0.01$.

had been validated among Chinese students (Zhang Bao Gen, 2020). This 13-item scale assessed three dimensions: behavioral engagement ("I try hard to do well in class."), emotional engagement ("When I am in class, I feel good"), and cognitive engagement ("I ask myself questions while practicing to monitor my performance"). Participants responded to items from 1 (strongly disagree) to 5 (strongly agree). In the present study, Cronbach's alpha was 0.917, and the split-half coefficient was 0.921.

A confirmatory factor analysis was conducted to test the validity of the whole set of measurement tools, which is composed of four sub-measurement tools (Table 2). The scale's structural validity was adequate [$x^2/df = 4.142$, goodness-of-fit index (GFI) = 0.943, normed fit index (NFI) = 0.939, incremental fit index (IFI) = 0.948, comparative fit index (CFI) = 0.951, root mean square error of approximation (RMSEA) = 0.063, and standardized root mean square residual (SRMR) = 0.047]. The scale's structural validity was adequate (Hu and Bentler, 1999).

Statistical analyses

Regarding statistical software, SPSS software (version 25.0) was used for correlations and descriptive statistics. The PROCESS for SPSS was used for mediation analyses, and the structural equation model was used to test the fit of the mediation path model.

Control and inspection of common method variance

Notably, only self-reported data were collected, which could have a common bias (Podsakoff et al., 2003). In order to reduce common bias, some necessary controls were carried out, such as using reverse expressions for some items. Harman's single-factor analysis was used to include weight self-stigma, basic psychological needs, teacher autonomy support, and student engagement items in the exploratory factor analysis. In the principal component analysis without a varimax rotation, 15 factors demonstrated eigenvalues >1, and the first factor explained 27.133% of the variance, with <40% critical value. These figures indicate no significant common method bias. Therefore, the common method of deviation in this study was acceptable.

Results

Descriptive statistical and correlation analysis

A Pearson's product-moment correlation analysis was used to analyze weight self-stigma, basic psychological needs, teacher autonomy support, and student engagement. The results showed Table 3 weight self-stigma was significantly negatively correlated with basic psychological needs, teacher autonomy support, and student engagement ($r = -0.237$, $p < 0.01$; $r = -0.220$, $p < 0.01$; $r = -0.327$, $p < 0.01$). Basic psychological needs were significantly positively correlated with teacher autonomy support and student engagement ($r = 0.614$, $p < 0.01$; $r = 0.675$, $p < 0.01$). Moreover, teacher autonomy support was significantly positively correlated with student engagement ($r = 0.541$, $p < 0.01$).

The test of mediating effect

Table 4 presents the results for Hypotheses 1 and 2. Regression analysis showed that self-stigma negatively affected

TABLE 4 A hierarchical regression analysis of the mediating effect of basic psychological needs.

Predictor	Student engagement		Basic psychological need satisfaction		
	M1	M2	M3	M4	M5
Weight self-stigma	−0.327**	−0.177**	−0.237**	−0.107**	−0.630**
Basic psychological need satisfaction		0.633**			
Teacher autonomy support				0.591**	0.421**
Basic psychological need satisfaction					0.519**
*Teacher autonomy support					
R^2	0.107	0.485	0.056	0.385	0.395
F	45.920	179.970	22.816	121.214	82.775

**Significant correlation at the 0.01 level (Two-tailed test), $p < 0.01$.

TABLE 5 Moderating effect of different levels of teacher autonomy support on the relationship between weight self-stigma and engagement among obese student.

Teacher autonomy support	Intermediate affect value	SE	LLCI	ULCI
M − SD	−0.084	0.038	−0.161	−0.013
M	−0.049	0.021	−0.094	−0.011
M + SD	−0.016	0.023	−0.067	0.025

engagement among obese students (M1), supporting Hypothesis 1. The regression results also revealed that weight self-stigma negatively affected basic psychological need satisfaction (M3). The regression results from M2 demonstrated that basic psychological need satisfaction significantly affected engagement among obese students. Simultaneously, weight self-stigma still negatively affected engagement among obese students. Therefore, we can conclude that basic psychological need satisfaction had a partial mediating effect, and this effect was significant, supporting Hypothesis 2. The structural mode model was used to test the model fit of the intermediary path of weight self-stigma → basic psychological need satisfaction → student engagement. Specifically, this model showed an ideal degree of fit ($x^2/df = 4.57$, GFI = 0.949, NFI = 0.937, IFI = 0.933, RFI = 0.916, CFI = 0.941, TLI = 0.956, RMSEA = 0.043, and SRMR = 0.037) (Hu and Bentler, 1999).

Moderated mediation effect test

The regression results of M4 and M5 demonstrate that teacher autonomy support significantly positively affects basic psychological need satisfaction. Moreover, the interaction between weight self-stigma and teacher autonomy significantly positively affects basic psychological need satisfaction. A simple slope analysis revealed that (Table 5 and Figure 2) with a higher level of perceived teacher autonomy support (M+1 SD) among obese students, weight self-stigma could not significantly negatively affect basic psychological need satisfaction. With low perceived teacher autonomy support (M−1 SD), weight self-stigma significantly negatively affected their basic psychological needs. The above information reveals that a higher level of teacher autonomy support can buffer the negative effect of weight self-stigma on basic psychological need satisfaction among obese students. Therefore, the association between weight self-stigma and basic psychological needs was moderated by the level of perceived teacher autonomy support, and thus, Hypothesis 3 was supported.

Discussion

Weight Self-stigma directly and significantly negatively affects engagement

In this study, we found that weight self-stigma negatively affects engagement directly among obese students, which is in line with previous studies (Myre et al., 2021). Weight self-stigma is a type of negative body image and may lead to obese students feeling incompetent and powerless (Tomiyama et al., 2018). A previous study has shown that weight self-stigma was associated with lower self-esteem (Alahmari et al., 2019) and poor self-esteem (Carr and Friedman, 2005; Tomiyama et al., 2018). Notably, weight self-stigma is a particularly negative emotion, and it is an accumulation of negative emotions over time that ultimately leads to depression. Unpleasant experiences cause more psychological problems and create a vicious circle, which some researchers have associated with lower engagement

(Mouchacca et al., 2013; Meadows and Bombak, 2019; Sabiston et al., 2019). The above analysis shows that weight self-stigma significantly affects engagement among obese students in physical education classes.

Intermediary role of basic psychological need satisfaction

This study has found that basic psychological need satisfaction is an intermediary between weight self-stigma and engagement among obese students. It also shows that basic psychological need satisfaction is the key factor in understanding the relationship between weight self-stigma and engagement among obese students in physical education classes. Weight self-stigma is averse to the satisfaction of basic psychological needs, reducing engagement among obese students. This finding is consistent with the basic hypothesis of SDT (Rm Ryan, 2017), which states that people are more receptive to changing their behavior when their basic psychological needs are met; otherwise, it impedes behavioral engagement. In turn, neglecting one's basic psychological needs and frustration are factors that lead people to stop participating in physical activity (Megías et al., 2018). This may be because weight self-stigma can be viewed as a study stressor. The generalized tension theory holds that when individuals experience stress and tension, they produce negative emotions such as anxiety, depression, and fear (Agnew and White, 1992); these negative emotions frustrate basic psychological needs. In addition, people struggling with self-stigma are ostracized by society, which harms their sense of belonging. Not feeling included is one of the main factors contributing to the failure to meet students' basic psychological needs. According to the theory of interpersonal perception, when an individual is excluded and marginalized by the outside world, they feel lonely due to emotional damage, which further causes them to withdraw from social activities (Schutz, 1958). If an individual feels lonely in interpersonal communication, it causes depression and social withdrawal and affects their subsequent behaviors.

Moderating effects of teacher autonomy support

The results show that teacher autonomy moderates the relationship between weight self-stigma and engagement among obese students. Those who report receiving more emotional support from teachers are more likely to be able to meet their most basic psychological requirements while dealing with weight self-stigma. This may be because a higher level of perceived teacher autonomy support among obese students in physical education classes makes them believe they still have room for choice and change. In this case, they can experience more positive emotions and remain optimistic. According to the expansion construction theory, positive emotions can help individuals expand their thinking and construct psychological resources to deal with the outside world (Jie, 2010).

Furthermore, positive emotions and optimism may have more self-determined motivations (Bartholomew et al., 2011). According to the SDT, more self-determined motivations lead to adaptive consequences. Therefore, teachers' autonomy support can help obese students maintain more self-efficacy in the face of perceived stigma and enhance their adaptability for engagement. This shows that teacher autonomy support can reduce the negative influence of self-stigma on basic psychological need satisfaction and further promote engagement among obese students in physical education classes.

Theoretical contributions and practical significance

This study discusses the relationship between weight self-stigma and engagement among obese students in physical education classes. It also features the construction of a moderated mediation model and reveals the internal mechanism of weight self-stigma on engagement in physical education classes. We found that basic psychological need satisfaction mediates how weight self-stigma affects engagement among obese students, which has not been reported in previous studies. Our results are consistent with the SDT postulates, which help raise awareness among physical education teachers regarding their potential responsibility in the struggle against weight stigma in their classes. Finally, this study has significant theoretical value for understanding the causes of engagement among obese students in high school, which enriches the theoretical research on and application of the effects of SDT.

In practice, this study's findings highlight that autonomy support is an essential skill for physical education teachers to promote engagement among their obese students. We then suggest that physical education teachers utilize the following autonomy-supportive skills, including providing choices to students with obesity, offering a rationale for study tasks, giving them opportunities to take the initiative, providing non-controlling competence feedback, and acknowledging their feelings and perspectives (Mageau and Vallerand, 2003). Physical education teachers should try their best to make these students more socially integrated into their peer group, strengthening their ties. This measure should make it difficult for potential peer bullies to obtain opportunities to reinforce their stigma and help teachers and students recognize obese students. Lastly, it is vital to promote legislation that prohibits weight-based discrimination.

Limitations and prospects for future research

Despite all the strengths, the present study did have some limitations. First, we only considered the mediating effect of basic psychological need satisfaction, but there may be other mediating variables, such as body image, self-esteem, loneliness, distress, anxiety, and depression, among others, which need to be further explored. Second, other moderate variables, such as the teacher's structural support, teacher's relatedness support, and peer support, also need to be further explored. Third, there were methodological limitations, including self-reports for data collection, the cross-sectional nature of the work, and the fact that we tested a single model in just one sample. Therefore, we suggest future research studies with similar models with experimental and/or qualitative methodologies. Fourth, obese students are more likely to perceive a controlling teaching style than a supportive one. Given this, future research should focus on exploring effective teaching strategies to reduce the controlling style of teaching. Finally, and most importantly, engagement among obese students in physical education classes should be improved, and future research should investigate how survey results correlate to actual teaching practice.

Conclusion

Using SDT, the novel findings from the present study showed that weight self-stigma not only directly affects engagement among obese students but also impacts the mediating effect of basic psychological need satisfaction on engagement. Moreover, perceived teacher autonomy support can moderate the effect of weight self-stigma on their engagement. In practice, our results showed that physical education teachers should create an environment supporting autonomy that meets obese students' three basic psychological needs.

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

Ethical approval was obtained from the Ethics Committee of Zhao Qing University. Participant's parents provided written informed consent.

Author contributions

BZ and XQ had substantial contributions to the conception and design of the work. BZ drafting the work and revising it critically for important intellectual content. The manuscript was written through the contributions of all authors. All authors have given approval to the final version of the manuscript.

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.

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EDITED BY
Rui Matos,
Quality of Life Research Center (CIEQV),
Portugal

REVIEWED BY
Noriaki Maeda,
Hiroshima University,
Japan
Pierluigi Diotaiuti,
University of Cassino,
Italy

*CORRESPONDENCE
Da-Wei Cao
✉ cdwsus@126.com
Teng Lyu
✉ 2711451545@qq.com
Ke-Lei Guo
✉ guokelei20040328@163.com

†These authors have contributed equally to this work

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The relationship between physical exercise and subjective well-being among Chinese junior high school students: A chain mediating model

Shu-Jun Yao[1†], Qi-Shuai Ma[2†], Chao Liu[2], Da-Wei Cao[2,3*], Teng Lyu[4*] and Ke-Lei Guo[5*]

[1]Department of Physical Education, Guang Dong Technology College, Zhaoqing, China, [2]School of Physical Education, Huaibei Normal University, Huaibei, China, [3]School of Economic and Management, Shanghai University of Sport, Shanghai, China, [4]Graduate School, University of Perpetual Help System Dalta, Manila, Philippines, [5]School of Physical Education and Health, Zhaoqing University, Zhaoqing, China

Objective: This study aims to help understand the mechanism behind the relationship between physical exercise and the subjective well-being among Chinese junior high school students, and it is of great significance for the intervention measures to improve the subjective well-being of junior high school students.

Methods: Using stratified cluster sampling method, 1,510 junior high school students (727 males and 783 females) were measured by physical exercise rating scale, perceived social support scale, physical exercise self-efficacy scale, and subjective well-being scale. For data analysis, Pearson's correlation analysis, structural equation model test, and bias-corrected percentile Bootstrap method were carried out in turn.

Results: Common method biases can be accepted in this study. (1) There is a positive correlation between physical exercise and subjective well-being, and physical exercise has a significant predictive effect on subjective well-being(β=0.367，t=9.415，p<0.01); (2) Perceived social support partially mediated the relationship between physical exercise and subjective well-being (β=0.08, t=3.083, p<0.01), and its effect ratio is 78.047%; (3) Physical exercise self-efficacy plays a partial mediating role between physical exercise and subjective well-being(β=0.181, t=5.132, p<0.01), accounting for 50.632%; (4) The chain mediating effect of perceived social support and physical exercise self-efficacy was significant (the mediating effect value was 0.028), and the effect amount was 7.629%.

Conclusion: (1) Physical exercise can significantly positively predict the subjective well-being of junior high school students; (2) Physical exercise can also indirectly affect the subjective well-being of junior high school students through the mediating effect of perceived social support and physical exercise self-efficacy. The intermediary effect includes three paths, namely, the individual intermediary effect of perceived social support and physical exercise self-efficacy and the chain intermediary effect of perceived social support physical exercise self-efficacy.

KEYWORDS

physical exercise, perceived social support, physical exercise self-efficacy, subjective well-being, junior high school students

Introduction

From the perspective of positive psychology, subjective well-being is an important content reflecting psychological development (Ryff, 1995). It can not only evaluate a person's quality of life, but also measure a person's mental health and psychological development level (Chen, 2004).

China's secondary school entrance examination system is a junior high school academic level examination based on nine-year compulsory education. The most important thing is the selective examination that students face for the first time. In recent years, Chinese junior high school students are not only facing increasing pressure on their studies, but also the pressure from their families, schools and society. It is easy for junior high school students to have psychological problems such as depression and anxiety, and bear enormous psychological pressure (Guo et al., 2022). This paper studies the relationship between physical exercise and subjective well-being of junior high school students, trying to sort out the influence mechanism of junior high school students' physical exercise on their subjective well-being.

Physical exercise and subjective well-being

Physical exercise is a kind of physical activity aimed at strengthening physical condition, adjusting spirit and enriching cultural life by using various physical exercise methods and combining natural forces and health measures (Hong Kong Sports Institute, 2000). Subjective well-being (SWB) is an overall evaluation of an individual's quality of life according to self-defined criteria, and is also an important indicator to measure a person's mental health (Diener et al., 1999). In addition to improving physical fitness, physical exercise also has a spillover effect (Hu and Yu, 2019). Researchers generally believe that physical exercise can improve individual subjective well-being (Schnohr et al., 2005). Ji et al. (1998) believe that appropriate physical exercise can make individuals obtain more sports pleasure, and the "smooth" (smooth, intoxicated and peak) experience gained by participants in the process of sports can make people forget those things that undermine our happiness, thus promoting the rise of the happiness base line (Qiao and Fan, 2020). Chen et al. (2013) research team also confirmed that the emotional effects of joy, fluency and peak experienced by participating in physical exercise can directly improve the level of subjective well-being of participants. Diener (2000) believes that the sources of subjective well-being experience include not only shopping, party and chat, but also the happiness gained by participating in physical exercise, which can not be replaced by other sources. Claus's (2017) research shows that by using the gradual relaxation exercise method, and by intervening individual anxiety, the research on the influence of physical exercise on subjective well-being has confirmed that physical exercise can make people obtain a durable and relatively stable state of well-being. The results of the research on the relationship between physical exercise and subjective well-being are mainly as follows: correlation and causality. Scholars adopted the method of stratified random sampling survey (Zang, 2009). Through the survey, it was found that there was a significant positive correlation between the level of physical exercise and the level of subjective well-being, that is, the level of subjective well-being of students who regularly participated in physical exercise was higher than that of students who did not participate in physical exercise (Zhang, 2003). Based on this, we propose the following hypotheses:

> *Hypothesis 1*: Physical exercise can positively predict subjective well-being. (H1).

Intermediary role of perceived social support

Perceived social support is a psychological fact, which contains people's perception of the social support they have received, and represents the individual's expectation and understanding ability of the social support they have (Dunkel-Schetter and Bennett, 1990). Perceived social support is often regarded as a mediating variable in addition to its direct effect on other psychological variables. For example, in Ye et al.'s (2012) study on the relationship between feelings, perceived social support and positive attribution style, perceived social support has no direct effect on feelings, but plays a mediating effect. Yang and Ye (2014) studied the subjective well-being of adolescent students and confirmed that perceived social support can be used as a mediating variable to affect adolescent students' well-being. Some studies have also shown that perceived social support has a mediating effect on the relationship between physical exercise and subjective well-being. For example, the study of Dong et al. (2019) showed that when individuals participated in physical exercise and received support from family and friends, they could generate lasting enthusiasm and interest in physical exercise. When they experience more social support, they will have a more positive description of themselves,

and thus a higher self-evaluation, thus improving the level of subjective well-being. Panza et al. (2019) investigated the relationship between physical exercise habits and subjective well-being. The study found that if physical exercise and subjective well-being is low, physical exercise can not directly affect subjective well-being, but by social support and sense of self health such as intermediary variable indirect effect on subjective well-being, individual comprehend from friends and family support, will have great influence on the level of subjective well-being (Xing, 2005). Lian (2009) confirms this view. Yang and Ye (2014) investigated the subjective well-being of adolescents and confirmed that perceived social support, as a mediating variable, affects the well-being of adolescent students. According to the research, when individuals experience more social support, they will have a more positive description of themselves, which will lead to positive self-evaluation, increase social activities, and improve their subjective well-being level (Xiong, 2008). Thus, we propose the following hypotheses:

> *Hypothesis 2*: Perceived social support plays a mediating role between physical exercise and subjective well-being. (H2).

Mediating effect of physical exercise self-efficacy

Another mediating variable of interest in this study is physical exercise self-efficacy. Physical exercise self-efficacy refers to the belief that individuals actively participate in and adhere to a certain intensity and duration of physical exercise ability (Motl et al., 2000). Some studies have found that self-efficacy acts as a mediator between variables and subjective well-being (Meng et al., 2010). With the deepening of cross-theoretical research, in the study of the effect mechanism of physical exercise self-efficacy. Wang et al. (2016) found that physical exercise self-efficacy partially mediated the study of group leadership behavior, team cohesion and exercise persistence. Yan et al.'s (2019) research on the relationship between transactional leadership behavior and willingness to persist in exercise of college P.E. teachers shows that self-efficacy of physical exercise plays a mediating role. Liu et al. (2017) also found that self-esteem and physical exercise self-efficacy had a statistically significant chain mediating effect between physical exercise and life satisfaction. Liu and Ma (2017) conducted a study on middle school students in boarding schools of *Tacheng* farming and pastoral areas, and confirmed that physical exercise was related to self-efficacy and subjective well-being. Meanwhile, social cognitive theory holds that self-efficacy can not only influence individual behavior, but also be influenced by individual successful behavior. Physical exercise strengthens the individual's sense of ability and value, thus enhancing subjective well-being (Barr-Anderson et al., 2007). Thus, we propose the following hypotheses:

> *Hypothesis 3*: Physical exercise self-efficacy plays a mediating role between physical exercise and subjective well-being. (H3).

Chain mediating effect of perceived social support and physical exercise self-efficacy

Perceived social support has a significant effect on physical exercise self-efficacy. For example, Bandura (1987) believed that social pressure could affect people's sense of efficacy through research. Sebastian (2013) further explained that when individuals receive positive or negative feedback from acquaintances, their self-efficacy changes accordingly depending on the type of feedback they receive. Au et al. (2009) found that self-efficacy and social support were significant predictors of life satisfaction. Therefore, the internal and external factors of perceived social support and physical exercise self-efficacy can jointly affect subjective well-being, which has a potential dual mediating effect. Song et al. (2010) showed that perceived social support can effectively relieve students' psychological pressure, improve their sense of self-efficacy, help students to face learning with a more positive attitude, and then have a positive impact on students' subjective well-being. Therefore, perceived social support and physical exercise self-efficacy, as internal and external factors, can jointly influence subjective well-being and have potential dual mediating effects. In conclusion, physical exercise self-efficacy not only plays a mediating effect between variables and subjective well-being, but also affects individual physical exercise self-efficacy through perceived social support, which can further affect individual subjective well-being experience. Thus, we propose the following hypotheses:

> *Hypothesis 4*: Perceived social support and physical exercise self-efficacy play the chain mediating roles between physical exercise and subjective well-being. (H4).

To sum up, we propose the following four hypotheses and build a conceptual model (see Figure 1).

> *H1*: Physical exercise can positively predict subjective well-being.
>
> *H2*: Perceived social support plays a mediating role between physical exercise and subjective well-being.
>
> *H3*: Physical exercise self-efficacy plays a mediating role between physical exercise and subjective well-being.

H4: Perceived social support and physical exercise self-efficacy play the chain mediating roles between physical exercise and subjective well-being.

Materials and methods

Procedure and participants

A cross-sectional survey was conducted by using the convenience sampling method in Shandong Province. In order to make the sample more representative, economic level and other reasons are considered. This study randomly selected one junior high school in urban and rural areas in the western, central and eastern parts of Shandong Province (6 junior high schools in total). Two classes will be randomly selected from each grade of each junior high school (36 classes in total), and 1,600 questionnaires will be issued. The recruitment flow chart is shown in Figure 2. The students were tested in the classroom, and the main testers were all psychology students who had received professional training. The test was approved by the school leaders, head teachers and participants, and all questionnaire were completed within 10 min. After the questionnaire was collected, follow the following criteria for exclusion: (1) missing date; (2) respond regularly; (3) inconsistent answers, and 1,510 valid questionnaires were recovered with a recovery rate of 94.38%. The participants including 727 boys and 783 girls. There are 509 students in Grade one, 541 students in Grade two, 460 students in Grade three.

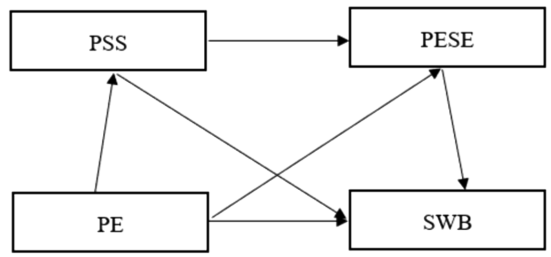

FIGURE 1
Conceptual model. PE, Physical Exercise; PSS, Perceived Social Support; PESE, Physical Exercise Self-Efficacy; SWB, Subjective Well-Being.

Demographic characteristics of the study sample

As shown in Table 1, of the total sample, 727 were boys, and 783 were girls. The PE level of boys was significantly higher than that of girls, PSS level of boys was significantly higher than that of girls, PESE level of boys was significantly higher than that of girls, SWB level of boys was significantly higher than that of girls.

Measures and instruments

Physical exercise

The physical exercise was measured by *Physical Activity Rating Scale* (PARS-3), and it compiled by Liang (1994). The study of Qi (2014) and Fu and Fan (2016) used *PARS-3* to measure physical exercise among Chinese junior students. The scale includes three items, which are, respectively, studied by the intensity of physical exercise, the time of each exercise and the frequency of monthly exercise, so as to measure the level of participation in physical exercise. Each aspect of the scale is divided into 5 levels, and the scale is scored on a 5-level scale, that is, the intensity, time and frequency are graded from 1 to 5 and scored 1–5, respectively. Score of physical exercise amount = score of exercise intensity × (score of exercise time − 1) × score of exercise frequency. The highest score for physical activity is 100, and the lowest is 0. According to the division rules of "Physical Exercise Rating Scale," the total score equal to or less than 19 is considered as small physical exercise, the score of 19–43 (excluding 19 and 43) is considered as medium physical exercise, and the score equal to or more than 43 is considered as large physical exercise. The higher the score means the higher the individual physical exercise. Based

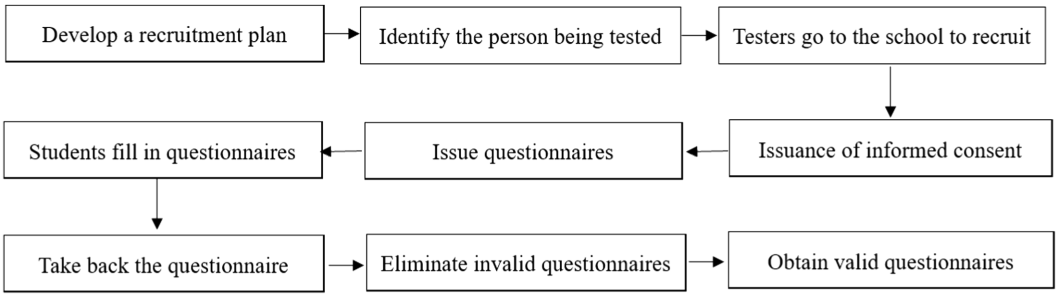

FIGURE 2
Recruiting flowchart.

TABLE 1 Differences in gender.

Variable	Gender	Number	*M*	SD	*t*	*p*
PE	Male	727	24.366	9.991	6.798	<0.001
	Female	783	14.345	6.134		
PSS	Male	727	5.344	1.124	4.97	<0.001
	Female	783	5.635	1.152		
PESE	Male	727	2.272	0.480	6.227	<0.001
	Female	783	2.113	0.515		
SWB	Male	727	11.107	2.420	5.786	<0.001
	Female	783	10.400	2.320		

PE, Physical Exercise; PSS, Perceived Social Support; PESE, Physical Exercise Self-Efficacy; SWB, Subjective Well-Being.

on previous experience (Xia et al., 2018), this study divided the small amount of physical exercise into two parts: no physical exercise and small amount of physical exercise. Therefore, the amount of physical exercise in this study was divided into four grades: no physical exercise, small physical exercise, medium physical exercise and large physical exercise. PARS-3 had reasonable internal consistency coefficient ($\alpha = 0.639$) and test–retest reliability ($r = 0.82$) in previous studies (Xia et al., 2018). In this study, the Cronbach α of *PARS-3* was 0.75.

Perceived social support

The perceived social support was measured by *Perceived Social Support Scale* (PSSS), and it compiled by Yan and Zheng (2006). In previous studies (Zhuang et al., 2016; Zhang et al., 2020), PSSS was used to measured perceived social support among Chinese junior students and it had good reliability and validity. The *PSSS* is a 7-point-Likert scale and comprises 12 items. It has 3 dimensions: family support (e.g., "I can talk about my problems with my family"), friends support (e.g., "My friends can share happiness and sadness with me") and other support (teachers, classmates and relatives; e.g., "In my life, teachers, classmates and relatives care about my feelings."). Each item is valued from 1 (completely disagree) to 7 (completely agree). The score is represented by the average score, and a higher score means higher level of the perceived social support (Zhuang et al., 2016). In the present study, confirmatory factor analysis results demonstrate that date fitting very well: $\chi^2/df = 4.835$, RMSEA = 0.078, GFI = 0.935, CFI =0.922, and the Cronbach's α was 0.90.

Physical exercise self-efficacy

Physical exercise self-efficacy was measured by Chinese version of *Physical Exercise Self-Efficacy Scale* (PESES; Wu et al., 2002). In previous studies, the *PESES* showed good validity and reliability among Chinese junior students (Zheng, 2019; Dong et al., 2020). The *PESES* is a 3-point-Likert scale and comprises 12 items (e.g., "Even if I have to get up early on weekends, I will keep exercising"). Each item is valued from 1 (I cannot do it) to 3 (I'm sure I can do it). The score is represented by the average score, and a higher score means higher level of the Physical exercise self-efficacy (Luo et al., 2019). In the present study, confirmatory factor analysis results demonstrate that date fitting very well: $\chi^2/df = 4.495$, RMSEA = 0.061, GFI = 0.965, CFI =0.952, and the Cronbach's α was 0.87.

Subjective well-being

Index of Well-Being Scale was compiled by Campbell (1976). Mei et al. (2015) translated and revised this scale to measure the subjective well-being among Chinese junior students. This study used Chinese version of *Index of Well-Being Scale* to measure subjective well-being. *Index of Well-Being Scale* comprises 9 items and divided into two indicators: overall emotional index (8 items; e.g., "How do you feel about life recently, scored from boring to interesting") and life satisfaction index (1 item; e.g., "How satisfied are you with life in general"). Each item is scored from 1 to 7 points, and the total score is the mean score of the overall emotional index plus the life satisfaction index score and can be from 0 to 14, a higher score shows a higher level of individual happiness (Anglim et al., 2020). In previous studies, *Index of Well-Being Scale* has a fair retest reliability ($r = 0.91$; Zhou et al., 2020). In the present study, confirmatory factor analysis results demonstrate that date fitting very well: $\chi^2/df = 1.40$, RMSEA = 0.036, GFI = 0.974, CFI = 0.991, and the Cronbach's α was 0.88.

Statistical analysis

Invalid data removed after questionnaire recall, and statistical analysis was carried out using the socio-statistical analysis software SPSS 23.0 and the Process plug-in. Firstly, testing for common method bias using Common latent factor. Secondly, SPSS 23.0 was used to examine the Pearson bivariate relationships between physical activity, perceived social support, physical activity self-efficacy and subjective well-being among junior high school students. Thirdly, using the PROCESS plug-in model4 to examine the separate mediating roles of perceived social support and physical exercise self-efficacy. Fourthly, using the PROCESS plug-in model6 and Bootstrap method test the chain mediating effect of perceived social support and physical exercise self-efficacy. In this study, $p < 0.05$ is reasonable.

Results and analysis

Common method bias test

Common method bias refers to artifactual covariation between a predictor and a valid scale variable because of the same data source or rater, the same measurement environment, the context of the item, and the characteristics of the item itself. Because this study collected data through self-reporting methods, it was possible that there could be an issue with common method variance (CMV). To reduce this possible deviation, according to the suggestion by Zhou and Long (2004) in the data collection stage, the participants were told that the results would be kept anonymous. It is stated that the data are for scientific purposes only, in order to control for sources of common method bias as much as possible. In order to further improve the rigor of the study, Harman's one-factor test was used for statistical control before data analysis, that is, unrotated principal component factor analysis is performed on all variables. The results show that the fit between the data and the model is not high (χ^2/df = 40.12, CFI = 0.54, NNFI = 0.58, NFI = 0.63, RMESA = 0.33). There is no obvious common methodological bias in this study.

Descriptive statistics and correlation analysis

Pearson bivariate correlation analysis results of each variable are shown in Table 2. Physical exercise was positively correlated with subjective well-being, physical exercise self-efficacy and perceived social support. Physical exercise self-efficacy and perceived social support were positively correlated with subjective well-being. Physical exercise self-efficacy was positively correlated with perceived social support.

The mediating effect of perceived social support between physical exercise and subjective well-being

The mediating effect of perceived social support between physical exercise and subjective well-being was analyzed by the sequential test method in the mediating effect test procedure proposed by Wen and Ye (2014).

TABLE 2 Mean, standard deviation, and correlation coefficient of each variable.

	M	SD	1	2	3	4
1. PE	19.161	8.455	1			
2. SWB	5.331	1.188	0.236**	1		
3. PESE	2.193	0.505	0.248**	0.510**	1	
4. PSS	5.484	1.147	0.242**	0.773**	0.501**	1

PE, Physical Exercise; PSS, Perceived Social Support; PESE, Physical Exercise Self-Efficacy; SWB, Subjective Well-Being. **$p < 0.01$.

Table 3 shows that physical exercise has a significant direct predictive effect on SWB ($t = 9.415$, $p < 0.01$). Physical exercise had a significant direct predictive effect on perceived social support ($t = 9.672$, $p < 0.01$). Hypothesis 1 is verified.

When physical exercise and perceived social support were added to the regression equation, the predictive effect of physical exercise on SWB was still significant ($t = 3.083$, $p < 0.01$). Perceived social support also positively predicted SWB ($t = 45.356$, $p < 0.01$). Formula A * B/C was calculated according to the proportion of effects. Perceived social support partially mediated the relationship between physical exercise and subjective well-being. The effect accounted for 78.047%. Hypothesis 2 is verified.

Mediating effect analysis of physical exercise self-efficacy between physical exercise and subjective well-being

It can be seen from Table 4. Physical exercise had a significant direct predictive effect on SWB ($t = 9.415$, $p < 0.01$). Physical exercise had a significant direct predictive effect on physical exercise self-efficacy ($t = 9.929$, $p < 0.01$). When physical exercise and physical exercise self-efficacy were added to the regression equation. The predictive effect of physical exercise on SWB was still significant ($t = 5.132$, $p < 0.01$). Physical exercise self-efficacy also positively predicted subjective well-being ($t = 21.242$, $p < 0.01$). Physical exercise self-efficacy partially mediates the relationship between physical exercise and subjective well-being. The effect accounted for 50.623%. Hypothesis 3 is verified.

The chain mediating effect analysis of perceived social support and physical exercise self-efficacy between physical exercise and subjective well-being

The bias corrected Bootstrap method was used to test the chain mediating effect of perceived social support and physical exercise self-efficacy between physical exercise and subjective well-being (Fang and Zhang, 2012). 5,000 Bootstrap samples were randomly selected from the original sample to estimate indirect effects.

Table 5 shows the 95% confidence intervals of the Bootstrap sampling test for each path. If the 95% interval does not include the number 0, the mediating effect is significant. According to Table 2. The 95% confidence intervals of the three influence paths do not contain the number 0. The mediating effect of perceived social support was significant (the mediating effect value was 0.258). The effect size was 70.299%; The mediating effect of physical exercise self-efficacy was significant (the mediating effect value was 0.033). The effect size was 8.991%. The chain mediating effect of perceived social support and physical exercise self-efficacy was significant

TABLE 3 Analysis results of mediating effect of perceived social support.

	SWB			PSS			SWB		
	β	SE	t	β	SE	t	β	SE	t
Constant	4.250**	0.119	35.859	4.414**	0.114	38.631	0.772**	0.109	7.095
PE	0.367**	0.039	9.415	0.363**	0.038	9.672	0.080**	0.026	3.083
PSS							0.788**	0.017	45.356
R^2	0.056			0.058			0.601		
ΔR^2	0.055			0.058			0.6		
F	F (1,1,508) = 88.639, p = 0.000			F (1,1,508) = 93.546, p = 0.000			F (2,1,507) = 1133.320, p = 0.000		

PE, Physical Exercise; PSS, Perceived Social Support; SWB, Subjective Well-Being.
**p < 0.01.

TABLE 4 Analysis results of mediating effect of physical exercise self-efficacy.

	SWB			PESE			SWB		
	β	SE	t	β	SE	t	β	SE	t
Constant	4.250**	0.119	35.859	1.707**	0.05	34.003	2.315**	0.138	16.749
PE	0.367**	0.039	9.415	0.164**	0.016	9.929	0.181**	0.035	5.132
PESE							1.133**	0.053	21.242
R^2	0.056			0.061			0.273		
ΔR^2	0.055			0.061			0.272		
F	F (1,1,508) = 88.639,p = 0.000			F (1,1,508) = 98.586,p = 0.000			F (2,1,507) = 283.151,p = 0.000		

PE, Physical Exercise; PESE, Physical Exercise Self-Efficacy; SWB, Subjective Well-Being. **p < 0.01.

TABLE 5 Bootstrap analysis of significance test of mediating effect.

Affect the path	Effect	Boot SE	Boot LLCI	Boot ULCI
PE ⇒ PSS ⇒ SWB	0.258	0.019	0.132	0.209
PE ⇒ PESE ⇒ SWB	0.033	0.003	0.013	0.026
PE ⇒ PSS ⇒ PESE ⇒ SWB	0.028	0.002	0.013	0.021

PE, Physical Exercise; PSS, Perceived Social Support; PESE, Physical Exercise Self-Efficacy; SWB, Subjective Well-Being.

(the mediating effect value was 0.028). The effect size was 7.629%. Hypothesis 4 is verified. The model diagram is shown in Figure 3.

Discussion

The relationship between physical exercise and subjective well-being

It was found that physical exercise, perceived social support and self-efficacy of physical exercise were significantly positive predictors of SWB. Adolescent students are at a critical time in their lives, both physically and mentally. The structure, function and psychological development of their body organs have great plasticity and development. Influenced by "exam-oriented education," China's basic education still focuses on academic goals. It neglects the problems in the physical and mental health of young students (Ding and Wang, 2004), which is extremely unfavorable to the healthy growth of young students. Therefore, it is of great practical significance to enhance the physical exercise and subjective well-being of young students to promote their psychological development and healthy growth. The results showed that physical exercise positively predicted the subjective well-being of junior high school students. The more junior high school students participate in physical exercise, the higher their subjective well-being level. This finding is backed up by previous studies (Chen and Ji, 2006). When regular physical exercise takes place over a long period of time, individuals regularly experience pleasurable emotions and form habits. If 1 day does not complete the physical exercise task, the body will have the uncomfortable reaction. Physical exercise activity can affect the physical and emotional health of junior high school students in early development. Therefore, junior high school students can promote the rise of subjective well-being baseline by participating in physical exercise. Lay the foundation for a lifetime of happiness (Lee et al., 2020).

Understanding the mediating effect of perceived social support and physical exercise self-efficacy

This study not only explored the direct relationship between physical exercise and subjective well-being, but also constructed a

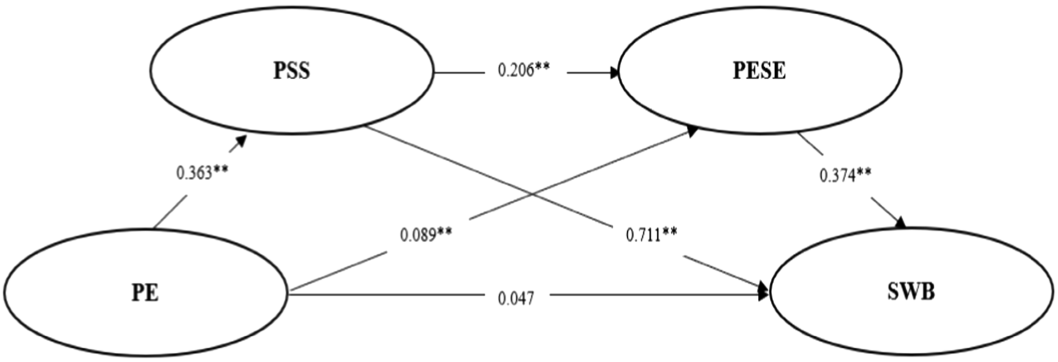

FIGURE 3
Chain mediation model of physical exercise and subjective well-being. PE, Physical Exercise; PSS, Perceived Social Support; PESE, Physical Exercise Self-Efficacy; SWB, Subjective Well-Being. **p<0.01.

chain mediating model through the mediating roles of perceived social support and physical exercise self-efficacy between them and further discusses how physical exercise affects the subjective well-being of junior middle school students. The research results showed that the chain mediating effect of perceived social support and exercise self-efficacy was significant, indicating the importance of mediating variables in explaining physical activity to enhance the subjective well-being of junior high school students.

In this study, perceived social support was significantly positively correlated with subjective well-being of junior high school students, it is consistent with the research results of Li et al. (2017) and Wang and Zhang (2015). Research on perceived social support and well-being has shown that the more social support a person receives, the stronger his subjective well-being will be. High levels perceived social support can lead to a higher level of self-harmony, which can improve their subjective well-being. (Jiang et al., 2013). Social support theory proposed that the stronger the social support network, the stronger the individual's ability to cope with various challenges (Jiang and Li, 2013). More importantly, this study found that perceived social support partially mediated the relationship between physical exercise and subjective well-being of junior high school students. This means that physical exercise can directly affect junior high school students' subjective well-being on the one hand, and indirectly affect junior high school students' subjective well-being through perceived social support on the other hand, this may be due to the fact that team sports provide junior high school students with opportunities to interact with peers and thus help them gain support (Jia, 2021). At the same time, when individuals encounter difficulties, the more they perceive the support from society, family and friends, the more they can solve problems in a positive way and avoid risks. Teachers and classmates are the closest people to students in school. When students perceive support from teachers or peers. Their subjective well-being also increases.

In addition, physical exercise self-efficacy could positively predict the subjective well-being of junior high school students. With the deepening of cross-theoretical research. In the study on the mechanism of physical exercise self-efficacy. Zhang and Wang (2015) found that individuals who regularly participate in physical exercise are good at communicating with others. When encountering negative stimulation will take a variety of effective measures to relieve anxiety. Therefore, negative emotional experience is less. Easy to produce happiness. This study is consistent with the results of Yuan and Zhang (2015). Physical exercise indirectly affects the subjective well-being of junior middle school students through physical exercise self-efficacy. Either after a single strenuous physical exercise or long-term exercise intervention can have a positive impact on physical exercise self-efficacy (Liu, 2020). Secondly, self-efficacy is one of the core contents of Bandura's social cognitive theory. People with a high sense of self-efficacy are interested in new things and devote themselves to them. Can make constant efforts to overcome difficulties. In this process, their sense of self-efficacy will be constantly strengthened. The self-efficacy of physical exercise will also affect people's emotions (Guo and Jiang, 2003). This may be due to physical exercise in individuals with high self-efficacy. They tend to be more positive and confident when encountering difficulties or setbacks. A sense of control and competence increases in the process of completing difficulties and challenges. Negative emotional experience is less. Therefore, the level of subjective well-being rises. In addition, the "smooth" experience of physical exercise is also one of the manifestations of positive state traits and can subtly affect subjective well-being (Tan et al., 2020). Junior high school students through long-term regular physical exercise can make their subjective happiness more prominent. Exercise situations with "happiness schema" can improve physical exercise self-efficacy as a fact. The results show that physical exercise self-efficacy is one of the important Bridges connecting physical exercise and mental health. Participating in physical exercise can not only effectively improve the subjective well-being of junior high school students, but also improve the mental health level of junior high school students by improving their physical exercise self-efficacy.

Physical exercise positively predicts subjective well-being through chain mediation

This study showed that perceived social support and physical exercise self-efficacy had a significant chain mediating effect. The mediation effect value was 0.028. Understanding social support through physical exercise of self-efficacy. The effect size of promoting subjective well-being of junior high school students reached 7.629%. That is, physical exercise can not only directly predict the subjective well-being of junior high school students, but also through understanding the chain effect of social support and physical exercise self-efficacy. It has an indirect effect on the subjective well-being of junior high school students. This is basically consistent with the research results of Au et al. (2009). This may be physical exercise strengthens the individual's sense of ability and value (Jackson et al., 2021). Relieve individual psychological pressure. Improved self-evaluation of health status (Zhang, 2010). The self-efficacy of individual physical exercise is enhanced. Help them take a more positive attitude toward a game or study, and have a positive impact on subjective well-being. According to social learning theory. The process of interaction between individuals and environment and its results show that the information related to individual interaction belongs to self-efficacy information. It is through cognitive processing of such information that self-efficacy is formed (Chen, 2016). According to Bandura's theory of four sources of information that affect the formation and change of self-efficacy. Being encouraged to believe in your own effectiveness by the language of others who think you are capable of performing a task. For example, verbal or social persuasion is the persuasive encouragement, advice and suggestions of others. It is one of the four sources of information that influence the formation and change of self-efficacy (Yan, 2008). When an individual has encouragement or persuasion from parents, teachers, classmates or trusted people. It is beneficial for them to participate in physical exercise better and produce a high level of physical exercise self-efficacy. Be able to accept in a positive manner. In the process, the individual experiences a great deal of positive emotion. And these positive emotions lead to happiness (Liang, 2020). This study has important guiding significance for improving the mental health of junior middle school students. Therefore, when thinking about the relationship between physical exercise and subjective well-being of junior high school students, we should pay attention to the important "bridge" role played by perceived social support and physical exercise self-efficacy.

Proposal

According to the research results, we can promote subjective well-being by improving physical exercise. In daily life, parents should strengthen the educational function of sports, increase family sports activities, build family sports culture, and guide students to participate in physical exercise. Schools should carry out physical education classes according to projects and interests, pay attention to gender differences and grade differences, make teachers' teaching more targeted, so as to promote junior high school students to actively participate in physical exercise, shape sports spirit, and obtain a sense of happiness. The school cooperates with the extracurricular sports clubs to improve the quality of extracurricular sports activities. The school encourages students to choose their own "sports club," and students can learn independently according to their hobbies, so as to master sports skills and develop the habit of physical exercise.

Understanding social support is the medium of the relationship between physical exercise and subjective well-being of junior high school students. The scope of activities of junior high school students is mainly between school and family, and the scope of communication is limited. Therefore, family, teachers and classmates have the greatest impact on themselves. Therefore, a social support system including teachers, classmates and parents should be established to help junior high school students develop their subjective well-being. The teacher-student relationship is one of the most important interpersonal relationships in schools. In schools, teachers should hold thematic class meetings to enhance teacher-student exchanges and fully reflect teachers' caring behavior. Good peer relationship can also promote students' adaptation to all aspects of learning and life. It is suggested that on the premise of ensuring safety, we should organize classmate gatherings or extracurricular practice in the class on weekends, so that junior high school students can have closer peer relationships and easily feel the power of support around them. Good parent–child relationship can make students feel safe in terms of parental care. It is suggested that parents should pay more attention to the interpersonal needs of boys and guide them to find various ways to obtain support, such as recording life, family group building, etc.

Physical exercise self-efficacy is an important medium between physical exercise and junior high school students' subjective well-being. Improving junior high school students' physical exercise self-efficacy is also a channel to improve their subjective well-being. Teachers, parents and peers have the closest relationship with students. Teachers should set an example and actively participate in the big break sports activities to play a leading role. In education and teaching, teachers should fully consider the original physical quality and ability level of students and take care of the individual differences of students. By participating in parent–child sports activities and conducting "emotional exchanges" with students, parents can let children feel the physical and mental experience brought by physical exercise, improve their self-efficacy of physical exercise from the perspective of psychological needs, and promote their subjective well-being.

Conclusion

(1) Physical exercise positively predicted the subjective well-being of junior high school students. That is to say, students

who often participate in physical exercise have a higher level of subjective well-being than students who do not often participate in physical exercise. (2) Physical exercise indirectly affects the subjective well-being of junior high school students through the mediating effect of perceived social support and physical exercise self-efficacy. There are three paths to this mediation. Namely, the separate mediating effect of perceived social support and physical exercise self-efficacy, and the chain mediating effect of perceived social support and physical exercise self-efficacy.

Limitations and future directions

There are still some areas to be improved in this study: although this study has further proved the relationship between physical exercise and subjective well-being of junior high school students. At the same time, the inner mechanism of physical exercise affecting the mental health of junior middle school students was discussed. However, this study is a cross-sectional study. Predictive results are only explored on the basis of relevant research. In the future, longitudinal follow-up experiments should be used to study the relationship between variables. In addition, this study only considered the mediating effect of perceived social support and physical exercise self-efficacy between physical exercise and subjective well-being of junior high school students. But in reality there may be other mediating variables such as resilience, interpersonal relationships and self-evaluation. Further research is needed. Follow-up research should be based on promoting the development of adolescents' physical and mental health. Highlight the education concept of "health first." To further explore the "dose effect" and the influence of related variables on improving the subjective well-being of junior high school students. To improve the core quality of physical education and health, and promote the development of junior middle school students' mental health.

This study reveals the influence mechanism of physical exercise on the subjective well-being of junior high school students. It has both theoretical and practical significance. In theory, this study further reveals the influence mechanism of physical exercise on the subjective well-being of junior high school students. It has important theoretical value to understand the causes of subjective well-being of junior high school students. Secondly, the psychological mechanism of physical exercise affecting subjective well-being was discussed. Enrich the sports psychology theory. Finally, the Curriculum Standard for Physical Education and Health serves as a national document guiding physical exercise to promote mental health at the macro level. To explore the influence mechanism of physical exercise on subjective well-being of junior high school students. It can promote the education value theory of PE subject and the core accomplishment theory of PE subject in the Curriculum Standard of PE and Health to give full play. In practice, to explore the formation mechanism of junior high school students' subjective well-being. It is beneficial to relieve the psychological pressure of junior high school students. Prevent mental illness. Cultivate a positive and healthy attitude. Secondly, it is beneficial to improve the level of subjective well-being of junior high school students. Promote the cultivation of core accomplishment of physical education. Finally, it can provide a basis for the government functional departments to formulate relevant policies. At the same time to improve the quality of physical education and teaching to provide support.

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 authors.

Ethics statement

This study was conducted in accordance with the Declaration of Helsinki, and it has been approved by the Human Research Ethics Committee of Guang Dong Technology College.

Author contributions

S-JY, CL, D-WC, and TL: conceptualization. CL, D-WC, TL, and K-LG: methodology, resources, and supervision. S-JY and Q-SM: software, formal analysis, and visualization. Q-SM, D-WC, and CL: validation. S-JY and K-LG: investigation. S-JY: data curation. S-JY, Q-SM, D-WC, and TL: writing—original draft preparation. S-JY, D-WC, and TL: writing—review and editing. D-WC and TL: funding acquisition. All authors contributed to the article and approved the submitted 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.

Publisher's note

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EDITED BY
Víctor Arufe Giráldez,
University of A Coruña, Spain

REVIEWED BY
José Luis Ubago-Jiménez,
University of Granada,
Spain
Diego Vasconcellos,
Australian Catholic University,
Australia

*CORRESPONDENCE
Sebastián Feu
✉ sfeu@unex.es

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Analysis of the motivational processes involved in university physical activity

Miguel Ángel Durán-Vinagre[1], Sergio J. Ibáñez[2], Sebastián Feu[3]* and Susana Sánchez-Herrera[1]

[1]Department of Psychology and Anthropology, Faculty of Education and Psychology, University of Extremadura, Badajoz, Spain, [2]Department of Didactics of Musical, Plastic, and Corporal Expression, Faculty of Sport Science, University of Extremadura, Cáceres, Spain, [3]Department of Didactics of Musical, Plastic, and Corporal Expression, Faculty of Education and Psychology, University of Extremadura, Badajoz, Spain

Introduction: Physical activity plays an important role in all stages of development, especially in adolescence, as it is a period in which different lifestyles are shaped. Therefore, regular practice of physical activity contributes to an improvement in quality of life. This study analyzed university students' motivational processes and intention to be physically active when engaging in physical activity (PA) according to gender and fields of study.

Methods: A total of 1.524 subjects participated in the study, 61.9% (n = 944) of whom were female and 38.1% (n = 580) were male, with an average age of 19.61 years. The fields of study consisted of Arts and Humanities (n = 118), Science (n = 132), Health Sciences (n = 351), Engineering and Architecture (n = 196) and Social and Legal Sciences (n = 727). The instruments used were the Behavioral Regulation in Exercise Questionnaire (BREQ-3) and the Intention to be Physically Active in the University Context (MIFAU) measurement scale.

Results: The results showed statistically significant differences in favour of men (p<0.01) in terms of intrinsic, integrated, identified, and introjected regulation of PA. Similarly, men were more likely to be physically active in the future than women (p<0.001). In terms of the study variables relating to the fields of study, statistically significant differences were obtained in the case of both more self-determined behavior (intrinsic, integrated and identified regulation) and amotivation (p<0.001).

Conclusion: It was concluded that there is a need for the promotion of intervention strategies to encourage young adults to take up sporting activities as a means of preventing noncommunicable diseases, thereby avoiding the negative consequences of a sedentary lifestyle, physical inactivity, or abandonment of such activities.

KEYWORDS

motivation, self-determination, university students, physical activity, health

1. Introduction

Physical activity (PA) has been applied to different areas of life, used through studies from motivation. Motivation is influenced by multiple and very diverse factors and is one of the most frequently studied aspects in the field of Sport Psychology, where it has been

associated with various of the variables and agents involved (De Francisco et al., 2020).

The regular practice of PA by young people is considered beneficial to health as it can reduce the risk of chronic and non-communicable diseases, such as heart disease, cardiovascular accidents, diabetes, among others. It also highlights that this PA practice reduces symptoms of depression and anxiety (Chávez et al., 2018; Flores and Aceutino, 2021). According to the World Health Organization (WHO), by 2022 chronic diseases will account for 71% of the total number of deaths per year, with the percentage increasing in recent years in countries with fewer economic resources. Evidence suggests that chronic diseases are one of the greatest challenges facing health systems worldwide and they are strongly associated with several modifiable risk factors, notably physical inactivity, sedentary lifestyles and poor lifestyle habits (Anderson and Durstine, 2019; Ferrara et al., 2022).

In this sense, a large percentage of young people and adolescents do not reach the international recommendations of 60 min per day of moderate to vigorous intensity PA (Troiano et al., 2008). PA is essential as a natural protective factor for health as it is associated with numerous age-related health benefits, such as maintaining energy balance and preventing overweight and obesity, improving mental health and psychological well-being, increasing muscle strength and function, helping to promote positive mental health, among others (Kumar et al., 2015; Baran et al., 2020; Bull et al., 2020; Rodríguez et al., 2020). In the academic context, some studies point to the important role of educators to transfer healthy lifestyle habits from a very early age (De Craemer et al., 2013; Pulimeno et al., 2020). These educators are also responsible for the development of active and healthy behavior patterns that favor and facilitate the design of interventions aimed at increasing PA levels in students (Murillo et al., 2013). PA improvement and motivation in the university population is not only essential due to the low number of individuals who meet the recommendations, but also due to the fact that these students, especially those linked to health or education careers, can exert a major influence through their professional work, transmitting their lifestyle and promoting healthy habits (Mendoza-Núñez et al., 2013; Rippe, 2018).

This situation has made the study of the lifestyle of university students linked to these educational branches a topic of growing interest in the scientific literature (Tirodimos et al., 2009; Varela-Mato et al., 2012). A study by Molina de la Torre et al. (2012) indicated that university students linked to educational degrees in the field of Social and Legal Sciences and Health Sciences presented much lower levels of PA than those linked to the field of sports. In this line, a study by Cancela and Ayán (2011), in Spanish university students of Health Sciences and Education, showed a high prevalence of physical inactivity. Other studies suggest that men who pursue health-related careers tend to be more active than those linked to education or other professions, while this pattern does not occur in the case of women (Varela-Mato et al., 2012). The work of Farinola (2011) found that university students of Physical Education perform more PA than students of other university degrees.

In recent years, different theories have facilitated the understanding of motivational processes in the context of school and sport context, with Achievement Goal Theory (AGT) and Self-Determination Theory (SDT) standing out. The first of these, AGT, aims for the subject to be able to demonstrate his or her capabilities, where achievements may be guided by different conceptions that are affected by the social context (Ames, 1992; Moreno et al., 2007; Rottensteiner et al., 2015). SDT (Deci and Ryan, 2000) has been used to address motivation from the point of view of physical activity (Wang et al., 2009; Gómez-Mazorra et al., 2021). However, despite the emphasis on empirically studying the benefits linked to the promotion of healthy lifestyle habits, it is becoming increasingly difficult to achieve levels of physical activity appropriate to each age that not only provide positive and meaningful sporting experiences but also mitigate the problems of modern life, including sedentary lifestyles, physical inactivity and bad lifestyle habits associated with alcohol consumption, smoking and unhealthy eating (Deci and Ryan, 2000; Vázquez et al., 2019; Moral-García et al., 2020).

Some authors point out that a good alternative to carry out PA is to propose its promotion from the academic environment through SDT (Deci and Ryan, 1985; Zhang and Solmon, 2013). In this sense, SDT considers motivation as a fundamental element for the development of behavior, therefore, relating motivation and SDT will favor that people are motivated to grow and change due to basic psychological needs thanks to self-determination, i.e., their behaviors can be modified based on their regulation (Ryan and Deci, 2000a). In this sense, motivation should be oriented to serve the satisfaction of basic psychological needs, such as autonomy (feeling the cause of one's actions), competence (perceiving oneself as capable of achieving specific goals) and relatedness (perceiving oneself as not emotionally isolated from others), which are key nutrients for the development of quality motivation and personal growth (Deci and Ryan, 2000; Ryan and Deci, 2017). In short, and as we well know, motivation plays an essential role in the practice and promotion of physical activity in all people, since human beings behave according to a series of motivational behaviors when it comes to achieving goals and objectives in different contexts (Rodríguez-Cañamero et al., 2010; Almagro et al., 2015).

According to its conceptualization of motivation, a psychological theory is only motivational if it takes into account the energy, direction, persistence and purpose of behavior, while at the same time considering the intentions behind certain resulting actions (Deci and Ryan, 1985). These authors considered SDT in relation to PA (Deci and Ryan, 1985; Deci and Ryan, 2000), proposing a self-determination continuum with the different types of motivation and their regulation styles. Depending on the satisfaction an individual obtains from doing physical activity, one type of motivation or another will come into play. These authors proposed a classification into intrinsic motivation, extrinsic motivation, and amotivation. The first mode involves engaging in activity for the pleasure deriving from its execution. Extrinsic

motivation concerns behavior influenced by rewards and external agents. Finally, located at the other end of the self-determination continuum is amotivation, which refers to behavior not regulated by the subject, i.e., lack of intention to act (Deci and Ryan, 1985; Deci and Ryan, 2000).

More in-depth studies of motivation (Deci and Ryan, 1985; Chantal et al., 1996; Deci and Ryan, 2000) have identified four types of behavioral regulation associated with extrinsic motivation: integrated, identified, introjected and external regulation. Integrated regulation refers to conduct that is engaged in freely in and is present when the activity itself is immersed in the activity itself is immersed in the person's lifestyle, in which characteristics that are which highlights characteristics related to values, goals, personal needs and identity (Deci and Ryan, 2000; Ryan and Deci, 2000a; Moreno and Martínez, 2006). Identified regulation differs from the rest in that it refers to highly-valued behavior that the individual identifies as important, i.e., the individual will perform the activity freely even if they do not enjoy it. It is a type of motivation in which the person perceives that the activity is carrying out is favorable, finding benefit from the fact of performing it, despite the fact that the person is not totally self-determined to perform it (Catarralá, 2004). This regulation of behaviors is autonomous, but the decision to participate in the activity is given by a series of external benefits and not by the pleasure and satisfaction inherent in the activity itself (Ntounamis, 2001). Introjected regulation is linked to expectations of self-approval, avoidance of anxiety or guilt and achievement of ego enhancement, such as pride. When participating in this type of activity, the main motive is social recognition, internal pressures or feelings of guilt (Ryan and Deci, 2000b). Finally, these authors understand external regulation as behavior in response to an external demand or the existence of rewards or compensation. Therefore, this regulation leads a subject to develop any activity for the reason of obtaining some kind of reward in return, without any kind of internalization, or for the consequent penalty of not developing it (Deci and Ryan, 2000).

Similarly, studies have shown there is a relationship between the practice of PA and more self-determined motivation (Moreno et al., 2007; DeFreese and Smith, 2013). The scientific literature supports the idea that more self-determined motivation is decisive to achieve greater beneficial effects from PA, such as control of body weight, increased physical fitness, positive improvement in mood, among others (Moreno-Murcia et al., 2011; Bermejo et al., 2018; Leyton et al., 2020). Studies by Durán-Vinagre et al. (2021) and Lauderdale et al. (2015) showed that there are statistically significant differences between men and women in terms of intrinsic motivation, integrated regulation and identified regulation. Furthermore, different studies suggest that the level of habitual physical-sports activity is higher in men than in women (López Sánchez et al., 2016; Li et al., 2017; Durán-Vinagre et al., 2019), with these levels decreasing progressively for both sexes as the years go by Sun et al. (2013), López Sánchez et al. (2016), and Li et al. (2017).

Different studies have concluded that PA plays a fundamental and irreplaceable role during adolescence because it is a stage characterized by the consolidation of patterns that will be maintained throughout an individual's life (Litt et al., 2011; Varela et al., 2011; Kalman et al., 2015), and also because it contributes to the creation of healthy lifestyle habits as it is related to the transition to adulthood during which lifestyles are shaped (González et al., 2012). This may in turn be related to the concept of intention to be physically active in the future: according to Leyton et al. (2018), it is important to know the individual's future intentions since beneficial behavior will lead to more effective healthy lifestyles accompanied by good practices, such as improving emotional well-being through PA, healthy eating, safety, and unintentional injuries, among others (Bonofiglio, 2022). Therefore, PA requires motivation to perform any bodily movement produced by skeletal muscles, with consequent energy consumption, as it determines the initiation, maintenance, and cessation of the conduct (Moreno et al., 2008).

Thus, although there are studies in different contexts in the scientific literature that use the psychological constructs outlined above with the university population (Práxedes et al., 2016; Leyton et al., 2018; Escamilla et al., 2020), to date there is no known research regarding PA in the university context, the motivational variables, and the intention to be physically active among first-year students, especially taking into account their different fields of study. This gap makes it difficult to argue this issue with the variables analyzed in the present study. Therefore, the main objective of this article is to analyze the motivational processes and the intention to be physically active of university students when engaging in PA according to gender and different fields of study.

2. Materials and methods

The method consisted of a non-experimental empirical study with a comparative research strategy using a cross-sectional (Ato et al., 2013) cohort design. The study used motivational variables and aspects associated with intention to be physically active in the future, taking into account gender and different fields of study.

2.1. Participants

A non-probability sample was selected of 1.524 first-year students from different degree courses of the University of Extremadura (Spain), of which 38.1% ($n = 580$) were male and 61.9% ($n = 944$) were female, with an average age of around 20 years ($M_{age} = 19.61 \pm 3.65$). The distribution of students by field of study was carried out according to the International Standard Classification of Education (ISCED) developed by the UNESCO Institute for Statistics (UNESCO, 2012) and was distributed as follows: Arts and Humanities 7.7% ($n = 118$), Science 8.7% ($n = 132$), Health Sciences 23% ($n = 351$), Engineering and Architecture 12.9% ($n = 196$) and Social and Legal Sciences 47.7% ($n = 727$).

2.2. Instruments

Two questionnaires were used as measurement instruments for this study. The first of these was the Behavioral Regulation in Exercise Questionnaire (BREQ-3) in its Spanish version (Wilson et al., 2007; González-Cutre et al., 2010). This questionnaire consists of 23 items grouped into six factors, of which four belong to intrinsic motivation (e.g., "Because I find exercise an enjoyable activity"), four for integrated regulation (e.g., "Because I consider exercise to be part of me"), three for identified regulation (e.g., "Because I value the benefits of exercise"), four for introjected regulation (e.g., "Because I get nervous if I do not exercise regularly"), four for external regulation (e.g., "Because others tell me I should do it"), and four for amotivation (e.g., "I do not see why I have to do it"). The response scale was a Likert-type scale ranging from 0 (Not true at all) to 4 (Completely true). The factors and their reliability were: Intrinsic motivation ($\alpha = 0.90$), Integrated regulation ($\alpha = 0.91$), Identified regulation ($\alpha = 0.78$), Introjected regulation ($\alpha = 0.70$), External regulation ($\alpha = 0.80$) and Amotivation ($\alpha = 0.78$). The values of Cronbach's alpha were mostly adequate ($\alpha > 0.70$; Nunnally and Bernstein, 1994).

The second instrument used was the Intention to be Physically Active in the University Context (MIFAU) measurement scale, based on the Spanish version by Expósito et al. (2012). The questionnaire begins with the sentence "Regarding your intention to engage in physical-sporting activity." and consists of five items, e.g., "I am interested in developing my physical condition." The responses consisted of a Likert-type scale ranging from 1 to 5, with 1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree and 5 = Strongly Agree. The internal consistency value was $\alpha = 0.79$ and it is therefore considered to have adequate reliability ($\alpha > 0.70$; Nunnally and Bernstein, 1994).

2.3. Procedure

The study was conducted in accordance with the standards required by the American Psychological Association (2010). It was also approved by the Bioethics and Biosafety Committee of the University of Extremadura during its meeting held on 16 June, 2022. Permission was sought from both the lecturers responsible for the subjects taught in the different university degrees and from all the participants who completed the questionnaire. They were also informed that their participation was voluntary and anonymous in accordance with Spanish Law 15/1999 of 13 December on Protection of Personal Data. Before distributing the questionnaires, the objective of the survey was explained in detail, and it was indicated that the survey would take no more than 15 min to complete. The survey was conducted in person, with the principal investigator being present to collect the questionnaires. None of the participants reported any difficulties completing the instrument. The period for the implementation of the instrument was carried out during the academic year 2021/2022, adjusting to the availability and class times of the collaborating teachers and students.

2.4. Statistical analysis

Initially, the psychometric properties of the BREQ-3 and MIFAU scales were analyzed by means of a confirmatory factor analysis and internal consistency values expressed by Cronbach's alpha.

Several indices (Hu and Benthler, 1999) were considered to evaluate the adequacy of the model fit of the questionnaires used (BREQ-3 and MIFAU): the global goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), the normalized fit index (NFI), the relative fit index (RFI), the root mean square residual (RMR) and the standardized root mean square residual (SRMR). The values of the GFI, AGRFI, NFI and RFI range from 0 to 1, where 0 indicates no fit and 1 indicates optimal fit. Values of 0.95 or above are considered excellent and values above 0.90 suggest an acceptable fit of the model to the data. The optimal values of the fit for RMR and SRMR should be ≤ 0.1 (Hu and Benthler, 1995; Kline, 2010; Byrne, 2013). A model was then considered in which the regulators of motivation were related to the intention to be physically active, intrinsic motivation integrated and positively identified, while introjected, external and amotivation were negatively identified. The maximum likelihood (ML) method was implemented. The invariance of the model between gender groups was tested using multi-sample invariance analysis. Differences not greater than 0.01 in CFI (ΔCFI) and not greater than 0.015 in RMSEA (ΔRMSEA) were considered an indication of insignificant differences between groups (Cheung and Rensvold, 2002).

A descriptive analysis was also carried out to determine the nature of the data. Subsequently, the Mann–Whitney U test was used to obtain the gender differences between the variables studied and the Kruskal–Wallis *H* test was used for the fields of study. The significance level was set at $p<0.05$ (Newell et al., 2014). Finally, the Effect Size was calculated using Cohen's *d*, classified as low effect (0–0.2), small effect (0.2–0.6), medium effect (0.6–1.2), large effect (1.2–2.0) and very large effect (>2.0; Hopkins et al., 2009). The software used was the SPSS 25 (Statistical Package for the Social Sciences, IBM Corp. Published in 2012. IBM SPSS Statistics for Windows, Version 25, IBM Corp, Armonk, NY, United States).

3. Results

Because the assumptions of normality were not met, the Unweighted Least Squares method was used for the confirmatory analysis of the Likert scales. The results indicated that the model had a good fit for the BREQ questionnaire (GFI = 0.99, AGFI = 0.98, NFI = 0.98 and RFI = 0.98) and that the values of the RMR (0.06) and SRMR (0.05) were adequate. In the case of the MIFAU questionnaire the indicators were also adequate

(GFI = 0.99, AGFI = 0.99, NFI = 0.99, RFI = 0.98, RMR = 0.04 and SRMR = 0.03; Hu and Benthler, 1995; Kline, 2010; Byrne, 2013).

Table 1 shows the results of the descriptive analysis of the variables associated with the BREQ-3 and the MIFAU. Overall, the highest factors were intrinsic motivation and integrated regulation, with mean scores of 2.65 ± 1.10 and 2.18 ± 1.19, respectively. Meanwhile, amotivation and external regulation were the variables with the lowest scores, with means of 0.59 ± 0.79 and 0.45 ± 0.72, respectively. Regarding intention to be physically active in the future (MIFAU), the average value obtained was 3.76 ± 0.85, with the maximum score of the questionnaire being five points. Significant positive correlations were found between the intention to be physically active and the most self-determined, intrinsic, integrated, and identified types of regulation $p<0.01$.

Figure 1 shows the structural model, where the coefficient of determination is very high ($R^2 = 0.81$), being greater than 0.3 (Chin, 1998). All factor loadings were greater than 0.50. The correlations between constructs are significant ($p<0.001$) in the case of intrinsic (β = 0.21), integrated (β = 0.39) and identified (β = 0.35) regulation, being the variables that predict being physically active. The X^2/df ratio yields a result of 4.720 below 5, indicating an adequate fit of the data. The remaining measures also take values within the limits that allow us to affirm a good fit of the data (GFI = 0.93; AGFI = 0.91; CFI = 0.94; RMSEA = 0.05; NFI = 0.93; RMSEA = 0.49).

A multi-group confirmatory factor analysis (CFA) was performed to test the measurement invariance of the model as a function of sex. Initially, the baseline configuration invariance model (M1) was tested, where the X^2/df, CFI, TLI and RMSA values ensured adequate fit (Table 2).

To obtain the metric invariance model, the regression weights or factor weights (M2) were added to the model. The values obtained are within the acceptable limits for goodness of fit ($X^2/df = 2.94$; CFI = 0.94; TLI = 0.93; RMSEA = 0.03). Based on the nested model's evaluation criterion, the CFI difference is less than 0.01 (0.003), and the RMSEA is less than 0.015 (0.000). To analyze the strong invariance (M3), the intercepts between groups were incorporated. The values obtained are within the acceptable limits for goodness of fit ($X^2/df = 3.16$; CFI = 0.93; TLI = 0.92; RMSEA = 0.03). Based on the evaluation criteria for nested models, the CFI difference is less than 0.01 (0.009), and the RMSEA is less than 0.015 (0.002). Finally, strict invariance (M3) was analyzed, where the values $X^2/df = 2.91$; CFI = 0.92; TLI = 0.92; RMSEA = 0.03 are within the limits for the sex variable. The variance of the AIC is not very high. Therefore, the goodness of fit of the model invariance of the compared models for the sex variable is verified (Cheung and Rensvold, 2002).

Motivational regulation and intention to be physically active were analyzed according to gender (Table 3). The results showed statistically significant differences in favour of men ($p<0.01$) in terms of intrinsic, integrated, identified, and introjected regulation of PA. The variable for the least self-determined behavior (amotivation) revealed more favorable results in the case of men, confirming the existence of significant gender differences ($p<0.05$). Men were also more likely to be physically active in the future than women ($p<0.001$). Finally, the analysis of the Effect Size found a medium effect for three of the variables analyzed: integrated ($d = 0.481$) and intrinsic ($d = 0.394$) regulation on the one hand, and the variable associated with the MIFAU scale on the other ($d = 0.390$).

Table 4 shows significant differences for several types of motivation according to the different fields of study, namely intrinsic motivation ($H = 32.85$; $p<0.001$), integrated regulation ($H = 22.29$; $p<0.001$), identified regulation ($H = 15.40$; $p<0.01$) and amotivation ($H = 34.97$; $p<0.001$). There were also statistically significant differences when analyzing intention to be physically active ($H = 18.43$; $p<0.001$). No significant differences were observed in the case of introjected regulation and external regulation ($p>0.05$; Figure 2).

4. Discussion

The aim of this study was to examine the differences in the types of motivation and the intention to be physically active

TABLE 1 Descriptive results of the variables associated with the BREQ-3 and the MIFAU.

	Mean	SD	Variance	Skewness (Desv. Err = 0.06)	Kurtosis (Desv. Err = 0.12)	K-S	I	II	III	IV	V	VI
Intrinsic	2.65	1.10	1.23	−0.67	−0.40	0.12**						
Integrated	2.18	1.19	1.42	−0.10	−1.07	0.08**	0.76**					
Identified	2.11	0.72	0.52	−0.69	0.36	0.17**	0.49**	0.60**				
Introjected	1.12	0.89	0.80	0.61	−0.34	0.11**	0.23**	0.37**	0.46**			
External	0.45	0.72	0.52	1.89	3.39	0.29**	−0.27**	−0.16**	0.22**	0.30**		
Amotivation	0.59	0.79	0.64	1.65	2.76	0.23**	−0.44**	−0.40**	−0.30**	−0.08**	0.36**	
MIFAU	3.76	0.85	0.72	−0.69	0.04	0.10**	0.69**	0.70**	0.51**	0.28**	−0.21**	−0.44**

**$p<0.01$.

among university students according to gender and different fields of study.

Our model findings show that the most self-determined behaviors (intrinsic, integrated and identified) predict intention to be physically active, the remaining behaviors (introjected, external and amotivation) do not. These data are in line with those obtained by other authors (Thøgersen-Ntoumani and Ntoumanis, 2006; Taylor et al., 2010; Esmaeilzadeh et al., 2022). We also found that there is no variance between genders, coinciding with other research showing that variables associated with PA are not consistent between genders (Azevedo et al., 2007).

The results indicate that the male students of the sample were characterized by greater intrinsic, integrated, identified, and introjected regulation than female students on the self-determination continuum. The results are similar to those of other studies, which found that individuals engaging in PA have high scores for these variables (Blázquez et al., 2015; Concha-Viera et al., 2017; Durán-Vinagre et al., 2022). This suggests a strengthening of the positive relationship between PA and more self-determined behavior (Concha-Viera et al., 2017).

On the other hand, the types of motivation that least characterized the study population were external motivation and amotivation. The same results were found in other studies, with low scores for these factors (Concha-Viera et al., 2017; Durán-Vinagre et al., 2021; Gutiérrez-García et al., 2021).

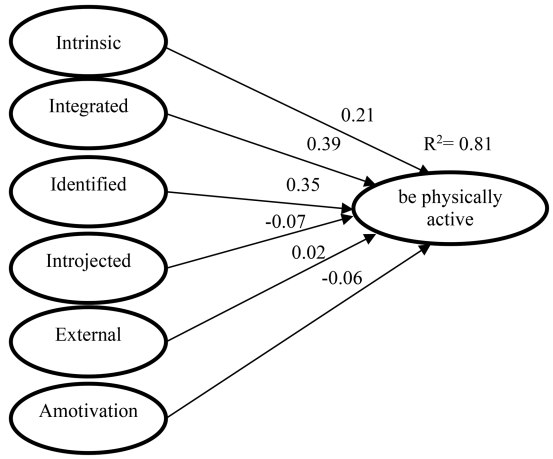

FIGURE 1
Model supporting regulators of motivation to be physically active.

Differences were also found between men and women in terms of the different types of regulation. The results indicate statistically significant differences for intrinsic, integrated, identified, introjected regulation, and amotivation with the mean differences for men standing out with respect to women. The studies by Durán-Vinagre et al. (2022) and Luque-Casado et al. (2021) revealed similar results, with the men in the sample being significantly more motivated than the women. One of the possible explanations for this significant gender difference may be that it is more culturally acceptable for the male role to be characterized by more stimulating, dynamic, and active activities than the female role (Concha-Viera et al., 2017; Martínez and Sauleda, 2019).

In terms of the study objectives, it can be seen that the sample showed statistically significant differences in terms of intention to be physically active in the future, with men scoring more favorably for this variable. In contrast to these findings, (Durán-Vinagre et al., 2019; Sánchez-Herrera et al., 2022) obtained the same statistical differences in terms of gender.

If we focus on the university years, women studying at Spanish universities have more sedentary lifestyles with low levels of physical activity. The main causes are the consumption of unhealthy foods, high levels of stress and anxiety and little free time due to the academic commitments of current degree courses (Díaz et al., 2014). These causes are considered by other authors to be the most frequent barriers to making academic tasks compatible with physical and sporting activity (Martínez-Lemos et al., 2014; Samperio et al., 2016; Castañeda et al., 2018).

Finally, the different types of motivational regulation and intention to be physically active were related to the different fields of study (Arts and Humanities, Science, Engineering and Architecture, Health Sciences and Social and Legal Sciences). Significant differences were found for these variables in terms of intrinsic, integrated and identified regulation, amotivation, and intention to be physically active. In contrast to these results, (Sánchez-Herrera et al., 2022) found that Health Sciences students showed a more favorable tendency towards intrinsic and integrated regulation and

TABLE 2 Factor invariance across the gender variable.

Model	X^2	*df*	X^2/df	*p*	CFI	TLI	RMSEA	AIC
M1 Configuration invariance (baseline)	1847.28	632	2.92	0.001***	0.94	0.93	0.036 (0.34–0.37)	2319.28
M2. Metric invariance	1925.12	653	2.94	0.001***	0.94	0.93	0.036 (0.34–0.38)	2355.12
M3 Scalar invariance	2156.13	681	3.16	0.001***	0.93	0.92	0.038 (0.34–0.38)	2530.13
M4. Strict invariance	2104.60	722	2.91	0.001***	0.92	0.92	0.037 (0.34–0.37)	2570.35

***$p<0.001$.

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TABLE 3 Inferential results of the regulation of motivation and intention to be physically active as a function of gender.

	Sex	Mean - SD	U	*p*	*d*
Intrinsic	Men	2.92 ± 0.41	210794.00	0.001***	0.394
	Woman	2.48 ± 0.03			
Integrated	Men	2.53 ± 0.04	197617.00	0.001***	0.481
	Woman	1.96 ± 0.03			
Identified	Men	2.20 ± 0.02	244654.50	0.001***	0.179
	Woman	2.05 ± 0.02			
Introjected	Men	1.21 ± 0.03	248678.50	0.003**	0.155
	Woman	1.06 ± 0.02			
External	Men	0.46 ± 0.02	265716.50	0.348	0.049
	Woman	0.44 ± 0.02			
Amotivation	Men	0.63 ± 0.03	257538.50	0.040*	0.100
	Woman	0.56 ± 0.02			
MIFAU	Men	3.95 ± 0.03	211460.50	0.001***	0.390
	Woman	3.64 ± 0.02			

*p<0.05; **p<0.01; ***p<0.001.

TABLE 4 Inferential results of the regulation of motivation and intention to be physically active as a function of the field of study.

	H	*p*	*d*	Pairwise comparisons
Intrinsic	32.85	0.001***	0.278	EA > AH
Integrated	22.29	0.001***	0.221	EA > SLS
Identified	15.40	0.004**	0.174	EA > SLS
Introjected	3.41	0.491	0.039	-
External	8.78	0.067	0.112	-
Amotivation	34.97	0.001***	0.289	EA > HS
MIFAU	18.43	0.001***	0.196	HS > SLS

**p<0.01; ***p<0.001; AH, Arts and Humanities; S, Sciences; HS, Health Sciences; EA, Engineering and Architecture; SLS, Social and Legal Sciences.

lower scores for external regulation and amotivation. Likewise, these results support those of Gutiérrez-García et al. (2021) given that the same differences were obtained when comparing the means. However, there is a lack of studies in the scientific literature that relate the variables studied with different fields of study, making it more difficult to compare the results obtained. There is research such as Práxedes et al. (2016), Chung et al. (2018), Sevil et al. (2018), Durán-Vinagre et al. (2019), and Durán-Vinagre et al. (2020) that consider the types of motivation or intentionality related to PA in university students from different specific university degrees or studies that do not specify the characteristics of the participants in the sample, without extracting and comparing results that are related to participants from other university degrees that are within the same field of knowledge.

This gap allows us to speculate on our findings, and we can deduce that students of Health Sciences are more likely to show a more intrinsic motivation, being able to value more the benefits and improvements that encompass motivation and PA from a healthy point of view. However, it is striking that students of Engineering and Architecture present a great difference with those of Arts and Humanities. These data are associated with the values obtained for amotivation, i.e., the lack of interest in doing PA, so that on this occasion it is the students of Engineering and Architecture who show a significant difference with respect to those of Social Sciences and Law. Finally, when considering the intentionality of being physically active, the students of Health Sciences show a greater interest in practicing sports than those of Social and Legal Sciences. These are data that should be contrasted with further research in the future in order to respond to similar empirical studies with another university population sample.

The results for the study population underline the importance of continuing with this line of research to generate information favoring the development of strategies that contribute to more self-determined regulation in the practice of PA. Resources, tools and other means are needed to promote values that are important for university students and thereby achieve greater enjoyment of regular physical activity in any of its forms. In this sense, it would be advisable to promote recreational activities that allow physical activity to be seen as an activity freely engaged in and not an institutionalized or compulsory activity.

5. Conclusion

The findings show that men are characterized by more self-regulated behavior than women. These results also offer an insight into the types of behavioral regulation of physical activity among university students in different fields of study. They are a valuable tool when it comes to establishing intervention strategies for the prevention of noncommunicable diseases that take into account the peculiarities of the university context and the possibility of promoting and facilitating physical-sports activity among university students according to their diversity.

Key activities need to be identified that represent an enjoyable and positive experience for these individuals. University students have many difficulties adhering to PA programs, but if we know their characteristic psychological variables, strategies can be proposed that take into account the improvement of physical condition and also the creation of healthier lifestyle habits that allow them to maintain more regular PA. Efforts should also be made to ensure this group adheres to sporting activities and does not abandon them. University sport services should promote an adequate environment and a range of physical-sporting activities to favor more self-determined motivation, allowing students to appreciate the benefits of being physically active and

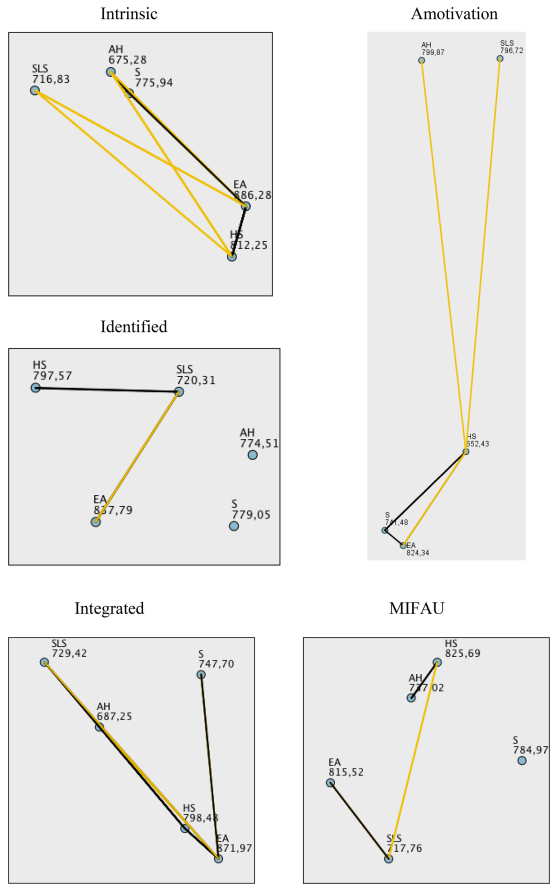

FIGURE 2
Multiple pairwise comparisons of exercise behavior regulation variables according to fields of study. AH, Arts and Humanities; S, Sciences; HS, Health Sciences; EA, Engineering and Architecture; SLS, Social and Legal Sciences.

thereby mitigating the consequences deriving from physical inactivity.

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.

Ethics statement

The studies involving human participants were reviewed and approved by Research Bioethics Committee of the University of Extremadura and received a favorable ethical opinion (code: 95/2022). The participants provided their written informed consent to participate in this study.

Author contributions

MÁD-V, SF, SJI, and SS-H conceived the aim of this study. MÁD-V participated in the data collection. MÁD-V, SF, and SJI participated in the methods and results. All authors have contributed to the writing-review and editing of the article and have also read and accepted the published version of the manuscript.

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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.

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EDITED BY
Alberto Sanmiguel-Rodríguez,
Camilo José Cela University, Spain

REVIEWED BY
Shu Wang,
Beijing Tiantan Hospital,
Capital Medical University,
China
Yong-Bo Zheng,
Peking University Sixth Hospital, China

*CORRESPONDENCE
Akiyoshi Shimura
✉sim@tokyo-med.ac.jp

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Too much is too little: Estimating the optimal physical activity level for a healthy mental state

Akiyoshi Shimura[1]*, Jiro Masuya[1], Katsunori Yokoi[2], Chihiro Morishita[1], Masayuki Kikkawa[1], Kazuki Nakajima[1], Chong Chen[3], Shin Nakagawa[3] and Takeshi Inoue[1]

[1]Department of Psychiatry, Tokyo Medical University, Shinjuku-ku, Tokyo, Japan, [2]School of Medicine, International University of Health and Welfare, Chiba, Japan, [3]Division of Neuropsychiatry, Department of Neuroscience, Yamaguchi University Graduate School of Medicine, Ube, Yamaguchi, Japan

Introduction: Although physical activity and exercise are generally thought to have favorable effects on mental health, excessive physical activity may have unfavorable effects. In this study, the associations between physical activity and the states of mental health with U-shaped dose–response curves were hypothesized, and the ranges of physical activity resulting in optimal effects on mental health were investigated.

Methods: A cross-sectional survey was conducted on 1,237 adult volunteers in 2017 and 2018. Of these volunteers, 526 participants validly answered the self-administered questionnaires asking about physical activity, depression, anxiety, resilience, insomnia vulnerability, and life events. A comparison of mental health measures by physical activity levels and quadratic equation model regressions were performed.

Results: No significant linear associations between physical activity levels and mental health measurements were observed; however, the U-shaped, quadratic equation models indicated a significance. The following levels of physical activity per week optimized the mental health measurements values of the participants: 6,953 MET-minutes and 25.70 h for depression, 5,277 MET-minutes and 21.60 h for state anxiety, 5,678 MET-minutes and 22.58h for trait anxiety, 25.41 h for resilience, and 9,152 MET-minutes and 31.17 h for insomnia vulnerability.

Conclusion: Physical activities in the optimal range were associated with more favorable mental health measurements. Physical activities that were too much or too long and outside of the optimal range were associated with less favorable mental health measurements.

KEYWORDS

physical activity, exercise, mental health, optimal level, depression, anxiety, resilience, insomnia vulnerability

Introduction

Physical activity and exercise generally result in favorable effects on mental health. The association between physical activity and depression, anxiety, neuroticism, resilience, and insomnia were indicated in various studies. Meta-analyses have indicated the treatment effects of physical activity and exercise on the symptoms of people with depression (Krogh et al., 2010; Bridle et al., 2012; Josefsson et al., 2014; Schuch et al., 2016; Nebiker et al., 2018), and exercise is expected to decrease and prevent depressive symptoms not only in patients but also in the general population (Brown et al., 2005; Teychenne et al., 2008; de Zeeuw et al., 2010; Chekroud et al., 2018). Regarding other mental health outcomes, physical activity also decreases the anxiety levels of patients (Petruzzello et al., 1991; Hansen et al., 2001; Herring et al., 2010; Jayakody et al., 2014; Wegner et al., 2014; Marcos de Souza Moura et al., 2015; Stonerock et al., 2015; Aylett et al., 2018), is associated with increased resilience (Childs and de Wit, 2014), and also reduces insomnia symptoms (Driver and Taylor, 2000; Baron et al., 2013; Kredlow et al., 2015; Kelley and Kelley, 2017; Banno et al., 2018) and may also prevent insomnia (Morse et al., 2019).

There are multiple possible biological mechanisms by which physical activity has positive effects on mental health. For example, exercise improves brain-derived neurotrophic factor (BDNF) secretion levels in humans (Szuhany et al., 2015), and modulates cortical glutamate and γ-amino butyric acid levels (Maddock et al., 2016). Physical activity augments neurogenesis and synaptogenesis in the hippocampus, and also increases serotonin levels in animals (Kondo and Shimada, 2015). These biological changes may decrease the level of depression, anxiety, or insomnia in humans.

On the other hand, the dose–response association between the level of physical activity and mental health remains unknown. A previous large-scale cross-sectional study (Hamer et al., 2009) and a randomized control trial (Dunn et al., 2005) indicated a dose–response association of relatively low level physical activity with psychological distress and depression; however, a review concluded that there was little evidence of a dose–response association of physical activity with depression and anxiety (Dunn et al., 2001). Particularly regarding relatively high levels of physical activity, it remains unclear whether a higher level of physical activity is simply better or not. Regarding physical health, physical activities that are too vigorous or too long will cause physical and functional impairments in individuals, which is known as "overtraining syndrome" (Johnson and Thiese, 1992; Armstrong and VanHeest, 2002; Wyatt et al., 2013). This adverse effect of too much physical activity is not only limited to physical health but is expected to also affect mental health (Johnson and Thiese, 1992). A possible path by which overexercising may lead to depressive or anxiety symptoms is through the hypothalamic–pituitary–adrenal axis, because overexercising causes the secretion of cytokines and cortisol (Smith, 2000; Wyatt et al., 2013; Anderson et al., 2016). This suggests that there is a nonlinear association between the amount of physical activity and mental health.

If both too little and too much physical activity have unfavorable effects on mental health, a nonlinear dose–response association, such as a U-shaped curve might be observed. In fact, a previous large-scale study (Chekroud et al., 2018) suggested a potential L-shaped or U-shaped association between physical activity level and mental health, and that performing certain types of exercise on most days of the month leads to unfavorable effects on mental health. However, to date, there have been no studies analyzing whether the model of the U-shaped association is true or not, and moreover, no study has clarified the optimal level of physical activity for mental health.

Here, we performed a cross-sectional study to analyze the associations between the amount of physical activity and representative mental health components, such as depression, anxiety, neuroticism, resilience, and insomnia, by assessing the quadratic equation model to confirm the hypothesis that there are significant non-linear, U-shaped dose–response associations between physical activity and aspects of mental health.

Materials and methods

Study design and participants

This study was designed as a cross-sectional survey using self-administered questionnaires. The data of the participants have been used in previous studies investigating the associations between job stress and sleep rhythm (Miyama et al., 2020) or resilience (Sameshima et al., 2020). First, the effect size of physical activity on mental health was conservatively estimated as "small to medium" (Cohen's $d = 0.2$ to 0.5). Thus, the optimal sample size was calculated to be 105 to 651, and hence approximately 1,300 participants were recruited, with an expected valid response rate of 50%. Subsequently, a paper-based survey form was distributed to 1,237 Japanese volunteers from the nonclinical adult population, from September 2017 to May 2018. The volunteers were nonclinical workers who were recruited by convenience sampling through person-to-person acquaintances at a University located in Tokyo, which is an urban area of Japan. Of those, 526 volunteers (42.5%) gave informed consent and valid answers to the questionnaire without any missing data. Answers were collected anonymously. There were no special inclusion or exclusion criteria. The study was conducted in accordance with the Declaration of Helsinki (amended in Fortaleza in 2013) and approved by the Tokyo Medical University Research Ethics Committee (study approval no.: SH3502).

Questionnaires

The International Physical Activity Questionnaire (IPAQ) was used to assess the physical activity level of the participants. For

assessment of the mental health states of the participants, The Patient Health Questionnaire-9 (PHQ-9) was used for depression, The State–Trait Anxiety Inventory, Form Y (STAI-Y) for anxiety, The Connor-Davidson Resilience Scale (CD-RISC) for resilience, and The Ford Insomnia Response to Stress Test (FIRST) for insomnia vulnerability.

IPAQ is a self-administered questionnaire that is widely used all over the world (Craig et al., 2003), and the validated Japanese short-form version (Murase, 2002) was used in this study. IPAQ assesses physical activity in the following 4 domains: leisure-time physical activity, domestic and gardening activities, work-associated physical activity, and transport-associated physical activity, and the short form asks about the following 3 specific types of activity: walking, moderate-intensity activities, and vigorous-intensity activities. IPAQ enables estimation of the total physical activity intensity indicated as METs and total physical activity duration. One MET is equivalent to the resting metabolic kilocalories for a person per bodyweight in kg. For example, if a person with a 50 kg bodyweight walks, which has a 3 METs score, for 60 min, the metabolic kilocalories are estimated as 50 kg * 3 METs * 1 h = 150 kcal, and is described as 3 METs * 60 min = 180 MET-minutes.

PHQ-9 (Kroenke et al., 2001) and its validated Japanese version (Muramatsu et al., 2007) was used for assessing depressive symptoms. PHQ-9 is a self-administered questionnaire consisting of 9 items associated with depression. PHQ-9 has high sensitivity and specificity for clinical major depressive episodes, with higher scores indicating a severer depressive state.

STAI-Y (Spielberger et al., 1971) and its validated Japanese version (Hidano et al., 2000) was used to assess trait and transient state anxiety. STAI-Y consists of a 40-item self-report questionnaire and subjects answer how they feel anxiety generally or at a particular moment specified in each item. In both the trait anxiety category and state anxiety category, higher scores indicate higher levels of anxiety.

CD-RISC (Connor and Davidson, 2003) and its validated Japanese version (Nishi et al., 2010) was used to assess psychological resilience. CD-RISC is a 25-item Likert scale questionnaire that assesses the "personal qualities that enable one to thrive in the face of adversity." A higher score on CD-RICS indicates that the person is in a more psychologically resilient state.

FIRST (Drake et al., 2004) and its validated Japanese version (Nakajima et al., 2014) was used to assess the tendency of having insomnia owing to stressful conditions. FIRST consists of a 9-item self-report questionnaire that analyzes the level of trait vulnerability and sleep reactivity to experience situational insomnia. Persons with higher scores on FIRST are more vulnerable to and easily develop insomnia as a result of their environment.

To assess the effects of private events on mental health measures, the validated Japanese version (Nakai et al., 2014) of Life Experiences Survey (LES; Sarason et al., 1978) was used. LES is a 57-item self-report measure assessing major life events in the past 12 months. Each item is given a score ranging from −3 to +3. LES positive change scores sum the impact ratings of positive life events, and LES negative change scores sum the impact ratings of negative life events.

Data analysis and quadratic equation model

First, the association between physical activities and mental health measurements were investigated, and a comparison by demographic variables was performed. Second, linear regression analyses were performed using total weekly physical activity volume and duration as independent variables, and mental health measurements as dependent variables. For the linear regression analyses, the squared term of total physical activity volume and duration were added. This enabled analysis of the significance of the U-shaped curve hypothesis, and estimation of physical activity volume and duration values that minimize or maximize the mental health measurements if it is significant, similar to the method that calculating the optimal BMI 22 for minimizing morbidity (Tokunaga et al., 1991; Figure 1).

Statistical analyses were performed using IBM SPSS Statistics version 23 software. A value of p of less than 0.05 was considered to indicate a statistically significant difference between groups.

Results

Participants comprised 228 men (43.3%) and 297 women (56.5%), and 1 other (0.2%). The mean age was 41.2 years [standard deviation (SD) = 11.9 years]. The mean weekly total physical activity volume was 2,479.6 MET-minutes (SD = 3,467.3 MET-minutes), which is equivalent to 2,479.6 kcal metabolism per week for participants with a 60-kg bodyweight. The mean weekly total physical activity duration was 10.4 h (SD = 14.3 h). The values of Cronbach's α of the mental health measurements were PHQ9: 0.854, STAI-Y: 0.783, CD-RISC: 0.948, and FIRST: 0.895, with acceptable to high (Cortina, 1993) reliability. The results of the comparison of gender differences and Pearson's correlation analysis are shown in Table 1. Significant gender differences were observed in mental health measurements ($p < 0.05$, t-test). Women had higher scores on depression, trait and state anxiety, and insomnia vulnerability, and a lower score on resilience.

Regression analyses were performed to investigate the associations between physical activity levels and mental health measurements. Univariate linear regression analyses demonstrated that there were no linear associations between physical activity level (both volume and duration), and mental health measurements. However, the quadratic equation models indicated statistical significances. Table 2 shows the result of the regression analyses of the effects of total physical activity volume on mental health measures. For depression, 6,953 MET-minutes per week minimized the PHQ-9 value ($F = 11.632$, $p < 0.001$); for state anxiety, 5,277 MET-minutes per week minimized the value of STAI-Y/state ($F = 7.441$, $p < 0.001$); for trait anxiety, 5,678 MET-minutes per week

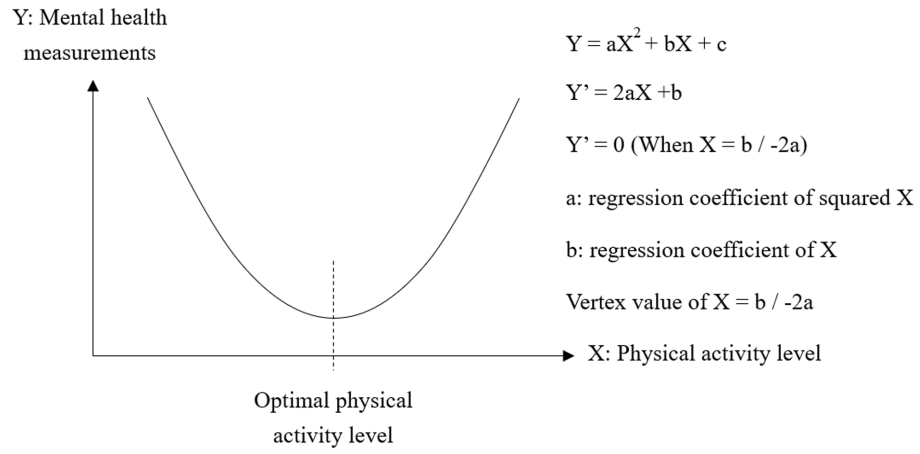

FIGURE 1
Explanation of quadratic equation model regression analysis.

minimized the value of STAI-Y/trait ($F=9.773$, $p<0.001$); and for insomnia vulnerability, 9,152 MET-minutes per week minimized the value of FIRST ($F=5.350$, $p=0.005$). Regarding resilience, although the physical activity volume model did not show statistical significance ($F=2.383$, $p=0.093$), after adjusting for gender, 7,468 MET-minutes per week maximized the value of CD-RISC score ($F=2.619$, $p=0.050$). The results adjusted by gender and positive/negative life experiences score indicated similar values. Supplementary Table 1 shows the results divided by gender. Each optimal physical activity level among males was higher than that of females. Table 3 shows the result of the regression analyses of the effects of total physical activity duration on mental health measures. For depression, 25.70 h per week minimized the value of PHQ-9 ($F=6.906$, $p=0.001$); for state anxiety, 21.60 h per week minimized the value of STAI-Y/state ($F=10.748$, $p<0.001$); for trait anxiety, 22.58 h per week minimized the value of STAI-Y/trait ($F=10.198$, $p<0.001$); for resilience, 25.41 h per week maximized the value of CD-RISC ($F=4.031$, $p=0.018$); and for insomnia vulnerability, 31.17 h per week minimized the value of FIRST ($F=5.726$, $p=0.003$). The results adjusted by gender and positive/negative life experiences score indicated similar values. Supplementary Table 2 shows the results divided by gender. Each optimal physical activity duration among males was longer than that of females. The calculated graphs of the U-shape curve were shown in Figure 2.

These results indicated that physical activity levels of approximately +1 SD can be regarded as optimal physical activity levels in this population. To compare between people performing different levels of physical activity, participants were divided into 3 groups; i.e., lower-intermediate (performing physical activities of less than the average volume or duration), higher-intermediate (performing physical activities of more than the average volume or duration and less than +1 SD), and high (more than +1 SD); the mental health measurements of each group are shown in Table 4. One-way ANOVA indicated that there are group differences, and the higher-intermediate group tended to show more favorable mental health measurement scores than the other groups.

Discussion

In this study, we statistically confirmed the nonlinear, but U-shaped associations between physical activity level and various mental health measurements. Approximately 21 to 31 h of physical activity per week (3 to 4.5 h daily), or 5.3 to 9.2 k METs-minutes (750 kcal to 1,300 kcal daily for a 60-kg person) was found to be associated with an optimal mental health state, regarding depression, anxiety, resilience, and insomnia. Under regular circumstances, exercise is expected to have favorable effects on mental health; however, beyond the optimal range, i.e., too intense or too long physical activity, is associated with impairment of mental health.

To date, no guidelines or optimal targets of exercise or physical activity level to efficiently maintain mental health have been established. The findings in this study indicating that a target level of physical activity to obtain an optimal mental health state can be set would be beneficial in clinical scenes or for mass-intervention from the aspect of public health. As described in previous studies, the associations between physical activity level and depression (Brown et al., 2005; Teychenne et al., 2008; de Zeeuw et al., 2010; Chekroud et al., 2018), anxiety (Petruzzello et al., 1991; Hansen et al., 2001; Herring et al., 2010; Jayakody et al., 2014; Wegner et al., 2014; Marcos de Souza Moura et al., 2015; Stonerock et al., 2015; Aylett et al., 2018), resilience (Childs and de Wit, 2014), and insomnia vulnerability (Morse et al., 2019) were also confirmed in this study. Particularly, in the "not too much" range, physical activity was associated linearly with mental health measurements. Regarding depression, although a review has concluded that both shorter and longer durations and vigorous-intensity physical activities are effective in reducing the likelihood of depression (Teychenne et al., 2008), the definitions of "longer" and "vigorous" were not specified, and a large-scale study (Chekroud et al., 2018) indicated that exercising on most days of the month results in unfavorable effects on mental health. The lack of a threshold regarding "how much is too much" is a

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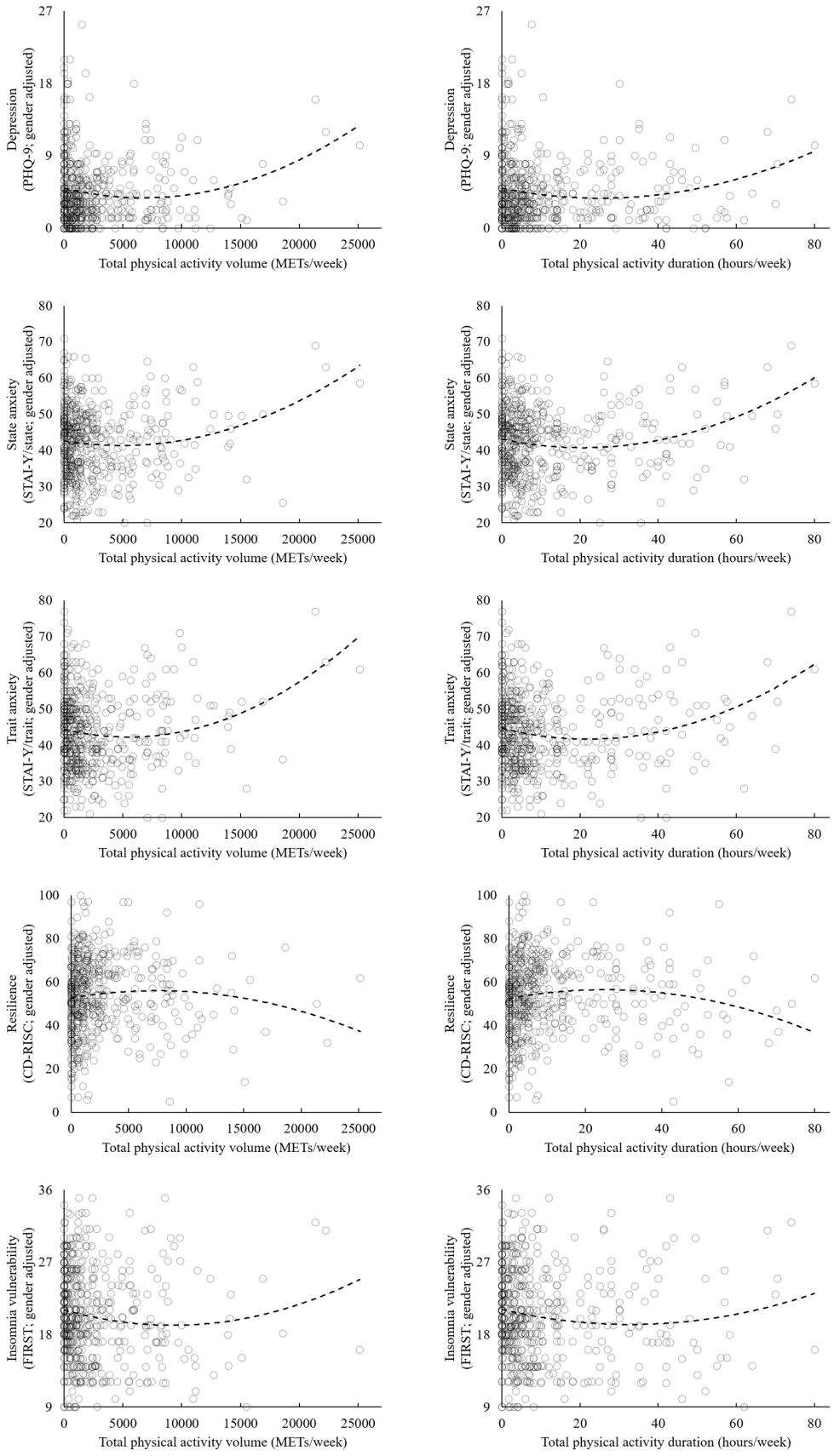

FIGURE 2
Physical activity levels and mental health measurements.

TABLE 1 Demographic characteristics, physical activity, and mental health measurements of the participants.

Characteristic or life habit	N (%) or mean (SD)	Mean (SD) or Pearson's correlation (*r*)						
		PA volume	PA duration	Depression	State anxiety	Trait anxiety	Resilience	Insomnia vulnerability
Demographic characteristic								
Male	228 (43.3%)	2,722.4 (3,317.6)	11.08 (13.00)	3.27 (3.79)**	39.8 (9.3)**	41.7 (10.2)*	56.9 (18.5)*	17.3 (5.6)**
Female	297 (56.5%)	2,292.1 (3,579.9)	9.93 (15.23)	4.51 (4.36)**	42.5 (9.9)**	43.7 (10.5)*	53.6 (16.2)*	20.5 (5.8)**
Age	41.2 (11.9)	−0.021	−0.024	−0.025	0.019	−0.052	0.006	0.082
LES: positive life experiences score	1.60 (2.69)	0.023	0.019	−0.106*	−0.125**	−0.135**	0.206**	−0.048
LES negative life experiences score	1.82 (3.32)	0.034	0.040	0.324**	0.298**	0.310**	−0.100*	0.221**
Physical activity per week								
Total physical activity volume (MET-minutes)	2,479.6 (3467.3)	1	0.968**	0.003	0.074	0.068	0.016	−0.074
Total physical activity duration (hours)	10.4 (14.3)	0.968**	1	−0.001	0.074	0.057	−0.003	−0.071
Mental health measurements								
Depression (PHQ-9)	3.97 (4.16)	0.003	−0.001	1	0.535**	0.642**	−0.385**	0.433**
State anxiety (STAI-Y/state)	41.3 (9.7)	0.074	0.074	0.535**	1	0.774**	−0.421**	0.411**
Trait anxiety (STAI-Y/trait)	42.9 (10.4)	0.068	0.057	0.642**	0.774**	1	−0.578**	0.489**
Resilience (CD-RISC)	55.0 (17.3)	0.016	−0.003	−0.385**	−0.421**	−0.578**	1	−0.309**
Insomnia vulnerability (FIRST)	19.1 (5.9)	−0.074	−0.071	0.433**	0.411**	0.489**	−0.309**	1

PA, physical activity; PHQ-9, Patient Health Questionnaire-9; STAI-Y, State–Trait Anxiety Inventory, Form Y; CD-RISC, Connor-Davidson Resilience Scale; FIRST, Ford Insomnia Response to Stress Test; LES, Life Experiences Survey. *$p < 0.05$, **$p < 0.01$ (Student t-test or Pearson's correlation).

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TABLE 2 Regression analyses of the effect of physical activity volume on mental health measures.

Explanatory variable	Univariate model		Quadratic equation model		Quadratic equation model: gender adjusted		Quadratic equation model: gender and LES adjusted	
	Coefficient	value of *p*	Coefficient	value of *p*	Coefficient	value of *p*	Coefficient	value of *p*
For depression (PHQ-9)								
PA volume (MET-minutes/week)	3.991×10^{-6}	0.940	-414.882×10^{-6}	<0.001	-366.946×10^{-6}	0.002	-377.570×10^{-6}	<0.001
(PA volume)^2	–		29.833×10^{-9}	<0.001	27.164×10^{-9}	<0.001	26.971×10^{-9}	<0.001
Gender (female vs. male)	1.309	<0.001			1.161	0.002	0.819	0.019
LES: positive life experiences							−0.178	0.006
LES: negative life experiences score							0.401	<0.001
F-value	0.006	0.940	11.632	<0.001	8.827	<0.001	19.186	<0.001
Adjusted R^2	−0.002		0.028		0.044		0.151	
Vertex value of PA (MET-minutes/week)			6,953		6,754		6,999	
For state anxiety (STAI-Y/state)								
PA volume (MET-minutes/week)	208.864×10^{-6}	0.092	-632.241×10^{-6}	0.021	-536.634×10^{-6}	0.049	-538.941×10^{-6}	0.037
(PA volume)^2	–		59.906×10^{-9}	<0.001	54.729×10^{-9}	0.002	53.201×10^{-9}	0.001
Gender (female vs. male)	2.583	0.003			2.371	0.006	1.674	0.041
LES: positive life experiences							−0.506	<0.001
LES: negative life experiences score							0.880	<0.001
F-value	2.850	0.092	7.441	<0.001	7.690	<0.001	17.641	<0.001
Adjusted R^2	0.004		0.024		0.038		0.140	
Vertex value of PA (MET-minutes/week)			5,277		4,902		5,065	
For trait anxiety (STAI-Y/trait)								
PA volume (MET-minutes/week)	206.547×10^{-6}	0.123	-873.636×10^{-6}	0.003	-803.979×10^{-6}	0.007	-810.625×10^{-6}	0.004
(PA volume)^2	–		76.934×10^{-9}	<0.001	73.139×10^{-9}	<0.001	71.557×10^{-9}	<0.001
Gender (female vs. male)	2.040	0.029			1.719	0.064	0.898	0.307
LES: positive life experiences							−0.580	<0.001
LES: negative life experiences score							0.998	<0.001
F-value	2.389	0.123	9.773	<0.001	7.743	<0.001	19.177	<0.001
Adjusted R^2	0.003		0.033		0.038		0.151	
Vertex value of PA (MET-minutes/week)			5,678		5,496		5,664	

(Continued)

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TABLE 2 (Continued)

Explanatory variable	Univariate model		Quadratic equation model		Quadratic equation model: gender adjusted		Quadratic equation model: gender and LES adjusted	
	Coefficient	value of *p*	Coefficient	value of *p*	Coefficient	value of *p*	Coefficient	value of *p*
For resilience (CD-RISC)								
PA volume (MET-minutes/week)	78.963×10^{-6}	0.721	$1{,}022.168\times10^{-6}$	0.038	909.725×10^{-6}	0.066	811.128×10^{-6}	0.006
$(\text{PA volume})^2$	–		-67.178×10^{-9}	0.032	-60.910×10^{-9}	0.053	-53.712×10^{-9}	0.024
Gender (female vs. male)	−3.090	0.046			−2.720	0.080	−2.209	<0.001
LES: positive life experiences							1.339	0.281
LES: negative life experiences score							−0.538	<0.001
F-value	0.127	0.721	2.383	0.093	2.618	0.050	7.066	<0.001
Adjusted R^2	−0.002		0.005		0.015		0.056	
Vertex value of PA (MET-minutes/week)			ns		7,468		7,551	
For insomnia vulnerability (FIRST)								
PA volume (MET-minutes/week)	-127.124×10^{-6}	0.094	-545.686×10^{-6}	0.001	-421.118×10^{-6}	0.010	-441.135×10^{-6}	0.006
$(\text{PA volume})^2$	–		29.811×10^{-9}	0.005	22.760×10^{-9}	0.029	23.139×10^{-9}	0.024
Gender (female vs. male)	3.145	<0.001			2.972	<0.001	2.638	<0.001
LES: positive life experiences							−0.101	0.281
LES: negative life experiences score							0.362	<0.001
F-value	2.817	0.094	5.350	0.005	14.917	<0.001	14.025	<0.001
Adjusted R^2	0.004		0.017		0.075		0.113	
Vertex value of PA (MET-minutes/week)			9,152		9,251		9,532	

PA, physical activity; PHQ-9, Patient Health Questionnaire-9; STAI-Y, State–Trait Anxiety Inventory, Form Y; CD-RISC, Connor-Davidson Resilience Scale; FIRST, Ford Insomnia Response to Stress Test; LES, Life Experiences Survey.

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TABLE 3 Regression analyses of the effects of physical activity duration on mental health measures.

Explanatory variable	Univariate model		Quadratic equation model		Quadratic equation model: gender adjusted		Quadratic equation model: gender and LES adjusted	
	Coefficient	value of *p*	Coefficient	value of *p*	Coefficient	value of *p*	Coefficient	value of *p*
For depression (PHQ-9)								
PA duration (hours/week)	-0.244×10^{-3}	0.985	-119.965×10^{-3}	<0.001	-102.728×10^{-3}	0.003	-110.039×10^{-3}	<0.001
(PA duration)^2	–		2.334×10^{-3}	<0.001	2.028×10^{-3}	0.001	2.099×10^{-3}	<0.001
Gender (female vs. male)	1.309	<0.001	–		1.040	0.005	0.707	0.042
LES: positive life experiences							−0.169	0.008
LES: negative life experiences score							0.405	<0.001
F-value	0.000	0.985	6.906	0.001	7.361	<0.001	18.448	<0.001
Adjusted R^2	−0.002		0.028		0.038		0.143	
Vertex value of PA (hours/week)			25.70		25.32		26.21	
For state anxiety (STAI-Y/state)								
PA duration (hours/week)	50.600×10^{-3}	0.092	-270.378×10^{-3}	0.021	-233.669×10^{-3}	0.004	-242.768×10^{-3}	0.002
(PA duration)^2	–		6.258×10^{-3}	<0.001	5.620×10^{-3}	<0.001	5.666×10^{-3}	<0.001
Gender (female vs. male)	2.583	0.003	–		2.181	0.010	1.523	0.060
LES: positive life experiences score							−0.481	0.001
LES: negative life experiences score							0.873	<0.001
F-value	2.922	0.088	10.748	<0.001	9.549	<0.001	18.806	<0.001
Adjusted R^2	0.004		0.036		0.047		0.145	
Vertex value of PA (hours/week)			21.60		20.79		21.42	
For trait anxiety (STAI-Y/trait)								
PA duration (hours/week)	41.523×10^{-3}	0.193	-305.694×10^{-3}	<0.001	-280.535×10^{-3}	0.001	-292.496×10^{-3}	<0.001
(PA duration)^2	–		6.770×10^{-3}	<0.001	6.331×10^{-3}	0.000	6.405×10^{-3}	<0.001
Gender (female vs. male)	2.040	0.029	–		1.499	0.103	0.716	0.441
LES: positive life experiences score							−0.541	<0.001
LES: negative life experiences score							0.997	<0.001
F-value	1.696	0.193	10.198	<0.001	7.736	<0.001	19.119	<0.001
Adjusted R^2	0.001		0.034		0.037		0.148	
Vertex value of PA (hours/week)			22.58		22.16		22.83	

(Continued)

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TABLE 3 (Continued)

Explanatory variable	Univariate model		Quadratic equation model		Quadratic equation model: gender adjusted		Quadratic equation model: gender and LES adjusted	
	Coefficient	value of *p*	Coefficient	value of *p*	Coefficient	value of *p*	Coefficient	value of *p*
For resilience (CD-RISC)								
PA duration (hours/week)	3.479×10^{-3}	0.947	378.017×10^{-3}	0.009	334.418×10^{-3}	0.023	305.898×10^{-3}	0.033
(PA duration)^2	–		-7.438×10^{-3}	0.005	-6.663×10^{-3}	0.012	-6.068×10^{-3}	0.020
Gender (female vs. male)	−3.090	0.046	–		−2.634	0.086	−2.207	0.144
LES: positive life experiences score							1.271	<0.001
LES: negative life experiences score							−0.544	0.015
F-value	0.004	0.947	4.031	0.018	3.678	0.012	7.517	<0.001
Adjusted R^2	−0.002		0.011		0.015		0.060	
Vertex value of PA (hours/week)			25.41		25.09		25.21	
For insomnia vulnerability (FIRST)								
PA duration (hours/week)	-29.352×10^{-3}	0.094	-165.573×10^{-3}	0.001	-116.540×10^{-3}	0.017	-126.040×10^{-3}	0.090
(PA duration)^2	–		2.660×10^{-3}	0.003	1.775×10^{-3}	0.045	-1.886×10^{-3}	0.030
Gender (female vs. male)	3.145	<0.001	–		−2.634	<0.001	2.666	<0.001
LES: positive life experiences score							−0.097	0.291
LES: negative life experiences score							0.358	<0.001
F-value	2.639	0.105	5.726	0.003	15.570	<0.001	14.415	<0.001
Adjusted R^2	0.003		0.018		0.077		0.114	
Vertex value of PA (hours/week)			31.17		32.84		33.42	

PA, physical activity; PHQ-9, Patient Health Questionnaire-9; STAI-Y, State–Trait Anxiety Inventory, Form Y; CD-RISC, Connor-Davidson Resilience Scale; FIRST, Ford Insomnia Response to Stress Test; LES, Life Experiences Survey.

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TABLE 4 Comparison between physical activity level and mental health measurements.

Physical activity level	N (%)	Mean (SD)						
		PA volume (MET-minutes/week)	PA duration (hours/week)	Depression	State anxiety	Trait anxiety	Resilience	Insomnia vulnerability
Physical activity volume per week								
Lower-intermediate (<mean)	368 (71.6%)	848.8 (832.2)	3.35 (2.91)	4.07 (4.33)	41.3 (9.8)	42.8 (10.4)	54.8 (17.4)	19.4 (5.8)
Higher-intermediate (≥mean, <1 SD)	71 (13.8%)	3816.2 (1354.1)	15.84 (4.04)	2.99 (2.83)	39.3 (7.9)	40.2 (8.6)	59.6 (15.2)	18.1 (5.8)
High (≥1 SD)	75 (14.6%)	9,215.6 (4152.8)	40.44 (13.32)	4.42 (4.24)	43.6 (10.6)	45.6 (11.8)	52.1 (17.7)	18.8 (6.5)
F-value		694.474***	1,326.618***	2.583	3.762*	5.051**	3.735*	1.564
Physical activity duration per week								
Lower-intermediate (<mean)	363 (70.6%)	792.2 (719.3)	3.37 (3.21)	4.09 (4.41)	41.3 (9.7)	43.2 (10.3)	54.2 (17.5)	19.5 (5.9)
Higher-intermediate (≥mean, <1 SD)	87 (16.9%)	3962.1 (1100.8)	16.72 (6.39)	3.52 (3.08)	38.4 (8.7)	39.1 (9.2)	60.2 (15.9)	17.5 (5.4)
High (≥1 SD)	64 (12.5%)	1,0034.5 (3,980.5)	42.06 (13.63)	4.11 (4.10)	44.1 (10.2)	46.1 (11.8)	53.2 (17.7)	18.5 (6.5)
F-value		966.294***	1,154.437***	0.677	6.762**	9.070***	4.602**	4.475*

PA, physical activity; PHQ-9, Patient Health Questionnaire-9; STAI-Y, State–Trait Anxiety Inventory, Form Y; CD-RISC, Connor-Davidson Resilience Scale; FIRST, Ford Insomnia Response to Stress Test. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$ (one-way ANOVA).

common problem in mental health, such as regarding depression, and the findings in this study may contribute toward setting the standard for further studies.

This study has several limitations. First, this study had a cross-sectional design, and hence the causal associations are unclear and cannot be determined. There is also the possibility that too much physical activity did not cause mental health impairments, but the mental health impairments led to individuals performing too much physical activity. For example, a person with a high level of anxiety might have exercised obsessively because of psychopathological reasons. An intervention study is required in the future to investigated the causal associations and to determine the exact optimal levels of physical activity. Second, the participants of this study were recruited through acquaintances of people working at the university, and were neither randomized nor validated to represent the general population. Furthermore, the sample size of this study was not large enough to estimate the optimal levels of physical activity for different categories of the population, such as younger persons, older persons, persons with illnesses, and those without. It is expected that the optimal range will differ between age, gender, physical condition, etc. Therefore, a large-scale study would help to clarify the optimal range of physical activity for each group. Particularly in recent years, the circumstances of physical activity have dramatically changed all over the world due to the COVID-19 aftermath. The life and work environmental changes affect their mental health status including anxiety, depression, or insomniac symptoms (Wang et al., 2020; Shimura et al., 2021; Wang et al., 2021), however, our data was collected before the COVID-19 pandemic, and was hence not affected by it. Therefore, further studies are required to investigate the effect of the COVID-19 pandemic on the physical activity and mental health. Finally, physical activity was evaluated subjectively, and it may differ from objective physical activity.

Conclusion

Physical activity in the optimal range was associated with more favorable mental health measurements, such as for depression, anxiety, resilience, and insomnia. The estimated optimal range of exercise volume was 5.3–9.2 k METs-minutes/week, and the optimal range of exercise duration was 21–31 h/week. Physical activities beyond or below the optimal ranges were associated with less favorable mental health measurements in the general adult 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 the Tokyo Medical University Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

Author contributions

AS: conceptualization, methodology, formal analysis, investigation, and writing—original draft. JM: investigation, data curation, writing—review and editing, and supervision. KY: formal analysis and writing—original draft. CM, MK, and KN: investigation. CC and SN: methodology, validation, writing—review and editing, and supervision. TI: conceptualization, methodology, validation, resources, data curation, writing—review and editing, supervision, and project administration. All authors contributed to the article and approved the submitted version.

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.

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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.2022.1044988/full#supplementary-material

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EDITED BY
Víctor Arufe Giráldez,
University of A Coruña, Spain

REVIEWED BY
Rong Xiao,
Southern Medical University, China
Javier Rico Díaz,
University of Santiago de Compostela, Spain
Leonte Nicoleta,
Polytechnic University of Bucharest, Romania

*CORRESPONDENCE
Shanping Chen
✉ chshp@mail.xjtu.edu.cn

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Family and social class differences in sports behavior motivation among college students: An empirical study based on the latent class model

Liping Liu[1,2], Shanping Chen[1]*, Xueyan Yang[2] and Yuqing Yang[1]

[1]Department of Physical Education, Xi'an Jiaotong University, Xi'an, China, [2]School of Public Policy and Administration, Xi'an Jiaotong University, Xi'an, China

Objective: This article aims to explore the potential categories of college students' sports behavior motivation and the differences between different family social classes on potential categories.

Participants: In total, 1,092 college students were investigated in this study.

Methods: This article used the "College Students' Sports Behavior Motivation Questionnaire" to survey 1,092 college students using the whole group sampling method. The potential profile analysis method was applied to classify the types of college students' sports behavior motivation and further analyze the characteristics of different family social classes and sports behavior motivation.

Results: College students' sports behavior motivation types can be divided into the following four categories: "low motivation type" (0.82%), "healthy appearance type" (11.45%), "healthy fun type" (37.36%), and "high motivation type" (50.37%). The higher the family's social class, the more the sports behavior motivation of college students tends to be healthy appearance, health, fun, and high motivation. The lower the family social class, the more motivational sports behavior of college students tends to be low motivation. The better the perception of health, the higher the probability that college students belong to the high-motivation type. The fewer chronic diseases that college students have are associated with a healthy appearance and high motivation.

Conclusion: There is a certain relationship between the type of college students' sports behavior motivation and their family social class. Therefore, in school physical education, we should open all kinds of sports activities according to college students' sports behavior motivation needs and focus on college students with lower family social class in order to intervene precisely on their motivation for sports behaviors, improve participation, and promote the overall health of college students.

KEYWORDS

sports behavior, motivation, family social class, integration of sports and education, health, college students

Introduction

In the new era, promoting the healthy development of youth is critical to promoting the construction of sports power. Strengthening teenagers' fitness through exercise is significant in improving the health level of youth. In August 2020, the State General Administration of Sports and the Ministry of Education jointly issued the *Opinions on Deepening the Integration of Sports and Education to Promote the Healthy Development of Youth* (hereafter referred to as the *Opinions*). It advanced the concept of health-first education (Chinese Government Website, 2020), giving new goals and development directions to the future physical health and school sports of teenagers. However, based on the relevant studies of physical education, scholars have focused on policy formulation and goals, ignoring the intrinsic correlation between individual behaviors and policy development, psychological factors such as attitudes, and behavioral motivations of the applicable subject (Chen et al., 2017). Therefore, this study focuses on the motivation of college students' physical exercise behavior as the entry point, analyzing and summarizing the characteristics, types, and influencing factors of current college students' sports behavior and motivation. This provides theoretical guidance and practical insight for better promoting physical health education and sports work in schools, enhancing the implementation effectiveness of the *Opinions*.

Motivation is the internal psychological process or internal power that directs and sustains individual activities toward goals (Zhang and Guo, 2018). Individual behavioral motivation is important to understand the logic of individual action. Research on behavior motivation is more mature in the fields of sociology and political science. Many academic problems about sports behavior motivation wait to be solved. Sports behavior motivation refers to individuals meeting needs and demands through sports behaviors (Chen and Li, 2007). Sports behavior motivation is an important psychological variable. Research has been conducted on the current state of motivation, explanatory factors, and the influence of motivation on behavior, focusing on the influence of self-perception, behavioral attitudes, positive affective experiences, and sociocultural contexts on teenagers' sports behavior motivation (Wang et al., 2021). Studies have explored the influence of demographic sociology variables such as gender, age, education level, and profession on teenagers' sports behavior motivation (Wu et al., 2015). Attention has also been paid to the intensity of sports enjoyment among adolescents and how it differs in terms of gender and physical constitution (Chai et al., 2021). These studies enrich the research perspectives and content of teenagers' sports behavior motivation. Still, the development and improvement of sports policies require more attention to structural characteristics at the macro level and understanding the heterogeneity of sports behavior motivation of different teenage groups. The social class theory provides the scientific theoretical tool to explore the motivation of youth sports behavior from a holistic perspective.

Social class is an important concept in analyzing the macro social structure as it captures differences in occupation, education, and income due to the social status of different groups throughout society (Kraus et al., 2012). Occupation, education, and income are common measurements of objective social class (Hu et al., 2014). Subjective social class measurement mainly interrogates the subjective cognition of individual level resulting from comparisons with others. The social class structure has changed significantly with economic development. It has become an important perspective for exploring structural differences in educational attainment, health levels, and public service satisfaction of social groups. Studies have demonstrated that the different sports' needs and sports benefit acquirement in different social class groups are significantly different (Fang, 2012; Peng, 2012) and that people's awareness and behavior of participating in leisure sports activities are significantly influenced by social class (Han et al., 2019). Certain scholars report that family social class has an important influence on youth physical activity (Pan, 2017; Andersen and Bakken, 2019), sports parenting style (Wang Fu, 2019), and sports expenditure (Jin and Zhao, 2018). On the whole, social class differences have been applied in sports research, from leisure activities to college students' sports behaviors research. All have demonstrated the important influence of social class.

The impact of family social class on individual development is that possession of objective material resources and the perception of subjective social status differ, which greatly impacts individual psychology and behavior (Chen et al., 2015). It is unclear whether the influence of social class differences exists in college students' sports behavior motivation. It is not favorable to sports behavior intervention, behavior motivation guidance, and political education for college students in different social classes in the integration of sports education. This study aims to analyze the category characteristics of college students' sports behavior motivation through the latent profile model, explore the influence of family social class on college students' sports behavior motivation, and provide scientific intervention strategies for the formation of motivation for positive sports behaviors among college students from different family social classes, which is conducive to the reasonable and effective implementation of the integration of sports education policy.

Research objects and methods

Research objects

This study used the whole group sampling method to survey 1,100 first- and second-year students in a key university in Shanxi Province. A total of 1,092 valid questionnaires were collected, with a recovery rate of 99.3%. The sample details were analyzed as follows (**Table 1**). In all, 369 (33.8%) were female students and 723 (66.2%) were male students. The self-weight feeling of college students is between "fat" and "normal" (2.81 ± 0.910). The description of their current health is between "medium" and "poor" (3.73 ± 0.808). The degree of chronic diseases ranged between "less" and "not at all" (4.59 ± 0.673). Regarding the distribution of college students' family and social class, 6.32% of college students were from low-class families, 30.40% were from middle- and low-class families, 40.84% were from middle- and high-class families, and 22.44% were from high-class families. These percentages are consistent with existing studies. The percentage of students from high-income families entering key undergraduate studies is higher compared with low-income families (Chen and Wei, 2013). Students from families with medium or higher income have two-thirds of the students from middle-income families and above enter key universities (Li et al., 2016), and the motivation for sports behavior is between "more strong" and "strong" (3.19–4.53).

TABLE 1 Descriptive statistical results of sample characteristics (N = 1,092).

Variable		Percentage/Mean (Standard deviation)	Variable	Percentage/Mean (Standard deviation)
Gender (%)	Female	33.8	Health motivation	4.47 (0.652)
	Male	66.2	Appearance motivation	4.31 (0.819)
Self-weight feeling		2.81 (0.910)	Fun motivation	4.35 (0.673)
Description of health		3.73 (0.808)	Ability motivation	3.98 (0.927)
Degree of chronic diseases		4.59 (0.673)	Social motivation	4.22 (0.881)
Social class (%)	Low class	6.32	Academic motivation	4.53 (0.723)
	Middle-low class	30.40	Obedience motivation	3.35 (1.143)
	Middle-high class	40.84	Economic motivation	3.19 (1.219)
	High class	22.44	Honor motivation	3.77 (1.054)

Measurement tools

Sports behavior motivation variables: The sports behavior motivation scale was revised based on the existing five internal motivations (health, appearance, fun, ability, and social motivations) and two external motivations (academic and obedience) scales (Chen et al., 2008) with open- and closed-ended questionnaires, using the original scale questions for internal motivation and supplementing the external motivation with economic motivation and honor motivation (Chen et al., 2021). Three new economic motivations include "I want to use sports activities to get a scholarship," "I want to use sports activities for economic benefits," and "I want an excellent postgraduate recommendation and communication opportunities." Three new topics of honor motivation include "I want to beat my opponent in a game," "I want collective success," and "I want to receive praise from others in sports activities." The scale has 9 dimensions, with 3 questions from each dimension for 27 questions in total. All questions were rated using the Likert 5-level measure, with options very strong, strong, more strong, a little, and none with the question scores of 5, 4, 3, 2, and 1, respectively. The alpha coefficients of each subscale ranged between 0.834 and 0.955, exceeding the acceptable standard of 0.7. The criterion validity for sports exercise behavior and each subscale score ranged from 0.138 ($p < 0.05$) to 0.230 ($p < 0.001$), indicating good reliability and validity of the topics of the sports behavior motivation measure.

Family and social class variables: College students' family and social class variables were calculated using the variables of parents' occupational status, years of education, and annual family income. Using Lu Xueyi's classification of social class, the higher of the two parents' scores is used for occupational status and years of education. The occupational status devised parents' profession into five grades as follows: unemployed and semi-unemployed class, the agricultural worker class, the industrial worker class, the business service worker class, the self-employed class and above (including state and social manager class, manager class, private entrepreneurs class, professional class, and clerk class), with a score ranging from 1 to 5 points. The higher the score, the higher the occupational class (Lu, 2003). The author uses principal component factor analysis to extract the above three variables into one factor to obtain college students' family and social class variables.

Personal characteristics variables (Control variables): These include three items, namely, body shape, health status, and chronic diseases. All used self-assessment questions, using the Likert 5-level measure. Body shape options were ① obese, ② fat, ③ normal, ④ thin, and ⑤ very thin. Current health status options were ① excellent, ② good, ③ medium, ④ worse, and ⑤ poor. Chronic disease options were ① very serious, ② more serious, ③ average, ④ slight, and ⑤ not at all (Liu et al., 2010).

Methods of data analysis

Latent profile analysis (LPA) is a statistical method distinguishing between types of subjects, further examining the relationship between types and other variables (Liu et al., 2020). Using this method to research college students' sports behavior motivation makes it possible to cluster but descend the multiple sports behavior motivations of college students and analyze the variability of different sports behavior motivation types.

We first used the SPSS version 22.0 statistical analysis software to conduct a descriptive statistical analysis of sample characteristics. This was followed by Mplus version 7.0 to conduct a LPA of college students' sports behavior motivation. Finally, the SPSS version 22.0 statistical analysis software was used to explore the relationship between college students' sports behavior motivation types and family social class using the chi-square analysis and multiple logistic regression analysis relationships.

Results and analysis

Latent profile analysis of college students' motivation for sports behavior

Based on the LPA steps, the 1–6 category model was fitted to each of the nine types of sports behavior motivation of college students (**Table 2**).

A latent profile analysis allows the homogeneous grouping of continuous data, and groups with similar data characteristics are classified into uniform subgroups (Kongsted and Nielsen, 2017). The test indexes of the model are mainly LOG/L (likelihood ratio test index), AIC and BIC (information evaluation index), and ABIC (sample correction). The smaller values of the above indexes indicate a better fit for the model. Certain scholars point out that BIC is

TABLE 2 Six latent structure model fit indices of college students' sports behavior motivation (N = 1,092).

C	LOG (L)increased	AIC reduced	BIC reduced	ABIC reduced	ENTROPY	LMRLR	BLRT
1	−12668.396	25372.791	25462.715	25405.543			
2	−11216.960	22489.920	22629.801	22540.867	0.887	**	***
3	−10641.782	21359.564	21549.403	21428.706	0.890	*	***
4	−10347.651	20791.302	21031.099	20878.640	0.916	***	***
5	−10207.297	20530.594	20820.348	20636.127	0.840	***	***
6	−10070.806	20277.612	20617.324	20401.341	0.860	0.269	***

*$p < 0.1$, **$p < 0.05$, and ***$p < 0.01$.

the best among these three indexes (Burnham and Anderson, 2004). The ENTROPY index was used to assess the quality of the model classification. When ENTROPY is 0.6, it indicates that about 20% of the individuals have classification errors. When ENTROPY is 0.8, it indicates that the classification accuracy is more than 90%. The value of ENTROPY ranges from 0 to 1, and the closer ENTROPY is to 1, the better the model quality. In addition, two likelihood ratio tests, LMR and BLRT, were used to compare the fit differences of latent profile models and if the p-values of these two values reached a significant level ($p < 0.05$). This indicates that the model with k categories is significantly better than the model with k-1 categories (Jung and Wickrama, 2008; Rosato and Baer, 2012). Thus, among these six models, the 6-category model has the smallest BIC value, indicating that it is optimal. In terms of LMRLR, the category 2 model outperforms the category 1 model, the category 3 model outperforms the category 2 model, the category 4 model outperforms the category 3 model, and the category 5 model outperforms the category 4 model. Considering the above information, the class 4 model is better.

Four types of analytical models were finally selected as the final model (**Figure 1**), and the mean scores of the nine sports behavior motivations were an important basis for type description and naming. The bottom type of sports behavior motivation in **Figure 1** has low mean scores, except for academic motivation. This is named "C1-low motivation" and has obvious differences from the other 3 types. The first five items (health, appearance, fun, ability, social) are internal motivations, and the last four items (academic, obedience, economic, and honor) are external motivations. The conditional probability of internal motivation is lower than external motivation, contrasting the three types of graphs above. Regarding the type of physical activity motivation mentioned above, except for academic motivation, the conditional probability of health and appearance motivation is high, and the conditional probability of other motivations is relatively low. Consequently, we named this type of sports behavior motivation "C2-healthy appearance type." In addition to the high academic motivation, the probability of health and fun motivation conditions is high, and the probability of other motivation conditions is relatively low, so we named this type of sports behavior motivation as "C3-healthy fun type." The top type of sports behavior motivation has a high probability of other motivation conditions, except academic motivation, and a relatively high probability of other motivation conditions. We named this type of sports behavior motivation "C4-high motivation" from the distribution ratio of the number of these four types of sports behavior motivation. "C1-low motivation" accounted for 0.82%, "C2-healthy appearance accounted for 11.45%, "C3-healthy fun type" accounted for 37.36%, and "C4-high motivation type" accounted for 50.37%.

Analysis of the relationship between college students' sports behavior motivation and family social class

The quartile was used to classify college students' family social class into four categories. Those who scored 1–2 on the social class variable for university students' families were defined as low class (69), those who scored 2–3 as middle-low class (332), those who scored 3–4 as the middle-high class (446), and those who scored 4–5 as high class (245). The cumulative percentage bar chart in **Figure 2** shows the distribution of the types of college students' sports behavior motivation among the four types of family social class. The cumulative percentage of college students' sports behavior motivation in low-class families from high to low: low motivation type (33.3%), high motivation type (6.7%), healthy appearance type (5.9%), and healthy fun type (4.0%). The cumulative percentage of college students' sports behavior motivation in middle-low class families from high to low was low motivation (33.3%), healthy fun (32.0%), high motivation (30.5%), and healthy appearance (29.7%). The cumulative percentage of college students' sports behavior motivation in middle-high class families from high to low was healthy fun (48.0%), high motivation (40.9%), healthy appearance (38.7%), and low motivation type (33.3%). The cumulative percentage of college students' sports behavior motivation in high-class families from high to low was healthy appearance type (25.7%), high motivation type (21.8%), and healthy fun type (16.0%). The chi-square test showed a significant difference in the distribution of college students' sports behavior motivation types among the four types of family social classes ($P < 0.05$). It can be tentatively judged that the higher the family social class, the more college students' sports behavior motivation types tend to be healthy appearance type, healthy fun type, and high motivation type. The lower the family social class, the more the college students' sports behavior motivation tends to be low motivation type.

To further analyze the influence of family social class on college students' sports behavior motivation, this essay constructs a multivariate logistic regression model with "college students' sports behavior motivation types" as the dependent variable and compares the differences between healthy appearance types. For healthy fun and high motivation types with low motivation type as a reference, the family social class was the core independent variable, and gender, self-weight feeling, description of health, and degree of chronic diseases of college students were the control variables. The results in **Table 3** show that the higher the family social class, the higher the probability of the healthy appearance type, healthy fun type, and high motivation type. The description of health and the degree of

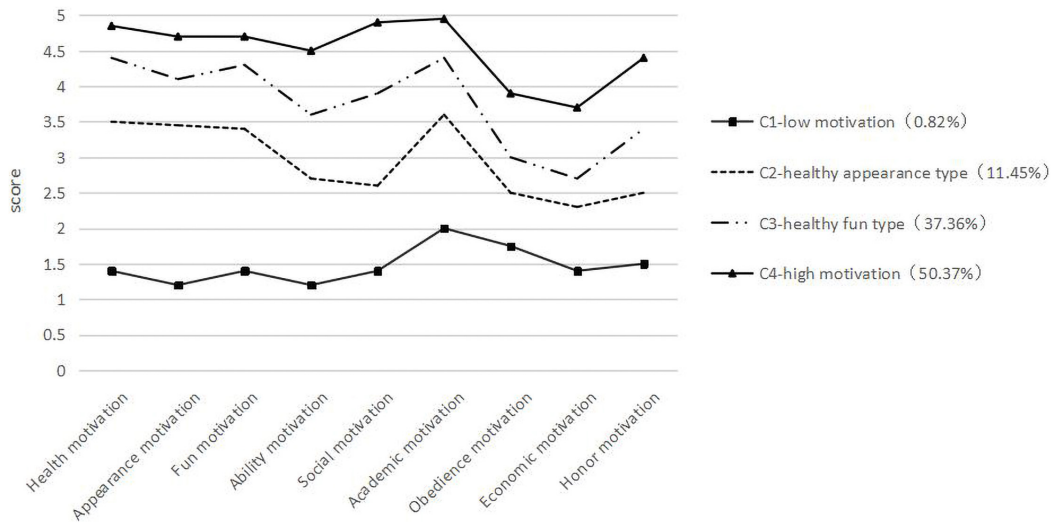

FIGURE 1
College students' scores in nine categories of behavior motivation.

chronic diseases significantly affected the motivation type of college students' sports behavior. Compared with the low motivation type, the better the description of health, the higher the probability of the high motivation type. The lower the degree of chronic diseases, the higher the possibility of healthy appearance and high motivation types.

Discussion

General characteristics of latent class of college students' sports behavior motivation

The profile analysis in **Figure 1** found that there are four potential profile types of college students' sports behavior motivation: low motivation type, healthy appearance type, healthy fun type, and high motivation type. In addition, there are high conditional probabilities for each factor for the high motivation type and low conditional probabilities for each factor for the low motivation type. Healthy appearance type and healthy fun type are between low and high motivations. The difference between the two types mainly focuses on health, appearance, and fun. The healthy fun types are higher than the healthy appearance type. In the distribution of the four types of college students, high motivation (50.37%) > healthy fun (37.44%) > healthy appearance (11.51%) > low motivation (0.82%), "higher and lower" indicates that college students' overall sports behavior motivation is strong. The main reasons are as follows: the increasingly rich material and spiritual culture of our times, the increased awareness of sports among students, the promotion of the diversified development of sports' needs, and the shift of college students from passive participation to active choice in college physical education (Bai and Gao, 2022). In recent years, we have deepened the reform of physical education teaching, from the teaching content of physical education class (Hu, 2020) and course selection, forming a rich and diverse content of physical education courses conducive to improving students' interest and motivation in physical education. It may also be related to the schools we surveyed being key universities in China. Students with exercise interests are more able to meet the actual demand for exercise at schools with higher strata. This effect is nearly half as high as that of students without exercise interests (Bai et al., 2022). Analysis of the reasons why the healthy fun type is much higher than the healthy outlook type shows two criteria. First, in China's health policy and integration of physical education (Li et al., 2020), the new concept of physical education of "enjoying fun, enhancing physical fitness, sound personality, and refining will" (Bu et al., 2022) has greatly affected students' sports awareness. They understand that "enjoying fun" is the foremost prerequisite for students to participate in sports. Second, it is very much in line with contemporary college students' development needs. College students focus on appearance and pay more attention to spiritual and cultural life. This also shows that the proposed policy of integrating sports and education caters to students' need to have fun in physical exercise.

Regarding the existential form of internal and external motivation, the high motivation type, healthy fun type, and healthy appearance type have a common ground. Their internal motivation is higher than external motivation. The low motivation type differs significantly from the other three types. The conditional probability of the first five internal motivations (health, appearance, fun, ability, and social) is lower than the last four external motivations (academic, obedience, economic, and honor). This indicates that external factors mainly influence the low motivation type of college students' sports behavior, and their external motivation is stronger. Psychology defines internal motivation as participating in the activity for satisfaction through behavior and external motivation as participating in the activity because of external pressure, award, and rewards (Richard and Edward, 2000). From the perspective analysis of conflicting behavioral motivations, individuals intend to resist other temptations before making a behavioral decision (Atkinson and Birch, 1970; Gollwitzer et al., 2004). However, this intention to resist temptation depends on the difficulty of the motivation goal (Kruglanski et al., 2002). Internal motivation only is achieved through normal sports behavior. When students with strong external motivation cannot satisfy external needs (or find

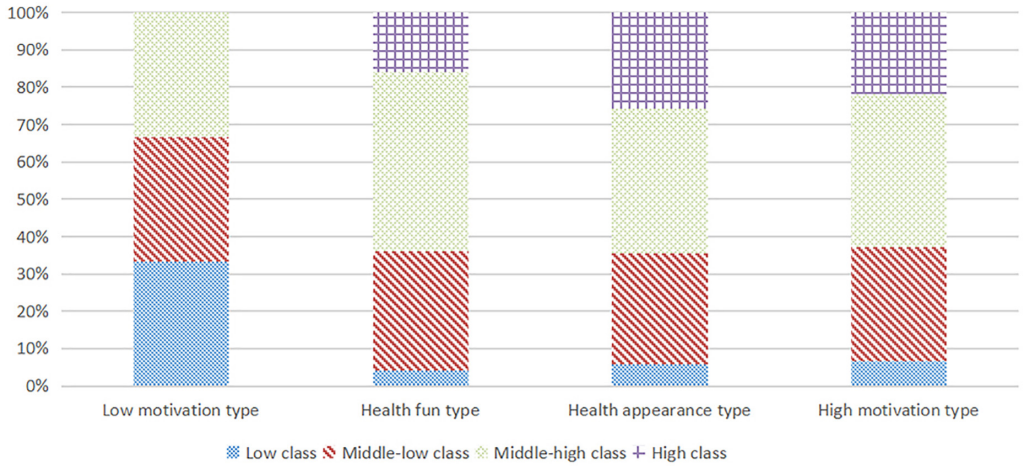

FIGURE 2
Distribution of college students' sports behavior motivation in different family social classes.

TABLE 3 Multivariate logistic regression of college students' sports behavior motivation (N = 1,092).

Factors of influence	Healthy appearance type/Low motivation type	Health fun type/Low motivation type	High motivation type/Low motivation type
Family social class	1.035* (0.018)	1.037* (0.017)	1.033* (0.017)
Gender	0.518 (0.840)	0.676 (0.828)	0.832 (0.827)
Self-weight feeling	1.182 (0.336)	1.159 (0.328)	1.002 (0.328)
Description of health	1.044 (0.400)	1.699 (0.391)	2.039* (0.390)
Degree of chronic diseases	1.871* (0.379)	1.809 (0.366)	2.103* (0.366)
−2 log likelihood	2052.350***		
Nagelkerke R^2	0.9061		

*$p < 0.1$, **$p < 0.05$, and ***$p < 0.01$. Data indicate Exp (B) with SE.

it difficult and inconvenient to finish normal behavior) according to normal sports behavior, it is highly possible to achieve through other methods of impropriety. Normally, misbehavior is a violation of the norms of sporting behavior through means other than normal sporting behavior. Sports is an important part of education. We should not only enhance the physical fitness of teenagers and promote growth and development through sports but also make students learn how to obey the rules, unity and cooperation, hard work, perseverance, and respect for others in sports to enhance the moral quality of teenagers. It is important to give full play to the value of "sports-nurturing" and "people-educating" (Liu and Li, 2020). Therefore, from the perspective of integrating sports and education, the low-motivation type groups need to be significantly concerned with physical education.

In addition, this study found that academic motivation has a higher conditional probability than other motivations among the four latent profile models. Research suggests that academic stress is the number one pressure source among contemporary college students (Wang and Yao, 2012). Due to the long-time influence of "test-based education," students' low health levels (Xiao and Qiu, 2020) and lack of participation and interest in sports are increasingly serious, and teenagers' health is neglected by schools and families (Yan, 2020). Academic motivation is a double-edged sword. Moderate academic pressure may promote college students' positive sports behavior. Nevertheless, if academic motivation is too strong, it may weaken the motivation for sports health, fun, and appearance. Students who cannot finish academic motivation through normal sports behavior will have abnormal sports behavior. It is unfavorable to form positive sports behavior and promote college students' physical and mental health.

Individual characteristics of latent class of college students' physical exercise motivation

The health condition and the degree of chronic diseases have a significant influence on college students' physical motivation types. Compared with college students of low motivation type, the better the perception of health, the greater the probability that the college students belong to the high motivation type. The less the students suffer from chronic diseases, the greater the probability that they belong to the healthy appearance type and the high motivation type. Based on the theory of exercise needs constructed by Maslow's needs theory, exercise needs are stage-specific, directional, and selective and vary from student to student (Yu, 2019). Only when people's basic needs, such as survival and security, are satisfied will they pursue higher-level spiritual needs As sports behavior motivation, if college students have good health without chronic diseases, they will have the most basic physical capital and the opportunity to pursue higher sports behavior motivation.

The incidence of health status and degree of chronic diseases on the type of motivation for sports behavior were compared. When comparing the low motivation type with the high motivation type, the significant effect of the health condition variable on the type of motivation [Exp (B) = 2.039, $p < 0.1$] was slightly lower than the significant effect of the chronic disease degree variable on the type of motivation [Exp (B) = 2.103, $p < 0.1$]. When comparing the low motivation type with the healthy appearance type, the chronic disease degree variable had a significant impact on the motivation type [Exp (B) = 1.871, $p < 0.1$]. Health conditions did not significantly affect the motivation type, indicating that the chronic disease degree had a greater effect on the college students' sports behavior motivation type than a health condition. The 2019 National student physical fitness and health research results show that the problem of overweight and obesity among college students is prominent, and declining physical fitness continues (Chen and Wu, 2022). Li et al. (2019) pointed out that college students had a higher detection rate of chronic hypertension disease and better self-health evaluation among male students. Low levels of physical activity are considered an important cause of the increasing prevalence of obesity and overweight (Sultoni et al., 2017). Physical activity developed during youth reduces the probability of health-related diseases such as obesity, diabetes, anxiety, and depression, and can have lifelong health benefits (Haegele et al., 2018). It has been demonstrated that students with high-intensity physical activity have higher physical health scores than those with low physical activity (Ge et al., 2019). Motivation for physical behavior as a predictor variable of physical activity can be explained by the fact that physical health status and severity of chronic diseases also have a significant effect on motivation for physical behavior. Li et al. (2020) proposed an "integration of physical education" strategy to intervene in chronic diseases. The "integration of sports and education" needs to reflect the influence of sports, and the process of sports is the means and way of integrating sports and education. Integration can improve the physical fitness of teenagers and reduce the phenomenon of chronic diseases or obesity by means of sports.

The influence of family social class on college students' sports behavior motivation

This study finds that the higher the family social class, the more the college students' sports behavior motivation tends to be healthy appearance type, healthy fun type, and high motivation type; the lower the family social class, the more the college students' sports behavior motivation tend to be low motivation type. It has been shown that people in middle-high and high social classes with a college degree comprise the best people in civil servants, heads of enterprises and institutions, professional and technical personnel, clerks, and the commercial service industry. They have higher education, economic income, and social resources (Zhao and Hong, 2012). Their knowledge of health, sports behavior (Wang and He, 2016), and consumption behavior are higher than low- and middle-low social classes. Health is considered a responsibility and part of upbringing among the upper and middle social class. It represents the energy of life and enjoyment of life, as well as a better sense of keeping healthy, but the lower social class people see health as the ability to keep working (D'Houtaud and Field, 2010). From the analysis of the motivation of participating in leisure sports, people in high and middle-high social classes tend to pay more attention to their hobbies, sports technology of enhancement, emotional communication, enjoying life, and bodybuilding, in addition to relieving physical and mental tension by participating in leisure sports activities (Xu and Bai, 2012). People in low social class generally focus on manual labor, long work time, stressful life, and poor exercise concept and awareness (Han et al., 2019).

The family environment is an important factor influencing students' sports behavior and motivation of behavior. Education, accompaniment, support, behaviors, and perceptions from parents implicitly influence children's physical activity behaviors and behavior motivation. It has been demonstrated that the higher the social class of the family, the stronger the role of parental accompaniment, support, and guidance in children's activities, and the greater possibility that children will achieve the recommended amount of physical activity. Therefore, the higher the family social class, the higher the influence of family parents, and the higher the motivation for sports behavior in terms of health, fun, and appearance; on the contrary, the lower the family social class, the lower and negative influence of parents in terms of sports behavior motivation.

Intervention strategy of integrating college students' sports behavior motivation

Research on the characteristics of latent class for college students' sports behavior motivation and their relationship with family social class has important practical implications for implementing policies to promote sports and education integration.

First, from the overall characteristics of latent motivation types, some college students still belong to the low motivation type, show low interest in various sports activities, and their external motivation exceeds their internal motivation. However, the small number of this part of college students should not be ignored. Physical education of schools should pay greater attention to this group. First, through rapid, scientific, and accurate screening and evaluation, building the establishment of one-to-one teacher exchanges, support, and peer-led approaches helps students have fun, improve their health, build healthy personalities, and refine the will to comprehensively enhance their motivation to participate in physical exercise. Second, schools should strengthen the goal of "people-education" in physical education, update the physical education concept and teaching methods, and guide and encourage college students to form the habit of participating in daily physical exercise to make physical education a comprehensive role in promoting teenagers' physical and mental health.

Second, college students with chronic diseases are still in the sports health promotion stage for disease prevention (Wang et al., 2020). In integrating sports and education, we need to treat them differently. First, the school should increase the humanistic care for them, provide free checkups regularly, combine physical with medical, and build scientific treatment and exercise prescriptions; second, offer effective physical health courses and after-school sports tutoring; and third, offer courses on prevention, treatment, and psychological counseling of chronic diseases for them.

Third, family and social class significantly influence college students' sports behavior motivation. We should avoid the unequal sports benefits among the college student groups by improving the policy of integrating sports and education and ensuring that all college students can promote their all-round development through sports exercise. With the improvement of the family's social class, it is evident that the pursuit of individual sports behavior for health, which has similarities with the study's findings, poor economic condition families pay insufficient attention to the health-promoting action of physical exercise. Therefore, in the process of implementing the policy of integration of physical education, it is necessary to emphasize the development concept of promoting individual health through physical exercise, pay greater attention to low-income family students' daily physical behaviors, and adopt appropriate support actions to help them develop the habit of exercise. Examples of this include providing them access to free stadiums and sports equipment.

Conclusion and insights

The types of college students' sports behavior motivation are divided into "high motivation type," "healthy and fun type," "healthy appearance type," and "low motivation type." The four types show the characteristics of "more high and less low" and a high consistency in academic motivation. In "high motivation type," "healthy and fun type," and "healthy appearance type," internal motivation is higher than external motivation, and the external motivation of "low motivation type" is higher than internal motivation. The better the college students' health condition, the more likely they are to belong to the high-motivation type. The fewer chronic diseases the students have, the more likely they are to belong to the healthy appearance and high motivation types. The severity of chronic diseases has a greater impact on the motivation of college students' sports behavior than their health condition. The higher the family social class, the more the college students' sports behavior motivation tends to be healthy appearance, health, fun, and highly motivated. The lower the family social class, the more the college students' sports behavior motivation tends to be low.

This article introduces the variable of "family social class," enriching research theory on sports behavior motivation and helping to study the influence of family social class on college students' sports behavior and physical health from the source. We analyze the potential categories of college students' sports behavior motivation. We also analyze the potential categories of college students' sports behavior motivation of different family social classes to provide a theoretical basis and practical guidance for school sports management and policy formulation. This is conducive to precise intervention in college students' sports behavior and motivation and promotes the health of all people.

There are several limitations to this study. The survey was conducted on college students in a major domestic university. Although the research results are in line with the actual situation in China, they need further research and testing on the overall and universal characteristics of college students. In the future, a series of studies might be conducted for various regions and school levels. Psychological mechanisms between willingness to regulate sports behavior, sports policy attitudes, and the types of behavioral motivation and different behavioral regulation and sports policy attitudes of students from different family social classes could also be explored.

Data availability statement

The original contributions presented in this study are included in this article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

LL and SC: formal analysis and writing—original draft preparation. XY and YY: investigation, writing—review and editing, and supervision. All authors have read and agreed to the published version of the manuscript.

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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.

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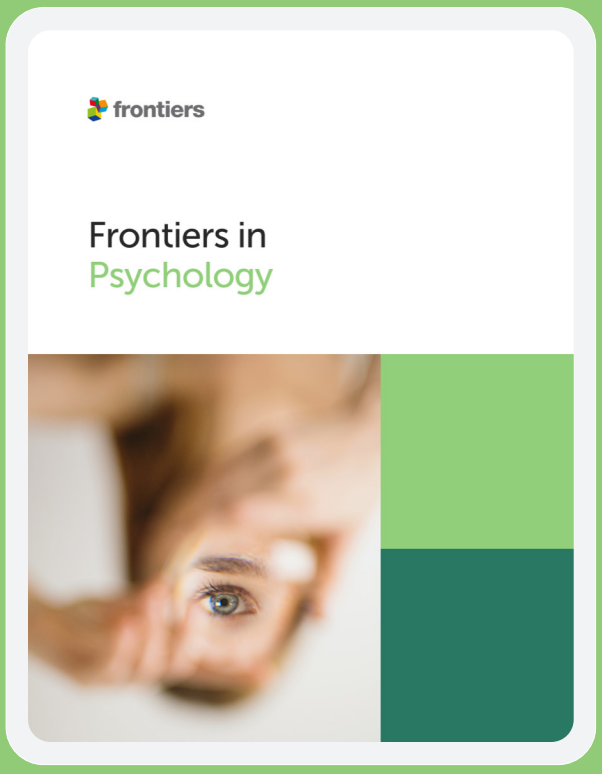

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