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Towards a psychophysiological approach in physical activity, exercise, and sports, volume II

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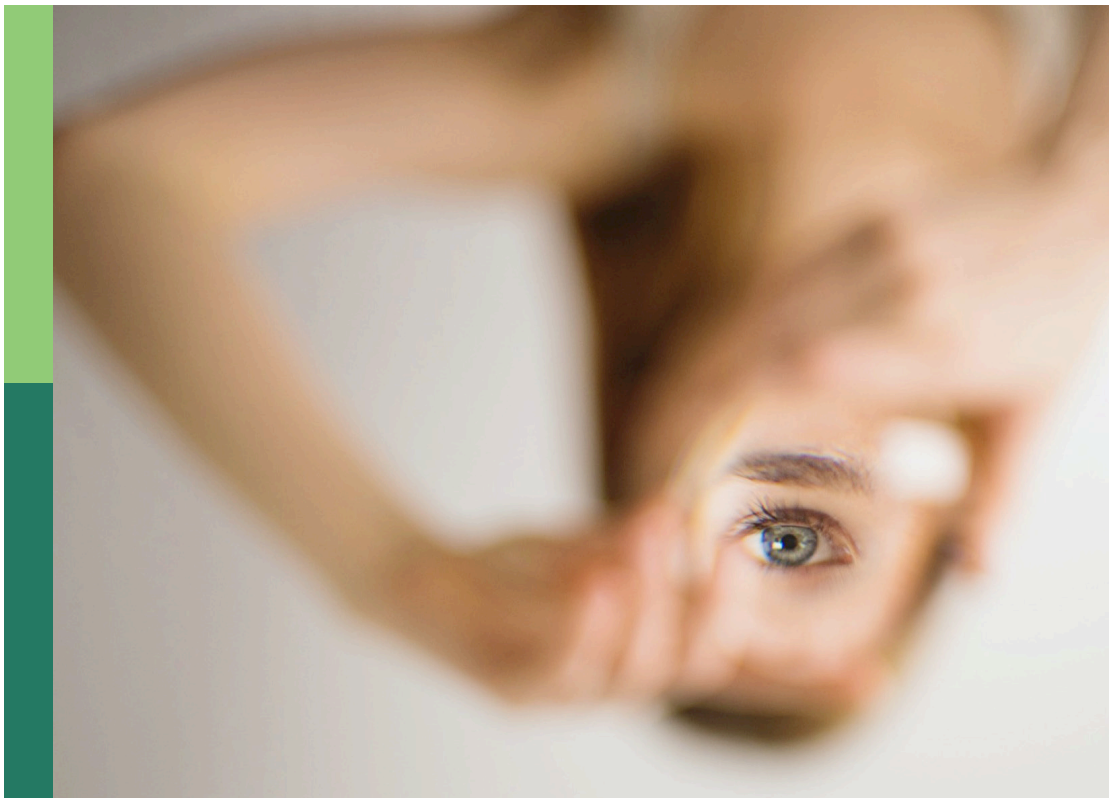

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Towards a psychophysiological approach in physical activity, exercise, and sports, volume II

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Editorial: Towards a psychophysiological approach in physical activity, exercise, and sports, volume II

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KEYWORDS

exercise, sports, performance, psychophysiological, physical activity

Editorial on the Research Topic
Towards a psychophysiological approach in physical activity, exercise, and sports, volume II

The critical role of physical activity in fostering physical and mental health and wellbeing has been well-documented across diverse populations and contexts. Recent studies published in leading journals provide compelling evidence of the multifaceted benefits of exercise, from improving physical metrics such as body mass index (BMI) and waist circumference to enhancing mental health and subjective wellbeing. These insights underscore the importance of promoting physical activity as a cornerstone of public health. Health related physical activity was a very important discussed topic during COVID-19 pandemic, and for that reason, it is cleared illuminated the critical intersection between physical activity and mental health. That's in line with the published study in this Research Topic by Tomezzoli et al. on young Italian athletes. The authors revealed the detrimental effects of sports activity limitations on mental health. The enforced inactivity during lockdowns led to increased anxiety, depression, and a sense of loss among children, adolescents, and young adults. This allows to remind the psychological benefits of regular physical activity and the need for robust policies to ensure continued access to sports and recreational activities. However, where and when to do is a critical aspect and environment may play an important role on wellbeing. The study from Sirotiak et al. highlight significant differences in how physical activity influences psychological wellbeing depending on the environment. This research underscores the importance of considering geographic and environmental factors when promoting physical activity, ensuring that interventions are tailored to the specific needs and contexts of different populations.

The society, culture, and wellbeing were also part of the discussion in this Research Topic. The study from Jacinto et al. delves into the effects of exercise on individuals with intellectual and developmental disabilities. The review highlighted significant reductions in BMI and waist circumference, underscoring the potential of tailored exercise programs

to improve physical health metrics in this population. This study was particularly crucial to understand the barriers to participating in physical activities, which can exacerbate health disparities. The study from Liao et al. identified perceived health, social support, and self-esteem as key mediating factors, reinforcing the idea that the benefits of physical activity extend beyond physical health to encompass mental and social dimensions. The transcultural analysis by Liang et al. on sports science students in France and China allowed to understand how cultural contexts shape values and attitudes toward physical activity. Finally, Liu et al. explored how partnership dynamics in DanceSport, suggesting that the strong interpersonal relationships and engagement can significantly boost performance, pointing to the broader psychosocial benefits of sports and dance activities.

Regarding to improving the sports performance, four studies measured performance, perceptions, competence, and strategies for long-term and to end the careers. Della Tommasina et al. explored the preventive benefits of exercise, examined a dry-land strengthening program for swimmers. The findings showed that exercises using elastic bands could significantly reduce shoulder injuries, highlighting the importance of injury prevention strategies in sports training. This approach not only enhances athletic performance but also ensures the long-term health and participation of athletes. Other study by Portella et al. on Brazilian football goalkeepers highlights the developmental differences in strength and force variables across age groups. This study provided critical data for age-appropriate training regimens, which are essential for the optimal development of young athletes. The impact of professional certification on perceptions of expertise and credibility among golf instructors was investigated by Yang et al.. In their study the perceived quality of instruction can significantly influence learning outcomes and participation intentions, emphasizing the need for professional development in sports education. The study from Teixeira et al. developed an interview guide for the retired Portuguese football players. This instrument allows to assess the long-term impacts of sports careers on quality of life. Finally, the Chen et al. study focused on systematic desensitization training to reduce competitive anxiety in Latin dance athletes. This approach demonstrates how psychological interventions can complement physical training to enhance overall athletic performance. Altogether, several psychological variables played an important role in physiological performance, reinforcing the importance to better understand the concept of Psychophysiology.

Altogether, these studies collectively highlight the indispensable role of physical activity, exercise, and sports in enhancing various dimensions of health and wellbeing. They also stress the importance of continued research and tailored interventions to address specific needs across different populations. As we advance, integrating these insights into public health strategies will be key to fostering a healthier, more active society. This Research Topic aimed to offer valuable insights into the complex relationship between psychological factors, cognition, and physiological variables within the domains of physical activity, exercise, and sports. By exploring these multifaceted interactions through a comprehensive psychophysiological approach, we have achieved a deeper understanding of new strategies for optimizing performance, promoting health, and improving the overall quality of life in sports and exercise contexts. However, benefits of physical activity help to offer a holistic approach to health and wellbeing. It is important to seek further studies on the psychophysiological concept to continue uncovering strategies for enhancing health and performance in diverse populations.

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Effects of exercise on body mass index and waist circumference of individuals with intellectual and developmental disabilities: a systematic review with meta-analysis

Miguel Jacinto[1,2,3], Diogo Monteiro[2,3,4]*, Raul Antunes[2,3,5], José Pedro Ferreira[1,6], Rui Matos[2,3] and Maria João Campos[1,6]

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Introduction/Methods: This systematic review with meta-analysis aims to assess the magnitude of the effects of physical exercise programs on body mass index (BMI) and waist circumference (WC) of individuals with Intellectual and Developmental Disabilities (IDD), metabolic and cardiovascular health markers.

Results: Considering the eligibility criteria, a final sample of nine articles was obtained. For BMI, the *Z*-value obtained to test the null hypothesis (difference between means is zero), showed a $Z = -2.176$ and $p = 0.03$. The highest magnitude of the effect was from the intervention with combined training (difference in means: −0.399), with a value of $Z = -1.815$ and $p = 0.07$. For WC, the *Z*-value is zero, showing a $Z = -3.306$ and $p = 0.001$. The highest magnitude of the effect was from the intervention with continuous cardiorespiratory training of −0.786, with a value of $Z = -2.793$ and $p = 0.005$.

Discussion: Physical exercise prevents increases in BMI and WC in individuals with IDD. Aerobic training seems to be more effective in promoting WC and combined training in BMI.

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KEYWORDS

anthropometric assessment, body mass index intellectual disability, obesity, overweight, waist circumference

1 Introduction

Obesity is a major public health problem due to its growing prevalence, as it increases the risk of developing various diseases such as cardiovascular or metabolic diseases (de Winter et al., 2009; Vancampfort et al., 2020), increasing mortality in earlier ages when compared to the general population (Hosking et al., 2016). Excessive adiposity results from an imbalance between energy intake and expenditure.

Body mass index (BMI) and abdominal adiposity assessed using waist circumference (WC), body composition and anthropometric variables, are essential markers to assess overweight and obesity and are associated to metabolic disease and QoL (Klein et al., 2007; Kobo et al., 2019). This measure are non-evasive methods widely used in individual with Intellectual and Developmental Disabilities (IDD) to measure nutritional status (Temple et al., 2010; Waninge et al., 2010) and individuals with IDD are more likely to be overweight or obese compared to the general population (Zwierzchowska et al., 2021).

A systematic review with meta-analysis carried out by Maïano and collaborators (Maïano et al., 2016) showed that children and adolescents with IDD were 1.54 and 1.89 times more likely to be overweight and obese, when compared to the population without disability. These results are transversal to all age groups, from children (Wang et al., 2018), to adolescents (Krause et al., 2016) and adults (de Winter et al., 2012). Several factors may influence this prevalence, such as: 1) being female (de Winter et al., 2012); 2) advancing in age (Ranjan et al., 2018); 3) having DS (Krause et al., 2016); 4) having a degree of mild or moderate disability (Ranjan et al., 2018); 5) genetic factors (Wang et al., 2018). Other additional factors such as socioeconomic level, perceptions and attitudes towards physical activity, health problems and other characteristics of the disability itself (McGillivray et al., 2013), may also play a determinant role in this prevalence.

Considering the BMI variable, Temple and collaborators (Temple et al., 2014), when evaluating 11,643 individuals with IDD, verified that 5.5% of the sample was underweight, 36.1% in the normal range, 24.7% overweight, and 32.1% obese. Concluded that levels of overweight and obesity were high. Likewise, Foley and collaborators (Foley et al., 2017), evaluating 4,174 individuals with IDD, he also found that 32% were overweight and 11% were obese. At the same time, 21% of the participants were above the cut-off for abdominal obesity.

High values of BMI and WC, show a high prevalence of overweight and obesity in individuals with IDD. These values are associated with high risk metabolic and cardiovascular disease, excessive health costs (Vohra et al., 2017; Wyszyńska et al., 2017) and increased risk of incidence and mortality (Parra-Soto et al., 2021). On the other hand, BMI and WC are recommended by ACSM (American College of Sports Medicine, 2021) as two possible measures of anthropometric and body composition for individuals with IDD.

The global impact of physical activity and physical exercise on BMI and WC in people with IDD is not known, nor is the most effective type of exercise training for promoting these variables. International guidelines recommend by WHO (World Health Organization, 2020) and ACSM (American College of Sports Medicine, 2021) identify physical activity and exercise as important tools to improve daily life and wellbeing with a positive impact in different age groups (Kim et al., 2019). For these people, the variable mentioned, when practiced regularly, seem to be associated with improvements not only in physical fitness but also in reducing the risk of the appearance of metabolic and cardiovascular disease, reducing health costs and promoting their QoL (Pestana et al., 2018; Jacinto et al., 2021).

Since all of this work is based on the Guidelines for Exercise Testing and Prescription for individual with IDD (American College of Sports Medicine, 2021), we consider aerobic, resistance and flexibility training. According to ACSM (American College of Sports Medicine, 2021) aerobic exercise is the ability of the circulatory and respiratory system to supply oxygen during sustained physical activity, resistance training is the capacity of muscle to exert force and flexibility is the range of motion available at a joint.

The main purpose of the present systematic review with meta-analysis is to measure the magnitude of effects of different types of physical exercise on BMI and WC, metabolic and cardiovascular health parameter, in individual with IDD aiming to provide relevant information to sport sciences and health sciences professionals when planning, implementing and monitoring exercise intervention programs in people with IDD.

2 Materials and methods

The present systematic review with meta-analysis followed the guidelines defined in the original checklist of Preferred Reporting Items for Systematic Reviews and Meta-Analyses—PRISMA (Page et al., 2021). The protocol has been registered at the PROSPERO International Propective Regiter of Sytematic Review, with a number 2021: CRD42021255316.

The PICOS strategy (Methley et al., 2014; Nang et al., 2015) was used to ensure rigor defining of the research question, in which: 1) "P" corresponded to participants with IDD of any age, regardless of ethnicity or gender; 2) "I" corresponded to any physical exercise program implemented in the population with IDD (DS included), regardless of the intervention time, according to ACSM (American College of Sports Medicine, 2021); 3) "C" (Comparison) corresponded to the comparison between the CG versus the; 4) "O" corresponded to BMI and WC as the first or second variable in focus; 5) "S" (Study Design) corresponded to randomized controlled clinical trials (RCT).

2.1 Data sources

The search was conducted in the English language, in the following electronic databases: PubMed (title and abstract), Web of Science, and Scopus (title, abstract and key words), accessed between February 2021 and December 2022, using the advanced search option, with randomized exercise intervention studies. The search has been updated until the 10th of December. The search strategy combined Key Medical Subject Heading and indexed search descriptors to refine the data, following the recommendation from the Cochrane Handbook for Systematic Review of Intervention (Higgins and Altman, 2008), as shown in Table 1.

2.2 Eligibility criteria and studies selection

To be included in the present systematic review with meta-analysis, studies must meet the following inclusion criteria: 1) RCT studies with exercise intervention (with intervention group and control group), with any prescription in terms of intensities and duration, according to ACSM guidelines (American College of Sports Medicine, 2021); 2) All participants mut have an IDD diagnosis, whatever the degrees, including other subgroups with IDD (diagnosis by Wechsler Adult Intelligence Scale—Fourth Edition (Wechsler, 2008) or The Wechsler

TABLE 1 Research Content.

Research content
("intellectual disability" OR "intellectual disabilities" OR "mental retardation" OR "Down Syndrome" OR "Intellectual Developmental Disorder" OR "Intellectual Developmental Disabilities" OR "Intellectual Developmental Disability") AND ("exercise" OR "training") AND ("body mass index" OR "waist circumference").

Intelligence Scale for Children—Fifth Edition Integrated (Raiford, 2018); 3) Participants with IDD of any age, gender, race or ethnicity, regarding ACSM (American College of Sports Medicine, 2021); 4) Studies focusing on aerobic, neuromuscular, flexibility or combined capacity (training that combines more than one physical capacity, e.g., strength and aerobic capacity), which recommended by ACSM (American College of Sports Medicine, 2021), Figure 1 shows research content. In turn, all studies with the following characteristics were excluded: 1) Studies published in a language other than English; 2) Studies that do no describe the intervention protocol; 3) Studies with participants with another type of disability or other associated pathologies; 4) Studies in which the intervention is multidimensional (studies involving exercise and nutrition, exercise and health education sessions); 5) Studies that do not show anthropometric data (BMI and WC); 6) Studies that the intervention protocol is through virtual reality (institution where we want to replicate the protocol does not have access to this material, as well as other institutions where most of this population usually spends their day); sports programs. All studies that did not meet the initial selection criteria and did not report results adequately (mean, standard deviation and sample size) or if the respective authors did not reply to our inquiries sent by email, were excluded. Finally, articles presented in abstracts, letters to the editor, systematic reviews, study protocols, and book chapters were excluded.

2.3 Data extraction

Studies were imported into EndNote X7 software, and duplicates were removed. The study selection procedure was carried out in phases. In the first phase, the search for potentially relevant studies was carried out with the participation of two independent reviewers, based on the titles and the abstract. These studies would proceed to the next evaluation phase in case of doubt following. In the second phase, the studies from the previous stage were reviewed by the same independent reviewers based on the application of the previously defined eligibility criteria. In case of doubt or disagreement regarding the inclusion of a study, this was solved through a third reviewer's opinion playing the mediator's role and whose decision was used as a tiebreaker. Finally, the first two reviewers involved in the selection of the studies participated independently in the analysis of the studies extracting all relevant information and characteristics, namely, the author's name, year and country where it was carried out, objective, participants, instruments/techniques, duration/frequency, and results. In this phase, discrepancies about the extracted data were resolved by consensus among reviewers.

2.4 Quality assessment of studies

The PEDro Scale from the Physiotherapy Evidence Database, was used (Maher et al., 2003) to assess the quality of each study. The scale consists of 11 items, which analyse the different characteristics of each study, one of which is not counted (item 1) and the two others are not applicable in the field of sports science (items 5 and 6). The results obtained by both were compared and discussed so that there was a consensus. When there was no consensus, a third researcher was invited to collaborate.

2.5 Statistical analysis

Meta-analysis was performed using Comprehensive Meta-analysis Version 3.0 statistical software. The standardised difference in means was calculated based on information on pre and post-intervention means, number of participants, and standard deviation, using the randomized effects model to measure the effect size, the confidence interval (CI) of 95%, the magnitude of effects and level of statistical significance ($p < 0,05$). Favours A corresponds to, EG and Favour B correspond to CG. Heterogeneity was measured using chi-square, Cochran's Q statistic, Higgin I squared (I^2), and Tau square tests (T^2). The Q statistic was used to test the null hypothesis, according to which all studies under analysis share a typical magnitude of effects. If all studies share the same effect-size, the expected values of Q would be equal to the number of degrees of freedom (N-1). I^2, which represents the percentage of variance attributed to the heterogeneity of the study, ranged from low (25%) to high (50%), with 50% being considered moderate (Batterham and Hopkins, 2006). T^2 is the variance of the true effect dimensions (in log units) between studies (Higgins et al., 2003), assuming that $T^2 > 1$ suggests the presence of substantial heterogeneity. The homogeneity was verified by visualizing the asymmetry of the funnel-shaped scatter plot (Egger et al., 1997), considering that there was no publication bias when the graph had an inverted funnel (Higgins and Altman, 2008). Since the funnel-shaped scatter plot interpretation is sometimes subjective, the Egger test was used to check for publication bias (Rosenblad, 2009). Four meta-analyses were carried out, two to investigate the impact of exercise on the BMI and WC and another two to find out which type of training is most effective in provoking such adaptations.

3 Results

3.1 Data search

With the search carried out in different databases PubMed, Web of Science, and Scopus) 329 studies were identified. Subsequently, after eliminating the duplicate studies and reading the titles and abstracts, 47 studies with potential relevance to the study were identified. Considering the eligibility criteria previously defined for this systematic review with meta-analysis, from the complete reading of the articles, a sample of nine studies was constituted for their full analysis (Figure 2).

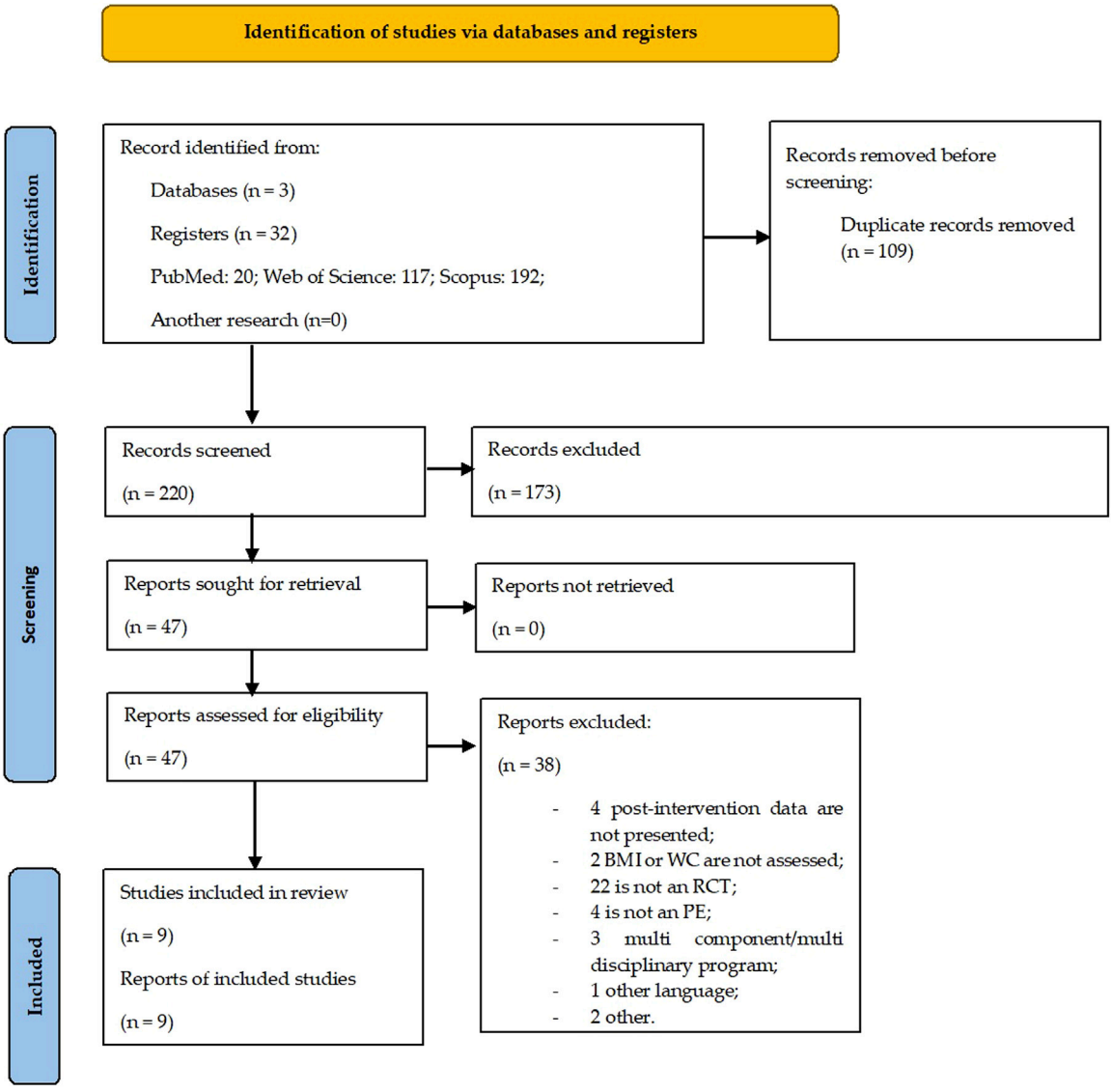

FIGURE 1
PRISMA flow diagram.

3.2 Characteristics of the studies

Details of the 9 studies included in the systematic review and assessed for quantitative analysis are presented in Table 2.

3.3 Quality of the information

Rosety-Rodriguez and collaborators (Rosety-Rodriguez et al., 2014) were the studies that obtained the lowest quality score (4 points—40%), and the studies with the best scores had 8 points (80%) Shields and Taylor (Shields and Taylor, 2015), showing a good quality of the methodological procedures.

3.4 Participants

The total number of participants included in the different studies was 291, 172 in experimental groups and 119 in CG. The studies included different types of IDD, whether it is DS, autism, or others. In Boer et al. study (Boer et al., 2014), participants were attending 40 secondary school at two Belgian special education school. In Boer and Moss study (Boer and Moss, 2016), participants were recruited from three care centres for persons with IDD. Participants in the Diaz and collaborators study (Diaz et al., 2021) and Ordonez and collaborators (Ordonez et al., 2014) were recruited via community support groups for people with IDD. Also, González-Agüero and collaborators (González-Agüero et al., 2012)

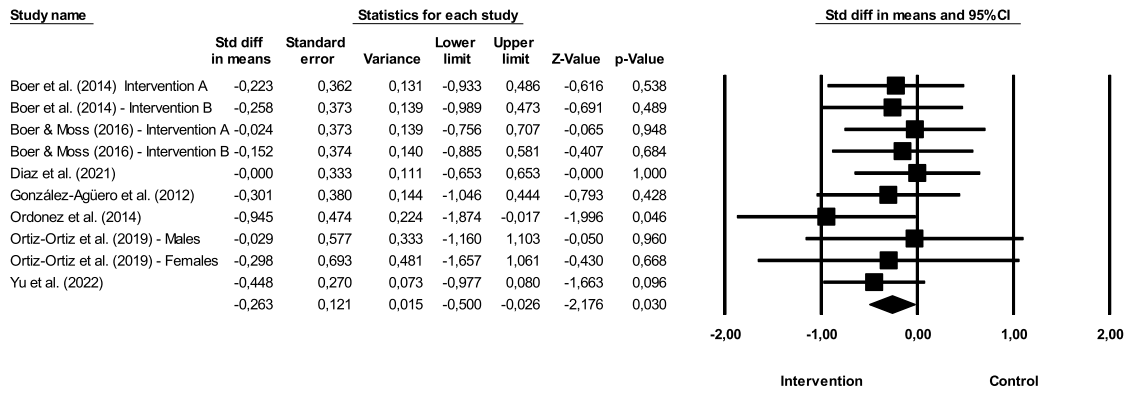

FIGURE 2
Difference of means of effect size comparing pre versus post intervention (BMI).

recruited participants from different schools and institutions. Ortiz-Ortiz (Boer et al., 2014) and Rosety-Rodriguez and collaborators (Rosety-Rodriguez et al., 2014) does not mention where and how participants were recruited. Shields and Taylor (Shields and Taylor, 2015) recruited participants by contacting family members who were interested and Yu and collaborators (Ortiz-Ortiz et al., 2019) recruited participants from six special schools for adolescents with mild/moderate IDD.

3.5 Duration

The exercise intervention programs ranged from 8 to 36 weeks, however is more prevalent a prescription of 10–12 weeks (Ordonez et al., 2014; Rosety-Rodriguez et al., 2014; Boer and Moss, 2016; Diaz et al., 2021), i.e., short duration programs. The two combined exercise programs included in this systematic review lasted for 21–36 weeks (González-Agüero et al., 2012; Yu et al., 2022), one of neuromuscular capacity exercise programs lasted 16 weeks (Ortiz-Ortiz et al., 2019) and other 12 weeks (Diaz et al., 2021) and the five aerobic exercise programs lasted from 8 to 15 weeks, with half being implemented over 10 weeks (Boer et al., 2014; Ordonez et al., 2014; Rosety-Rodriguez et al., 2014; Shields and Taylor, 2015; Boer and Moss, 2016).

The frequency varied between 2 and 5 times per week, with most studies implementing 3 times per week (Ordonez et al., 2014; Rosety-Rodriguez et al., 2014; Shields and Taylor, 2015; Boer and Moss, 2016; Diaz et al., 2021). The two combined exercise programs included in this systematic review with meta-analysis have a frequency of 2 times per week (González-Agüero et al., 2012; Yu et al., 2022). Regarding neuromuscular capacity, one of the exercise programs have a frequency of 5 times per week (Ortiz-Ortiz et al., 2019) and other 3 times per week (Diaz et al., 2021). Finally, the 5 aerobic exercise programs have a frequency of 2 and 3 times per week, with the majority implemented 3 times per week (Boer et al., 2014; Ordonez et al., 2014; Rosety-Rodriguez et al., 2014; Shields and Taylor, 2015; Boer and Moss, 2016). Regarding the duration of the exercise intervention session, sessions varied between 25 and 65 min including a brief warm-up and a return to calm period. The duration of the training session in the two combined exercise programs varied from 25 to 60 min (González-Agüero et al., 2012; Yu et al., 2022), one of the exercise programs for neuromuscular capacity were implemented for 55 min (Ortiz-Ortiz et al., 2019), with the other one not showing the session duration (Diaz et al., 2021), and from the five aerobic exercise programs four lasted from 30 to 60 min (Boer et al., 2014; Ordonez et al., 2014; Rosety-Rodriguez et al., 2014; Boer and Moss, 2016). One of the studies did not mention the duration of the training session, but mentions the weekly volume, namely, 150 min per week (Shields and Taylor, 2015).

3.6 Type of exercise program

Concerning aerobic training, different intensities were reported following the global recommendations/guidelines presented of the ACSM (American College of Sports Medicine, 2021) for efforts within the interval of 60%–85% of maximum heart rate (HRmax).

Some studies used an intensity of 40%–65% HRmax (Ordonez et al., 2014; Rosety-Rodriguez et al., 2014; Diaz et al., 2021), others used 100%–110% of the ventilatory threshold (Boer et al., 2014) while others reported a 70%–80% maximum oxygen consumption (VO2max) (Boer and Moss, 2016) intensity value, with gradual increments throughout the intervention. These studies use different equipment such as stationary cycling, treadmills, or other materials such as steps or walking/running.

Interval training programs demonstrate a reduced volume compared to continuo training and used periods of 10 s of maximum speed, followed by 90 s of rest (Boer and Moss, 2016) or 15 s of full speed followed by 45 s of rest (Boer et al., 2014) using cycle ergometers or simple walks/runs.

All the exercise programs focused on neuromuscular capacity used a training circuit with different materials. The study by Diaz and collaborators (Diaz et al., 2021) worked at loads of 40%–65% of 8 repetition maximum (RM). One of the combined training programs is based time set (10–30 s per set; 4 sets) and aerobic intensity interval with a HRmax between 30% and 60% (Yu et al., 2022), and a second one is a four-stage circuit based on training with body weight, fitness bands and medicine balls (González-Agüero et al., 2012).

TABLE 2 Characteristics of the 9 selected studies.

Author	Aims	Participants	Assessment tools	Exercise program	Results	Quality score
Boer et al. (2014)	Effects of sprint interval training on metabolic and physical fitness.	N = 46	BMI (kg/m2); WC (tape: level of the umbilicus with the 92 subject in a standing position after normal expiration).	15 weeks; 2 x week; 40 min/session	BMI (pre vs. post) Intervention A: 28.4 ± 4.7 vs. 27.7 ± 4.7; Intervention B: 27.5 ± 2.7 vs. 26.9 ± 3.1; Control: 26.9 ± 3.2 vs. 26.9 ± 2.9.	5/8
		17 ± 3 years; IDD (fragile X syndrome, fetal alcohol syndrome, Prader–Willi and others)		Intervention A - Interval training: a sprint interval block (10 min), continuous aerobic exercise (10 min), and another sprint interval block (10 min); each sprint interval block consisted of 10 sprint bouts (>100 r/min) of 15s at a resistance matching with the VTR, alternated with 45s relative rest (50 r/min at VTR); 100%–110% of VTR	WC (pre vs. post) Intervention A: 95.8 ± 13.1 vs. 91.5 ± 13.1; Intervention B: 95.9 ± 9.6 vs. 93.4 ± 9.6; Control: 95 ± 8.8 vs. 95.9 ± 8.2.	
		Randomized groups: interval training—Intervention A (N = 17); continuous aerobic training—Intervention B (N = 15); control (N = 14).		Intervention B—Continuous aerobic training: cycling (10 min), walking/running (10 min), stepping (10 min); 100%–110% of VTR.		
Boer and Moss (2016)	Determine the effect of continuous aerobic training vs. interval training on several parameters.	N = 42; 33.8 ± 8.6 years; DS	Body weight; Height; WC (tape: measured at the umbilicus with the participant standing upright after a normal expiration).	12 weeks; 3 x week; 30 min/session	BMI (pre vs. post) Intervention A: 30.6 ± 6.1 vs. 30.2 ± 6.3; Intervention B: 29.3 ± 4 vs. 28.5 ± 4; Control: 31.2 ± 4.6 vs. 30.9 ± 4.2.	7/8
		Randomized groups: continuous aerobic training—Intervention A (N = 13), interval training—Intervention B (N = 13); control (N = 16).		Intervention A—Continuous aerobic training: cycling or walking at an intensity of 70%–80% of VO_{2max}	WC (pre vs. post) Intervention A: 95 ± 11.1 vs. 93.7 ± 11.9; Intervention B: 94.2 ± 8.1 vs. 93.8 ± 8; Control: 99.4 ± 10.9 vs. 98 ± 10.6.	
				Intervention B—Interval training: 10–30 s all out sprints with the 90 s (1: 3 work-rest ratio) of low cadence, low intensity walking or cycling.		
Diaz et al. (2021)	Analyze the impact of circuit RT on markers of muscle damage.	N = 36; mean age 28.1 ± 3.3 years; DS	BMI (kg/m2); WC (tape: between the costal edge and the iliac crest).	12 weeks; 3 x week; Duration of session: NA	BMI (pre vs. post): EG: 31.4 ± 5.7 vs. 31.6 ± 6; CG: 30.8 ± 5.2 vs. 31 ± 5.5.	7/8
		Randomized groups: exercise (N = 18); control (N = 18).		Resistance circuit training: 40%–65% 8RM; 2 sets; 6 to 10 reps; 90s rest between stations; Exer: arm curl (elbow flexion), triceps extension (elbow extension), leg extension, seated row, leg curl (knee flexion), and leg press (combined hip and knee extension)	WC (pre vs. post): EG: 91.4 ± 12.8 vs. 90.8 ± 13.4; Control group: 88.9 ± 13.3 vs. 89 ± 13.4.	
González-Agüero et al. (2012)	Effect of training on bone mass.	N = 28; 10–19 years; DS	Height; Weight; BMI (kg/m^2)	21 weeks; 2 x week; 25 min/session	BMI (pre vs. post): EG: 19.6 ± 2.7 vs. 20.2 ± 2.6; CG: 22.4 ± 3.4 vs. 22.3 ± 3.2.	5/8
		Randomized groups: exercise (N = 14); control (N = 14).		1 or 2 rotations in a four-stage circuit: jumps, press-ups on the wall, fitness bands and medicine balls.		

(Continued on following page)

TABLE 2 (*Continued*) Characteristics of the 9 selected studies.

Author	Aims	Participants	Assessment tools	Exercise program	Results	Quality score
Ordonez et al. (2014)	Influence of aerobic training on pro-inflammatory cytokines and acute phase proteins.	N = 20; 8–30 years; DS Randomized groups: exercise (N = 11); control (N = 9).	Height; Body weight; BMI (kg/m2); WC (tape: between the costal edge and the iliac crest).	10 weeks; 3 x week; 45–65 min/session. Aerobic training: 30–40 min treadmill exercise at 55%–65% of peak heart rate.	BMI (pre vs. post): EG: 30.2 ± 0.9 vs. 29.8 ± 0.7; CG: 30.7 ± 0.8 vs. 30.9 ± 0.8. WC (pre vs. post): EG: 94.7 ± 3.3 vs. 91.5 ± 3.1; CG: 93.5 ± 3.1 vs. 93.7 ± 3.2.	5/8
Ortiz-Ortiz et al. (2019)	Effect of a exercise on body composition and isometric strength.	N = 22; 8–16 years; DS Randomized groups: exercise (N = 13); control (N = 9).	Height; Weight; BMI (kg/m^2).	16 weeks; 5 x week; 55 min/session Strength training: circuit and "tabata" exercises; Different materials were used, such as weight discs, tension ropes, dumbbells, medicine balls, and handgrips; Exer: biceps curl, triceps extension, chest press, and handgrip with different degrees of tension.	BMI (pre vs. post) Males: 21.1 ± 1.8 vs. 19.7 ± 1.8; Females: 23.2 ± 2.9 vs. 21.5 ± 3; CG: Males: 23.3 ± 6.3 vs. 21.8 ± 5.9; CG Females: 23.3 ± 1 vs. 22.2 ± 0.9	7/8
Rosety-Rodriguez et al. (2014)	Determine for how long the anti-inflammatory effect induced by aerobic training.	N = 20; 18–30 years; DS Randomized groups: exercise (N = 11); control (N = 9).	WC (tape: do not mention the procedures).	10 weeks; 3 x week; 60 min/session. Aerobic training: 30–40 min—treadmill; 55%–65% of peak heart rate.	WC (pre vs. post): EG: 94.7 ± 3.3 vs. 91.5 ± 3.1; CG: 93.5 ± 3.1 vs. 93.7 ± 3.2.	4/8
Shields and Taylor (2015)	Feasibility of a physical activity program.	N = 16; 18–35 years; DS Randomized groups: exercise (N = 8); control (N = 8).	WC (tape: do not mention the procedures).	8 weeks; 3 x week; 150 min of moderate intensity PA per week Aerobic training: walking.	WC (pre vs. post): EG: 95.6 ± 17.2 vs. 90.1 ± 12.1; CG: 89.3 ± 8.8 vs. 94.1 ± 7.4.	8/8
Yu et al. (2022)	Effectiveness school-based adapted physical activity.	N = 61; 12–18 years; IDD Randomized groups: EG (N = 39); CG (N = 22).	BMI: (kg/m2); WC (tape: midway point between the lowest rib margin and the top of the iliac crest at the end of a gentle ventilatory expiration).	36 weeks; 2 x week; 45–60 min/session Aerobic training: 30%–60% peak heart rate—walk/run Strength training: jumping jacks, high kness, sit-ups; 10–30s/sets; 4 sets; 1 min to 40 s break between sets.	BMI (pre vs. post): EG: 28.16 ± 3.69 vs. 27.5 ± 3.97; CG: 27.37 ± 3.99 vs. 28.05 ± 3.75. WC (pre vs. post): EG 93.55 ± 10.11 vs. 91.54 ± 11.1; CG: 90.51 ± 11.72 vs. 92.27 ± 9.26.	6/8

Note: CG, control group; EG, exercise group; DS, down syndrome; Exer, Exercise/s; Min, minutes; N, participants; Rep, repetitions; RM, maximum repetition; s, Seconds; SD, standard deviation; VO_{2max}, maximum oxygen consumption; VTR, ventilatory threshold; *, Only analysed the exercise and control group.

3.7 Results of intervention on BMI

Figure 2 show the impact of exercise on BMI.

The sum of the effects is −0.263, which means that individuals in the, EG are 0.263 times more likely to report decreases when compared to the CG when the inclusion and exclusion criteria previously described in the study are met. The CI for the difference in means is from −0.5 to −0.026, which means that the gross disparity in means, in the universe of studies, may fall somewhere in this interval. On the other hand, this range does not include the difference of zero, which means that the true difference in means is different from zero. The Z values obtained to test the null hypothesis, according to which the difference between means is zero, showed a $Z = -2.176$, with the corresponding value of $p = 0.03$. The obtained value of Q is 3.856 with 9 degrees of freedom and with a $p \geq 0.05$. We cannot reject the null hypothesis that the true magnitude of effects is the same across studies, and we can say that the true extent of effects does not varies from study to study. In the present meta-analysis, the I^2 value obtained is 0, which means that the variance in the observed effects reflect 0% the variance in the true results. On the other hand, T^2 corresponds to the variance of the true magnitude of the impact

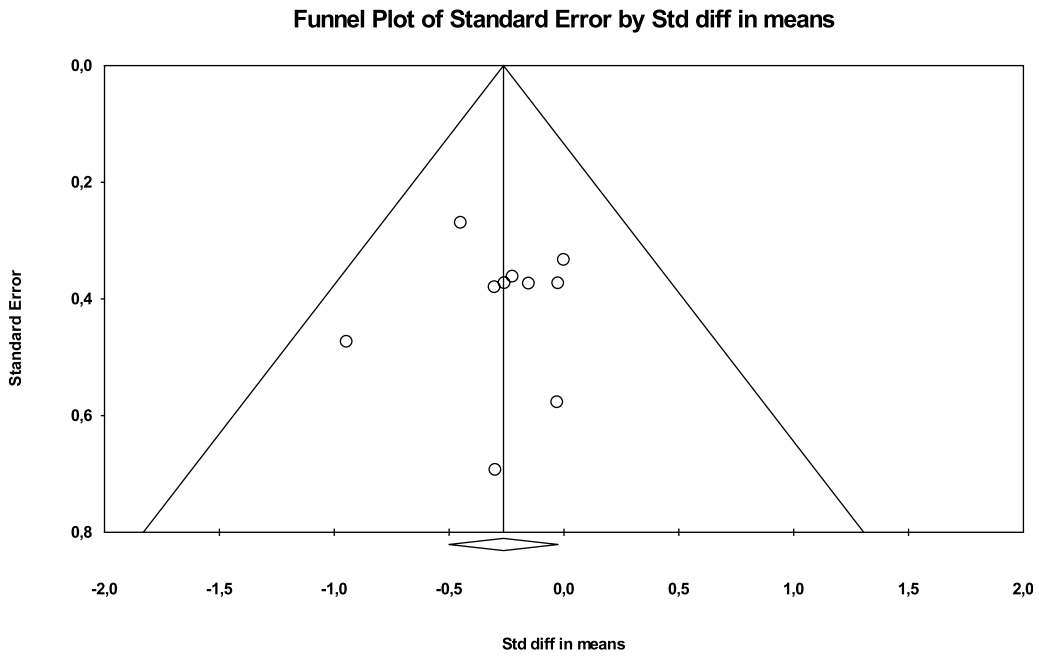

FIGURE 3
Scatterplot in funnel format for verification of publication bias (BMI).

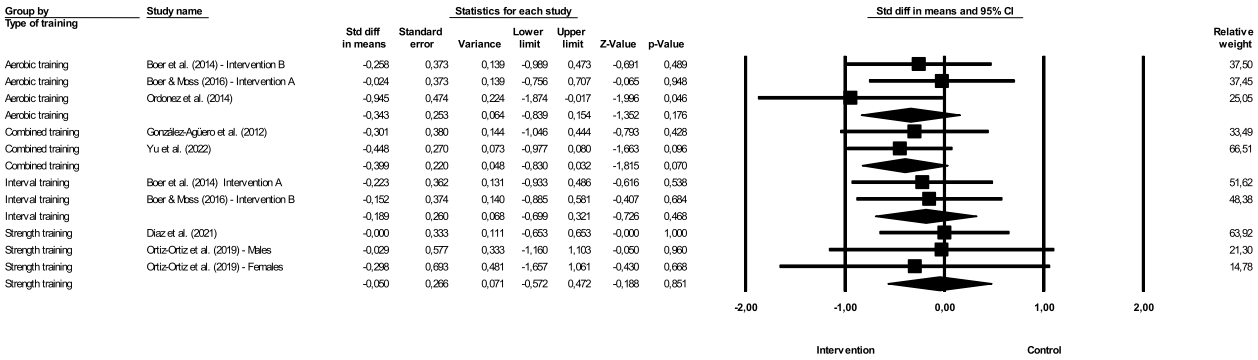

FIGURE 4
Difference in effect size means comparing different exercise (BMI).

(true effect sizes) between studies that, in the present study, have a value of 0, as well as the value of *T*, concerning the deviation pattern of the true magnitude of the effects.

Figure 3 show the publication bias.

In addition, the Egger test was carried out, which proposes to test the null hypothesis according to which the intercept is equal to zero in the population. For Figure 4, the intercept is −0.03655, 95% CI (−2.20324, −2.13014), with $t = 0.0389$, degrees of freedom = 8 The recommended value of p (2-tailed) is 0.96. There is no statistical evidence for the existence of publication bias.

3.7.1 Most effective type of training to improve BMI

Figure 4 show the impact of different exercise on BMI.

Continuous aerobic training—The magnitude of the effect of the intervention with aerobic training was −0.343, with a value of $Z = -1.352$ and $p = 0.176$. Combined training—The effect of the intervention with interval training was −0.399, with a value of $Z = -1.815$ and $p = 0.07$. Interval training—The effect of the intervention with interval training was −0.189, with a value of $Z = -0.726$ and $p = 0.468$. Strength training—The magnitude of the effect of the intervention with strength training was −0.05, with a value of $Z = -0.188$ and $p = 0.851$. In this case, $Q = 1.202$ with 3 degrees of freedom and $p > 0.05$. We can accept the null hypothesis that the actual effect size is the same in all studies. However, the study that shows the greatest effectiveness is combined training, which has a higher magnitude of effect, although the difference between the effects of different studies is not significant.

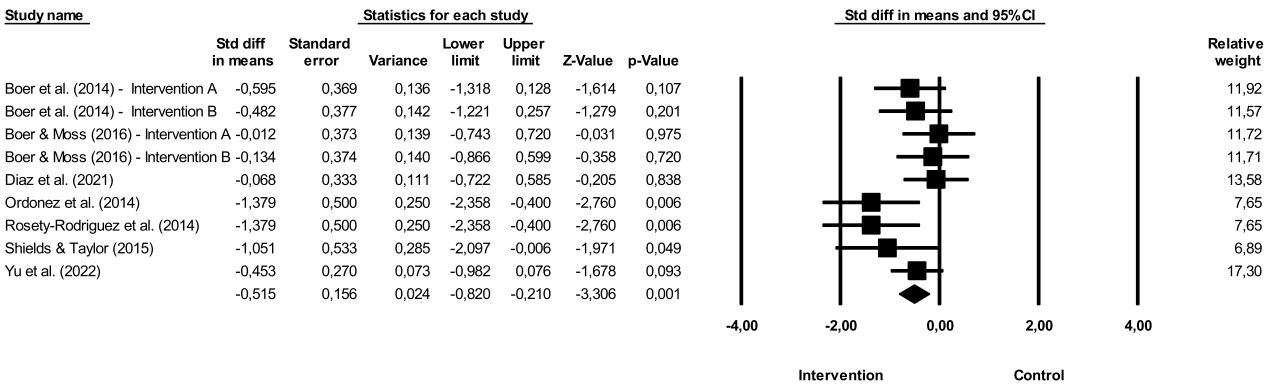

FIGURE 5
Difference in mean effect size comparing pre versus post intervention (WC).

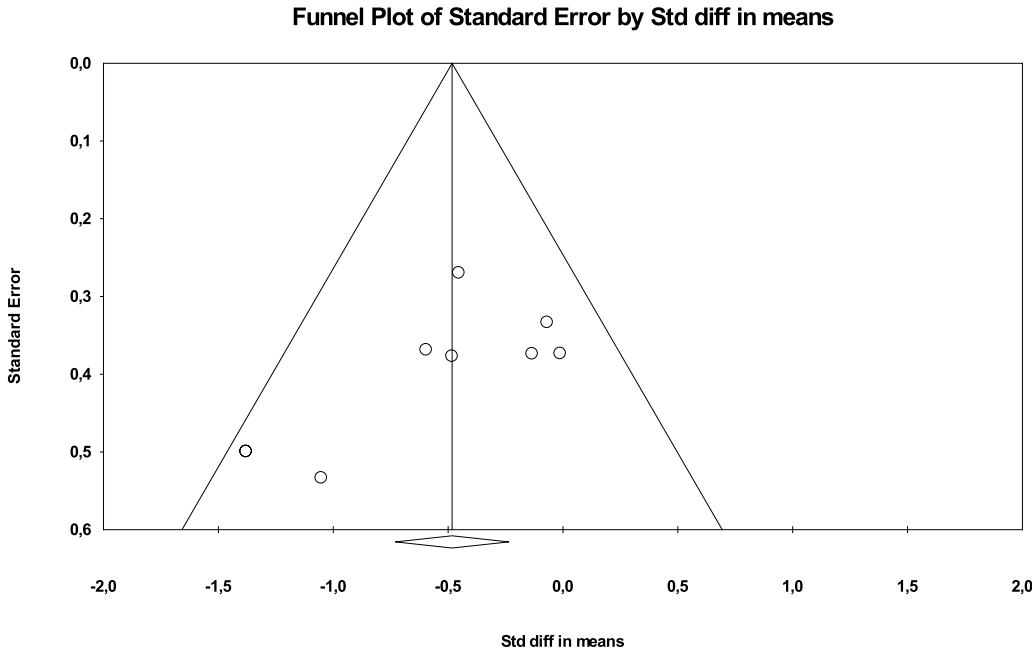

FIGURE 6
Scatterplot in funnel format for verification of publication bias (WC).

3.8 Results of intervention on WC

Figure 5 show the impact of exercise on WC.

The sum of the effects is −0.515, which means that individuals in the, EG are 0.515 times more likely to report decreases when compared to the CG when the inclusion and exclusion criteria previously described in the study are met. The CI for the difference in means is from −0.82 to −0.21, which means that the gross disparity in means, in the universe of studies, may fall somewhere in this interval. On the other hand, this range does not include the difference of zero, which means that the true difference in means is different from zero. The Z values obtained to test the null hypothesis, according to which the difference between means is zero, showed a $Z = -3.306$, with the corresponding value of $p = 0.001$. The obtained value of Q is 11.683 with 8 degrees of freedom and with a $p = 0.166$. We cannot reject the null hypothesis that the true magnitude of effects is the same across studies, and we cannot say that the true extent of effects varies from study to study. In the present meta-analysis, the I^2 value obtained is 31.526, which means that the variance in the observed effects does not reflect the variance in the true results (just reflect 31%). On the other hand, T^2 corresponds to the variance of the true magnitude of the impact (true effect sizes) between studies that, in the present study, have a value of 0.067, as

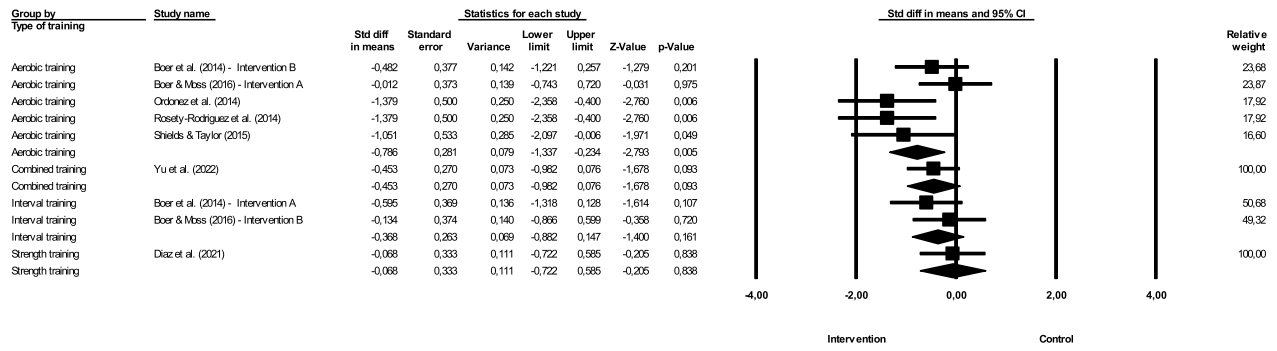

FIGURE 7
Difference in mean Effect size comparing different exercise (WC).

well as the value of *T*, concerning the deviation pattern of the true magnitude of the effects.

Figure 6 show the publication bias.

In addition, the Egger test was carried out, which proposes to test the null hypothesis according to which the intercept is equal to zero in the population. For Figure 7, the intercept is −3.7287, 95% CI (−7.40536, −0.04837), with t = 2.39572, degrees of freedom = 7. The recommended value of p (2-tailed) is 0.04777. There is statistical evidence of the existence of publication bias.

3.8.1 Most effective type of training to improve WC

Figure 7 show the impact of different exercise on WC.

Continuous aerobic training—The effect of the intervention with continuous aerobic training was −0.786, with a value of Z = −2.793 and p = 0.005. Combined training—The effect of the intervention with combined training was −0.453, with a value of Z = −1.678 and p = 0.093. Interval training—The effect of the intervention with interval training was −0.368, with a value of Z = −1.4 and p = 0.161. Strength training—The magnitude of the effect of the intervention with strength training was −0.068, with a value of Z = −0.205 and p = 0.838. In this case, Q = 2.831 with 3 degree of freedom and p > 0.05, so we can accept the null hypothesis that the actual effect size is the same in all studies. However, the study that shows the greatest effectiveness is continuous aerobic training, which has a higher magnitude of effect, although the difference between the effects of different studies is not significant.

4 Discussion

This systematic review with meta-analysis aimed to assess the magnitude of the effects of different types of exercise programs on BMI and WC, variables related to metabolic and cardiovascular health of individuals with IDD.

The results of exercise programs are varied, depending on the objectives and the assessment tools/techniques. The fact that the present systematic review encompassed people with IDD of varying degrees and diagnoses (DS, autism, or others) may have influenced our results, because subgroups may have different responses to exercise ACSM (American College of Sports Medicine, 2021). However, these different responses to exercise still need further study to determine the optimal exercise intensities and modes for the population. However, taking into account the purposes of this systematic review with meta-analysis, we found that all studies that assess the BMI (Boer et al., 2014; Ordonez et al., 2014; Boer and Moss, 2016; Ortiz-Ortiz et al., 2019; Yu et al., 2022) and WC (Boer et al., 2014; Ordonez et al., 2014; Rosety-Rodriguez et al., 2014; Shields and Taylor, 2015; Boer and Moss, 2016; Yu et al., 2022) had a decrease in the values of these same variables through the implementation of exercise programs, except studies by González-Agüero and collaborators (González-Agüero et al., 2012) and Diaz and collaborators (Diaz et al., 2021), where there were an increases in BMI. In the González-Agüero and collaborators (González-Agüero et al., 2012) study, it was natural to see an increase in BMI due to the aim of the study. On the other hand, this increase was beneficial due to the relatively low mean BMI values of the sample, according to the cut-off values, in contrast to most of the literature. In the Diaz and collaborators (Diaz et al., 2021) study, the increase in BMI values may be justified by increases in muscle mass.

All studies used the same paradigm, whereby individuals with IDD were randomly placed in the experimental group (with exercise) or the CG. There is a shortage of exercise programs with randomized controlled methodology that assesses the impact on BMI and WC, along with only the population with IDD. The results were reported regarding the improvement of the BMI or WC.

Exercise was different in the studies, also differing in the physical capacity for training (aerobic training, strength, and/or combined training). The most used training methodology is the continuous aerobic type (Boer et al., 2014; Ordonez et al., 2014; Rosety-Rodriguez et al., 2014; Shields and Taylor, 2015; Boer and Moss, 2016), with observing a reduced or null number of interventions focusing on other physical fitness components. Therefore, which presupposes that the results of this study should be taken with caution.

Considering the present systematic review with meta-analysis, exercise had superior effects in most studies. However, the differences were not significant in some studies. Thus, we can reject the null hypothesis that exercise does not affect the BMI or WC of individuals with IDD, on the other hand, exercise seems decreases BMI and WC values. This is the strength of the study, since previous research shows that exercise interventions did not promote BMI and WC of individuals with IDD (Harris et al., 2015), even multi-component

weight management interventions, namely, inclusion of an energy deficit diet, physical activity, and behaviour change techniques, are effective (Harris et al., 2018) and that only exercise and diet interventions could promote the variables under study (Harris et al., 2018; Ptomey et al., 2018). Currently, more researchers interested in promoting the QoL of these individuals may be at the origin of the results of the present study (Schalock et al., 2002), since recommendations for the assessment and prescription of exercise in individuals with IDD are frequently published, adapted, from previously implemented studies (American College of Sports Medicine, 2021). This increased interest increases knowledge of effective strategy and methodologies for QoL improvement. Since individuals with disabilities usually have high levels of overweight and obesity, the results of this study highlight the importance of regular exercise practice by individuals with IDD, to prevent the increase in values such as BMI and WC and, consequently, prevent the onset of metabolic and cardiovascular diseases. On the other hand, a follow-up by the technical of exercise, in order to assess and prescribe exercise in a correct and adapted way should be considered (American College of Sports Medicine, 2021).

According to this systematic review with meta-analysis, combined training appears to be the most efficient method for the promotion of BMI and aerobic training for WC and, in turn, the metabolic health of individuals with IDD. The literature is not clear about the training methodology that best promotes the variables under study. For Skrypnik and collaborators (Skrypnik et al., 2015) there are no significant differences between the different methods. Aerobic training reduces fat mass but has little effect on maintaining fat free mass (Garrow and Summerbell, 1995), and some authors point out that it is effectively the best method to reduce body mass (Willis et al., 2012). However, strength training, which produces fat-free mass gain, also increases resting energy expenditure (Hunter et al., 2000). Exercise combined resistance and aerobic training showed to be a good alternative for increasing fat-free mass and reducing fat mass (Willis et al., 2012), with authors claiming that it is the best method for losing weight and fat mass and maintaining fat free mass (Ho et al., 2012).

This article investigates which type of intervention best promotes BMI and WC in individuals with IDD. However, the small number of articles included and heterogeneity of population and diagnosis in the meta-analysis and a higher prevalence of studies with continuous aerobic methodology may have limited the results. It is recommended to continue implementing exercise programs with different methods, focusing on physical abilities in isolation or combination, so that further studies can measure these results way more precisely and robustly. On the other hand, waist circumference, may be considered a limitation of the present study, despite its usefulness, low cost and wide availability in any clinical setting, due to measurement errors because of its lack of reproducibility (Bouchard, 2007). Several studies are recommending the use of imaging techniques as they are more accurate and reproducible, however, they are also more expensive and complex (El Ghoch et al., 2012). At the same time, we recommend that future studies investigate the impact of a multidisciplinary intervention on these variables. Seeing if it can have more impact than exercise alone. We also recommend that future interventions are aimed at reducing energy intake and not just energy expenditure through the exercise.

5 Conclusion

Based on the results of the systematic review with meta-analysis, we can affirm that exercise programs prevent BMI and WC increments of individuals with IDD. Although without significant results, combined training looks to be more effective in promoting BMI and continuous aerobic training for WC since it had a greater effect size. The interest of various stakeholders in studying the QoL of individuals with IDD has increased, and the results of this systematic review with meta-analysis should be considered when planning interventions with the focus populations, in the sense that exercise programs promote BMI and WC, which, in turn, is associated with metabolic and cardiovascular health. The practice of exercise, in addition to promoting physical capacity, reduces the risk of diseases, being an essential aspect for a better QoL in individuals with IDD.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

MJ, MC, JF, and RM contributed to the conception and design of the study. MJ organized the database. MJ, DM, and RA performed the statistical analysis. MJ wrote the first draft of the manuscript. DM, RA, MC, JF, and RM wrote sections of the manuscript. 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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Sports activity limitation during the COVID-19 pandemic in young Italian athletes: impact on mental health in children, adolescents, and young adults

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Introduction: The closure of sports centres was implemented as a preventive measure to mitigate the transmission of SARS-CoV-2. Given the observed global decline in physical activity and concurrent rise in sedentary behaviour, even among younger age groups, a retrospective cross-sectional study was undertaken to evaluate the effects of this measure on mental health in children, adolescents, and young adults during the initial phases of the COVID-19 pandemic.

Methods: A total of 1,717 non-professional athletes (age range: 6–25; 53.9% males, 44.6% females) completed an online questionnaire including widely used and validated measures for mental health assessment (SDQ and PGWB-S) and questions regarding sociodemographic characteristics (such as gender), physical activity, and screen time. The association between mental health and sociodemographic characteristics, physical activity, and screen time was evaluated by using univariate and multivariable logistic regression models.

Results: In children and adolescents, the incidence of psychological difficulties was associated with not being physically active (OR = 1.49; 95% CI: 1.09, 2.07; $p = 0.015$). Engaging in physical activity during the period of closures, particularly if more than twice a week, was significantly associated with less psychological difficulties for children/adolescents (OR = 0.54; 95% CI: 0.35, 0.82; $p = 0.004$) and psychological symptoms (i.e., psychological well-being lower than the median) for youth/young adults (OR = 0.25; 95% CI: 0.14, 0.45; $p < 0.001$). More psychological difficulties were also found in males for children and adolescents (OR = 1.37; 95% CI: 1.06, 1.79; $p = 0.018$). However, young adult males showed less psychological symptoms than females (OR = 0.35; 95% CI: 0.22, 0.55; $p = 0.001$). Additionally,

a greater amount of screen time was associated with a higher incidence of psychological symptoms in the whole sample.

Conclusions: Our results confirm the positive impact of physical activity on mental health during the COVID-19 pandemic among younger age groups. They also provide valuable insights into the risk-benefit relationship of interrupting sports activities as a preventive measure for infectious diseases.

KEYWORDS

COVID-19, preventive measures, physical activity, mental health, children, adolescents, young adults

Introduction

Coronavirus disease 2019 (COVID-19), caused by the SARS-CoV-2 infection, was first identified in China in December 2019 (1). Since the virus started spreading steadily in several countries in all continents, the World Health Organisation (WHO) declared a pandemic in March 2020. Having it posed a serious threat to public health worldwide, many governments introduced lockdowns to reduce the spread of the virus. Since transmission of SARS-CoV-2 is mainly related to direct exposure to aerosolised respiratory particles (2), it was suggested that their spread could be enhanced by high-intensity exercise (3). Indeed, during the different pandemic waves, shutdown of sports activities, centres, and clubs was included among other preventive measures.

However, it is well-known that physical activity (PA) improves physical and psychological well-being at any age. Specifically, PA is beneficial for the preservation of the immune system, cardiorespiratory and muscular fitness, cardiometabolic health, and bone health (4, 5). It is therefore crucial in preventing infections, cardiovascular diseases, type-2 diabetes, and certain types of cancer (6). As for the psychological aspect, PA entails release of endorphins and reduction in the levels of stress hormones such as cortisol and adrenaline, thus being associated with lower levels of stress, anxiety, and depression (7–11).

Given that risk factors for severe COVID-19 include heart and respiratory problems, cancer, diabetes, and obesity (12–15), which might be exacerbated by a sedentary lifestyle and physical inactivity, the WHO reiterated the importance of PA and provided specific guidelines during the pandemic (16). On a psychological level, PA was considered a key strategy to cope with distress associated with the implementation of preventive measures such as lockdowns and quarantines (17, 18). Indeed, physical inactivity can also contribute to mental health conditions that in turn are known to further encourage sedentary behaviours (19), such as depressive symptoms.

Nevertheless, several studies showed that during the COVID-19 pandemic mental health was deeply affected (20, 21), and PA levels substantially decreased while sedentary behaviours increased in several countries (22–24), also in younger age groups (25). Even prior to the COVID-19 pandemic, physical inactivity was recognised as a global health concern (26), with younger individuals also being affected (27). Since this might entail detrimental consequences on the overall well-being of individuals, and risks associated with physical inactivity might as well affect public health in the long term, it is crucial to address this issue across all ages and countries.

Italy was the first country outside of China where SARS-CoV-2 local transmission was detected and that soon implemented some of the strictest anti-COVID-19 measures (28, 29). However, our previous study (30) showed that there is no evidence that shutdown and limitation of sports activities were effective in reducing the spread of COVID-19 in Italy in young Italian athletes, namely children, adolescents, and young adults. Additionally, our findings indicated an increase in Body Mass Index (BMI) within this demographic. In order to deepen these results, we further investigated the impact of the interruption of sports activities on mental health, which is the focus of the present paper. The primary hypothesis asserted that levels of PA performed during the beginning of the second European and North American pandemic wave and the following months are associated with a different mental health status among young Italian non-professional athletes. Secondary aims regard the evaluation of possible differences concerning mental health with respect to sociodemographic variables (such as gender and educational level) and screen time.

Materials and methods

Procedures and sampling

Between June and September 2021, a national retrospective survey-based cross-sectional study involving children ($\geq$6 years), adolescents, and young adults (aged $\leq$ 25 years) who used to play sports before the COVID-19 pandemic at a non-professional level was conducted. Data were collected via Google Forms and the link to the questionnaire was sent to Italian sports clubs and centres and shared on social media platforms. The survey administration was preceded by a 2-week pilot phase in which the reliability of the questionnaire and the clarity of the questions were assessed.

For participants under the age of 13, completion of the questionnaire required the involvement of legal guardians, while participants aged 13 and above were able to independently complete the questionnaire.

Eligibility criteria

In order to be included in the study, participants needed to meet specific inclusion criteria. These criteria included: (a) being aged between 6 and 25 years old, (b) not being professional athletes, and (c) providing informed consent. Participants who were 18 years or older were required to provide their own informed consent, while legal guardians were responsible for providing informed consent for participants under the age of 18. Conformity with these criteria was assessed through specific questions at the beginning of the questionnaire. As a result, participants who met the inclusion criteria were able to fully complete the questionnaire. Instead, individuals who were younger than 6 or older than 25 years, professional athletes, or those who did not provide informed consent were not permitted to proceed with the questionnaire.

Sample selection

Among the initial sample of 2,910 individuals who intended to complete the questionnaire, a total of 790 participants were unable to proceed. This was due to either their failure to provide the required informed consent ($n = 5$) or their non-conformity with the inclusion criteria ($n = 540$ participants older than 25 years; $n = 245$ professional athletes). After conducting quality checks to evaluate the completeness and validity of responses, 356 submissions were excluded due to incomplete/unrealistic answers. From the remaining 1,764 submissions, 47 were excluded due to missing responses for the mental health assessment. Consequently, a total of 1,717 submissions were used for the statistical analyses presented in this paper (Supplementary Figure 1).

Sample representativeness

The collected sample has proven to be representative of young Italian athletes to a good extent. In fact, according to a report released by the Italian National Olympic Committee (CONI) (31), the geographical representativeness of our sample closely aligns with the national distribution in 2020. Specifically, the CONI observed that 56% of athletes were situated in northern Italy, while 22% were located in central Italy, and another 22% in southern Italy/islands. In our study, 64.5% of the sample was located in northern Italy, 16.1% in the central Italy, and 15.5% in southern Italy/islands (see Table 1). A good representativeness was also achieved in terms of age. Indeed, national data concerning the age distribution of young Italian athletes (<35 years) indicates that young adults (age range: 18–35 years) constitute roughly one-third of the total, mirroring the findings of our study. Specifically, in our study, youth/young adults (age range: 16–25 years) accounted for 24.8% ($n = 1,292$) of the overall sample, while children/adolescents (age range: 6–15 years) constituted 75.2% ($n = 425$). Regarding gender, Italian data report a higher percentage of male athletes (71.8%), whereas our study shows a good balance between both genders (53.9% males and 44.6% females). Notably, the CONI sample includes professional athletes, a category that was excluded from the present study. Nevertheless, it is important to highlight that data from both the CONI and our study refer to the pandemic period.

Ethics statement

The study was conducted in agreement with the national and international regulations and the Declaration of Helsinki (2000). Approval by the Ethics Committee was not required as the online survey was completely anonymous, and it was not possible to keep track of any identifiable personal data. Further details regarding the procedure can be found in the previous publication (30).

Materials

The questionnaire was developed by a panel of experts with in-depth knowledge in different subjects, such as epidemiology, psychology, and nutrition. It was administered in Italian language and required ∼12–15 min to be completed. The questionnaire included multiple choice and open-ended questions covering six different areas: (a) SARS-CoV-2 infections, (b) socio-demographic information, (c) sports practice and level of PA, (d) mental health, (e) diet, and (f) screen time. The original version of the questionnaire has been previously published (30). The present paper is focused on the results regarding the following areas and corresponding aspects.

Sociodemographic information: participants were asked to report their gender, age, geographical area, currently attended school year, presence of outdoor spaces where to exercise at home between September 2020 and May 2021.

Sports practice: practice of any sports activity between September 2020 and May 2021, sport type, weekly frequency of training sessions, participation in sports competitions and/or activities organised by sports societies and centres, individual/team training, indoor/outdoor PA.

Level of PA was evaluated by using an adaptation of the International Physical Activity Questionnaire (32) in its short form (IPAQ-SF), a widely used 7-item self-report measure of habitual PA, whose reliability and validity have been confirmed in different countries (33). In this context, time spent on PA was recorded according to three intensity levels (vigorous, moderate, and light), along with the time spent in a sedentary position, in the period of COVID-19 waves instead of the previous week. This questionnaire was used to define compliance to WHO guidelines (34) according to athletes' age.

Mental health was investigated through two questionnaires: the Strengths and Difficulties Questionnaire (SDQ) (35) and the Psychological General Well-Being Index—Short Version (PGWB-S) (36). The SDQ is a 25-item scale with response options provided on a 3-point Likert-type scale (from 0 to 2) widely used to screen children and adolescents' mental health in terms of psychological difficulties. This scale allows evaluating emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behaviour. The first four subscales can be added together to generate a total difficulties score, and higher scores indicate a higher level of symptomatology. As for the latter subscale, higher scores indicate higher prosocial behaviour. The parent version was used for participants up to the age of 12, whereas the self-report version was administered to participants aged 13 and older. In this study, Cronbach's alpha for both versions of the SDQ was 0.85, indicating good internal consistency. The PGWB-S

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TABLE 1 Characteristics of overall participants and by number of weekly training sessions.

		Weekly training sessions			
	Overall (n = 1,717)	0 (n = 479)	1–2 (n = 834)	>2 (n = 404)	p-value
Gender					**<0.001**
Male	926 (53.9)	218 (45.5)	503 (60.3)	205 (50.7)	
Female	766 (44.6)	252 (52.6)	325 (39.0)	189 (46.8)	
Missing	25 (1.5)	9 (1.9)	6 (0.7)	10 (2.5)	
Compliance with WHO guidelines for PA					**<0.001**
Yes	568 (33.1)	112 (23.4)	228 (27.3)	228 (56.4)	
No	1,138 (66.3)	362 (75.6)	602 (72.2)	174 (43.1)	
Missing	11 (0.6)	5 (1.0)	4 (0.5)	2 (0.5)	
Outdoor PA					**<0.001**
Yes	1,173 (68.3)	212 (44.3)	652 (78.2)	309 (76.5)	
No	538 (31.3)	265 (55.3)	179 (21.5)	94 (23.3)	
Missing	6 (0.4)	2 (0.4)	3 (0.3)	1 (0.2)	
Sport					**<0.001**
Contact sports	685 (39.9)	126 (26.3)	415 (49.8)	144 (35.6)	
Non-contact sports	966 (56.3)	292 (61.0)	415 (49.8)	259 (64.1)	
Missing	66 (3.8)	61 (12.7)	4 (0.4)	1 (0.2)	
Educational level					**<0.001**
Kindergarten, primary school	679 (39.5)	178 (37.2)	417 (50.0)	84 (20.8)	
Middle school	425 (24.8)	93 (19.4)	206 (24.7)	126 (31.2)	
Technical or professional institute	76 (4.4)	13 (2.7)	29 (3.5)	34 (8.4)	
High school	298 (17.4)	74 (15.4)	112 (13.4)	112 (27.7)	
University	152 (8.9)	87 (18.2)	32 (3.8)	33 (8.2)	
Currently not attending school	74 (4.3)	34 (7.1)	26 (3.1)	14 (3.5)	
Missing	13 (0.7)	0 (0)	12 (0.2)	1 (0.2)	
Geographical area					**<0.001**
Southern Italy/Islands	266 (15.5)	115 (24.0)	98 (11.8)	53 (13.1)	
Central Italy	276 (16.1)	52 (10.9)	122 (14.6)	102 (25.2)	
Northern Italy	1,107 (64.5)	293 (61.2)	585 (70.1)	229 (56.7)	
Abroad	30 (1.7)	7 (1.5)	14 (1.7)	9 (2.2)	
Missing	38 (2.2)	12 (2.5)	15 (1.8)	11 (2.7)	
Outdoor spaces at home					**<0.001**
Yes	958 (55.8)	203 (42.4)	492 (59.0)	263 (65.1)	
No	743 (43.3)	271 (56.6)	332 (39.8)	140 (34.7)	
Missing	16 (0.9)	5 (1.0)	10 (1.2)	1 (0.2)	
Screen time (hours)					**<0.001**
≤2 h	427 (24.9)	87 (18.2)	229 (27.4)	111 (27.5)	
2–4 h	398 (23.2)	114 (23.8)	209 (25.0)	75 (18.6)	
>4 h	662 (38.6)	209 (43.6)	284 (34.1)	169 (41.8)	
Missing	230 (13.3)	69 (14.4)	112 (13.5)	49 (12.1)	

Frequencies and percentages (in parentheses) are reported in the table. Significant values are in bold.

is a 6-item health-related Quality of Life (HRQoL) questionnaire that investigates psychological general well-being in youth and adulthood and was therefore used to assess participants' mental health from 16 years of age. Response options are provided on a 6-point Likert-type scale (from 0 to 5), and higher scores indicate higher levels of psychological well-being. Cronbach's alpha for the PGWB-S in this study was 0.90, showing high internal consistency.

Screen time: participants were asked to report the amount of time spent on screens daily in terms of hours between September 2020 and May 2021, including television, personal computer, tablet, smartphone, and videogames.

The validated questionnaires used for the present study are summarised in Supplementary Table 1.

Variables definition

In order to assess the association between PA/sports activity and mental health during the study period, we defined different variables. Specifically, two different variables were defined with respect to PA/sports activity: (1) *training during periods of openings/closures*, which refers to PA/sports activity carried out only in periods of openings (September–October 2020 and April–May 2021), also throughout the period of lockdowns and closures (November 2020–March 2021), or none; and (2) *weekly training sessions*, which refers to the average number of weekly trainings. Continuous training sessions refer to PA carried out both during periods of closures and during periods of reopening. Non-continuous training sessions refer to PA carried out only during periods of openings. Furthermore, compliance with the WHO guidelines measured with the IPAQ-SF was assigned the value of 1, and non-compliance was assigned the value of 0. Compliance or non-compliance were specifically assessed by considering duration and frequency of moderate and vigorous-intensity activities per week, as well as age, as reported (34).

As for mental health, all the scores for the SDQ (35) and for the PGWB-S (36) were considered both as continuous and categorical variables. When considered as continuous variables, as previously stated, higher scores for the SDQ indicate higher levels of difficulties/symptomatology, whereas higher scores for the PGWB-S indicate higher levels of psychological well-being. However, in order to clarify the treatment of scores as categorical variables, further explanations are required. Indeed, scores for children/adolescents were categorised into three groups (i.e., normal, borderline, and abnormal) following the 3-band categorisation from the SDQ scoring guidelines. Subsequently, borderline and abnormal scores were merged for the present analyses. The four subscales related to psychological difficulties (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems) were analysed both individually and combined to create a total difficulties score. Psychological difficulties for each subscale and for the total score were intended as scoring as borderline or abnormal. Conversely, prosocial behaviour was considered as absent when scoring as borderline or abnormal. For youth and young adults, the median for the PGWB-S was calculated (Median = 14) to separate the half of the sample showing higher levels of psychological well-being from the half that showed lower levels. Since the items of the PGWB-S evaluate psychological well-being by assessing the presence/absence of psychological symptoms, those who scored below the median were considered to be experiencing psychological symptoms. When presenting and discussing the overall results of the study, psychological difficulties measured for children/adolescents and levels of psychological well-being below the median measured for youth/young adults are collectively referred to as psychological symptoms.

Note that, in Italy, children who are 6 years old may attend either kindergarten or primary school. Consequently, we merged the data of children aged 6 who were attending kindergarten with those attending primary school.

Statistical analyses

Separating the analyses based on the type of questionnaire used to assess mental health between (SDQ for children/adolescents aged 6–15 years, and PGWB-S for youth/young adults aged 16–25 years), multivariable logistic regression models were used to estimate the risk of psychological difficulties; odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. Scores both for the SDQ and each subscale and for the PGWB-S were considered as continuous variables for the boxplots.

Besides gender, age range (i.e., educational level), and geographical area, significant variables identified during the univariate analysis were included as co-factors in the multivariable analysis.

Chi-square test, Kruskal-Wallis test, and Wilcoxon-sum rank test were performed to investigate the association between variables regarding training and the participants' characteristics depending on the nature of the variable.

P-values < 0.05 were considered statistically significant. The analyses were performed by using the statistical software R (version 4.1.1).

Results

Characteristics of the subjects in terms of weekly training sessions are presented in Table 1. Females reported training 1–2 times/week significantly less compared to males (39.0% vs. 60.3%), while demonstrating similar levels of intensive weekly training sessions (>2 times/week). Furthermore, individuals training >2 times/week reported significantly lower screen time (27.5% ≤2 h) than those who did not train (18.2%). Similar results were obtained considering periods of openings and closures (Supplementary Table 2).

Children and adolescents

The association of sports activity and other covariables with mental health for children and adolescents and for youth and young adults are presented separately in Supplementary Tables 3, 4 and Figures 1–3, respectively. ORs and 95% CIs are presented indicating the strength of the association of sports activity with

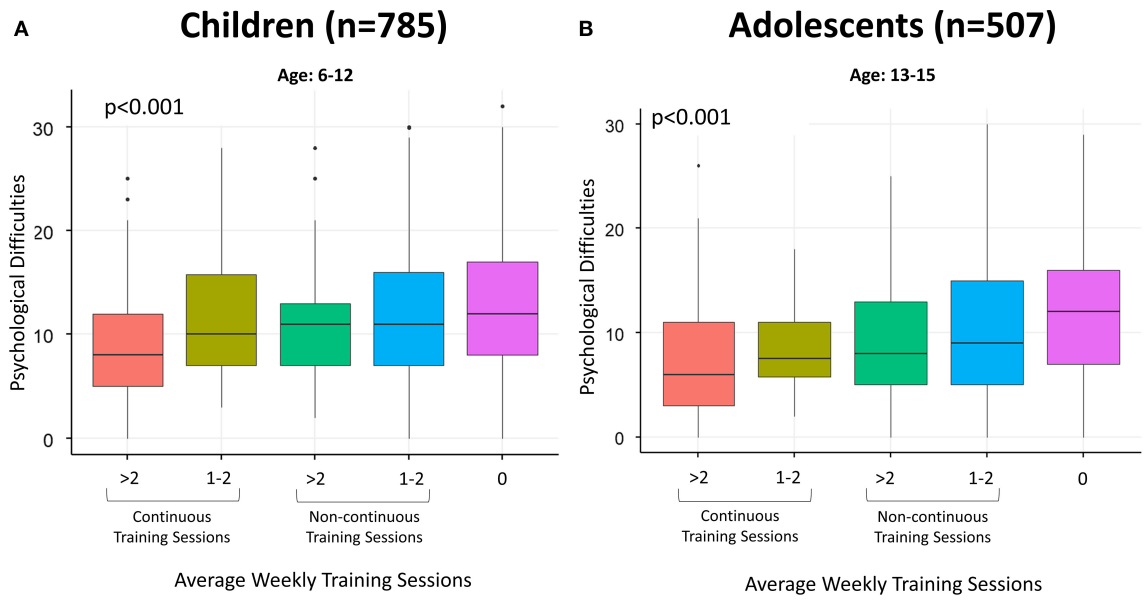

FIGURE 1
(A, B) Boxplots regarding psychological difficulties in terms of average weekly training sessions (continuous vs. non-continuous) in children **(A)** and adolescents **(B)**. Psychological difficulties were calculated by adding together continuous scores from the subscales referring to emotional symptoms, conduct problems, peer relationship problems, and hyperactivity/inattention of the SDQ (35). Higher scores indicate a higher level of symptomatology. Continuous training sessions refer to PA carried out both during periods of closures and during periods of openings. Non-continuous training sessions refer to PA carried out only during periods of openings.

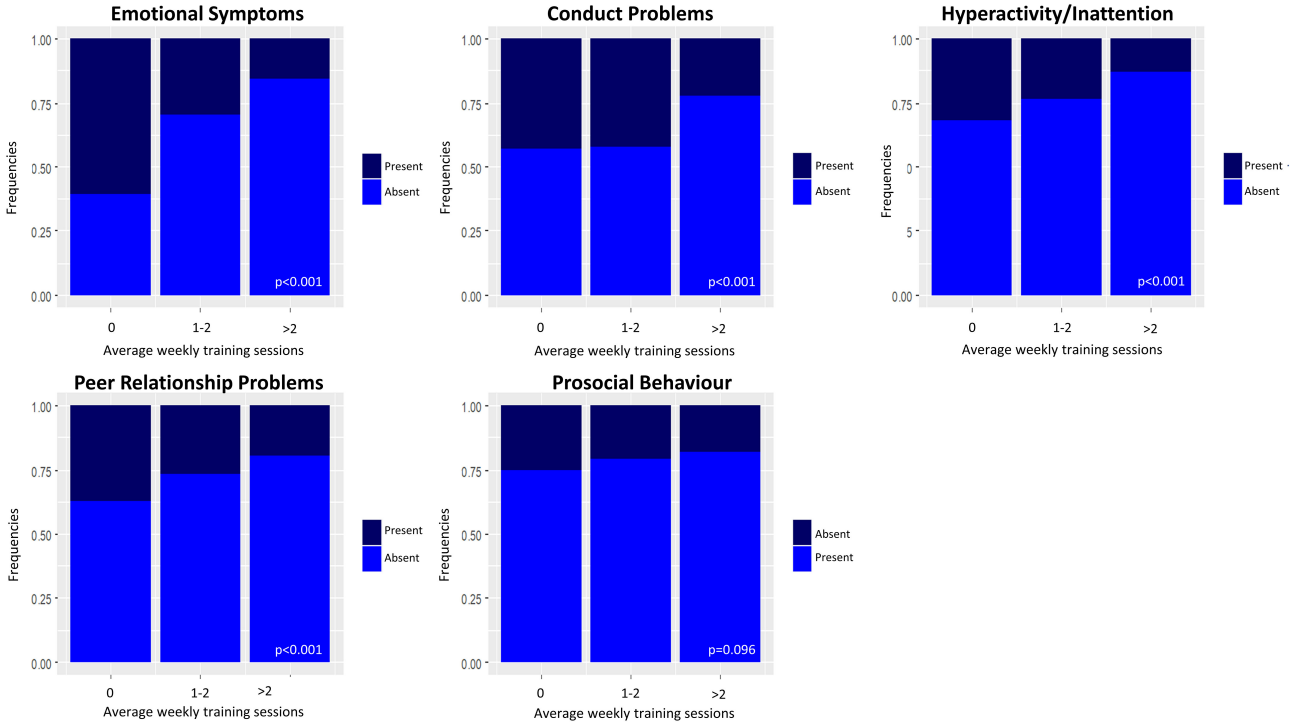

FIGURE 2
Relative frequencies of psychological difficulties in children and adolescents by average weekly training sessions. Presence/absence for the subscales referring to psychological difficulties (emotional symptoms, conduct problems, hyperactivity/inattention, and peer relationship problems) and prosocial behaviour were determined using the 3-band categorisation (37) suggested in the scoring guidelines for the Strengths and Difficulties Questionnaire (SDQ) (35). Absence for the four subscales related to psychological difficulties indicates a normal score, while presence indicates a borderline or abnormal score. Conversely, absence for the prosocial behaviour scale indicates a borderline or abnormal score, while presence indicates a normal score.

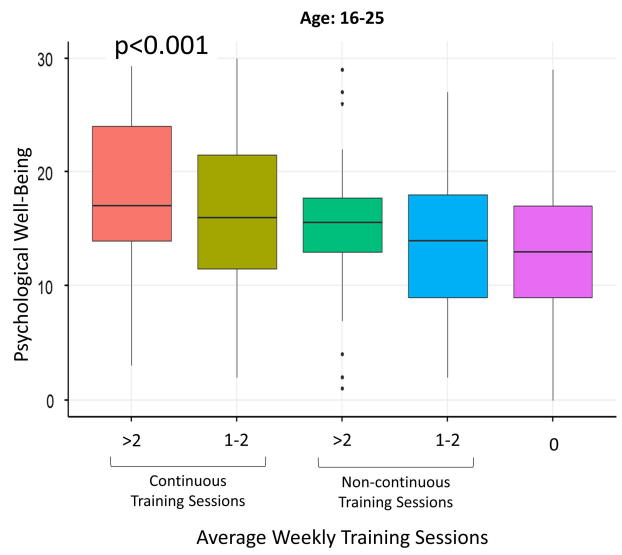

FIGURE 3
Boxplots regarding psychological well-being in terms of average weekly training sessions (continuous vs. non-continuous) in youth and young adults. Psychological well-being was calculated by using the continuous score obtained through the PGWB-S (36), and higher scores indicate a higher level of psychological well-being. Continuous training sessions refer to PA carried out both during periods of closures and during periods of reopening. Non-continuous training sessions refer to PA carried out only during periods of openings.

psychological difficulties and with each subscale of the SDQ, adjusted for possible confounding factors presented in Table 1 and Supplementary Table 2.

As shown in Figures 1A, B, training more than twice a week, especially in a continuous way, is associated with lower levels of psychological difficulties in children and adolescents. On the other hand, those who did not train during the study period showed higher levels of psychological difficulties. As shown in Supplementary Table 3, carrying out >2 training sessions per week compared to none is inversely associated with psychological difficulties (OR = 0.54, 95% CI 0.35–0.82) for children and adolescents. Being male, not adherent to WHO guidelines for PA, living in a house with no outdoor space and using electronic devices >2 h/day were found to be significantly associated with psychological difficulties, as well as not engaging in outdoor PA. Psychological difficulties were more prevalent in kindergarten and primary school students than middle and high school students.

Results regarding each subscale of the SDQ are presented in Table 2.

Figure 2 shows that children and adolescents who have not exercised show more frequent emotional symptoms, conduct problems, hyperactivity/inattention, and peer relationships problems compared to those who have exercised. The difference is particularly noticeable when comparing those who did not exercise and those who exercised more than twice a week.

Emotional symptoms

Exercising is significantly inversely associated with emotional symptoms (1–2 times/week vs. 0: OR = 0.72, 95% CI 0.54–0.97; >2 times/week vs. 0: OR = 0.54, 95% CI 0.36–0.81), along with having outdoor spaces at home. Spending >2 h/day using electronic devices is significantly directly associated with emotional symptoms, which are more prevalent in kindergarten/primary school and middle school compared to high school. No association emerged with gender and geographical area.

Conduct problems

Variables significantly inversely associated with conduct problems are the following: exercising >2 times/week (OR = 0.63, 95% CI 0.43–0.92), outdoors PA during the period between September 2020 and May 2021, and having outdoor space at home. Males showed more conduct problems than females. A difference emerged in terms of conduct problems between education levels: kindergarten, primary school and middle school students show more conduct problems than high school students. Finally, children and adolescents from Southern Italy/Islands reported more conduct problems than North Italians.

Hyperactivity/inattention

Exercising more than twice a week (OR = 0.61, 95% CI 0.44–0.84), having carried out at least 1 training session during the period of closures (OR = 0.61, 95% CI 0.44–0.84; result not shown), outdoor PA, and being physically active according to WHO guidelines are significantly inversely associated with hyperactivity/inattention. Males compared to females are more prone to hyperactivity/inattention. A difference in terms of hyperactivity/inattention also emerged among educational levels: subjects in kindergarten/primary school and middle school are at higher risk of presenting hyperactivity/inattention than students in high school.

Peer relationship problems

Being physically active according to WHO guidelines and engaging in outdoor PA during the study period are inversely associated with peer relationship problems. Those living in Southern Italy/Islands and those using electronic devices for >2 h/day are more prone to peer relationship problems. A difference in terms of peer relationship problems emerged between educational levels, with higher problems reported for children compared to adolescents, while no significant differences emerged for gender.

Prosocial behaviour

Outdoor PA and compliance to WHO guidelines are associated with lower probability of lack of prosocial behaviour. As for gender, males are less likely to show prosocial behaviour than females. No association emerged with educational levels and geographical area.

TABLE 2 Estimates of association from multivariable model regarding each subscale of the SDQ in children and adolescents.

	Emotional symptoms	Conduct problems	Hyperactivity/ inattention	Peer relationships problems	Lack of prosocial behaviour
Variables	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Average weekly trainings (days)					
>2 vs. 0	**0.54 (0.36–0.81)****	**0.63 (0.43–0.92)***	**0.61 (0.44–0.84)****	-	-
1–2 vs. 0	**0.72 (0.54–0.97)***	1.17 (0.87–1.58)	0.73 (0.49–1.07)	-	-
Compliance with WHO guidelines for PA					
Yes vs. no	**0.61 (0.44–0.83)****	-	**0.56 (0.39–0.78)*****	**0.53 (0.38–0.73)*****	**0.72 (0.52–1.00)***
Outdoor PA					
Yes vs. no	-	**0.66 (0.50–0.87)****	**0.68 (0.52–0.90)*****	**0.58 (0.45–0.76)*****	**0.70 (0.52–0.94)***
Gender					
Males vs. females	0.93 (0.73–1.21)	**1.45 (1.14–1.86)****	**1.82 (1.38–2.43)*****	1.13 (0.87–1.46)	**1.51 (1.14–2.01)****
Education					
Technical or professional institute vs. High school	0.97 (0.21–3.20)	1.61 (0.61–3.99)	1.64 (0.43–5.16)	0.60 (0.16–1.73)	2.19 (0.91–5.13)
Kindergarten, primary school vs. High school	**5.49 (3.23–9.79)*****	**3.59 (2.32–5.69)*****	**3.98 (2.26–7.61)*****	**2.07 (1.32–3.32)****	1.01 (0.65–1.60)
Middle school vs. High school	**2.77 (1.62–4.98)*****	**1.64 (1.04–2.64)***	**2.03 (1.11–3.98)***	**1.67 (1.05–2.70)***	0.84 (0.52–1.37)
Geographical area					
Abroad vs. Northern Italy	1.83 (0.49–6.56)	0.86 (0.21–3.03)	3.18 (0.85–11.4)	1.46 (0.37–5.09)	1.61 (0.34–5.78)
Central vs. Northern Italy	0.94 (0.65–1.34)	1.12 (0.80–1.56)	0.88 (0.59–1.30)	0.92 (0.64–1.31)	1.01 (0.68–1.46)
Southern Italy Islands vs. Northern Italy	1.17 (0.82–1.67)	**1.86 (1.32–2.62)*****	1.07(0.73–1.57)	**1.43 (1.01–2.01)***	1.31 (0.89–1.89)
Outdoor spaces at home					
Yes vs. no	**0.64 (0.50–0.82)****	**0.66 (0.52–0.84)*****	-	-	-
Screen time (hours)					
>4 vs. ≤2 h	**1.92 (1.37–2.71)*****	-	-	**2.00 (1.41–2.84)*****	-
2–4 h vs. ≤2 h	**1.44 (1.03–2.02)***			**1.77 (1.25–2.52)****	

OR, Odds Ratio; CI, Confidence Interval.

Odds Ratios (ORs) and 95% Confidence Intervals (CIs) for significant variables for each subscale were reported. All the models were adjusted by gender, age range (i.e., educational level), and geographical area. The event consisted of presenting the problem corresponding to each subscale, i.e., scoring as borderline or abnormal according to the 3-band categorisation suggested in the scoring guidelines (37) for the SDQ (35).

*p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001. Significant values in bold.

Youth and young adults

Results regarding youth and young adults are reported in Supplementary Table 4. Training >2 times/week vs. zero is inversely associated with psychological symptoms (OR = 0.25, 95% CI 0.14–0.45), as well as training during the period of closures (OR = 0.35, 95% CI 0.21–0.57, results not shown) and being male. Using electronic devices >2 h/day is significantly associated with psychological symptoms.

Figure 3 shows that exercising twice a week is associated with higher levels of psychological well-being, especially compared to those who have not exercised, in participants aged 16–25 years.

Discussion

The current study sought to investigate the relationship between PA and psychological health in various young age groups during the COVID-19 pandemic. Particularly, levels of PA performed during the beginning of the second European and North American pandemic wave and the following months were expected to be associated with a different mental health status among young Italian non-professional athletes. Our findings confirmed this hypothesis, revealing that not engaging in PA was associated with a higher incidence of psychological symptoms in both children/adolescents and youth/young adults. Those who were able to train continuously, both during closures/lockdowns and openings, showed fewer psychological symptoms.

In addition, engaging in outdoor PA or having access to outdoor spaces at home appears to be particularly crucial for children and adolescents. This is in line with previous studies highlighting an association between outdoor activities and psychological well-being (38–42). As suggested by previous research (43, 44), these findings emphasise the need to facilitate outdoor recreation opportunities, which should be taken into

account for younger age groups during times of crisis in Italy as well. It should also be considered that outdoor activities reduce the probability of transmission of respiratory viruses (45, 46).

Furthermore, screen time has been found to be associated with psychological symptoms in children and adolescents, as well as youth and young adults. As we discovered, excessive use of electronic devices has a negative impact on psychological well-being (47–50) and is associated with a decrease in PA (51, 52). Over 2 h of daily screen time, in particular, was linked to emotional and peer relationship problems in children/adolescents. Indeed, studies show that increased screen time is linked to lower levels of social competence (53, 54), as well as higher levels of depression and anxiety symptoms (55–57). It is to note that emotional and social competences and PA/sports show a reciprocal relationship, with one positively influencing the other. In fact, PA and sports can enhance emotional and social competences (58, 59), explaining why exercise resulted as linked to the adoption of prosocial behaviour in children/adolescents as well. It is to note that possessing high levels of these competences (such as self-control, empathy, and communication) can in turn improve one's likelihood of engaging in PA and sports activities. Social contact and support from others due to sports activities increases the beneficial effects of physical exercise interventions (60), and these benefits should be taken into account (17). In fact, in a Norwegian cohort study involving 382 children, it was found that there was no clear link between post COVID-19 conditions and the previous infection. Instead, loneliness and lack of PA were shown to be important factors. However, it is important to note that the increase in remote learning has contributed to the amount of screen time.

The current study also discovered significant gender differences. Indeed, male children and adolescents were more prone to present psychological difficulties overall—specifically, conduct problems, hyperactivity/inattention, and lower prosocial behaviour. This is consistent with research showing that males exhibit externalising problems more frequently than females (i.e., dysfunctional acting-out and outward behaviours related to poor impulse control, such as rule-breaking, aggression, and impulsivity) (61–65). However, young adult males presented less psychological symptoms than young adult females. This is in line with previous findings (66) and might be due to the fact that females reported training less than males during the study period.

In a study conducted on 3,245 children and adolescents (67), caregivers reported behavioural changes in 64.3% of children under 6 years old and in 72.5% of those between the ages of 6 and 18 during the COVID-19 pandemic. In both age groups, distress linked to quarantine was significantly associated with such behavioural changes. However, in our study more psychological difficulties were found among children in kindergarten and primary school students, along with middle school students, compared to high school. Indeed, children attending kindergarten, primary and middle schools were more frequently reported as not having trained at all during the study period.

Along with the positive effects of PA on mental health, its beneficial outcomes on physical health, specifically concerning infectious diseases, should be considered as well. By boosting the immune system, PA can help minimise the adverse effects of the infectious process caused by COVID-19 (68). Recent publications showed a reduction in aggravation of the disease, in hospital admissions and a decrease of death from COVID-19 (69, 70). Furthermore, PA can also prevent COVID-19 infection, and the mechanisms can be partially explained by the higher concentration of immune cells, such as T lymphocytes, and the increased resistance of the mucosal immune barrier (salivary IgA immunoglobulin), observed in more physically active individuals (71, 72), providing a greater immunity against different types of viruses and bacteria entering the human body through the oral cavity and upper airways.

Fortunately, COVID-19 showed a very good prognosis in youth (73), and young index cases were found to be significantly less likely than adults to favour viral spread (74). In fact, it has been shown that the increased exposure to various types of viruses during childhood, including some cold coronaviruses, increased the immune response to SARS-CoV-2 (75).

All these factors should be duly considered when determining the appropriate preventive measures to be implemented for the younger demographic, given the impact on the psychological dimensions, which could affect the adoption of health behaviours.

A limitation of this study is that data were collected retroactively by using a self-administered web survey, raising questions about the accuracy of such information. However, the high interpretability of our results and the agreement with previous research suggest that the overall standard was high. Although other unmeasured confounders might affect the outcomes, key athletes' and sport-related characteristics were taken into account, as well as several sociodemographic variables, and a longer questionnaire might have led to lower compliance and accuracy. Lastly, the findings reported in the present paper refer to the young Italian population and may not necessarily apply to other regions and age groups. However, our results are in line with previous studies conducted in other countries investigating the impact of PA on psychological health during the COVID-19 pandemic (43, 76–80).

Ultimately, the present study confirms the positive impact of PA on mental health during the COVID-19 pandemic among younger age groups, and limitation of sports activities as a preventive measure should be considered in light of the associated risks. Indeed, these findings also provide further understanding of the risk-benefit relationship of interrupting sports activities as a preventive measure against contagion, having significant implications for policymakers and healthcare professionals in developing effective strategies to promote PA and mental health in younger populations. Particularly, the psychosocial aspects most related to PA identified in this study can be helpful to identify alternative and targeted solutions for future epidemics/pandemics. Although these results can provide valuable insights on possible solutions, further research is needed to develop effective interventions. The assessment of PA benefits and its promotion is particularly relevant in childhood and adolescents, as it is a critical period for the establishment of future lifestyles and the development of habits that exert a profound impact on overall health throughout the lifespan (81), also affecting public health in the long term.

Conclusions

The current study provides additional evidence supporting the positive impact of PA on mental health among younger age groups during the COVID-19 pandemic. Moreover, it emphasises the importance of considering the potential risks associated with the restriction of sports activities as a preventive measure. Specifically, by assessing the psychosocial dimensions closely linked to PA, targeted strategies can be developed. These findings contribute to a better understanding of the global situation and can be valuable in enhancing the management of infectious diseases in the future.

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 agreement with the national and international regulations and the Declaration of Helsinki (2000). Approval by the Ethics Committee was not required as the online survey was completely anonymous, and it was not possible to keep track of any identifiable personal data. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. No potentially identifiable images or data are presented in this study.

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Author contributions

ET, SR, and OD'E: conception, design, analysis and interpretation of data, and drafting and revising manuscript critically for important intellectual content. GT: conception, design, and drafting and revising manuscript critically for important intellectual content. FB and GC: analysis and interpretation of data and revising manuscript critically for important intellectual content. FG, PG, and SG: conception, design, interpretation of data, and revising manuscript critically for important intellectual content. MI, DR, AS, CS, GP, and NM: conception, design, and revising manuscript critically for important intellectual content. All authors provided final approval of the version to be published and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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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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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2023.1237443/full#supplementary-material

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The relationship between physical activity and subjective well-being in Chinese university students: the mediating roles of perceived health, social support and self-esteem

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Purpose: The intent of this paper is to understand the effect of Physical Activity on university students' Subjective Well-being and to explore whether Perceived Health, Social Support, and Self-esteem play roles as mediating variables.
Methods: Self-reported data from 404 college students (147 males and 257 females) were analyzed using structural equation modeling (SEM). The relationships between the study variables were tested by mediation models and 5,000 bootstrap samples using AMOS version 24.
Results: (1) The six hypotheses were supported in the measurement model in the results ($P < 0.05$). Physical Activity was related to Social Support, Perceived Health, and to Self-esteem; Social Support, Perceived Health, and Self-esteem were all related to Subjective Well-being. However, the direct positive effect of Physical Activity gradually decreased in the order of Self-esteem, Social Support, and Perceived Health. The direct effect of Perceived Health, Social Support, and Self-esteem on Subjective Well-being also decreased sequentially. (2) In the Structural Equation Model ($\chi^2 = 825.451$, $p < 0.001$, df = 455, CMIN/df = 1.814, CFI = 0.942, RMSEA = 0.045), the three hypotheses of mediation were supported ($P < 0.05$), showing positive indirect effects between Physical Activity and Subjective Well-being. Of the three mediating effects, Social Support and Self-esteem were not different, and the mediating effect of Perceived Health showed the largest impact. This indicates that Social Support, Perceived Health, and Self-esteem mediate the effects of Physical Activity, and Subjective Well-being regulation has positive indirect effects.
Conclusion: This study demonstrates the importance of meeting the needs of Social Support, Perceived Health, and Self-esteem when designing interventions to promote college students' sports participation to enhance Subjective Well-being.

KEYWORDS

physical activity, subjective well-being, social support, perceived health, self-esteem

1. Introduction

Most college students face mental health problems such as depression and anxiety (1, 2). In the United States, almost half of college-aged individuals have a psychiatric disorder (3). The prevalence of mental health problems among U.S. college students was higher in 2011 than in 2008, with 34.5% of college students reporting depressive symptoms according to the 2015 National College Health Assessment (4). Likewise, more than 20% of Chinese college students suffer from depression, and this ratio has continued to grow over the past decade (5). Research indicates that approximately half of university students have moderate stress-related mental health concerns, including anxiety and depression (6). Physical activity (PA), as a modifiable health behavior, has been identified as an influential factor in promoting physical and mental health (7). Regular participation in PA is associated with a reduced risk of cardiovascular disease, hypertension, type 2 diabetes, and depression (8). Mental health research should study positive psychological traits such as subjective well-being (SWB) (9). Despite evidence suggesting a positive impact of PA on mental health, PA has been primarily considered a method of preventing or treating mental disorders.

"The body of research on the link between PA and SWB is still in its early stages. SWB, according to Diener et al., is "a person's cognitive and affective evaluations of their life" (10). Living satisfaction is the overall judgment people make of their living situations (11, 12), and is the cognitive component of SWB, whereas positive and negative affect are the affective components (13). Happiness, defined as a subjective psychological state characterized by enjoyment and contentment, is extensively employed as a measure of SWB and an effective component of SWB (14). Life satisfaction is an essential variable since it is related to university students" mental and physical health and has been identified as one of the basic conceptions in the field of positive psychology (15). Thus, Understanding the factors that contribute to life satisfaction is a critical problem for university students. SWB dimensions can be mixed in a variety of ways, and SWB can be studied as a rapid cognitive assessment of one's health satisfaction."

Perceived or self-rated health refers to an individual's perception of their health status. There is evidence that perceived health correlates more with SWB than objectively measured health (16, 17). From the perspective of perceived health, perceived health and well-being in adults are positively correlated among individuals and communities in the United States (18), and perceived health status is significantly associated with well-being in Sweden (19). Although objective health indicators such as physical health and functional rate have a relatively small effect on life satisfaction in older adults (20, 21), perceived health is significantly associated with well-being (22), and perceived health in middle-aged and older adults mediates PA and SWB (23). However, whether perceived health also mediates this relationship in college students remains unknown.

Social support is the feeling or experience of being loved, cared for, respected, and valued by a person as part of a social network of mutual aid and obligation (24). Social support is widely believed to be positively related to SWB (25, 26). Some studies suggest that social support is necessary for SWB (27). Social support should promote well-being by influencing cognition, emotion, and behavior to support positive affect (28). Social support varies by partner, family, and friends (29). Social help from family and friends positively relates to life satisfaction, but the interaction between these two variables is not statistically significant (30). Diener et al. (1999) (31) suggested that the theory must be refined to identify differential effects of input variables on components of SWB-specific predictions. There are separable components of SWB that exhibit unique patterns of relationships with different variables.

Self-esteem is an individual's overall sense of worth or value (Rosenberg, 1979) (32) and is framed in the context of demographic characteristics, social relationships, and personality (33–35). In many past studies, self-esteem has been strongly correlated with each component of SWB. Individuals with higher levels of self-esteem report higher life satisfaction and positive emotions and lower negative emotions, especially in individualistic cultures (33, 34, 36, 37). Self-esteem is strongly correlated with PA in children (38), and adolescents (39–41), and adults (42–44). Rosenberg et al. (1995) (45) emphasized that specific behaviors may be related to similar explicit self-esteem. In addition, it has been proposed that participation in PA contributes indirectly to an overall sense of self-worth and may enhance perceptions of the physical self, such as perceived physical appearance and physical motor ability (46).

In addition, several studies have shown that self-esteem is one of the strongest predictors of the cognitive component of SWB in adolescents and adults (47, 48). On the other hand, past research has shown that social support appears to have direct and indirect effects on well-being through specific cognitive mechanisms, personality factors (e.g., optimism, self-efficacy), and health behaviors (49–51). Considering that social support contributes theoretically (32, 52)and empirically (53–55) to self-esteem, self-esteem contributes theoretically and empirically to SWB.

The positive effects of PA on physical and mental health are well documented. Previous research has widely documented the positive relationship between PA and various physical health parameters (56–58). PA is associated with lower overall mortality (59), improved cardiovascular and musculoskeletal health (60), lower risk of obesity and stroke (59), lower mental health burdens (61), and reduced symptoms of depression and anxiety (62–64). Studies based on a large general population suggest a positive correlation between PA and SWB (65, 66), and some studies suggest that regular PA may increase SWB in all age groups: children and adolescents (15, 67); young adults (68); adults (69, 70); and older adults (71–73). Research on this relationship among college students is limited, and only a few relevant studies exist.

The findings reveal the relationship between PA and SWB but can only provide generalizability to a limited extent. Most recent well-being studies focus on the relationship between a single factor and SWB, lacking systematic integration of various influencing factors, yet multiple factors influence SWB simultaneously. Only by considering individual factors, i.e.,

external environmental factors, can a multidimensional integration model be formed to explore the direct or indirect effects and contributions of individual factors on well-being. In addition, perceived health, social support, and self-esteem positively impact psychological well-being. In conclusion, given the robust evidence of a strong relationship between health and SWB and the beneficial effects of PA on health, we conclude that the relationship between PA and SWB among university students may be mediated by perceived health, social support, and self-esteem.

Research on the mediating variables of PA and SWB among the areas of university students, PA and Perceived Health, Social Support, and Self-esteem has become a significant research topic. This study uses the Physical Activity Scale, SWB Scale, Perceived Health Scale, Social Support Scale, and Self-esteem to analyze the effects of PA on university students' SWB and to explore whether Perceived Health, Social Support, and Self-esteem mediate the effects of PA on SWB, taking Chinese university students, a particular group, as its sample.

2. Method

The purpose of this study was to investigate the association between PA and SWB among university students, as well as the function of Perceived Health, Social Support, and Self-esteem in mediating the relationship between PA and SWB. As a result, the research subjects, research equipment, and data processing were carried out in accordance with the study's purpose.

2.1. Research model and research hypothesis

2.1.1. Research model

As shown in **Figure 1**, this study aimed to determine the effect of PA on university students' SWB and explore whether Perceived Health, Social Support, and Self-esteem mediate the effect of PA on SWB.

2.1.2. Research hypothesis

According to the research model and the problems to be solved, we put forward nine corresponding research hypotheses, which are described as follows:

H1 Physical activity affects social support.
H2 Physical activity affects perceived health.
H3 Physical activity affects self-esteem.
H4 Social support affects subjective well-being.
H5 Perceived health affects subjective well-being.
H6 Self-esteem affects subjective well-being.
H7 Social support mediates the relationship between physical activity and subjective well-being.
H8 Perceived health mediates the relationship between physical activity and subjective well-being.
H9 Self-esteem mediates the relationship between physical activity and subjective well-being.

2.2. Participants

Participants for this study were recruited through Questionnaire Star, and 420 Chinese university students were identified from May to June 2022. An explanation of the primary purpose and content of the survey was given to participants in Questionnaire Star, and written informed consent was obtained from all participants before the survey. The study protocol was approved by the Institutional Review Board (IRB)-(1040875-202202-SB-021) in Korea. These participants completed questionnaires assessing their well-being, life satisfaction, PA, and perceived health during the assessment. As reported in **Table 1**, a total of 420 questionnaires were recovered, and those who skipped more than 16 questions or answered the questionnaire incorrectly were excluded, leaving 404 samples for further analysis. Looking at the individual characteristics in detail, 147 males (36.4%) and 257 females (63.6%) were included. As indicated previously, the survey captured College year groups: Freshman (28, 6.9%); Sophomore (141, 34.9%); Junior (143, 35.4%); Senior (92, 22.8%). In terms of Habit, less than 12 months (304, 75.2%), more than 12 months (100, 24.8%).

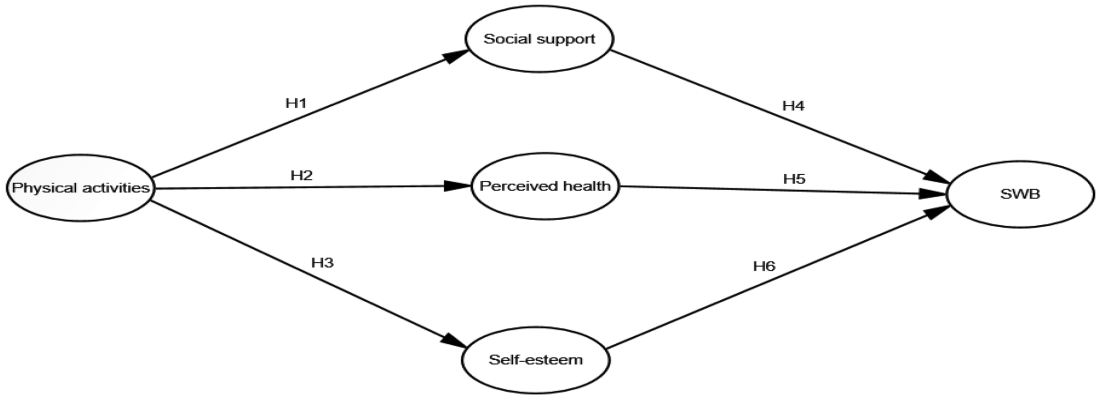

FIGURE 1
Research model.

TABLE 1 Socio-demographic characteristics of participants ($N = 404$).

Characteristics		Number (persons)	percent (%)
Sex	Male	147	36.4
	Female	257	63.6
Age	18	5	1.2
	19	47	11.6
	20	88	21.8
	21	78	19.3
	22	75	18.6
	23	62	15.3
	24	31	7.7
	25	10	2.5
	26	6	1.5
	27	2	0.5
College year	Freshman	28	6.9
	Sophomore	141	34.9
	Junior	143	35.4
	Senior	92	22.8
Habits	0–3 months	166	41.1
	3–6 months	95	23.5
	6–12 months	43	10.6
	12–18 months	18	4.5
	More than18 months	82	20.3

2.3. Measures

The Physical Activity Scale, Social Support Scale, and SWB, and Perceived Health, and Self-esteem measures were employed in this study. We investigated the effect of PA on college students' SWB using a cohort of Chinese university students as subjects. We investigated whether perceived health, social support, and self-esteem act as moderators of the effect of PA on SWB.

2.3.1. Moderate to vigorous physical activity (MVPA)

MVPA was measured using two questions adapted from the PA and physical fitness section of the 2007–2008 National Health and Nutrition Examination Survey (74):(1) "In a typical week, how much time do you usually spend doing moderate-intensity physical activities that cause small increases in breathing or heart rate?" and (2) "In a typical week, how much time do you usually spend doing vigorous-intensity physical activities that cause large increases in breathing or heart rate?" (75, 76).

2.3.2. Subjective well-being scale

2.3.2.1. Positive affect and negative affect scale

Positive affect and negative affect were assessed using the Chinese-translated version of the Scale of Positive and Negative Experience (SPANE) (77). The validity and reliability of SPANE have been tested previously among Chinese adults (78). The SPANE has twelve items describing positive and negative feelings such as "pleasant," "joyful," and "sad." The respondents were asked to rate the extent to which they experienced each item using a 5-point Likert scale from 1 (very rarely or never) to 5 (very often or always). The SPANE produces a score for positive affect (Cronbach's Alpha = 0.914) and a score for negative affect (Cronbach's Alpha = 0.901) by adding the scores of the corresponding items.

2.3.2.2. Happiness scale

Happiness was measured as the affective component of SWB using the Chinese translated version of the Subjective Happiness Scale (SHS) (79). The SHS consists of four items on happiness, asking to what extent you agree or disagree with statements including (1) "In general, I consider myself a very happy person," and (2) "Compared to most of my peers, I consider myself happier." Response options were scaled from 1 (strongly disagree) to 7 (strongly agree). In this study, Cronbach's alpha coefficient for the Happiness Scale index was 0.871.

2.3.2.3. Life satisfaction scale

Life satisfaction was measured as the cognitive component of SWB using the Chinese translated version of the Satisfaction with Life Scale (SWLS) (80). The SWLS consists of five items to measure global cognitive judgments of life satisfaction, including (1) "In most ways, my life is close to my ideal," (2) "The conditions of my life are excellent," (3) "I am satisfied with life," (4) "So far, I have gotten the important things I want in life," and (5) "If I could live my life over, I would change almost nothing." The score of each item ranges from 1 (strongly disagree) to 7 (strongly agree), indicating how much you agree or disagree with each statement. A mean score was computed by averaging the score of each item, with higher scores indicating greater life satisfaction. Previous studies have shown that the SWLS has good levels of reliability and validity for Chinese university students (81, 82). In this study, Cronbach's alpha coefficient for the Life Satisfaction Scale index was 0.879.

2.3.3. Perceived health scale

Perceived health was assessed using a single item: "During the past 30 days, how often did you feel very healthy and full of energy?" The predefined responses were "never," "seldom," "sometimes," "oftentimes," and "always" (coded as 1–5). This one-item question was adapted from the healthy days core module of the 2001 Behavioral Risk Factor Surveillance System (BRFSS) survey (83, 84).

2.3.4. Social support scale

To assess perceived social support in participants, we administered the Multi-Dimensional Scale of Perceived Social Support (MSPSS) (85), consisting of twelve items. The scale assesses three sources of support: significant other, family, and friends. Example items include statements like "There is a special person who is around when I am in need", "There is a special person with whom I can share my joys and sorrows", and "My family really tries to help me". Each item is answered on a seven-point Likert scale ranging from 1 = strongly disagree to 7 = strongly agree. In this study, Cronbach's alpha coefficient for the Social Support Scale index was 0.865.

2.3.5. Self-Esteem scale

The Rosenberg Self-Esteem Scale contains ten items scored on a four-point Likert scale and provides an overall evaluation of one's worth or value (Rosenberg, 1965) (86). For example, items included "I feel that I have a number of good qualities," "I feel I do not have

much to be proud of," and "I feel that I'm a person of worth, at least on an equal plane with others." In this study, Cronbach's alpha coefficient for the Self-Esteem Scale index was 0.811.

2.4. Statistical analysis

In this study, the descriptive statistics and reliability of the demographic characteristics of the study population were studied using SPSS 23.0, and correlation analysis was performed using SPSS 23.0. The AMOS 24.0 program was used to perform validation factor analysis, construct models, etc. The main research questions and analysis were conducted in the following ways.

First, the questions were subjected to a validation factor analysis to filter out the questions suitable for representing each dimension and verify the validity of the measurement instrument. Second, Cronbach's alpha values were calculated to verify the reliability of each item of the questionnaire, such as the tools from the measurement scales for PA, SWB, perceived health, social support, and self-esteem. Third, correlation analysis was conducted using the correlation coefficient of Person to identify problems of multicollinearity in the observed variables. Fourth, descriptive statistical analysis was conducted to understand the demographic characteristics of each measured variable. Fifth, the direct effects in the model were analyzed by using structural equation modeling to predict the variables. Sixth, the PA factor of college students was used as the independent variable, the SWB factor was used as the dependent variable, and the perceived health, social support, and self-esteem of college students were used as mediating variables. The significance of indirect effects was verified by bootstrapping. All statistical tests set the statistical significance level at $p < 0.05$.

3. Results

In this study, AMOS 24.0 was used to construct structural equation models before structural modeling analysis to test the proposed hypotheses. Confirmatory factor analysis (CFA) was conducted first, followed structural equation modeling (SEM) estimation according to Anderson and Gerbing's (1988) (87) two-step approach and recommended principles. The consistency of all scales was assessed, with a high Cronbach's alpha of 0.70 indicating good internal consistency (Fomell & Lacker, 1981) (88). In addition, this study used χ^2, df, CMIN/DF, CFI, and RMSEA to further analyze the model's fit to the data, with CMIN/DF less than 3, CFI greater than 0.9, and RMSEA less than 0.08.

3.1. Structural model

AMOS 24.0 was used to establish the structural equation model and test the hypotheses based on the theoretical model and hypotheses proposed in the study. Table 2 shows that the fitness of the structural equation model of the complete model is $\chi^2 = 825.451$, $p < 0.001$, df = 455, CMIN/df = 1.814, CFI = 0.942, RMSEA = 0.045. The fitness of the structural equation model can be evaluated as good. The structural equation model analysis result is shown in Figure 2.

TABLE 2 The result of the structural model.

CMIN	DF	CMIN/DF	CFI	RMSEA
825.451	455	1.814	0.942	0.045

Table 3 show the results of hypothesis testing.

The path coefficient of the effect of PA on social support was significantly positive, with a path coefficient of 0.813; hypothesis H1 was supported.

The path coefficient of the effect of PA on perceived health was significantly positive, with a path coefficient of 0.650; hypothesis H2 was supported.

The path coefficient of the effect of PA on self-esteem was significantly positive, with a path coefficient of 0.930; hypothesis H3 was supported.

The path coefficient of the effect of social support on SWB was significantly positive, with a path coefficient of 0.253; hypothesis H4 was supported.

The path coefficient of the effect of perceived health on SWB was significantly positive, with a path coefficient of 0.484; hypothesis H5 was supported.

The path coefficient of the effect of self-esteem on SWB was significantly positive, with a path coefficient of 0.217; hypothesis H6 was supported.

The R^2 value was used to analyze the predictive power of each variable. The values should be sufficiently high for the model to have a minimum level of explanatory power. Chin (1998) (89) considers values of approximately 0.670 substantial, approximately 0.333 average, and values of 0.190 and lower weak. PA accounted for 66.1% of the variance in social support ($R^2 = .661$). PA was 42.3% of the variance in perceived health ($R^2 = .423$) and 86.5% of the variance in self-esteem ($R^2 = .865$). Social support for SWB, perceived health, and self-esteem explained 68.5% of the variance in SWB ($R^2 = .685$).

3.2. Mediation effect

To verify the mediation effect more accurately, the bootstrap method is adopted. The data were bootstrapped with repeated sampling 5,000 times, with the confidence interval level set at 95%, and the sampling method was a nonparametric percentile with deviation correction.

As seen in Table 4, the indirect effect of PA→SS→SWB was 0.067 with a 95% confidence interval (.019-.164), excluding zero, indicating a significant mediating impact. The indirect effect of PA→PH→SWB was 0.103, with a 95% confidence interval (.057-.180), excluding zero, marking a significant mediating effect. The immediate impact of PA→SE→SWB was 0.066, with a 95% confidence interval (.009-.172), excluding zero, indicating a significant mediating effect.

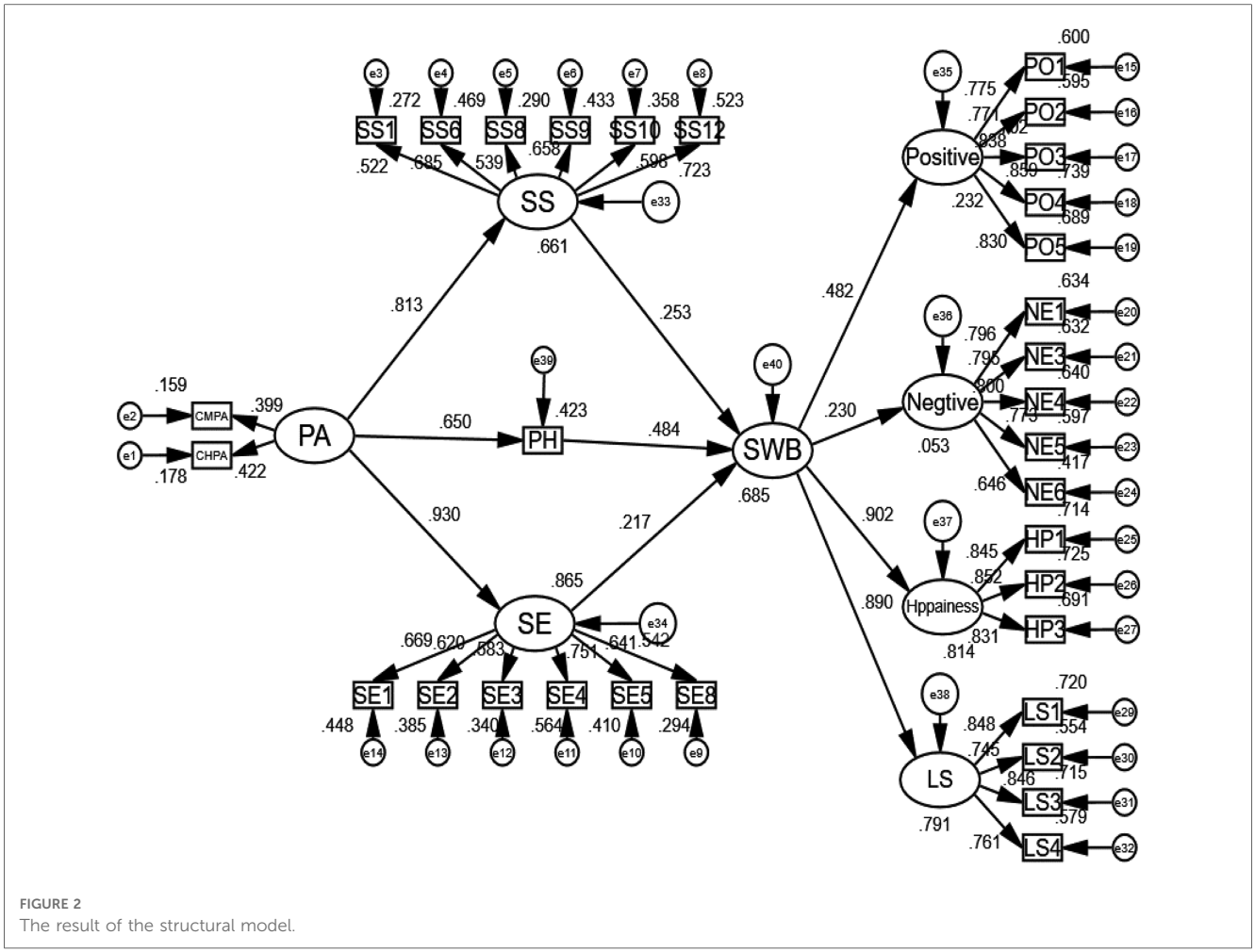

FIGURE 2
The result of the structural model.

4. Discussion

There is much research on PA and SWB, and many studies and meta-analyses report a close relationship between the variables of PA and SWB (66). According to Zhang and Chen's (4) recommendations, the researchers combine PA with SWB by leveraging their theoretical advantages for describing health to improve their interpretations through the mediating effects of perceived health, and social support, and self-esteem. Predictions were made through a holistic model that promotes approach- and reality-based intervention plans. This study attempted to address the following areas: To examine the relationship between PA and the SWB of university students, and to observe whether perceived health, social support, and self-esteem played a mediating role on the relationship between PA and SWB.

This study helps to elucidate the effect of PA on SWB. The results showed that (1) according to the measurement model, all hypotheses were supported by the results. PA was related to social support, perceived health, and self-esteem; social support, perceived health, and self-esteem were related to SWB. However, the direct effect of PA observed in H1-H3 became more minor in self-esteem, social support, and perceived health. The direct effects of perceived health, social support, and self-esteem on SWB decrease sequentially. (2) According to the structural

TABLE 3 The structural model analysis result.

Path		Estimate	SE	Z	*P*	*β*	R^2	Results
H1	PA→SS	0.262	0.045	5.851	***	0.813	0.661	support
H2	PA→PH	0.513	0.075	6.874	***	0.650	0.423	support
H3	PA→SE	0.354	0.058	6.127	***	0.930	0.865	support
H4	SS→SWB	0.257	0.087	2.934	0.003	0.253	0.685	support
H5	PH→SWB	0.200	0.029	6.841	***	0.484		support
H6	SE→SWB	0.186	0.077	2.411	0.02	0.217		support

PA, Physical Activities; SS, Social Support; PH, Perceived Health; SE, Self-Esteem; SWB, Subjective Well-Being; $\chi^2 = 825.451$, $p < 0.001$, df = 455, CMIN/df = 1.814, CFI = 0.942, RMSEA = 0.045; 3.
***$P < .001$.

TABLE 4 Mediation test.

Path		Estimate	Product of Coefficients		Bootstrapping		
					BC 95% CI		Two-tailed significance
			SE	Z	Lower	Upper	
H7	PA→SS→SWB	0.067	0.035	1.914	0.019	0.164	0.005 (***)
H8	PA→PH→SWB	0.103	0.030	3.433	0.057	0.180	0 (***)
H9	PA→SE→SWB	0.066	0.041	1.610	0.009	0.172	0.026 (**)

PA, Physical Activities; SS, Social Support; PH, Perceived Health; SE, Self-Esteem; SWB, Subjective Well-Being; $\chi^2 = 825.451$, $p < 0.001$, df = 455, CMIN/df = 1.814, CFI = 0.942, RMSEA = 0.045; 3.
**$P < .01$
***$P < .001$.

model, all three mediating hypotheses were supported. All three mediating effects showed positive indirect effects between PA and SWB. Of the three mediating effects, social support and self-esteem were not different, and the mediating result of perceived health had the greatest effect. This indicates that social support, perceived health, and self-esteem mediate PA to positively affect SWB regulation.

Studies based on a large general population have shown a positive correlation between PA and SWB and that PA is a crucial predictor of life satisfaction (90), consistent with the results of college students in this study (65, 66). It is widely accepted that social support positively relates to SWB (25, 26). Some studies have even shown that social support is necessary for SWB, consistent with the results of the college students in this study (27).

Direct impact studies in research have shown that self-esteem explains PA better than social support and perceived health, with PA contributing less to predictions of perceived health. Self-esteem was one of the strongest predictors of the cognitive component of SWB in adolescents and adults, which is consistent with the results of previous studies (35, 47, 48). Perceived health better explained SWB, with similar levels of prediction for social support and self-esteem. Perceived health was more strongly correlated with SWB than objectively measured health (16, 17), similar to previous studies. When social support, perceived health, and self-esteem were used as mediating variables, they positively influenced PA and SWB, with all three mediating effects significantly moderated. Analysis of the pathway results indicated that perceived health was the best mediator of the mediating effect. Past research has shown that social support appears to have a direct and indirect impact on wellbeing through specific cognitive mechanisms, personality factors, and health behaviors (26, 49–51). Perceived health in middle-aged and older adults mediates PA and SWB (23). This study demonstrated this relationship is mediated by perceived health also among college students.

The present study has important theoretical implications for research related to PA and SWB. In this paper, we systematically review the literature on PA and SWB to identify as many factors that affect them as possible and to provide a more comprehensive understanding of the research in this field. Some scholars have studied the relationship between PA and SWB in the past, and some studies have separately modeled the three dimensions of social support, perceived health, and self-esteem, but no scholars have developed a comprehensive structural model of social support, perceived health, and self-esteem along with PA and SWB to explore their relationship. In this paper, we explore the relationship between PA and SWB among Chinese university students through a web-based survey and verify the mediating effects of social support, perceived health, and self-esteem.

From a practical perspective, this study provides guidance for future scholars who study PA and SWB. First, based on the final results of the mediated effects, we will increase the attention brough to social support, perceived health, and self-esteem in future PA interventions for college students to enhance physical fitness and improve SWB at the same time. Second, in the context of enhancing SWB, this study strengthens the capacity of physical education teachers to give guidance to students to mobilize their own pursuits, changing traditional teaching concepts to keep up with the times, and improving the developmental consciousness of students in a comprehensive manner to better provide precise services for Chinese university sports participants.

Despite the limitations of the study, the findings are valuable. The study discovered a mediation influence between PA and SWB in terms of social support, perceived health, and self-esteem. However, there are some restrictions, most notably in the following areas: (1) To begin, the study employs a cross-sectional design, which gives a measure of past or current behavior rather than a prediction of future conduct. Because of its limitations, consistency bias may exist, making it impossible to discern causal links between variables. Longitudinal designs and randomized controlled trials may be used in future studies to assist in demonstrate causal links between SWB and PA. (2) One weakness of this study is the use of self-report tools. Because of the assessor, the context of measurement, and the content and qualities of the question items, such self-reporting can lead to changes in independent variables and changes in artifacts across variables, all of which can lead to differing participant reports. Thus, despite efforts to control for ambiguity in the question items, scale format, and questionnaire length, some uncontrollable elements in the study, such as societal expectations and subject response emotions, may have nevertheless influenced the outcomes. (3) Because this study was conducted with Chinese university students, it is crucial to exercise caution when extrapolating the findings to other populations.

5. Conclusion

This study focused on determining the relationship between physical activity and subjective well-being among Chinese university students, and the mediating effects of social support, perceived health, and self-esteem was verified in the composed integrated theoretical model. For application in physical activity research, we emphasized the role of social support, perceived health, and self-esteem in physical activity and subjective well-being based on evidence from previous studies, with theory-guided research promoting a more profound understanding among researchers and research subjects. Thus, the current study provides a valuable framework for research related to physical activity and subjective well-being. Finally, our findings suggest that creating a psychological environment that satisfies social support, perceived health, and self-esteem is essential to encouraging college students to participate in sports. This study theoretically confirms that interventions in the areas of social support, perceived health, and self-esteem ultimately results in enhancing college students' subjective well-being and quality of life and reducing conditions such as stress and depression.

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 humans were approved by Soonchunhyang Institutional Review Board on Human Subjects Research and Ethics Committees, Soonchunhyang University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

TL: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Software, Writing – original draft. YY: Writing – original draft, Writing – review & editing. XH: Writing – original draft, Writing – review & editing. ST: Data curation, Formal Analysis, Investigation, Software, Writing – original draft. YS: Conceptualization, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing.

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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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Effects of a dry-land strengthening exercise program with elastic bands following the Kabat D2 diagonal flexion pattern for the prevention of shoulder injuries in swimmers

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Background: During the repetitive execution of the swimming strokes, the muscles responsible for the internal rotations of the shoulders tend to become stronger compared to the muscles that oppose these movements. The aim of this study was to analyse the effect of a strengthening program for the shoulder rotator muscles using elastic band exercises in a diagonal Kabat pattern (D2 for flexion) in swimmers, to develop an effective, quick and easy-to-implement protocol for preventive training routines.

Methods: A randomized controlled trial design was carried out. Internal and external rotation range of movement, isometric strength of the muscles responsible for internal and external rotation of the shoulder, scapular movements, was measured at the beginning of the study and after 8 weeks post-intervention. A total of 22 male swimmers participated in the study and were randomly assigned to either an experimental group (n = 11) or a control group (n = 11). The experimental group underwent a 8-week shoulder-strength program using elastic bands, while the control group focused on aquatic training.

Results: The strength-training program resulted in an improvement in the isometric strength of the muscles responsible for external rotation and a better balance between the shoulder rotator muscles in the experimental group. However, these improvements have not been significant ($p > 0.05$).

Conclusion: The strengthening exercise program showed minimal improvement in shoulder rotation strength and range of motion. These findings suggest that the prescribed shoulder-strengthening exercise could be a quick-beneficial dry-land training option to improve external rotation shoulder strength or range of motion, but more studies with larger sample sizes and more weeks of treatment are needed to determine the efficacy of this protocol.

KEYWORDS

swimming, shoulder injuries, exercise, rotator cuff, elastic band

1 Introduction

Swimming is a cyclical sport with high technical demands, training loads and strength requirements to overcome an external load on the upper body (Jürimäe et al., 2007). The leverage effect of the upper limbs in the water can lead to joint and muscle overload and even injury (Hill et al., 2015). The rotator cuff in particular plays an important role in this process, as it is involved in stabilizing the shoulder against the addiction and internal rotation movements required to propel the swimmer through the water (Batalha et al., 2015). However, during the training season, overuse of the internal rotators and shoulder adductors can lead to a strength imbalance in swimmers, as the internal rotators gain much more strength compared to the external rotators and shoulder abductors, weakening the latter by the end of the season (Trinidad et al., 2021). This reason, an imbalance between these antagonistic muscle groups can lead to rotator cuff injuries known as "swimmer's shoulder" (Batalha et al., 2015; Kluemper et al., 2016). As a preventive measure, strength and stretching exercises have been incorporated into training in various sports disciplines to improve the performance of athletes (Asker et al., 2018). It would thus be advisable to develop protocols to prevent shoulder injuries caused by these muscular imbalances by strengthening the muscles responsible for external rotation and abduction of the shoulder (Marek et al., 2014).

In terms of etiology, prevalence and incidence, the shoulder is the joint with the greatest range of motion in the whole body, so the incidence of injury is very high (Tooth et al., 2020). In so-called "overhead athletes," which include swimmers, injuries to this joint complex have a high prevalence (Gaunt and Mafulli, 2012; Wanivenhaus et al., 2012). However, the incidence of shoulder pain in swimmers is around 38%, with between 29% and 91% of swimmers having experienced this symptom during their sporting career (Bak, 2010). This could be explained by the fact that in water, propulsion is based on the upper limbs, in contrast to land sports where the lower limbs are predominantly used (Sein et al., 2010). In addition, overuse of the shoulder muscles during weekly training sessions, which can be as many as 6 or 7 per week, leads to muscle imbalances between the rotators which, if not treated or prevented, can lead to injury later (Tessaro et al., 2017). Furthermore, in terms of therapeutic treatment, the most commonly used techniques to increase rotator cuff strength and muscular balance in overhead athletes include scapular-humeral stabilisation exercises, plyometrics, maximal strength exercises and the use of electrotherapy (Feijen et al., 2020). However, in recent years some studies have been published demonstrating the efficacy of strength exercises with elastic bands following a PNF-type diagonal Kabat pattern (Page et al., 1993; Richards and Dawson, 2009), showing positive effects on the improvement of rotator cuff strength (Moeller et al., 2014) after combining compensatory training with elastic bands with the diagonal Kabat pattern. However, most of these studies analysed sports with similar biomechanics to swimmers, such as handball, volleyball and baseball (Swanik et al., 2002).

In relation to elastic band training, scientific evidence has demonstrated the effectiveness of Kabat diagonal training using elastic bands following a progressive strength training protocol (Page et al., 1993). The elastic bands used in the current studies are characterised by different resistances, indicated by different colours, and are thought to provide greater electromyographic activation of the scapular musculature compared to free weight training (Witt et al., 2011). The protocol proposed by Manske et al. (Manske et al., 2015) shows the progression of the resistance of the elastic band as a function of the subject's perceived exertion (RPE) after performing the training tasks, using a numerical scale from 0 to 10 (Wong-Baker scale): if the RPE value was lower than 6, the resistance was increased. During the repetitions, each patient's subjective perception of exertion (RPE) was assessed. If the RPE was equal to or less than 6, the repetitions were increased to a maximum of 25, then the resistance was increased by changing the elastic band and returning to 15 repetitions (Manske et al., 2015). But the position of the patient to perform the Kabat diagonals varies according to the studies, the most common position being seated to avoid thoracic compensations (Escamilla et al., 2009). As for the point of fixation of the elastic band, this varies according to the studies in 3 points: head, feet, and iliac crest. However, there is no single consensus in the current literature on protocols applied to swimmers, with most studies focusing on overhead athletes in water polo, volleyball, baseball and softball (Escamilla et al., 2009; Witt et al., 2011; Manske et al., 2015; Batalha et al., 2018; Park and Park, 2019).

Therefore, training the external rotators of the shoulder may be a strategy to prevent rotator cuff injuries in swimmers due to the high incidence of injuries and the biomechanical importance of the rotator cuff during the sporting gesture [Batalha et al., 2015; Costa et al., 2014). For this reason, the aim of the study was to examine the effects of a diagonal Kabat pattern (D2 for flexion) on the strength of all the movements involving external rotation of the shoulder, scapular movements, and shoulder range of motion (ROM). We hypothesized that the experimental group had an improvement in shoulder strength, ROM and scapular movements.

2 Material and methods

2.1 Study design

A prospective, longitudinal, randomised, controlled, single-blind, 8-week clinical trial was conducted following the CONSORT guidelines and registered at www.clinicaltrials.gov (No. NCT05884996). Subjects who agreed to take part in the study were randomised into two groups using opaque envelopes: Control Group and Intervention Group (shoulder external rotator cuff strengthening using Kabat diagonal of D2 flexion and progressive resistance using elastic bands). All pre- and post-intervention assessments were performed by 2 assessors blinded to the subject's group.

2.2 Participants

A total of twenty-two university swimmers were included in this study. Inclusion criteria were to be between 18 and 33 years old, male, and to train at least 2 days per week; exclusion criteria were to have no acute infections or to have any shoulder pathology. On the other hand, subjects who did not sign the informed consent form

were not included in the study, which was approved by the Research Ethics Committee of the European University of Madrid (code CIPI/20/007) in accordance with the Declaration of Helsinki (World Medical Association, 2001).

2.3 Instruments

2.3.1 Maximum isometric strength of the external and internal rotators of the shoulder joint complex

An Active Force 2 dynamometer (San Diego, United States of America) was used according to the protocol of Hébert et al. (2011). Prior to the start of the test, the swimmers were instructed in the entire procedure, given time to familiarise themselves with the equipment and given 3 min to warm up with 2 test sets at minimum effort. The unit of measurement of the device was the kilogram (kg).

Subjects were then placed in the supine decubitus position. The upper limb to be assessed was placed in shoulder abduction and 90° elbow flexion so that the forearm was perpendicular to the ground and the stretcher. The dynamometer was placed transversely to the distal extremity of the upper limb, in precise contact with the patient's wrist. Two maximal isometric contractions were performed for 5 s, with 30 s rest between contractions, for the external and internal rotation movements. During execution, the blinded physiotherapist maintained firm contact with the dynamometer and applied a parallel resistance equal to the force applied by the athlete, without allowing the swimmer's upper limb to move. In addition, the athletes were verbally stimulated to produce the maximum possible effort and were instructed not to perform the Valsava manoeuvre during the test. Finally, the force exerted was digitally recorded by the apparatus and only the maximum value achieved was used, as a higher value indicated greater muscular effort.

2.3.2 Range of motion in external rotation

A goniometer (Tandou_1AA800252®) was used to measure the swimmers in the supine position on a stretcher, with the arm stabilised and a towel placed under the humerus to maintain a 10/15° arm position anterior to the coronal plane. The athlete's arms were placed at 90° shoulder abduction, the elbow off the stretcher at 90° flexion, and the forearm and wrist at 0° (perpendicular to the stretcher and floor). The axis of the goniometer was placed over the central part of the acromion. The fixed arm of the goniometer was positioned perpendicular to the floor, while the movable arm was superimposed on the fixed arm, aligned with the longitudinal midline between the ulna and its styloid process.

2.3.3 Muscular balance of the rotator cuff

With the results of the maximum isometric strength assessment, a ratio was made between the internal and external rotators of each arm (maximum isometric strength - maximum internal rotation/maximum isometric strength—maximum external rotation); a value closer to 1 indicates a better muscular balance.

2.3.4 Scapulohumeral coordination using the PALM

The PALM was used to measure the medial/lateral displacement of the shoulder blade and its upward rotation during arm raising and at rest. The swimmers were placed in a standing position and the arms of the PALM (da Costa et al., 2010) were placed corresponding to the inferior angle of the scapula and the spinous process of the closest thoracic vertebra. The distance between the two points was measured at rest and at the end of arm elevation. The results were then compared with the contralateral side.

2.4 Procedure

Elastic bands were used during the test, according to the protocol described by Batalha et al. (Batalha et al., 2015) with the aim of increasing the muscle strength of the external rotators and achieving the optimal angle of force application of the external rotators. Each session with the experimental group lasted approximately 4 min per subject and took place 2 days per week during the 8-week period. The intervention took place before the usual aquatic exercise session. The control group had to follow their usual routine without repeating the exercises suggested to the experimental group. The sessions were led by the physiotherapist-researchers of the study, who were responsible for supervising the correct performance of the exercises.

During each repetition, the subjects had to carry the end of the elastic band following Kabat's D2 diagonal pattern for flexion. All started from a position of adduction, extension and internal rotation of the shoulder with extension and pronation of the elbow, flexion and ulnar tilt of the wrist, to a position of flexion, abduction and external rotation of the shoulder with extension and supination of the elbow, extension and radial tilt of the wrist. Each subject in the experimental group began the first session by performing 3 sets of 10 repetitions for each upper extremity. Each subject in the intervention group performed 3 sets of 10 repetitions for each upper extremity. At the end of each set, each patient's subjective perception of exertion (RPE) was assessed using a visual scale with values from 0 to 10, depending on the intensity of the perceived exertion. If a value of 6 or less was reached on the RPE, 5 repetitions were added up to a maximum of 20. Once 20 repetitions were reached, the resistance of the elastic band could be increased in the following session, starting again with 10 repetitions.

2.4.1 Sample size calculation

The sample size calculation was performed using the G*Power Software version 3.1.9.2, considering an alpha error of 0.05 and a statistical power of 0.8, with a medium effect size (f = 0.33 or Eta partial squared = 0.10) based on the primary outcome (shoulder strength) and an estimated dropout rate of 10%. Therefore, a total of 22 participants were determined as the required sample size. This sample was divided into two groups, with each group consisting of 11 participants.

2.5 Data analysis

Statistical analysis was performed using IBM SPSS Statistics version 29 for Windows (IBM, Armonk, NY, United States). The distribution of the data was assessed using the Shapiro-Wilk test for sample sizes less than 50, in addition to examining histograms. For parametric variables ($p > 0.05$), central tendency and dispersion data

TABLE 1 Sociodemographic data of the total sample, experimental and control group.

Variables	Total sample (n = 22)	Experimental group (n = 11)	Control group (n = 11)	*p*-value (between-group)
Age (years)	25.71 ± 3.22	25.7 ± 3.4	25.7 ± 2.9	0.981
Height (cm)	177.34 ± 3.52	176.3 ± 2.6	178.5 ± 4.2	0.142
Weight (kg)	75.53 ± 4.31	74.1 ± 3.0	77.1 ± 5.0	0.098
BMI (kg/m2)	23.93 ± 0.64	177.3 ± 3.5	177.3 ± 3.5	0.189
Training frequency (days/week)	2.20 ± 40.44	2.2 ± 0.4	2.2 ± 0.4	0.849
Experience (years)	13.32 ± 6.36	11.8 ± 6.0	15.1 ± 6.5	0.235
Arm Dominance (L/R)	4/18	3/9	1/9	0.594
Swimming breathing side (L/R)	5/17	3/9	2/8	0.999

Abbreviations: BMI, body mass index; L, left side; R, right side. Data are expressed are mean ± standard deviation or frequency

were presented as mean and standard deviation, while for non-parametric variables ($p < 0.05$), median and interquartile range were reported.

An independent *t*-test or Mann-Whitney U test was performed to compare baseline characteristics between the two groups, taking into account the assumptions of homoscedasticity and sphericity. If the assumptions were met, a two-way analysis of variance (ANOVA) with a 2 × 2 design was performed. Effect size was assessed using partial eta squared (η2p), with values of 0.01 interpreted as small, 0.06 as medium and 0.14 as large. A 95% confidence interval was used for all analyses.

3 Results

A total of 22 participants with a mean age of 25.71 years old, weight of 75.53 kg, height 177.34 cm and 13.32 years of swimming experience were included in the study, divided into two groups: experimental group (n = 11) and control group (n = 11). Table 1 shows the sociodemographic characteristics of the total sample. No differences were observed between the experimental and control group ($p > 0.05$).

Baseline outcome measures did not show significant differences between groups ($p > 0.05$). There was no group-by-time interaction for the variables related to shoulder range of movement, shoulder muscle strength and scapular position at rest and at maximum flexion ($p > 0.05$) (Table 2). Small to medium effect size was observed in shoulder internal and external rotation ROM, isometric shoulder internal and external rotation strength and scapular position ($\eta 2p = 0.00—0.10$).

4 Discussion

The aim of this study was to analyse the effect of a strengthening programme for the shoulder rotator muscles using elastic band exercises in a diagonal Kabat pattern (D2 for flexion) in swimmers, in order to develop an effective, quick and easy-to-implement protocol for preventive training routines. In contrast with our hypothesis, the participants of the experimental group did not show a significant improvement in shoulder strength, ROM or scapular movement compared to the control group post-intervention.

Training loads generate an imbalance in swimmers between the adductor and internal rotator muscles due to overload, while the antagonist muscles do not receive the same training load. Indeed, there is evidence of a mismatch between the strength developed by these muscle groups, altering the agonist-antagonist relationship (Weldon and Richardson, 2001; Drigny et al., 2020) as a potential cause of injury. However, corrective measures for this imbalance should be accessible to all swimmers, regardless of their competitive level and technical means.

On the other hand, the natural progression that swimmers undergo with training is towards muscle imbalance, according to data observed in young swimmers (15–18 years old), who develop internal rotator strength with training, but lose external rotator strength over 3 years of continuous training (Habechian et al., 2018) It seems logical to assume that the gains in internal rotator strength are part of the expected athletic development with training. Therefore, the loss of strength in the external rotators should alert coaches to take measures to ensure a harmonious development of strength in the shoulder complex. The isometric agonist-antagonist RE/RI strength ratio that would be expected in healthy shoulders should be between 75%–100% (Cools et al., 2016).

However, it is not only muscle strength that is a parameter to be monitored in the prevention of shoulder pathology in swimmers. Limited glenohumeral mobility is also a risk factor (Cejudo et al., 2019). According to a cohort study with a 12-month follow-up (Walker et al., 2012), the risk of shoulder pain is multiplied by 8.1 in swimmers with an excess of range in external rotation and by 12.5 in swimmers with a restriction of joint range in external rotation. However, in a retrospective study, no relationship was found between variability in humeral torsion parameters and rotation ranges with athletes' history of shoulder injury (Holt et al., 2017). In addition to improved monitoring of agonist-antagonist strength ratios, it seems sensible to monitor joint ranges as a risk factor through systematic screening to identify at-risk populations early. In the present study, the inclusion of this risk factor as an inclusion criterion may have provided meaningful results in the study population, as altered scapular kinematics has also been shown to be a potential risk factor (Su et al., 2004). In contrast, there is no consensus on which of the therapeutic approaches developed to date

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TABLE 2 Outcome measures at baseline and 8 weeks post-treatment.

Variables	Group	Baseline	Post 8 Weeks	*p*-value time x group	$\eta^2 p$
Range of Movement (o)					
Right IR	EG	77.09 ± 10.17	80.81 ± 12.21	0.208	0.08
	CG	80.40 ± 7.49	79.18 ± 11.12		
Left IR	EG	80.82 ± 12.21	73.36 ± 12.75	0.263	0.06
	CG	77.90 ± 6.26	76.80 ± 9.98		
Right ER	EG	85.55 ± 12.39	88.91 ± 7.35	0.163	0.10
	CG	91.80 ± 9.08	90.60 ± 5.50		
Left ER	EG	85.27 ± 8.30	88.45 ± 8.85	0.350	0.05
	CG	87.50 ± 8.32	88.70 ± 7.87		
Isometric Strength (kg)					
Right IR	EG	14.92 ± 3.07	14.94 ± 2.51	0.265	0.07
	CG	15.67 ± 3.71	17.71 ± 4.36		
Left IR	EG	16.25 ± 4.76	15.45 ± 1.91	0.447	0.03
	CG	16.16 ± 6.21	16.66 ± 3.68		
Right ER	EG	14.76 ± 2.92	16.49 ± 3.25	0.263	0.10
	CG	13.89 ± 4.35	15.09 ± 3.72		
Left ER	EG	16.04 ± 3.54	16.73 ± 4.47	0.709	0.01
	CG	14.38 ± 4.73	15.73 ± 3.87		
Right ER/IR Ratio	IG	1.06 ± 0.32	0.92 ± 0.15	0.431	0.03
	CG	1.19 ± 0.37	1.19 ± 0.20		
Left ER/IR Ratio	IG	1.02 ± 0.21	0.96 ± 0.21	0.926	0.00
	CG	1.13 ± 0.18	1.08 ± 0.17		
Scapular position (cm)					
Right at Rest	IG	10.27 ± 1.10	10.57 ± 1.65	0.379	0.04
	CG	9.95 ± 1.04	9.88 ± 1.05		
Left at Rest	IG	10.05 ± 1.08	10.18 ± 1.25	0.657	0.01
	CG	9.95 ± 1.01	10.29 ± 1.51		
Right at maximum flexion	IG	16.08 ± 0.87	16.17 ± 0.81	0.233	0.07
	CG	15.53 ± 1.22	15.16 ± 0.67		
Left at maximum flexion	IG	16.13 ± 0.75	15.48 ± 1.44	0.788	0.00
	CG	15.70 ± 0.89	15.21 ± 1.52		

to control the agonist-antagonist ratio is the most appropriate (Yoma et al., 2022).

The present study did not obtain the expected results in terms of muscle strength and shoulder ROM. Our results suggest that could be a positive trend in shoulder external rotation strength or range of motion. A previous study (Batalha et al., 2015) obtained significant results in terms of muscle strength. With a similar training protocol using elastic bands, they obtained significant differences in the strength of the external rotators (not the internal rotators) and in the RE/RI ratio. There are several reasons for the difference between the two studies. On the one hand, the follow-up was longer (16 vs. 8 weeks) and closer (supervised training vs. autonomous training). On the other hand, the age of the swimmers (14–15 years vs. 18–33 years) and the strength measurement was isokinetic vs. isometric.

In accordance with the above, the follow-up time seems to be the key that distinguishes the studies that obtained significant

differences between groups in terms of muscle strength. Protocols lasting more than 12 weeks (Batalha et al., 2015) proved to be effective, while those with follow-ups of less than 8 weeks were unable to demonstrate differences between the proposed approaches (Hibberd et al., 2012).

However, a new unknown factor is being analysed here. It seems that adolescent swimmers (<18 years) are able to correct muscular decompensation in the shoulder with training protocols of longer duration (12–16 weeks) based on strength exercises with elastic bands (Batalha et al., 2015; Manske et al., 2015). Nevertheless, the asymmetry between the present study and these two previous studies does not allow conclusions to be drawn regarding age, but it seems important to clarify in the future whether the preventive approach could be carried out at any age or whether it would be essential to carry it out in the early stages of sporting development. On the other hand, the therapeutic approaches differ between studies, but all include resistance exercises, for external rotation of the shoulder. It appears that open kinetic chain dry training was the most appropriate for the correct development of muscle strength (Hibberd et al., 2012), so the protocol proposed in this article has the potential to be effective in overcoming the limitations found.

There are several causes that may have led to the non-significant results found. The small sample size (22 participants), in addition to a short follow-up (8 weeks), with a treatment protocol that was too simplified (1 single exercise) and supervision limited to explanation and correction on the first day of treatment. On the other hand, the variables measured could have been improved with isokinetic measurement of muscle strength.

The challenge of creating a research protocol that, while retaining simplicity to encourage swimmer accessibility and adherence, was capable of demonstrating efficacy in the control of risk factors linked to swimming for the development of shoulder pathology. Further research is still needed to create an followed protocol for balancing muscle strength and shoulder joint range in swimmers. This protocol should be available to all swimmers, regardless of competitive level, age, financial or technical means.

5 Conclusion

The strengthening exercise program showed minimal improvement in shoulder rotation strength and range of motion. These findings suggest that the prescribed shoulder-strengthening exercise could be a quick-beneficial dry-land training option to improve external rotation shoulder strength or range of motion, but more studies with larger sample sizes and more weeks of treatment are needed to determine the efficacy of this protocol.

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 humans were approved by the Research Ethics Committee of the European University of Madrid (code CIPI/20/007). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

ID: Conceptualization, Methodology, Project administration, Writing–review and editing. AT-M: Conceptualization, Methodology, Writing–review and editing. PM-L: Writing–review and editing. AG-F: Formal Analysis, Writing–original draft. JD-B-M: Conceptualization, Methodology, Writing–original draft.

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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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The effect of the partnership between DanceSport couples on competitive performance: the mediating role of athlete engagement

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Objectives: Although the positive association of partnership between DanceSport couples with competitive performance (CP) is documented, less is known about the mediating factors of this relationship. According to the related literature and self-determination theory (SDT), the present study finds and verifies that athlete engagement (AE) mediates the association between partnership and competitive performance.

Methods: A total of 242 Chinese sports dancers were recruited using the purposive sampling method. The Partnership Scale-DanceSport Couples (PS-DSC), the Athlete Engagement Questionnaire (AEQ), and the Competitive Performance Questionnaire (CPQ) were adopted to collect data.

Results: The obligatory instrumental ties, expressive ties, and interpersonal perception scores are all positively correlated with both athlete engagement and competitive performance, and athlete engagement scores are positively correlated with competitive performance. Athlete engagement completely mediates the association between obligatory instrumental ties and competitive performance, and it partially mediates the association between expressive ties, interpersonal perception, and competitive performance, with the mediating effect accounting for 25.29 and 24.40% of the total effect, respectively.

Conclusion: Athlete engagement mediates the association between DanceSport couples' partnership and competitive performance. High levels of athlete engagement are needed to improve the chance of promoting obligatory instrumental ties, expressive ties, and interpersonal perception between DanceSport couples toward excellent competitive performance. Overall, the results represent an attempt to extend our understanding of the mechanisms by which the three partnership stereotype factors individually influence dancers' cognitive and psychological states.

KEYWORDS

DanceSport, partnership, competitive performance, athlete engagement, self-determination theory

1. Introduction

Achieving high-level competitive performance is important for competitive sports (Taylor et al., 2022). To improve competitive performance, researchers have traditionally focused on individual-level variables such as anxiety (Hardy and Parfitt, 1991). However, Isoahola (1995) proposes an interactionist model, which indicates that behavior or performance is a function of the interaction between the person and their environment [$B=f$ (P X E)]. Interpersonal relationship, in this context, is a very important environment for athletes to achieve excellent competitive results, which is supported by the literature on the coaches-athletes relationship (Jowett and Meek, 2000; Jowett and Cockerill, 2003; Jowett and Ntoumanis, 2004; Jowett and Poczwardowski, 2007; Jowett and Palmer, 2010; Davis et al., 2013) and the athlete-athlete partnership (Poczwardowski et al., 2019). As a competitive sport, DanceSport requires partners to follow the rhythm of the music and compete against a couple of contestants to display the beauty of the sport (Chae and Koh, 2012). Therefore, competitive performance is also affected by the partnership between DanceSport couples (e.g., Fostiak, 1996; Majoross et al., 2008; Lai, 2014; Budnik-Przybylska et al., 2015). Even the top dancers in the world are not immune to the fluctuations in their performance caused by problems in dance partnerships. For example, Slavik Kryklyvyy, the legendary Ukrainian dancer, kept changing partners, resulting in a lower world ranking. Similarly, Ralf Lepehne, Germany's top dancer, retired early after his partner split.

The partnership between DanceSport couples is the psychological projection of mutual adaptation and the basis of high-level cooperation (Majoross et al., 2008). The premise of showing a perfect image in the competition is to establish a stable and high-quality partnership (Fostiak, 1996). Scholars find that partners who achieve elite performance are always in a romantic partnership (Pistole, 2003; Ifrar et al., 2020). The reason may be that the nature of the partnership affects the performance of partner skills, which is one of the important judging factors in the World DanceSport Federation competitions (Remelcˇ et al., 2019; Yoshida et al., 2020). During the competition, judges look for body control, posture, shape, footwork, timing, rhythm, and the level of difficulty of the routine (Pittman et al., 2005), and they assess all these components within a noticeably fleeting period. With up to 50 couples on the floor in the early heats, judges eliminate 50% of the couples in 2 min (Tremayne and Ballinger, 2008). Therefore, it is not enough to execute technically correct steps but to make it look effortless, graceful, enjoyable, and harmonious. Even as in other sports that combine esthetic art with athletic ability, due to the subjective nature of scoring, the judgment may lead to unexpected or undesired results, which is still maintained for now (Tremayne and Ballinger, 2008).

Given that partnership is so vital, any analysis of the various problems surrounding DanceSport always considers the partnership between couples (Wiesława et al., 2013). Therefore, belittling or ignoring partnerships might hurt performance (e.g., persistence, motivation, and success) (Davis et al., 2013). However, thus far, there are few theories to guide the management methods of partnership. The reason may be that the mediating factor of the association of partnership between DanceSport couples with competitive performance remains unclear. Therefore, to address this problem, in this study, we draw useful experiences from the previous research results. Based on the conceptual framework of the partnership between DanceSport couples (expressive ties, obligatory instrumental ties, and interpersonal perception) (Liu et al., 2022; 2023), we review the literature on the relationship between partnership and competitive performance and propose athlete engagement as an important mediating variable based on self-determination theory and other research findings. In addition, the first author of our study has been involved in professional DanceSport training for seven years and has competition experience; she has a deep sense and understanding of partnerships, which is also extremely valuable in completing this study.

1.1. Partnership between DanceSport couples and competitive performance

1.1.1. Obligatory instrumental ties and competitive performance

Obligatory instrumental ties (OIT) refer to the reciprocal behavior tendency of elite dance couples based on the principle of obligation ruled by *"renqing (favor) or mianzi (face)*." It mixes instrumental and obligatory factors (Liu et al., 2023), which is also possessed by elite dancers. On the one hand, achieving excellent competitive performance is rewarded with international recognition; on the other hand, dancers who are unable to achieve excellent competitive performance are eliminated in the elimination rounds (Joanna, 2015, p. 26). Therefore, to obtain prizes and prestige, dancers take the competitive victory as the most important starting point for participation (Budnik-Przybylska et al., 2015), and partners are always considered instrumental tools and assets that help dancers improve their athletic ability and performance outcomes (Lai, 2014). Consequently, partners often exhibit a high degree of reciprocity and interaction (Reisman, 1981; Marion, 2006), and the partnership is taken as an instrument to obtain benefits (Lai, 2014; Liu et al., 2023). Even when describing the qualities of an ideal dance partner, a good dancer states that a perfect partner is one who helps them improve their dancing skills and stand out in competitions (Marion, 2006). Therefore, the questionnaire on obligatory instrumental ties includes the following four items: "Cooperating with my partner promotes my ability," "Cooperating with my partner will make me grow professionally," "My partner and I are tied together," and "Cooperating with my partner will get me closer to my goal" (Liu et al., 2023). These items all reflect the obligatory instrumental ties between DanceSport partners in order to obtain excellent competition results.

On the other hand, there is a strong emphasis on obligation ruled by *"renqing"* between partners, which is different from the contractual obligation emphasizing taking an interest. In Asian countries, such as China, the obligation between DanceSport couples is stressed (Liu et al., 2023). This obligation is defined by *"renqing"* or *"mianzi"* based on Confucianism, which is based on personal feelings rather than commercial law to uphold the obligation. When people fail to follow the rules, they invite public criticism. So, they obey the rules to maintain harmonious relationships (Hwang, 1987; Seligman, 1999). Thus, the obligatory instrumental ties questionnaire developed by Liu et al. (2023) includes the item: "X20 I obligately follow the training plan agreed with my partner," indicating that dance partners must obey the training plan to dance together, which is vital to achieving better performance.

1.1.2. Expressive ties and competitive performance

Expressive ties refer to the emotional bond between elite dance couples (Liu et al., 2023), which exerts a profound influence on dancers' partnerships (Julia, 2011, pp. xii-46; Majoross et al., 2008). It includes instant intimacy (Julia, 2011, pp. 20–21) and long-term affection (Brewińska and Poczwardowski, 2012; Yang, 2015). Instant intimacy is a short-term enthusiastic state of desire formed between dance partners in the context of the competition. Long-term affection develops over a long period of time, resulting from interactions in personal and professional contexts, which is different from instant intimacy marked by weaker emotional concentrations and slower emotional outbursts. For long-term affection to be established, dancers must feel appreciated and cared for and be in a harmonious relationship with their partners.

Based on the previous literature, the expressive ties between DanceSport couples have a positive impact on competitive performance (e.g., Fostiak, 1996; Majoross et al., 2008; Brewińska and Poczwardowski, 2012; Lai, 2014; Park and Choi, 2014; Budnik-Przybylska et al., 2015; Liu et al., 2023). In particular, studies involving participants in dyadic groups have found that dyadic groups perform better if the members like each other (Krivonos et al., 1976). Very often, elite DanceSport couples are also pairs in life (Majoross et al., 2008; Brewińska and Poczwardowski, 2012), and the connection between them is intimate, passionate, and immersive (Yang, 2015).

The reasons are as follows: first, DanceSport is a discipline based on romantic fantasies about love and sex between heterosexual dyads (Julia, 2011, pp. xii). It requires open expression of sexual intimacy (Julia, 2011; Harman, 2019), and romance is at the core of the sport (John, 1998, p. 11). Therefore, the instant intimacy among the couples in competition is a key factor in achieving excellence. Although sexual attraction does not pass between the dancing couples (McMains, 2006; Gainor, 2007; Joanna, 2015, p. 61), most of the high-level participants tend to interpret the romantic relationship among the sexes in dance as the passion for their partners, at least in their on-stage performances (Liu et al., 2023). In addition, the idea that instant intimacy is a requirement for partners under mirror neural mechanisms is also supported by neuroscientific perspectives. For example, Fogassi (2011) and Ye et al. (2016) hold that the human cerebral cortex has a "mapping" function of mirror neurons in the inferior parietal lobe, ventral premotor cortical area, and posterior inferior frontal gyrus. This mapping function translates sensual movements, such as tightly connected crotches, closely attracted eyes and breath, and feelings of passion into emotional boosters between them and their partners. Scholars describe sexy movements in detail:

"Dancers employ a number of signals of varying subtlety to express romantic interest within a dance. They include placing hands on a partner's intimate body parts (such as low hips and buttocks), wrapping arms completely around a partner to ensure shoulder-to-knee contact, stroking a partner's hair or face, dancing literally cheek to cheek, looking directly into one another's eyes, and other idiosyncratic gestures" Joanna (2015, p. 61).

"He approaches her from behind until his chest touches her back, then thrusts his hands to her lower thighs and caresses her upwards. After grabbing her waist, he pushes her away and sharply pulls her back to him, provoking an impact of her back against his ribcage" Valentin (2020).

"Shimmering in a beaded gold costume, Tanya alternately approached and fled from Edward, spiraling in toward him, hesitating, smiling, then spinning rapidly away. Hands caressed lightly, fleetingly, arms swirled in a serpentine embrace. Edward moved deliberately to showcase Tanya, their bodies forming luxurious and strangely balletic lines as she acquiesced to his touch. And all the while, their hips undulated in Latin motion, that sensuous pelvic movement that is the essence of the rumba/bolero. Desire begot desire, stirring reveries" Peters (1992).

"The judges watched as the dancers dipped low to the floor, the pelvis wed to the pelvis, man guiding woman into an "over sway." The dancers moved cautiously, pulling themselves across the floor heel first. One couple had a decidedly Argentine look. Sleek in black, they revolved warily, crouched into the knees, Alicia exaggeratedly arched, Miguel proudly upright. They maintained this posture even as they punctuated their stalking with legs that flashed with lightning speed, hooking around hips and thrusting between thighs. Both executed the sharp libidinous jabs and pelvic climbs, which sometimes began or ended with the elegance of around de jambe. This eroticism vaguely recalled the knives carried by male dancers a century ago in Argentina as they challenged one another to combat Mack the Knife as a tango dancer. In Boston, the judges were not impressed" Peters (1992).

Peters (1992) wonders whether dancers sometimes get caught up in the desire for each other on the dance floor.

Second, long-term affection is a prerequisite for satisfactory performance. To be more specific, excellent competitive performance requires a prolonged period of systematic and professional practice (Ericsson et al., 1993). Like any skill, dancing requires practice—perhaps 5 h for every lesson (John, 1998, p. 168), and dancers may train with a partner for more than 10 or 20 years, or even a lifetime, as John (1998) stressed, "there is no final destination. Learning to dance is a lifetime process, which represents part of its fascination. There will always be a new dance to learn, a new figure to experiment with, and a new dancing style to explore (p. 166)." During this time, they often leave home to train elsewhere, and a rapport between the dancers is essential, whether it is a romantic attraction to each other or a shared passion for dance (John, 1998, p. 27). Eventually, a pattern of harmonious partnership develops, in which partners face difficulties together and share intimate emotions, such as a romantic relationship. Most couples in the field of international professional sports dancers are married (John, 1998, p. 117) and rarely define their partnerships as mere working relationships (Majoross et al., 2008).

While the positive effect of expressive ties between DanceSport couples on competitive performance has been recognized, no study has tested this idea with the widest possible range of investigations, which is the goal of our study.

1.1.3. Interpersonal perception and competitive performance

Interpersonal perception (IP) refers to the ability of elite dance couples to share and expose each other in the full process of taking competition as the goal, to sensitively perceive the psychological and behavioral tendencies of dance partners, including revealing their hearts, sharing, and understanding each other (Liu et al., 2023). Interpersonal perception plays a significant role in improving the quality of training and competitive performance. The reasons may be that interpersonal ability is the engine of artistic communication, and the desire to dance comes from the wish to communicate and feel

connected to partners (Dan, 2012). Strengthening the sense of bonding and communication between partners increases the effectiveness of training and satisfaction with competitive performance (Jin and In, 2006). Wulff (1998) flags how "dancers are, for example, extremely skilled at communicating without looking at each other, which is something they learn in dancing but carry over to how they move and behave when they are not dancing" (p. 108).

In addition, the DanceSport partnership is a special bond that mixes expressive ties and instrumental professional ties (Wang, 2018) and falls under the principles of "need" and "fairness," respectively (Hwang, 1987). Under the principle of "fairness" in expressive ties with partners, cooperation is likely to intersect with love, leading to quarrels and conflicts (Liu et al., 2023). However, under the principle of "need" in instrumental professional ties, dancers may miss training or competitions because of a lack of professionalism. For Chinese dancers, intimacy is about blurring the boundaries between the individual and others so as to achieve a state of separation between "you" and "me" (Lynn, 1998; Sara, 2005). Therefore, we believe that high-quality interpersonal perception can help alleviate the above contradictions. However, this view has not been proven. This study aims to test this view.

1.2. Mediating variable: athlete engagement

At present, few studies have explored the mediating variables between partnership and competitive performance, making it difficult to obtain reliable hypotheses from relevant studies on partnerships between DanceSport couples. Therefore, our study draws on the interdependence theory, which forms the basis of the coach-athlete relationship. We constructed this theory by conducting in-depth interviews with four couples. We also explored the pathway of influence that this theory suggests on competitive performance.

Related studies and self-determination theory (SDT) support the hypothesis that athlete engagement mediates the association between partnership and competitive performance. To be more specific, Jowett and Cockerill (2003) show that high-quality communication and respect between athletes and coaches contribute to athletes' satisfaction and improve competitive performance. Building on his previous study, Jowett and Poczwardowski (2007) propose an integrated research model of the coach-athlete relationship that further clarifies that the relationship between the two affects competitive performance (Jowett and Palmer, 2010). The self-determination theory suggests that a sense of human relatedness and a basic human psychological need is significantly correlated with athlete engagement (Lonsdale et al., 2007; Hodge et al., 2009). Following that, Wang et al. (2014) find that the coach-athlete relationship significantly influences the athlete engagement. They construct a chain mediation model in which athlete engagement is the mediating variable between the coaches-athletes relationship and the satisfaction of competition performance (as a proxy variable of competition performance) ($\beta = 0.04$, $p < 0.001$) (Ye et al., 2016).

Based on this literature, it is believed that athlete engagement mediates the association between obligatory instrumental ties, expressive ties, and interpersonal perception, and competitive performance. To be more specific:

1. Athlete engagement between obligatory instrumental ties and competitive performance. Sport dancers need to consciously observe the normative manners with their partners, including mutual respect, appreciation, and a sense of responsibility (especially the responsibility to adhere to the training schedule and to work hard). According to John (1998, p. 33), successful DanceSport competitors are dedicated athletes; the dancers need to devote as much time as possible to practice skill techniques with their partners and be more enthusiastic and dedicated. At the same time, according to Ostrom (2003), repetitive interaction helps individuals to promote mutual benefit and mutual assistance with others. Through continuous cooperative training, partnerships between DanceSport couples generate mutually beneficial behaviors that promote the achievement of the dancers' own training goals. Furthermore, better-performing dancers tend to be more diligent with a firm belief in their success, confident in attaining their goals, and more motivated (Ifrar et al., 2020). Therefore, to a considerable extent, athlete engagement mediates the association of obligatory instrumental ties with competitive performance.
2. Athlete engagement between expressive ties and competitive performance. A long-term relationship between partners triggers positive psychological feelings, such as recognition among both partners, thereby increasing their athlete engagement. More importantly, through the "mapping" function of mirror neurons in several areas of the human cerebral cortex, the inferior parietal lobule, the ventral premotor gyrus Broca's area, and the posterior inferior frontal gyrus (Fogassi, 2011; Ye et al., 2016), the tightly absorbed eyes and breath, emotions and feelings between partners get transformed into emotional boosters for the dancers themselves and their partners, which may enhance the infectiousness and competitive performance of the dance. At the same time, the instant intimacy between the partners stimulates the dancers' passion for the dance and deepens their immersion in the dance (Yang, 2016). This immersion is like vigor and enthusiasm (two dimensions of athlete engagement). Vigor is defined as "a feeling of being physically and mentally active," and enthusiasm is characterized as "a feeling of excitement and high enjoyment." Therefore, high-quality expressive ties directly contribute to athlete engagement. This positive psychological trait also enables dancers to overcome difficulties and burnout, thus increasing their competitive ability (Gustafsson et al., 2011). In addition, from the judges' point of view, they will give the final decision based on whether the partners are harmonious, vigorous, and confident (Tremayne and Ballinger, 2008). Therefore, athlete engagement mediates the association of expressive ties with competitive performance.
3. Athlete engagement between interpersonal perception and competitive performance.

Relatedness is an innate and indispensable element for humans (Ryan, 1995; Deci and Ryan, 2002, 2004), and all dualistic relationships begin with a process of interpersonal perception in which both parties participate (Kang and Bodenhausen, 2015). Therefore, the partnership perception among DanceSport dancers is inevitable, and its satisfaction contributes to the generation of self-determination, motivation, and the maintenance of partnership behavior (i.e., athlete engagement), thus affecting competitive performance. Effective communication and understanding between partners, along with providing encouragement and confidence in difficult situations, are important means to improve

compatibility, according to Majoross et al. (2008). When dancers perceive that their partners sincerely express emotional support and reciprocate, they tend to communicate with each other in a more friendly manner and exhibit positive emotional tendencies and behaviors, which becomes instrumental to achieving their expected goals (Miller, 1990). In addition, individuals predict their future behavior through what they know about others in interpersonal interactions (Sang, 2014). Therefore, the higher the degree of interpersonal perception, the more it can provide a good foundation for cooperation with partners and the more it is instrumental in improving the dancers' athlete engagement and obtaining excellent competitive results. Therefore, athlete engagement mediates the association of interpersonal perception with competitive performance.

1.3. The current study: development of theoretical framework and hypotheses

Analyzing DanceSport practices and related theories, we find that athlete engagement mediates the partnership between DanceSport couples (the three dimensions of obligatory instrumental ties, expressive ties, and interpersonal perception) and competitive performance. However, of the studies we reviewed, none had tested the hypotheses with surveys. Hence, the present study aims to test the following hypotheses:

> *H1*: Athlete engagement partially mediates the association between obligatory instrumental ties and competitive performance.
>
> *H2*: Athlete engagement partially mediates the association between expressive ties and competitive performance.
>
> *H3*: Athlete engagement partially mediates the association between interpersonal perception and competitive performance.

In addition, since athletic ability also plays a crucial role in competitive performance, it is used as a control variable in this study.

2. Methods

2.1. Participants

Our sample consisted of 242 participants (see Table 1) who had participated in the 2019 Chinese DanceSport Championship (Beijing Station)—the highest-level event of Chinese DanceSport held at the Ditan Gymnasium. They were selected by five experienced national-level DanceSport judges who were engaged in front-line teaching of DanceSport and were from Beijing Sports University, Wuhan Sports University, Capital University of Physical Education and Sports, Xi'an Physical Education University, and the Institute of Psychology of the Chinese Academy of Sciences (CAS). Among them, there were two professors, two doctors, and one champion. The champion had 20 years of training and experience in DanceSport, was the champion of Latin dance among the Chinese professional team for three consecutive years (2013–2016), and broke international competition records among Chinese athletes. The judges used the following selection criteria: (a) having a regular partner for at least 3 years; (b) outstanding performance in the past.

TABLE 1 Demographic information of the participants (n = 242).

Variable	Classification	Frequency	Percent(%)
Sex	Male	122	50.4
	Female	120	49.6
Training time	5.1 ~ 10 years	107	44.2
	10.1 ~ 15 years	28	9.92
	>15 years	16	6.61
Partner time	0 ~ 12 month	151	62.4
	13 ~ 36 month	58	24
	37 ~ 60 month	22	9.1
	>60 month	11	4.5
Athletic ability	High-level	134	55.4
	Low-level	108	44.6

2.2. Materials

2.2.1. Partnership quality

We used the Partnership Scale-DanceSport Couples (PS-DSC) (Liu et al., 2023), which had a three-dimensional scale consisting of 13 items. Cronbach's α of the subscales relating to obligatory instrumental ties, expressive ties, and interpersonal perception was 0.905, 0.846, and 0.848, respectively, which established that the scale could be applied in this study.

2.2.2. Athlete engagement

We adopted the Athlete Engagement Questionnaire (AEQ) (Lonsdale et al., 2007), which already had good adaptability among Chinese athletes and has been verified (Wang et al., 2014; Ye, 2014; Ye et al., 2016). The scale with its 16 items had Cronbach's α of 0.951, and its four dimensions had a Cronbach's α of 0.921, 0.939, 0.900, and 0.873, respectively, proving that the scale could be applied in this study.

2.2.3. Competitive performance

Competitive performance includes the satisfaction degree of field performance and field performance; therefore, we used the Competitive Performance Questionnaire with four items (Liu et al., 2023). Furthermore, the Athlete Satisfaction Questionnaire (ASQ) (Riemer and Chelladurai, 1998) was adopted. The competition ranking was determined by the performance outcomes, which were evaluated by five international-level DanceSport judges. The ranking was assigned to a 5-level Likert scale, which took into account the five levels of ordinal variables. The results obtained after processing the data from these variables were considered unbiased, even when combined with continuous variables. The scale consisted of four items, and Cronbach's α was 0.704, which indicated that the scale could be applied in this study.

2.3. Analysis strategy

We used SPSS 22.0 to process and analyze the data. First, the Pearson correlation was used to examine the relationship between partnership, athlete engagement, and competitive performance. Second, all variables were standardized, and then Model 4 in PROCESS, developed by Hayes (2018), was adopted to test the mediating effect of athlete engagement between partnership and

competitive performance, controlling for gender, training time, partner time, and athletic ability.

2.4. Common method variance bias

Since the data used in this study was collected from self-report questionnaires, common method variance bias (CMVB), which affects the results and even draws wrong conclusions, was a potential concern. The possibility of CMVB is assessed when independent and dependent variables are measured under the same context and obtained from the same source. We adopted the harmony one-factor test to inspect whether there was an artificial covariation between the independent and dependent variables. The results showed that the variance of the first common factor explanation was 18.05%, which is lower than the 40% criterion proposed by Podsakoff et al. (2003). Therefore, CMVB was not found in this study.

3. Results

As shown in Table 2, obligatory instrumental ties, expressive ties, and interpersonal perception scores were all positively correlated with athlete engagement and competitive performance. Furthermore, athlete engagement scores were positively correlated with competitive performance.

After controlling for gender, training time, partner time, and athletic ability, three regression models were established to analyze the influence of partnership quality on competitive performance through the moderating effect of athlete engagement. In the first model, obligatory instrumental ties were used as the independent variable. The model and regression coefficient are shown in Table 3.

As seen in Table 3, obligatory instrumental ties significantly influenced competitive performance ($\beta = 0.12$, $t = 2.01$, $p<0.05$) when athlete engagement was added to the regression model. Obligatory instrumental ties by itself could not significantly influence competitive performance ($\beta = -0.04$, $t = -0.56$, $p>0.05$); however, it could significantly influence athlete engagement ($\beta = 0.48$, $t = 8.45$, $p<0.001$) and athlete engagement could influence competitive performance ($\beta = 0.33$, $t = 4.99$, $p<0.001$). This demonstrated that athlete engagement completely mediated the effect of obligatory instrumental ties on competitive performance. Thus, H1 that athlete engagement partially mediates the association between obligatory instrumental ties and competitive performance is supported by this study.

In the second model, expressive ties were used as the independent variable. The model and regression coefficient are shown in Table 4.

As seen in Table 4, expressive ties significantly influenced competitive performance ($\beta = 0.35$, $t = 5.81$, $p<0.001$) when athlete engagement was added to the regression model. Expressive ties could also independently significantly influence competitive performance ($\beta = 0.26$, $t = 4.09$, $p < 0.001$) and athlete engagement ($\beta = 0.41$, $t = 6.54$, $p < 0.001$), and athlete engagement could significantly influence competitive performance ($\beta = 0.22$, $t = 3.52$, $p < 0.01$). The direct effect value of expressive ties affecting competitive performance was 0.26 [95% confidence intervals (CI) = 0.14, 0.39]. In addition, athlete engagement partially mediated the effect of expressive ties on competitive performance [indirect effect = 0.09, 95% CI = 0.04, 0.15]. The direct effect value and indirect value accounted for 74.71 and 25.29% of the total effect, respectively. Thus, H2 proposing that athlete engagement partially mediates the association between expressive ties and competitive performance is supported by this study.

In the third model, interpersonal perception was used as the independent variable. The model and regression coefficient are shown in Table 5.

As seen in Table 5, interpersonal perception significantly influenced competitive performance ($\beta = 0.34$, $t = 5.54$, $p < 0.001$) when athlete engagement was added to the regression model. Interpersonal perception could also significantly influence competitive performance ($\beta = 0.25$, $t = 4.05$, $p < 0.001$) and athlete engagement ($\beta = 0.35$, $t = 5.53$, $p < 0.001$), and athlete engagement could significantly influence competitive performance ($\beta = 0.23$, $t = 3.87$, $p < 0.001$). The direct effect value of interpersonal perception affecting competitive performance was 0.25 [95% CI = 0.13, 0.38]. In addition, athlete engagement partially mediated the effect of interpersonal perception on competitive performance [indirect effect = 0.08, 95% CI = 0.03, 0.14]. The direct effect value and indirect value accounted for 75.60 and 24.40% of the total effect, respectively. Thus, H3 on athlete engagement partially mediating the association between interpersonal perception and competitive performance is supported by this study.

TABLE 2 Correlation matrix of each research variable.

	OIT	ET	IP	AE	CP
OIT	1				
ET	0.58**	1			
IP	0.55**	0.67**	1		
AE	0.59**	0.40**	0.35**	1	
CP	0.19**	0.37**	0.37**	0.36**	1

** indicates $p < 0.01$; OIT: obligatory instrumental ties; ET: expressive ties; IP: interpersonal perception. AE: athlete engagement and CP: competitive performance.

4. Discussion

Our results indicate that athlete engagement completely mediates the association between obligatory instrumental ties and competitive performance (H1), partially mediates the association between expressive ties and competitive performance (H2), and partially mediates the association between interpersonal perception and competitive performance (H3). These findings demonstrate that obligatory instrumental ties, expressive ties, and interpersonal perception between DanceSport couples and athlete engagement are critical factors influencing individuals' competitive performance. The findings are a result of the self-determination theory (SDT) and research mentioned in the current study's introduction and other theories.

4.1. Athlete engagement completely mediates the association between obligatory instrumental ties and competitive performance

In our study, athlete engagement completely mediates the association between obligatory instrumental ties and competitive performance. It suggests that athlete engagement influences the relationship between obligatory instrumental ties and competitive performance. On its own, obligatory instrumental ties are unable to significantly influence competitive performance, contradicting the

TABLE 3 Results of the mediating effects of athlete engagement between obligatory instrumental ties and competitive performance.

Dependent variable	Independent variable	β	SE	*t*	95% Bootstrap CL		R^2	*F*
					LLCI	ULCI		
CP	Gender	−0.01	0.12	−1.65	−0.44	0.04	0.16	8.75
	Training time	0.07	0.07	1.11	−0.06	0.22		
	Partner time	0.22	0.07	3.49**	0.11	0.40		
	Athletic ability	0.19	0.12	3.18**	0.15	0.63		
	OIT	0.12	0.06	2.01*	0.00	0.25		
AE	Gender	−0.14	0.11	−2.46*	−0.50	−0.06	0.27	17.82
	Training time	−0.05	0.07	−0.82	−0.19	0.08		
	Partner time	−0.01	0.07	−0.16	−0.15	0.12		
	Athletic ability	0.10	0.11	1.68	−0.03	0.41		
	OIT	0.48	0.06	8.45***	0.37	0.60		
CP	Gender	−0.06	0.12	−0.92	−0.336	0.12	0.24	12.17
	Training time	0.09	0.07	1.42	−0.04	0.24		
	Partner time	0.22	0.07	3.71***	0.12	0.40		
	Athletic ability	0.16	0.12	2.78**	0.10	0.55		
	OIT	−0.04	0.07	−0.56	−0.17	0.10		
	AE	0.33	0.07	4.99***	0.20	0.47		

* indicates $p < 0.05$ **, $p < 0.01$; and ***, $p < 0.001$. CP: competitive performance; AE: athlete engagement; and OIT: obligatory instrumental ties.

TABLE 4 Results of the mediating effects of athlete engagement between expressive ties and competitive performance.

Dependent variable	Independent variable	β	SE	*t*	95% Bootstrap CL		R^2	*F*
					LLCI	ULCI		
CP	Gender	−0.05	0.12	−0.87	−0.33	0.13	0.25	15.66
	Training time	0.03	0.07	0.45	−0.11	0.17		
	Partner time	0.18	0.07	2.98**	0.07	0.35		
	Athletic ability	0.25	0.12	4.23***	0.26	0.72		
	ET	0.35	0.06	5.81***	0.23	0.47		
AE	Gender	−0.12	0.12	−2.03*	−0.47	−0.01	0.20	11.77
	Training time	−0.05	0.07	−0.74	−0.19	0.09		
	Partner time	−0.02	0.07	−0.25	−0.16	0.12		
	Athletic ability	0.16	0.12	2.65**	0.08	0.55		
	ET	0.41	0.06	6.54***	0.28	0.53		
CP	Gender	−0.02	0.11	−0.42	−0.27	0.18	0.29	15.75
	Training time	0.04	0.07	0.62	−0.09	0.18		
	Partner time	0.18	0.07	3.11**	0.08	0.35		
	Athletic ability	0.21	0.12	3.67***	0.20	0.65		
	ET	0.26	0.06	4.09***	0.14	0.39		
	AE	0.22	0.06	3.52**	0.10	0.34		

* indicates $p < 0.05$; **, $p < 0.01$; and ***, $p < 0.001$. CP: competitive performance; AE: athlete engagement; and ET: expressive ties.

hypothesis of economic man. Moreover, it also contradicts the theory of group dynamics, which holds that a harmonious interpersonal atmosphere within a group can stimulate the creation of excellent competitive performance in a sports team. For dance dyads, their partnership is premised on meeting specific needs and achieving competitive goals. The reason may lie in special norms inherent in Chinese culture relating to instrumental relationships, which weaken the utilitarian purpose and pay more attention to "renqing" and "mianzi" (Hwang, 1987). Establishing and maintaining interpersonal relationships is to maintain an interpersonal relationship that is different from other partnerships that emphasize mission and work completion, and the latter is covered under the principle of "contractual obligations." For Chinese dancers, showing utilitarian tendencies in their interpersonal relationships with their partners is not supported by "renqing" and "mianzi" and can even undermine the stability of partnerships, the quality of athlete engagement, and their impact on

TABLE 5 Results of the mediating effects of athlete engagement between interpersonal perception and competitive performance.

Dependent variable	Independent variable	β	SE	*t*	95% Bootstrap CL		R^2	*F*
					LLCI	ULCI		
CP	Gender	−0.06	0.12	−1.07	−0.35	0.10	0.24	14.95
	Training time	0.01	0.07	0.22	−0.12	0.15		
	Partner time	0.18	0.07	2.95**	0.07	0.35		
	Athletic ability	0.23	0.12	4.02***	0.24	0.69		
	IP	0.34	0.06	5.54***	0.22	0.46		
AE	Gender	−0.14	0.12	−2.32*	−0.52	−0.04	0.16	9.18
	Training time	−0.05	0.07	−0.82	−0.21	0.09		
	Partner time	−0.01	0.07	−0.15	−0.16	0.14		
	Athletic ability	0.14	0.12	2.30*	0.041	0.52		
	IP	0.35	0.06	5.53***	0.226	0.48		
CP	Gender	−0.03	0.11	−0.52	−0.28	0.16	0.29	15.69
	Training time	0.03	0.07	0.43	−0.11	0.16		
	Partner time	0.18	0.07	3.08**	0.08	0.35		
	Athletic ability	0.20	0.11	3.51**	0.18	0.62		
	IP	0.25	0.06	4.05***	0.13	0.38		
	AE	0.23	0.06	3.87***	0.11	0.35		

* indicates $p < 0.05$; **, $p < 0.01$; and ***, $p < 0.001$. CP: competitive performance; AE: athlete engagement; and IP: interpersonal perception.

performance outcomes. In a previous study, when interviewed by our first author, a DanceSport champion said, "We are like a business relationship," embarrassing his partner on the spot. The partnership later broke apart, with each of them finding new partners (Liu et al., 2023). During follow-up interviews aimed at understanding the reason for the partner splitting, it was found that the interpersonal relationship was also filled with a more exposed utilitarian purpose. Therefore, the study holds that instrumental ties should foreground the Chinese "obligatory" principle, such as "renqing" and "mianzi," that considers partnership as not only a tool to achieve personal goals but also to maintain and develop partnerships. By maintaining the partnership between dance couples, dancers can promote each other's dedication, enthusiasm, and confidence and promote athlete engagement. In this way, obligatory instrumental ties can promote performance results.

4.2. Athlete engagement partially mediates the association between expressive ties and competitive performance

Our results indicate that athlete engagement partially mediates the association between expressive ties and competitive performance (H2). This finding demonstrates that expressive ties and athlete engagement are critical factors influencing individuals' competitive performance, which also reaffirms findings under relevant literature (Julia, 2011, pp. xii-46; Majoross et al., 2008). On the one hand, instant intimacy—a vital element of expressive ties referred to as a short-duration passionate state of desire formed between dance partners in the competition context—can showcase romantic sexual relationships and give a good impression to the judges. The reason may be that the inferior parietal lobule of the human cerebral cortex, the Broca region before the ventral motor, and the posterior part of the inferior frontal gyrus have the "mapping" function of mirror neurons (Fogassi, 2011; Ye et al., 2016). This mapping function turns sexy movements such as intricately connected crotch, closely attracted eyes and breath, and passionate feelings into an emotional booster between the partners, transforming "interpretation" into "experience," at least a real experience on the court, potentially further enhancing the appeal and expressiveness of dance. In addition, the instant intimacy (e.g., passion) of the dancers deepens their immersion in the dance (Yang, 2016), which becomes the sufficient basis for judges to give "marks (scores)" (Tremayne and Ballinger, 2008). Based on the passionate movements, Peters (1992) points out that even dancers get confused by the desire expressed by partners on the dance floor and are surprised whether they are just a partner off the court.

On the other hand, expressive ties, including long-term affection, which requires the dancers to appreciate, care for, and be harmonious with their partners, refers to an emotional tie generated in long-time interactions in life and professional contexts between dance partners. According to Krivonos et al.'s (1976) research on the social-psychological attributes of interpersonal relationships between two people shows that, if dancers like each other, they will perform better. The care, appreciation, and other emotions formed by the long time of the dance partners will help them to complete the competition routine of showing the intimate partnership among the sexes with a more open mind, help stimulate positive feelings, and promote the dancers' athlete engagement and competitive performance.

4.3. Athlete engagement partially mediates the association between interpersonal perception and competitive performance

Our results indicate that athlete engagement partially mediates the association between interpersonal perception and competitive performance (H3). This finding demonstrates that interpersonal

perception between DanceSport couples and athlete engagement is a critical factor that influences individuals' competitive performance. This finding is not only proven under SDT and its applied research but is also supported by many psychological theories. According to Kang and Bodenhausen (2015), all dyadic relationships begin with a personal perception process in which both parties participate. The satisfaction of the dancers' sense of partnership helps in motivating self-determination, thus promoting athlete engagement and competitive performance. In addition, individuals can predict their future behavior by understanding others in interpersonal interactions. Increased communication and understanding between dance partners, tolerance toward each other, and offering more encouragement and confidence to dance partners in difficult situations are important means to improve tacit cooperation (Majoross et al., 2008).

Social exchange theory and Pavlov's dynamic stereotype theory also support our results. To be more specific, according to social exchange theory, when dancers perceive that their sense of unfamiliarity with their partners has diminished and instead perceive sincere and expressive ties between them, they tend to communicate in a more friendly manner, often displaying positive emotional tendencies. This can lead to behaviors that are beneficial for achieving their desired goals. On the contrary, the performance (such as persistence and success) of athletes can be affected if the partnership is belittled or ignored (e.g., coach-athlete relationship) (Isoahola, 1995). Therefore, DanceSport partners can promote the satisfaction of interpersonal perception by being open with each other by engaging with and treating each other sincerely, stimulating the cooperative behavior of continuous cooperation and effort. Likewise, according to Pavlov's dynamic stereotype theory, after repeated practice, the dance movement can be shaped, and the excitement and inhibition of the cerebral cortex are more concentrated and accurate in time and space. It is not only helpful for accurate and beautiful movements but can also control and complete the movements unconsciously. So only when dancer partners reach a certain tacit understanding can they pay more attention to the overall artistic expression, which is the key to obtaining competitive performance (Majoross et al., 2008; Liu et al., 2023), often among elite dancers (Majoross et al., 2008). In addition, it needs to be emphasized that within Chinese culture, the state of mutual understanding, mutual benefit, and heart-to-heart connection is to ease the blurring of the "I-He" boundary of intimate relationships and inhibit the contradiction in the athletes' rational thinking and field theory that requires the athletes to rationally deal with emotional and cooperative issues to ensure effective training and improve competitive performance. To sum up, having a high degree of interpersonal perception leads to a better foundation for cooperation among dance couples, and it also promotes athlete engagement, resulting in excellent competitive performance.

5. Conclusion

This study found that based on relationship-related theories, such as SDT and Pavlov's dynamic stereotype theory, athlete engagement mediates the association between obligatory instrumental ties, expressive ties, interpersonal perception, and competitive performance. Among them, the intermediary effect of athlete engagement explains 100% of the variation of obligatory instrumental ties. It partially mediates between expressive ties, interpersonal perception, and competitive performance, respectively, with the upper and lower limits of the 95% confidence interval of the mediating effect being (0.036, 0.148) and (0.034, 0.138). The effect values of 0.088 and 0.082 accounted for 25.29 and 24.40% of the total effect. Overall, the results represent an attempt to extend our understanding of the mechanisms by which partnerships influence dancers' cognitive and psychological states.

In addition, the results apply to countries influenced by Confucian culture, such as South Korea and Japan, and apply to professional athletes rather than amateur athletes.

6. Strengths and limitations

The findings of this study should be considered in light of two strengths and two limitations. The two strengths include: 1) offering a path for transforming DanceSport partnerships into competitive performances and providing dancers with high-quality ideas for strengthening partnerships; 2) Further strengthening the scientific nature of the self-determination theory and providing evidence to enrich and improve the theory of self-determination to a certain extent. Nonetheless, due to the preliminary nature of our study, two limitations should also be noted. First, the sample comprised dance couples only from China. This has implications for the international generalizability of the study findings. Future research with diverse samples from other countries should be considered. Second, the sample size needs to be expanded further. Because of the need to control as much as possible the influence of referees, lighting, venues, and other factors on the results of the study, we obtained data from a single match. However, it is difficult to increase the sample size beyond 242 people in a single match. In the future, other methods need to be explored to compensate for the difficulty of expanding the sample size so as to avoid statistical bias in the study.

7. Future research directions

DanceSport couples are cognitively, emotionally, and behaviorally interdependent. However, the two have gender and individual differences, and how their psychology and behavior affect each other needs to be further studied. Our study suggests that, in the future, the actor-partner interdependence mediation model (methods of dyadic data analysis for interpersonal relationships between couples) can be used to further explore the relationship between partnerships, athlete engagement, and competitive performance. Thus, opinions can be provided to male and female dancers, respectively, to ensure excellent competitive performance.

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 humans were approved by the Ethics Committee of the Wuhan Sport University. The studies were conducted in accordance with the local legislation and institutional

requirements. The participants provided their written informed consent to participate in this study.

Author contributions

XL: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. BW: Conceptualization, Funding acquisition, Writing – original draft. XW: Funding acquisition, Methodology, Writing – review & editing. QS: Writing – review & editing.

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Conflict of interest

The authors declared 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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Values and physical activity among sports science students in France and China: a transcultural analysis

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Objective: The aim of this study was to analyze the relationships between values and physical activity in France (a Western European individualistic country) and in China (an East Asian collectivist country).

Method: Six hundred and twenty-seven sport science students in France ($N = 308$, $M_{age} = 18.99$, $SD = 1.64$) and China ($N = 319$, $M_{age} = 20.44$, $SD = 1.09$) completed the International Physical Activity Questionnaire long version and the Portrait Values Questionnaire.

Results: In both France and China, moderated regression analysis revealed that hedonism positively/negatively predicted physical activity, while security-societal, security-personal, and conformity-rules values negatively predicted physical activity. In contrast, stimulation and universalism-nature values positively predicted physical activity only in France. In China, benevolence and benevolence-care positively predicted physical activity, while power dominance negatively predicted physical activity. Additionally, we found evidence of measurement invariance of the value questionnaire.

Discussion and conclusion: Our findings add to the literature by showing that the value–behavior link is partly the same across countries and partly different. Further, our findings show that for certain populations, the previously established hierarchy of human values does not replicate.

KEYWORDS

human values, physical activity, cross-cultural research, France, China

Introduction

Values (e.g., freedom, pleasure) can be defined as abstract ideals that are important guiding principles in one's life (Schwartz, 1992; Sagiv and Roccas, 2021). Values motivate people over time and across situations (Schwartz, 1992; Maio, 2010; Arieli et al., 2020) and represent a central part of identity and self-concept (Verplanken and Holland, 2002; Maio, 2016). As such, values shape both individuals' current and future health-related behaviors. There is evidence that specific values relate to several everyday health-related behaviors such as smoking (Nieh et al., 2018), drinking alcohol (Inman et al., 2017; Rudnev and Vauclair, 2018), or drug-use (Sanchez et al., 2018; for an overview, see Hanel et al., 2022).

One important health-related behavior is engagement in physical activity. The latter can be defined as any bodily movement produced by skeletal muscles that requires energy expenditure and can be done at a variety of intensities and accumulated through work, domestic chores, transportation, or during leisure time, or when participating in sport, walking, cycling, active recreation, and active play (World Health Organization, 2022). Physical activity can be considered as a complex system of relationships affected by multiple levels of the surrounding environment, from immediate family and school settings to broad cultural values and customs (Lee and Park, 2021).

However, an understudied question is how values impact physical activities and whether this impact is invariant across cultures. Previous research suggests that the pattern might be different across countries. Culture can affect the specific behaviors that individuals spontaneously associate with a specific value (Hanel et al., 2017, 2018). We focus on human values as predictors, because they are the core of a culture (e.g., Sagiv and Schwartz, 2022) and they influence human behaviors (e.g., Maio, 2010; Sagiv and Roccas, 2021). Hence, it is conceivable that people attribute a different meaning to physical activities across countries and associate physical activity with different values across countries.

Focusing on sports science students in France and China, the aim of this study was consequently to establish which values predict physical activity in France (a West European individualistic country) and in China (an East Asians collectivist country), and whether these associations differ between countries.

Schwartz's model of values

Values are grounded in one or more of three universal requirements of human existence: the needs of individuals as biological organisms, requisites of coordinated social interaction, and survival and welfare needs of groups (Schwartz, 1992). Schwartz's (1992) model of values is considered to be one of the most important theoretical advances in the field of human values (Maio, 2016). Schwartz's (1992) model is central in psychology, but also in other disciplines such as philosophy, sociology, and anthropology (Maio, 2010). Its structure (Figure 1) has been supported in more than 100 countries (e.g., Schwartz et al., 2017; Sagiv and Schwartz, 2022).

Schwartz (1992) universally identified ten broader categories of values (see Supplementary Table S1) and organized these value types into a quasi-circumplex to highlight the dynamic relationships between them (Figure 1). Schwartz represents motivationally compatible values (e.g., stimulation and self-direction) adjacently in the model, while motivationally incompatible values are on opposite sides in the model (e.g., self-direction and security).

Moreover, the model (Figure 1) distinguishes between values conveying (1) openness to change: i.e., stimulation, self-direction, and hedonism; (2) conservation of the status quo: i.e., tradition, conformity, and security; (3) serving self-interests: i.e., power and achievement; and (4) transcendence of self-interests in the service of others: i.e., universalism and benevolence, all of which explain different variables such as behavior (e.g., Maio, 2016; Sagiv and Roccas, 2021).

More recently, Schwartz et al. (2012) proposed a refined model that divided the motivational quasi-circumplex from 10 into 19 value types. For example, security was divided into security-personal and security-societal, and conformity into conformity-interpersonal and conformity-rules. This was done to get a better understanding of the relations of values with other variables. For example, behavior that aimed to increase one's personal safety was as expected connected to security-personal, but not connected with security-societal (Schwartz and Butenko, 2014).

Research has shown that values predict emotional reactions (e.g., Conte et al., 2023), political orientation (e.g., Caprara et al., 2006), prejudice (e.g., Wolf et al., 2019), well-being (e.g., Sortheix and Schwartz, 2017), and a series of health behaviors (Rudnev and Vauclair, 2018). However, only four studies to our knowledge have tested the relationships between values and physical activity using Schwartz's (1992) model (Worsley et al., 2013; Souchon et al., 2015; Skimina et al., 2019, 2021).

Values and physical activity

In one of these studies, the aim was to analyze relationships between values and more general health behaviors (Worsley et al., 2013), while in two other studies, the aim was to test relationships between values and more general typical everyday behaviors (Skimina et al., 2019, 2021). This particularity explains why the authors in these three studies used a short measure of self-reported frequency of everyday behavior rather than a well-validated self-reported measure of physical activity.

Skimina et al. (2021) found that security and security-personal values were negatively related to physical activity, while stimulation was positively related to physical activity. In another study, Skimina et al. (2019) found that both security-personal and conformity-interpersonal were negatively related to physical activity. Finally, measuring only universalism and conformity values, Worsley et al. (2013) found a positive relationship between universalism and physical activity.

To the best of our knowledge, only one study tested the relationships between values and a well-validated self-reported measure of physical activity. Souchon et al. (2015) investigated the associations between a value measure, the PVQ-40, and the Godin Leisure Time Exercise Questionnaire (GLTEQ, Godin and Shephard, 1985). Results indicated that stimulation, hedonism, and achievement were positively related to physical activity, while tradition was negatively related to physical activity. These findings were consistent with Skimina et al.'s (2021) results on the role of stimulation values, but were less reliable for other values.

Moreover, none of the studies explored whether human values predict physical activity in China. Nevertheless, the relationships between values and behaviors are complex and research has shown that individuals in different cultures prototypically instantiate different behaviors to the same values. For example, security in Brazil is related to avoiding gunshots when walking in the street, while in United Kingdom, security is related to being able to finance higher education for children (Hanel et al., 2018; Coelho et al., 2022).

The present study

Our aim in this study was to establish if values predict physical activity in France and China in the same way or differently. The

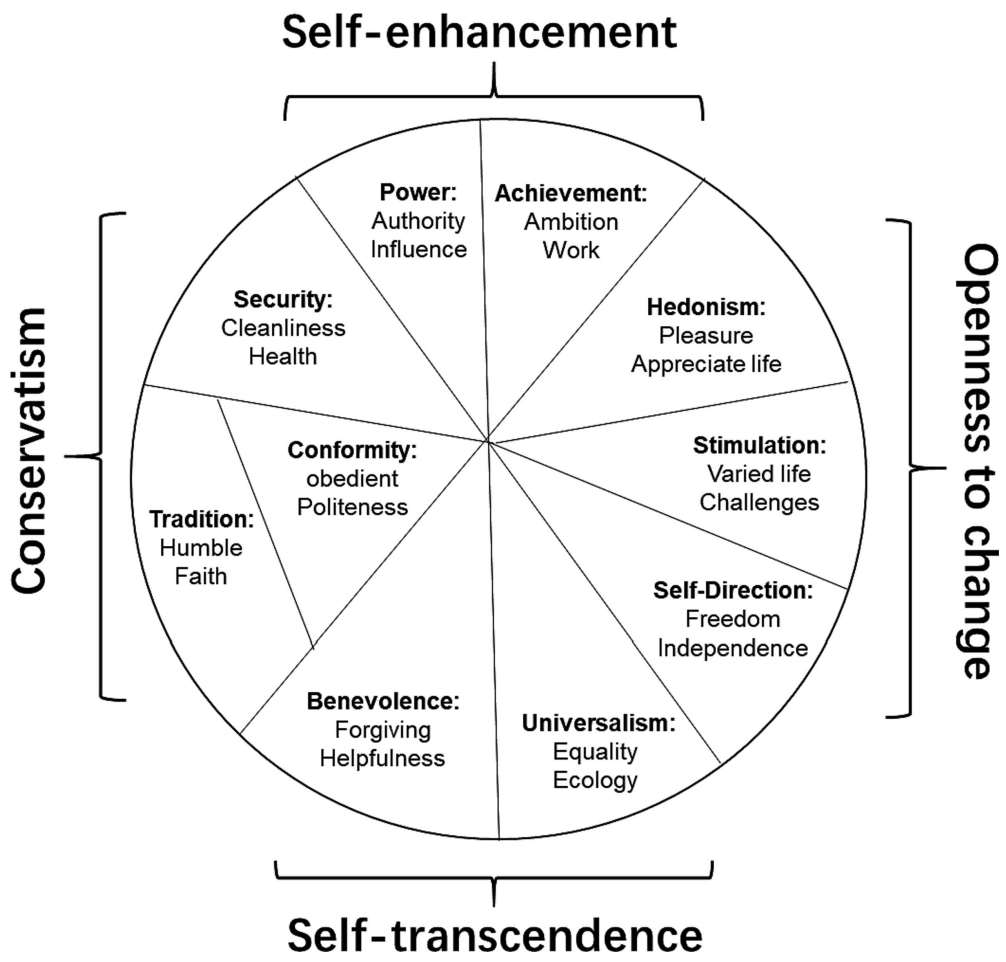

FIGURE 1
Schwartz's (1992) circumplex model of personal values displaying 10 value types (bold font) and examples of values in each type (normal font).

comparison between French participants and Chinese participants is particularly relevant as there is a remarkable social cognitive distinction in cultures. Western culture, particularly those influenced by European traditions, tend to emphasize individual freedom, autonomy, and personal achievement. In contrast, Eastern cultures, such as those found in Asia, place greater emphasis on collective harmony, familial ties, and societal obligations (Vignoles et al., 2016). A large amount of cross-culture studies have focused on the comparison across Western and Eastern cultures to better understand the similarities and diversity across two culture paradigms and foster a deeper understanding and appreciation of the global community (e.g., Honka et al., 2019; Ho et al., 2022). We expect the present study could reveal the similarities and/or diversity in the relationships between values and physical activity to provide further valuable suggestion to the physical activity promotion plans in China and France (World Health Organization, 2018).

For the participants, we focused on sports science students in France and China. The aim of sports science students is not to become professional athletes but to work in the general management of physical and sporting activities (e.g., teachers or working in health domain). This population has not been studied in research on values–physical activity relationships before. Sport science students have presumably a positive attitude toward physical activity and should often engage in it. Given that a high level of physical activity is desirable because it is associated with physical and mental health benefits, investigating predictors of physical activity in a population that routinely engage in it can have important policy implications.

Hypotheses in the present study

Openness to change

Openness to change values emphasize independence of thought, action, and feelings, and readiness for change (hedonism, self-direction, and stimulation). Souchon et al. (2015) and Skimina et al. (2021) found that hedonism (pleasure) and stimulation (excitement, novelty, and challenge in life) were positively associated with physical activity. These results suggest that pleasure, emotion, and challenges experienced during physical activity could be an important drive for people who value hedonism or stimulation. We expect to replicate those findings in France with sport science students.

However, compared to Western culture, the cultural tradition in China inclines to Daoism, which advocates the pursuit of a peaceful life rather than a stimulating one (no excess). Daoism emphasizes respect for life, nature, adaptation to changes, supplemented by appropriate moderate exercise (Li, 2015). From

the perspective of Daoism, we propose that stimulation does not significantly relate to physical activity in China. Finally, self-direction has shown a non-significant relationship to physical activity in previous studies (Souchon et al., 2015; Skimina et al., 2021). We expect no relationship between self-direction and physical activity in this study.

> *H1*: Hedonism and stimulation are positively associated with physical activity in France but not in China.

> *H2*: Self-direction is not significantly associated with physical activity in France and China.

Self-transcendence

Self-transcendence values emphasize concern for the welfare and interests of others (universalism and benevolence) in Schwartz's (1992) model. In the physical activity domain, Worsley et al. (2013) found in Australia a positive relationship between universalism and physical activity, but Souchon et al. (2015) in France and Skimina et al. (2019, 2021) in Polona did not find any associations. Consequently, we do not have clear expectations on the role of universalism in France.

In China, we speculate that an association between universalism and physical activity might exist, because one of the most important doctrines of Chinese thoughts, Confucianism, emphasizes Ren (仁), which is very similar to benevolence in Schwartz's (1992) model and which emphasizes the need to develop virtuous qualities through proper social engagement, such as to love parents, siblings, and the whole family, but also to share activities with others (Low, 2011; Ahmad et al., 2020). We therefore hypothesize that benevolence values are positively associated with physical activity, because participants are eager to integrate into society and involve more prosocial behavior.

> *H3*: Universalism and benevolence values are positively associated with physical activity in China.

Conservation values

Conservation emphasizes order, self-restriction, preservation of the past, and resistance to change (conformity, tradition, and security). In previous studies, conservation values were negatively related to physical activity. Especially, security-personal (Skimina et al., 2019), conformity-interpersonal (Skimina et al., 2021), and tradition were negatively related to physical activity (Souchon et al., 2015). Consequently, conservation values should be negatively related to physical activity in this research both in France and China.

This reasoning is further supported by Confucianism, which perceives the body as the medium of moral practice. Conformity and tradition are correlated with body ideology in tradition Daoism. Daoism emphasizes respect for life and adaptability to changes, supplemented by appropriate moderate exercise (Li, 2015). One of the functions of ritual training in body is to maintain the order of the superior and inferior in social order (Guan, 2022). Zuo and Wang proposed that the anchoring concepts "psyche is precious rather than body" and "advocate morality development rather than physical strength" have certain limitations and have even played a negative role in the development of Chinese sports (Zuo and Wang, 1998). Therefore, we hypothesize that the conservation values conformity, tradition, and security are negatively associated with physical activity in China.

> *H4*: Conservation values (including humility and face) are negatively related to physical activity both in France and China.

Self-enhancement

Self-enhancement is defined as the pursuit of one's own interests and relative success and dominance over others (achievement and power; Schwartz, 1992). Achievement is defined as personal success through demonstrating competence according to social standards. As the sporting context is an achievement area (Gröpel et al., 2016), achievement values may be related to a higher level of physical activity especially among sport science students because they tend to be passionate about sport and physical activity. This prediction is in line with previous research showing this within the general population in France (Souchon et al., 2015). Consequently, we expect that in France, achievement and physical activity are positively associated. However, since we are assuming that in China, benevolence values, which are opposed to achievement values in Schwartz's (1992) model, are positively associated with physical activity due to the cultural importance of Ren values, the association between achievement and benevolence will be non-significant.

Moreover, power value is defined as social status and prestige, control or dominance over people and resources. Although power values are motivationally compatible with achievement values which might positively predict physical activity, power values were found to be unrelated with physical activity in France (Souchon et al., 2015). Consequently, we expect no relationship between power and physical activity in France.

Finally, traditional Chinese culture emphasizes "self-cultivation, family management, state governance, and bringing peace to all under heaven" as the four terminal goals in life (Zhang, 2023). Self-cultivation is explained as the cultivation of mind, which advocates improving one's mental character through studying knowledge rather than body training (Li, 2015). Therefore, studying to pass the imperial examination was basically the only approach to enter the higher societal class in China (Ko, 2017), whereas excessive physical labor was regarded as a sign of the lower class in Chinese society (Lu, 2012). Hence, we postulate that Chinese participants who attach more importance to power tend to engage in less physical activity due to the idea that "psyche is more precious rather than body."

> *H5*: Achievement is positively associated with physical activity in France, but not in China.

> *H6*: Power is negatively associated with physical activity in China, but not in France.

The hypotheses are summarized in Table 1.

Method

Participants and procedure

A power analysis using G*Power 3.1.9.7 (Faul et al., 2009) revealed that to detect a small effect size of $f=0.15$ with a power of 0.95 and

TABLE 1 Hypothesis synthesis.

	H1: Hedonism and stimulation are positively associated with physical activity in France, but not in China *H2*: Self-direction does not significantly predict physical activity in France and China.
Openness to change	
Self-transcendence	*H3*: Universalism and benevolence are positively associated with physical activity in China.
Conservation	*H4*: Conservation values (including humility and face) are negatively related to physical activity both in France and in China
Self-enhancement	*H5*: Achievement is positively associated with physical activity in France, but not in China. *H6*: Power is negatively associated with physical activity in China, but not in France.

TABLE 2 Description of the sample.

	Sum (*N* = 627)		France (*N* = 308)		China (*N* = 319)	
	Male	Female	Male	Female	Male	Female
N	414	211	196	112	220	99
Age (SD)	19.88 (0.60)	19.73 (1.57)	19.05 (1.64)	18.89 (1.65)	20.61 (1.14)	20.07 (0.88)
BMI (SD)	22.35 (2.38)	21.95 (2.38)	22.13 (2.39)	21.65 (2.38)	22.55 (2.16)	20.61 (2.25)

$\alpha = 0.05$ in a $2 \times 2 \times 2$ between-subjects design, a total sample size of 580 is required. While previous research (e.g., Worsley et al., 2013; Skimina et al., 2019) found small and medium effect sizes, we assumed a small effect size to be conservative. Six hundred and twenty-seven sport science students completed the study individually in France and in China. The study included two hundred and eleven women and four hundred and fourteen men in France and China (see Supplementary material for more information). Table 2 describes the sample in France and China.

Participants provided informed consent prior to completing the pen-and-paper questionnaire in Chinese or French in class before lectures in a sport science department. Participants were informed that participation was voluntarily and they were able to drop out at any point. All procedures performed in our studies were in accordance with the ethical standards of the 1964 Helsinki declaration and its later amendments, and also in line with the American Psychological Association (2017) and the British Psychological Society (2009). Moreover, the present study received ethical approval by the University Committee on Human Research Protection of East China Normal University (HR 725–2021). The data can be found online on https://osf.io/kjz5d/?view_only=c9fef240a011443abaad89a235023483.

Measures

Values

In France and in China, participants first completed the PVQ-RR-57 (Portrait Values Questionnaire refined model; Schwartz et al., 2017), which we downloaded from the Schwartz's repository of value instruments[1], the official website of the Schwartz Value Questionnaire. The PVQ-RR-57 has been validated both in France and in China (Schwartz and Cieciuch, 2022). It measures each of the 19 value types with three items. Each question refers to a portrait of an individual that participants are asked to identify with by responding from 1 (not at all like me) to 6 (very much like me). For example, the items that measure the importance male participants attach to self-direction-thought are: "It is important to him to form his views independently," "It is important to him to develop his own opinions," and "It is important to him to figure things out himself." The 57 items can be combined into four higher order values, 10 basic values, or 19 narrowly refined values.

Self-reported physical activity behavior

To measure physical activity, we used the well-validated International Physical Activity Questionnaire long version (IPAQ-L) which has been successfully used cross-culturally (Bauman et al., 2009) and also been validated in French by Crinière et al. (2011) and in Chinese by Fan et al. (2014).

The IPAQ-Long version contains 27 items and examines four PA domains (job-related, transportation, domestic, and leisure). The results can be described as a continuous score, by domain, and by intensity of PA (moderate or vigorous). PA is found according to the following formula (in MET-min-week): the number of days making physical activity X mean duration of the activity per day X the energy cost of the activity. The energy cost of an activity is expressed in METs (the metabolic equivalent of task).

MET is the ratio of the energy expenditure during a given activity divided by the resting energy expenditure. The following MET values were drawn from the scoring protocol: 3.3 for walking, 4 for moderate intensity PA, 8.0 for vigorous PA, 6.0 for cycling, 5.5 for vigorous PA in a garden or yard, and 3.0 for domestic activities (IPAQ group, 2005).

Data cleaning and analysis

Following best practice recommendations, participants who responded more than 45 times with the same response option or had more than 28 missing values were excluded (Schwartz, 2021). Twelve French participants and 13 Chinese participants were excluded, leaving 308 French participants and 319 Chinese participants. Analyses were conducted using STATISTICA 13.0 and SPSS 24.0 software IBM Corp (2016). IBM SPSS Statistics for Windows, Version 24.0. Armonk, New York: IBM Corp.

To test for configural, metric, and scaler invariance of the PVQ-RR in our sample, we used the simultaneous factor analysis framework (Schwartz et al., 2012, see analysis in Supplementary Material).

1 https://scholarworks.gvsu.edu/orpc/vol2/iss2/9/

Reliability

We used Cronbach's alpha to report the internal reliability for the 19 narrowly defined values, 10 broader values, and four higher order values in France and in China. Since some of the 19 value types are broad, some Cronbach's alphas were below 0.60 (Graham et al., 2011). This is in line with the literature (e.g., Schwartz et al., 2012). In contrast, the internal reliabilities of all four higher order value types were satisfactory. They ranged from 0.75 to 0.84 in France and 0.76 to 0.87 in China (see the confirmatory factor analysis, measurement invariance, and fit of the 19 values to the circular structure in the Supplementary Material).

Other statistical analysis

We analyzed global physical activity and mean values with mixed ANOVAs and we analyzed the relationships between values and global physical activity with moderated regression analysis (see in Supplementary Tables S8–S13 the interrelations between four values, 10 values, 19 values and in Supplementary Table S14, the interrelations between values and physical activity in the four specific domains). Specifically, we tested the relationships between values and physical activity using one single value type at a time. Following Schwartz's recommendations, we used values centered on a person level within the ANOVA and within the regressions.

Moreover, we tested in simple regressions whether gender, $\beta = 0.08$, $p < 0.05$ (women −0.5 and men +0.5), age, $\beta = -0.10$, $p < 0.01$, BMI (weight: kg /height: meters^2), $\beta = 0.06$, $p = 0.141$, country (France +0.5 and China −0.5), $\beta = 0.16$, $p < 0.001$, and competition level (coded 0 "leisure time," 1 "low local level," 2 "high local level," "3 low intermediate level," 4 "high intermediate level," "5 low national level," 6 "high national level" and "7 international level"), $\beta = 0.28$, $p < 0.001$, predicted global physical activity. As the results were significant for gender, age, country, and competition level, we tested in multiple regressions whether the effects obtained in the main analyses remained significant after controlling for the impact of these variables.

Results

Descriptive statistics

Global physical activity was analyzed with a 2 × 2 × 2 between-subjects ANOVA, with country (France vs. China), gender (men vs. women), and competition statement (competition vs. leisure) as factors. The adjusted R^2 was 0.096, and the model was significant, $F(7,619) = 10.50$, $p < 0.001$.

The results indicated a marginally significant main effect of country, $F(1,619) = 3.41$, $p = 0.065$, $\eta^2 = 0.005$, a significant main effect of gender, $F(1,619) = 4.87$, $p = 0.027$, $\eta^2 = 0.027$, a significant main effect of competition, $F(1,619) = 32.08$, $p < 0.001$, $\eta^2 = 0.049$, and a significant two-way interaction between country and competition, $F(1,619) = 11.71$, $p < 0.001$, $\eta^2 = 0.018$.

The marginally significant main effect of country suggested that participants in France ($M_{France} = 9432.21$, $SD = 6311.27$) were slightly more physically active than participants in China ($M_{China} = 7312.88$, $SD = 6600.96$). The significant main effect of gender revealed that men ($M_{men} = 8749.57$, $SD = 7024.16$) were more physically active than women ($M_{women} = 7573.96$, $SD = 5398.10$). The significant main effect of competition indicated that participants who took part in competition ($M_{men} = 10210.63$, $SD = 7071.50$) were more physically active than participants who did not take part in competition ($M_{men} = 6661.44$, $SD = 5506.81$). The interaction between country and competition showed that participants who took part in competition in France ($M = 10027.32$, $SD = 6765.11$) and in China ($M = 10569.98$, $SD = 7659.04$) had a similar level of physical activity, $p = 0.465$, while participants who did not take part in competition were more physically active in France ($M = 8361.03$, $SD = 5260.28$) than in China ($M = 5803.86$, $SD = 5440.12$, $p < 0.001$).

Regression analysis

Higher order values and physical activity in France and in China.

Supplementary Table S5 describes the regression analysis made for testing whether higher order values, controlling for the influence of gender (coded −0.05 for female and + 0.05 for male), age, country (coded a − 0.05 for France and + 0.05 for China), and competition level (from 0 "leisure" to 7 "international competition level"), predict global physical activity.

The results indicate that only openness to change values predicted global physical activity across the two samples from France and China ($B = 0.12$, $p = 0.002$). This effect remained significant even after controlling for the influence of gender, $B = 0.10$, $p = 0.009$, age, $B = 0.00$, $p = 0.992$, country, $B = 0.04$, $p = 0.305$, and competition level, $B = 0.26$, $p < 0.001$, $R^2 = 0.106$, $F(5,621) = 15.87$, $p < 0.001$.

Ten broader categories of values and physical activity in France and in China

Tables 3–5 present significant regression analyses (see the non-significant regression analysis in Supplementary Tables S6, S7) testing how the single-value categories predict global physical activity, controlling for the influence of gender, BMI, age, country, and competition level.

Specifically, there was a simple effect of hedonism values. This effect remained significant after controlling for gender, age, country, and competition level (Table 3). There was a significant interaction between stimulation values and country in the prediction of global physical activity (Table 3): stimulation values positively predicted global physical activity in France, but not in China, after controlling for gender, age, and competition level. There was also a significant interaction for self-direction action in predicting global physical activity. Nevertheless, the self-direction action values did not remain significant both in France and in China after controlling for age, gender, and competition level.

Moreover, there was a significant interaction between univer-salism nature and country in the prediction of global physical activity (Table 4). After controlling in France and in China for the influence of gender, age, and competition level, univer-salism nature positively predicted global physical activity in France but not in China. Also, there was a significant interaction between benevolence values and country in predicting global physical activity (see Table 4). Benevolence values positively predicted global physical activity in China but not in France after controlling for gender, age, and competition level. Specifically, there was a significant interaction between benevolence care and country. After controlling for gender, age, and competition level, benevolence care positively predicted

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TABLE 3 Results of moderated regressions for hedonism, stimulation, and self-direction values with country as the moderator in predicting global physical activity.

		Global physical activity		
		T	*p*	*B*
Hedonism	$R^2 = 0.047$, $F(3,623) = 11.29$, $p < 0.001$			
	Hedonism	1.94	0.052	0.08
	Country	2.91	0.003	0.12
	Hedonism X country	0.94	0.346	0.03
	$R^2 = 0.097$, $F(5,621) = 14.55$, $p < 0.001$			
	Gender	2.58	0.010	0.10
	Age	0.16	0.871	0.007
	Country	−1.44	0.148	0.06
	Competition level	6.57	<0.001	0.26
	Hedonism	1.79	0.073	0.07
Stimulation	$R^2 = 0.047$, $F(3,623) = 11.29$, $p < 0.001$			
	Stimulation	3.32	0.006	0.11
	Country	2.75	<0.001	0.13
	Stimulation X country	2.62	0.008	0.10
France	$R^2 = 0.123$, $F(4,303) = 11.81$, $p < 0.001$			
	Gender	2.53	0.011	0.13
	Age	1.55	0.121	0.08
	Competition level	4.50	<0.001	0.24
	Stimulation	4.86	<0.001	0.26
China	$R^2 = 0.099$, $F(4,314) = 9.75$, $p < 0.001$			
	Gender	2.02	0.043	0.11
	Age	−1.98	0.047	−0.11
	Competition level	5.38	<0.001	0.29
	Stimulation	0.51	0.611	0.03
Self-direction-action	$R^2 = 0.028$, $F(3,623) = 7.13$, $p < 0.001$			
	Self-direction-action	−0.19	0.841	−0.01
	Country	4.11	<0.001	0.16
	Self-direction-action X country	−2.03	0.042	−0.08
France $R^2 = 0.061$, $F(4,303) = 6.03$, $p < 0.001$				
	Gender	2.09	0.036	0.11
	Age	1.50	0.133	0.08
	Competition level	3.89	<0.001	0.22
	Self-direction-action	−1.44	0.149	−0.08
China $R^2 = 0.099$, $F(4,314) = 9.77$, $p < 0.001$				
	Gender	2.00	0.046	0.11
	Age	−1.96	0.050	−0.11
	Competition level	5.25	<0.001	0.28
	Self-direction-action	0.55	0.580	0.03

Gender: −0.05 for women and + 0.05 for men, Country: −0.05 for France and + 0.05 for China.

global physical activity in China but not in France, albeit the effect was only marginally significant.

Finally, Table 5 shows significant simple effects and/or significant interaction effects for conformity-rules, security, security personal, and power-dominance. Conformity-rules and security negatively predicted global physical activity across countries after controlling for gender, age, country, and competition level. Also, there was a significant interaction between security personal values

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TABLE 4 Results of moderated regressions for universalism-nature, benevolence, and benevolence-care values with country as the moderator in predicting global physical activity.

		Global physical activity		
		T	*p*	*B*
Universalism-nature	$R^2 = 0.030$, F (3,623) = 7.62, $p < 0.001$			
	Universalism-nature	−0.15	0.875	0.00
	Country	4.11	<0.001	0.16
	Universalism-nature X country	2.40	0.016	0.10
France	$R^2 = 0.074$, F (4,303) = 7.20, $p < 0.001$			
	Gender	2.24	0.025	0.12
	Age	1.56	0.118	0.08
	Competition level	4.37	<0.001	0.25
	Universalism-nature	2.53	0.011	0.14
China	$R^2 = 0.100$, F (4,314) = 9.85, $p < 0.001$			
	Gender	1.76	0.079	0.10
	Age	−1.89	0.058	−0.10
	Competition level	5.28	<0.001	0.29
	Universalism-nature	−0.77	0.438	−0.04
Benevolence	$R^2 = 0.038$, F (3,623) = 9.35, $p < 0.001$			
	Benevolence	0.88	0.375	0.04
	Country	3.27	0.001	0.04
	Benevolence X country	−3.25	0.001	−0.13
France	$R^2 = 0.051$, F (4,291) = 4.98, $p < 0.001$			
	Gender	1.85	0.064	0.10
	Age	1.14	0.255	0.06
	Competition level	3.77	<0.001	0.22
	Benevolence	−1.10	0.269	−0.06
China	$R^2 = 0.109$, F (4,314) = 10.76, $p < 0.001$			
	Gender	2.12	0.034	0.11
	Age	−1.85	0.064	−0.10
	Competition level	5.02	<0.001	0.27
	Benevolence	1.96	0.050	0.11
Benevolence-care	$R^2 = 0.033$, F (3,623) = 8.14, $p < 0.001$			
	Benevolence-care	1.10	0.269	0.04
	Country	3.74	<0.001	0.15
	Benevolence-care X country	−2.61	0.009	−0.10
France	$R^2 = 0.058$, F (4,303) = 5.73, $p < 0.001$			
	Gender	2.05	0.040	0.11
	Age	1.28	0.198	0.07
	Competition level	4.05	<0.001	0.23
	Benevolence-care	−0.99	0.322	−0.05
China	$R^2 = 0.107$, F (4,314) = 10.55, $p < 0.001$			
	Gender	2.10	0.036	0.11
	Age	−1.83	0.067	−0.10
	Competition level	5.14	<0.001	0.28
	Benevolence care	1.76	0.078	0.09

Gender: −0.05 for women and + 0.05 for men, Country: −0.05 for France and + 0.05 for China.

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TABLE 5 Results of moderated regressions for conformity-rules, security, security-personal, and power-dominance values with country as the moderator in predicting global physical activity.

		Global physical activity		
		T	*p*	*B*
Conformity-rules	$R^2 = 0.029$, $F(3,623) = 7.41$, $p < 0.001$			
	Conformity-rules	−1.74	0.080	−0.07
	Country	3.19	0.001	0.13
	Conformity-rules X country	−0.81	0.414	−0.03
	$R^2 = 0.100$, $F(5,621) = 14.97$, $p < 0.001$			
	Gender	2.43	0.015	0.09
	Age	−0.04	0.967	−0.01
	Country	1.33	0.181	0.06
	Competition level	6.68	<0.001	0.27
	Conformity-rules	−2.25	0.024	−0.09
Security	$R^2 = 0.033$, $F(3,623) = 8.26$, $p < 0.001$			
	Security	−1.75	0.078	−0.07
	Country	3.49	<0.001	0.18
	Security X country	−1.33	0.180	−0.07
	$R^2 = 0.100$, $F(5,621) = 14.92$, $p < 0.001$			
	Gender	2.33	0.019	0.09
	Age	−0.03	0.975	−0.01
	Country	−1.64	0.101	0.07
	Competition level	6.59	<0.001	0.26
	Security	−2.21	0.027	−0.09
Security-personal	$R^2 = 0.043$, $F(3,623) = 10.57$, $p < 0.001$			
	Security-personal	−1.62	0.103	−0.06
	Country	3.79	<0.001	0.15
	Security-personal X country	−2.83	0.004	−0.11
France	$R^2 = 0.089$, $F(4,303) = 8.49$, $p < 0.001$			
	Gender	1.46	0.144	0.08
	Age	1.17	0.242	0.06
	Competition level	3.96	<0.001	0.22
	Security-personal	−3.35	<0.001	−0.19
China	$R^2 = 0.099$, $F(4,314) = 9.74$, $p < 0.001$			
	Gender	2.05	0.041	0.11
	Age	−1.91	0.056	−0.10
	Competition level	5.33	<0.001	0.29
	Security-personal	0.46	0.639	0.025
Power-dominance	$R^2 = 0.038$, $F(3,623) = 9.41$, $p < 0.001$			
	Power-dominance	−1.52	0.128	−0.06
	Country	3.10	0.001	0.13
	Power-dominance X country	3.16	0.001	0.12
France	$R^2 = 0.055$, $F(4,303) = 5.52$, $p < 0.001$			
	Gender	2.04	0.041	0.11
	Age	1.29	0.194	0.07
	Competition level	3.97	<0.001	0.23
	Power-dominance	0.45	0.648	0.02

(Continued)

TABLE 5 (Continued)

		Global physical activity		
		T	*p*	*B*
China	$R^2 = 0.125$, $F(4,314) = 12.40$, $p < 0.001$			
	Gender	2.47	0.013	0.13
	Age	−1.92	0.055	−0.10
	Competition level	5.29	<0.001	0.28
	Power-dominance	−3.11	0.002	−0.16

Gender: −0.05 for women and + 0.05 for men, Country: −0.05 for France and + 0.05 for China.

and country. Security personal negatively predicted global physical activity after controlling for gender, age, and competition level in France, but not in China. There was a significant interaction term between power dominance and country for global physical activity. Power dominance negatively predicted global physical activity in China, but not in France, after controlling for gender, age, and competition level. Additional analyses, such as correlations between values and physical activity separately for each of the four domain and country, are reported in the Supplemental materials (e.g., Supplementary Table S13).

Discussion

Using sports science students as participants, our aim of this study was to establish if values predict physical activity in France and in China in the same way or differently. Our research adds to the literature because only very few studies have been undertaken on the relationships between values and physical activity previously (Worsley et al., 2013; Souchon et al., 2015; Skimina et al., 2019, 2021). All of these studies were conducted in Western countries and no study to our knowledge has been undertaken on the relationships between values and physical activity in China. Below, we discuss the findings in detail, as well as limitations and future directions.

Openness to change and physical activity

Our first hypothesis was that hedonism and stimulation are positively associated with physical activity in France, but not in China. Our results tended to validate this hypothesis as hedonism predicted marginally positively a greater level of physical activity across countries. Also, stimulation positively predicted a greater level of physical activity in France, but not in China. The relationships between hedonism and stimulation and physical activity in France were overall consistent with our expectations and previous research (Souchon et al., 2015; Skimina et al., 2019, 2021).

These results showing that hedonism and stimulation are related to physical activity in France add to the literature showing that openness to change values predict antisocial and violent behaviors (e.g., delinquency) in real life (e.g., Benish-Weisman, 2015) or aggressive behaviors in sporting activities (e.g., Danioni and Barni, 2017). They also add to the literature showing that hedonism and stimulation are positively related to drinking behaviors (e.g., Rudnev and Vauclair, 2018) or internet consumption (Metin-Orta and Demirtepe-Saygili, 2021).

Interestingly, aggressive-antisocial behaviors, drinking behaviors, or internet consumption behaviors may all have, like physical activity, an addictive component (e.g., Rendi et al., 2007; Symons Downs et al., 2019). Someone may become dependent on physical activity as being dependent on being aggressive towards other people (e.g., fighting in a pub) due to dependency on physiological responses (e.g., searching for adrenaline or endorphin, Howard, 2011). An interesting question is why stimulation–hedonism did not relate to physical activity the same way in China.

Results have shown that a greater attachment to hedonism is marginally related to a greater level of physical activity across countries, but stimulation values are not related to physical activity in China. So, globally, hedonism–stimulation values are not related to physical activity in China. An explanation may be the importance attributed to Daoism in China. This cultural "conservation" principle emphasizes the importance of being in harmony with others, and reducing excessive exercise or avoiding aggressive body contact with others is the appropriate approach to practicing moral development in Confucianism (Li, 2015; Guan, 2022). Interestingly, our results indicated (see Supplementary Material) that French participants attached a higher importance to openness to change values than Chinese participants, while these latter attached more importance to conservation values, which is in line overall with previous research (e.g., Schwartz, 2006). Also, in the French sample hedonism values were the most important values, while security values were the most important values in the Chinese sample, albeit hedonism remained fairly important in China as well. This adds to the literature by showing that for young people who clearly like physical activity, the value hierarchy is somewhat different. Across 54 nations, Schwartz and Bardi (2001) found that for students, benevolence was most important, while hedonism ranked only in position 7 (out of 10). This suggests that there are some self-selection effects or socialization effects for sports science students (Bardi et al., 2014).

The simple fact that Chinese participants attached less importance to openness to change values does not explain intrinsically why stimulation values were not related to physical activity in China. A possibility is that physical activity in China would not be represented in memory as something fun, pleasant, and stimulating as it would in France. For example, Chinese individuals are the best players in table tennis in the world, but their very well-known method involves very hard work from a very young age (e.g., 8 h of training a day). The large number of players available all over the country presumably forces them to place less emphasis on the game's playful dimensions and instead focus on the competitive side (e.g., authoritarian coaching, strong conformity to the rules, etc.); while in Europe, the

hedonist–playful dimension of the game is seen as very important for motivating players over the long term (Lenartowicz, 2023). We therefore speculate that sport or physical activity is prototypically associated in memory in Europe with hedonism and stimulation, but not necessarily in China (Hanel et al., 2017, 2018). Previous research supports the notion that certain physical activities are differently perceived across countries. For example, cycling is perceived as tiresome and socially undesirable in China but as normative and even fashionable in Denmark (Bauman et al., 2009).

Our second hypothesis was that self-direction is not associated with physical activity in France and China. Our results validate this hypothesis as self-direction, self-direction action and thought, are not related to physical activity. This result is consistent with previous studies on the relationships between values and physical activity (e.g., Souchon et al., 2015). Interestingly, research has shown that attaching a greater importance to self-direction is related to a higher level of well-being (Sortheix and Schwartz, 2017). Also, people attaching greater important to self-direction and self-direction thought tend to be more academically successful (Vecchione and Schwartz, 2022). Nevertheless, self-direction is not related to physical activity. This is surprising as people attaching a greater xxx importance to self-direction and especially self-direction thought could better understand the importance of doing physical activity for their health or well-being.

Self-transcendence value and physical activity

Our third hypothesis was that universalism and benevolence are positively associated with physical activity in China. Our results do not support this hypothesis. Indeed, a greater attachment to benevolence values was associated with a higher level of physical activity in China, while universalism values were not related to physical activity in this country. Moreover, a greater attachment to univer-salism nature predicted a greater level of physical activity in France. These results are nonetheless very interesting.

Ren principles in traditional Chinese culture, very close to benevolence values, promote sharing activities with others and then acting collectively in opposition to individualistically. Moreover, in China, due to a rapid population expansion, doing physical activity is becoming increasingly difficult, leading individuals to share it (e.g., large Qi Gong event) more and more collectively (Day, 2016). This may explain why, in China, benevolence values could be prototypically associated in memory with physical activity (Hanel et al., 2017, 2018). Sharing physical activity with other would be part of the culture in China.

In France, Souchon et al. (2015) as well as Skimina et al. (2019, 2021) did not find any relationship between universalism and physical activity within their samples. Nevertheless, the relationship between universalism nature and physical activity in our sample is in agreement with a previous study undertaken in Australia in which the authors found that a greater attachment to universalism predicted a higher level of physical activity habits (Worsley et al., 2013). Universalism nature values are defined as preservation of the natural environment (Schwartz et al., 2012) and people who attach a high importance to universalism values may like being outside (e.g., de Groot and Steg, 2007). Universalism nature-oriented people may be motivated to run, ride, or walk outside to be part of nature or at least because they need to be outside.

Conservation value and physical activity

Our fourth hypothesis was that conservation values (including humility and face) are negatively related to physical activity both in France and in China. Our results tended to validate this hypothesis, as a greater attachment to conformity rules and security predicted a lower level of physical activity. Nevertheless, tradition, humility, and face were not related to physical activity. Also, a greater attachment to security personal predicted a lower level of physical activity in France, but not in China. These results are interesting and in agreement with previous studies undertaken on the relationships between values and physical activity (e.g., Souchon et al., 2015; Skimina et al., 2019).

Interestingly, at first glance, it appears surprising that security-personal negatively predicted physical activity, as health is part of security-personal values (Schwartz, 1992; Schwartz et al., 2012). Nevertheless, security-personal values are defined as the "Security of self and one's immediate environment" (Schwartz et al., 2012) and doing physical activity implies taking some risks. Cycling as a means of transport may be perceived to be dangerous, especially in big cities. Also, security value-oriented people may be afraid to walk, run, or ride in some areas of big cities (e.g., because they might fear to being hit by a car; Foster and Giles-Corti, 2008). Security-oriented people could also be reluctant to meet other people to do physical activity (fear of meeting new people) and may feel easily threatened.

Security personal values are adjacent in Schwartz et al.'s (2012) model to conformity-rules values, which are defined as "Compliance with rules, laws, and formal obligations." Our research also revealed that conformity-rules predicted a lower level of physical activity. In some circumstances, physical activity could violate conformity rules values. For example, the way people dress when running (or their nudity level) could be perceived to be socially inappropriate. Cycling in towns may also be perceived as inappropriate as it may be a problem for cars and road circulation in general. Understanding these processes may help politicians to better communicate with people who are valuing security to encourage them to be physically active (e.g., by emphasizing measures to be taken to improve safety for cyclists, if applicable).

Security-personal and conformity-rules values are "self-protection anxiety control values" with a social focus. They are directly in opposition in the Schwartz's model with stimulation–hedonism values which are "growth, self-expansion, and anxiety free" values with a personal focus. Schwartz et al. (2017) demonstrated that value-expressive behaviors, such as physical activity in our present research, are regularly not the product of a single value (e.g., stimulation). Rather, values on one side of the motivational structure (here stimulation and hedonism) promote them whereas values on the opposite side of the motivational structure prevent them (here conformity rules and security personal). Thus, behaviors are a product of value trade-offs. Finally, this is particularly interesting that conservation values were related to physical activity the same way in both France and China.

Self-enhancement value and physical activity

Our fifth hypothesis was that achievement is positively associated with physical activity in France, but not in China. Our results invalidated this hypothesis in France. Achievement was not related to physical activity both in France and China. In France, a possible

explanation may be related to the diversity of values pursued by sport science students. Indeed, sport science departments in France, but also in China, are not devoted to developing professional sportsmen or sportswomen. Students most often study to become teachers in national education institutions or health institutes like hospitals (e.g., teaching physical activity (PA) to patients with obesity). For example, in our French sport science sample, the most important values were hedonism and benevolence (see Supplementary Material). Consequently, it was not so surprising to find no relationship in our sample between achievement values and physical activity. Students could not strongly associate in memory physical activity (PA) with achievement values in a sport science department (e.g., Hanel et al., 2018) or think about achievement values (i.e., value states) when they did physical activity in a sport science department (Skimina et al., 2019). They may simply relate achievement values to simple success in academia (Vecchione and Schwartz, 2022). Also, a statistical analysis (see Supplementary Table S8) indicates that competition level status (playing a sport in competition vs. playing a sport not in competition) did not interact with achievement values to predict physical activity in France and in China.

Our sixth hypothesis was that power is negatively associated with physical activity in China, but not in France. Our results tended to validate this hypothesis, as a greater attachment to power dominance was related to a lower level of physical activity in China, but not in France. This result is interesting as power dominance is motivationally opposed to benevolence values in the Schwartz model, and the results indicate that benevolence and benevolence care values in China positively predict physical activity. These results are congruent with our expectations and are related to prior research showing that the self in China is more interdependent and harmonious (Markus and Kitayama, 1991; Fiske and Taylor, 2008). The findings suggest that Chinese sport students are less likely to express power-dominance by engaging in physical activity. It might be the case that people who are perceived as dominant are more reluctant to engage in physical activities because it could have a negative impact on how they are perceived by others. Globally, this result confirms that Chinese individuals could associate strongly in memory physical activity with benevolence values (Hanel et al., 2018).

Limitations and future directions

Several limitations of this work need to be mentioned. First, we did not measure objective but self-reported measures of physical activity, and participants tend to overestimate physical activity in self-reported measures (Nelson et al., 2019). However, as long as participants overestimated it to a similar extent, it does not threaten the validity of our findings. Previous research indicates that our measures are not impacted by socially desirable responding (Danioni and Barni, 2017), suggesting that our findings are probably not biased. Second, our participants were not representative of the whole populations both in France and in China, and we focused on sports science students. Consequently, the generalizability of the findings is limited. Future research with representative samples from France and China could add to the literature by also investigating whether our effects also generalize across a wider range of demographic groups (e.g., older participants and participants from different social backgrounds). Especially, following Skimina et al. (2019), it may be interesting in another study to understand the specific values (i.e., value states) participants have in mind when engaging in physical activity in the context of a sporting club. This may help to better understand the influence of achievement values (i.e., value traits) when engaging in physical activity in a competitive context.

Moreover, we did not focus on the gender impact on values–physical activity in this research. Future research can focus on how values may differently relate to physical activity according to gender. Crucially, it is important to explore what behaviors individuals in France and in China spontaneously associate with stimulation and benevolence values (e.g., Hanel et al., 2017). Finally, numerous studies have made use of the self-determination theory (Ryan and Deci, 2020) to understand physical activity (e.g., Teixeira et al., 2012). Recently, Vecchione and Schwartz (2022) have shown that values relate to autonomous and controlled forms of academic motivation to predict academic success. An interesting question and perspective for future research is to better understand how abstract values may relate to more specific forms of motivation (e.g., more or less autonomous or controlled) to predict physical activity.

Conclusion

We found that conservation values were associated negatively with physical activity in similar ways in France and in China. In contrast, openness to change values were positively related to physical activity in France, but not in China. Similarly, benevolence values were related positively to physical activity in China, but not in France. Finally, the role of universalism and achievement values both in France and in China remained unclear in this research. Future research with representative samples from France and in China could clarify those relations.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/Supplementary material.

Ethics statement

The studies involving humans were approved by the University Committee on Human Research Protection of East China Normal University (HR 725–2021). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

YL: Conceptualization, Data curation, Investigation, Software, Validation, Writing – original draft. OR: Investigation, Project administration, Supervision, Validation, Writing – review & editing. PH: Methodology, Supervision, Visualization, Writing – review & editing. JY: Supervision, Writing – review & editing. NS: Supervision,

Writing – review & editing, Conceptualization, Data curation, Formal analysis, Project administration, Software, Writing – original draft.

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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

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1304019/full#supplementary-material

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Comparison of force variables and dynamic strength index between age groups in elite young Brazilian football goalkeepers

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Introduction: The application of muscle force is a determinant of football success as it is inherent to the motor control and sport. The aims of this study are: (1) to describe force variables Isometric Maximal Force (IMF), Concentric Peak Force (CPPF), and Dynamic Strength Index (DSI) in football goalkeepers from different age groups; (2) to compare these variables' behavior between those groups.
Methods: The sample was formed by 19 youth players (15.97 ± 1.55 years old) from a first-division Brazilian football team. The CPPF and IMF variables were obtained through the Countermovement jump and isometric squat tests, respectively. For data collection, a force plate (Cefise, Brazil) was used with an acquisition frequency of 600 Hz and mono-axial. The DSI was calculated using the ratio between CPPF and IMF. For data analysis, the sample was separated into clusters by age. After the grouping, a descriptive analysis of the data and a comparison between the groups with $p < 0.05$.
Results: The sample was grouped into three groups (GA, GB, and GC) and one of the individuals did not enter the group, totaling 18 individuals in the analyzed sample. The comparison between the ages of the groups showed a significant difference and small and moderate effect size (ES), validating the cluster strategy. The CPPF and IMF variables showed increased values according to chronological age. CPPF showed a significant difference between GA-GB, (ES = very large) GA-GC (ES = very large), and GB-GC (ES = moderate). The IMF variable had significant differences between GA-GB (ES = moderate) and GA-GC (ES = very large). However, DSI showed significant differences only between GA GB (ES = small) and GB-GC (ES = very large).
Conclusions: The CPPF and IMF variables had constant increases and distinct values with an increase according to age, and this did not occur for DSI. The difference between CPPF and IMF compared to DSI bring to light the variability in dynamics and proportionality between muscular force in the concentric phase and maximal force in the isometric regime during the developmental process over chronological age in soccer goalkeepers.

KEYWORDS

youth, force, countermovement jump, goalkeeper, soccer

1 Introduction

The application of force is a determinant of football success as it is inherent to the motor activity required by the sport (accelerations, decelerations, changes of directions, etc.) (1, 2). In that regard, it is of uttermost value for goalkeepers, who explosively apply force to perform jumps, dives, and saves, hence influencing directly the outcome of matches (3, 4). Thus, the football goalkeeper presents characteristics related to strength, power, agility and power particular in relation to the other field positions. Specifically, quick reactions and agility are crucial for goalkeepers to make rapid movements and save shots effectively (5, 6). Goalkeepers need strength in their arms, legs, and core to generate powerful dives and clears. The ability to catch, parry, or punch the ball safely is a fundamental goalkeeping skill (7). Also, goalkeepers should be adept at stopping shots, whether they come from close range, long-range shots, or set-pieces, requiring an optimal footwork allows goalkeepers to position themselves correctly, move swiftly, and distribute the ball effectively getting the ball back in the right direction (7, 8). Additionally, the goalkeeper's tactical behavior requires a good game reading, decision making and position themselves optimally to cut down angles and be ready for shots in which agility, power and strength are key (7).

The development of explosive force depends on morpho-functional elements such as the increase in the transverse section of skeletal muscle, tendon stiffness, motor unit recruitment (1), and the kinetic and kinematic applied to the action itself (9). Thus, the training tasks should increase goalkeeper skills for fast decisions, direction changes, and movement on the pitch (10). Speed, agility, and response time are all essential characteristics in football, and training methodologies such as speed, agility, and quickness (SAQ) ttraining focuses on building the neuromuscular system to improve these skills (11, 12). The literature has been debating some biomechanical parameters that allow to evaluate concentric, isometric, and dynamic strength parameters because it can be difficult to determine if the trainning stimulus is in the right dose and direction for each age group or maturational (13, 14). Furthermore, explosive power stands out among the conditional and coordinated qualities that make up agility in goalkeeper position (10).

There are appropriate measurements to verify if the application of force is fit for the task. The Dynamic Strength Index (DSI) is a relationship between concentric peak power and isometric maximal strength (IMS) (15–17). The Concentric Phase Peak Force (CPPF) refers to the maximum force exerted by a muscle or group of muscles during the concentric phase of a dynamic movement. The concentric phase is the phase of muscular contraction where the muscle shortens, and it is typically associated with overcoming resistance or lifting a load (15). Additionally, the IMS refers to the maximum force that a muscle or group of muscles can generate during a static, or non-moving, contraction. The young football players often need to maintain stability or hold a specific position against resistance (16). Strength levels tend to increase with age as individuals go through puberty and experience physical development, where playing positions in football may have distinct strength requirements (17). The CPPF is measured through countermovement jumps and presents the force generated at the highest velocity, whereas IMS is measured through isometric half-squats and presents the maximal force generated employing a larger motor unit recruitment (16, 17). The information arising from these tests combined with DSI offers sports coaches and practitioners practical knowledge for elaborating interventions aiming at the improvement of strength-dependent capacities (18, 19).

Force platforms, dynamometers, or other force-measuring devices are commonly used to assess CPPF and IMS. Countermovement jump (CMJ), squat jump (SJ) and isometric squat tests allow for the assessment of players' lower limb strength and power (20, 21). CMJ involves the utilization of the stretch-shortening cycle (SSC), where the pre-stretching of muscles during the countermovement enhances the subsequent force production during the jump. In an SJ, the individual starts from a static squatting position with the knees flexed, and then jumps vertically without any countermovement (22).

However, biological development is a non-linear process that entails different paces of evolution for CPPF and IMS over time, thus affecting DSI itself throughout the chronological age of youth football goalkeepers (1, 23, 24). In this sense, it is of uttermost importance to understand the dynamics of each of these variables to prescribe more accurate hence effective training stimulus (25). Although there is a large amount of research showing distinct correlations between isometric and dynamic strength, less research has been done on how training affects the changes in each kind of strength (18, 19). Previous research showed a wide range in the difference between isometric and dynamic strength improvements. A strong evidence that isometric and dynamic strength represent separate neuromuscular domains (20). Specifically, the goalkeepers may have different strength demands compared to outfield players, however little is known about the normality values for DSI indexes in elite young Brazilian football goalkeepers. Thus, the aims of this study were: (1) to describe force variables IMS, CPPF and DSI in football goalkeepers from different age groups; (2) to compare these variables' behavior between those groups.

2 Methods

2.1 Sample

This study had a cross-sectional observational prospective design with descriptive and comparative purposes. The sample was formed by 19 academy players (age = 15.97 ± 1.55 years; height = 184.28 m ± 6.22; body mass = 74.94 ± 7.38 kg/m^2) from an elite Brazilian football club competing with its professional team in the highest national division as well as in continental tournaments. The study was conducted in accordance with the Declaration of Helsinki ethics guidelines and protocols

from the local Ethical Committee of University of São Caetano do Sul, Brazil.

2.2 Inclusion criteria

The sample was selected according to the following inclusion criteria: (i) athletes had to be goalkeepers between 13 and 20 years old; (ii) duly affiliated to their club through registration in the Brazilian Confederation of Football (CBF); (iii) young football players performed all data collection tests. Non-compliance with either inclusion criterion represented the subject's removal from the convenience sample.

2.3 Data collection

Data were collected between 8 and 11 AM (GMT -3 h) on two subsequent days. Football players from U17 and U20 were tested on the first day, whereas athletes from U14, U16, and U17 were tested the day after. All of them undertook a 48 h period of rest before the test. For data collection, for both the IMS variable and CPPF variable, a force plate (Cefise, Brazil) was used with an acquisition frequency of 600 Hz and monoaxial. In order to calculate body weight for the countermovement jump (CMJ) (vertical force averaged over one second), individuals were required to remain stationary for the first second of data collection (15, 16). With a minute of rest in between each trial, each subject completed three CMJ trials using their maximum effort. With their hands on their hips, the subjects were encouraged to execute the leaps as quickly and high as they could (15, 19). CPPF, IMS and DSI have been previously validated in youth football insights as critical force variables (18, 26).

2.4 Statistical procedures

Descriptive statistics, the Kolmogorov–Smirnov and Levene's test were used to assess the normality and homogeneity. Data are presented as the mean ± one standard deviation (SD). A cluster modeling was performed using single linkage for rescaled distance cluster combination, represented by a dendogram. Based on the similarities between a set of points or subjects, the k-means defines a centroid, or the mean of the cluster. To guarantee a logical comparison of data sets with various magnitudes and/or units, standardized z-scores were employed. To determine how many clusters should be kept for analysis, the elbow approach was applied (27). Additionally, a one-way analysis of variance (ANOVA) for repeated measures were tested to identify differences between age group with turkey's *post-hoc* tests for localized effects. The effect size index (eta square: η^2) was computed and interpreted as: (i) without effect if $0 < \eta^2 \leq 0.04$; (ii) minimum if $0.04 < \eta^2 \leq 0.25$; (iii) moderate if $0.25 < \eta^2 \leq 0.64$; and (iv) strong if $\eta^2 > 0.64$. For pairwise comparison, using the Tukey *post hocs*, the standardized effect sizes (ES) were calculated with Cohen's d, classified as: without effect if $d < 0.2$, moderate effect if $0.2 > d \geq 0.5$ and strong effect if $d > 0.5$. Statistical significance was set at $p < 0.05$ (28). All statistical analyses were conducted using SPSS for Windows Version 22.0 (SPSS Inc., Chicago, IL, USA) and Microsoft Excel® spreadsheet (Microsoft Corporation, U.S.).

3 Results

Figure 1 presented the distance cluster combination using a Single Linkage Dendrogram. The DSI of cluster A and B athletes (younger) occurs at the expense of a concentric peak force proportionally greater than the isometric peak force. Unlike the younger clusters (A and B), cluster C presents its DSI values because of a higher IMS proportional to the CPPF.

Table 1 showed the descriptive statistic for age, body mass, height, CPPF, IMS, and DSI from Clusters A, B, and C.

There are differences between the performance variables by age clusters ($F = 5.92$–53.38, $p < 0.001$ to $p < 0.05$, $\eta^2 = 0.72$ to 0.96) with significant pairwise on all variables. Pairwise comparison confirmed significant differences between three age groups with small to very large effect size (ES) ($d = 0.63$–5.79) (Table 2).

The evolution dynamics of the CPPF and IMS occur increasingly in the course of age, unlike the variable DSI (Figure 2).

4 Discussion

This study is the first to address DSI in a population of young athletes, that is, under 19 years of age, in the present study, in particular for goalkeepers. This is of great importance, as these are variables with precise acquisition as well as tools such as protocols. The main results of the study were: (1) The concentric action was statistically different between all groups; (2) peak isometric strength did not show statistical difference between groups B and C; (3) DSI appears as a non-linear variable between groups according to age group.

The force peak in the concentric action showed an incremental dynamic from groups A to B and from groups B to C, with moderate effect sizes or above. This demonstrates that over chronological age this variable behaves linearly and positively concerning the increase in the values obtained. This is largely explained by two points, the first being the natural increase in body mass and in particular muscle mass that occurs during adolescence as a result of biological maturation (15, 29, 30). The second point is the improvement of muscle function as force production through concentric action, both due to the training stimuli (31, 32) and the biological development arising from the increase in the hormone secretion rate (33–35).

The IMS showed a dynamic similar to the CPPF, however, the differences demonstrated were significant only between groups A and B as well as A and C, and the effect size between A and C was very large and between B and B moderate. A possible explanation for why the same dynamics did not occur concerning the significant differences in the IMS variable

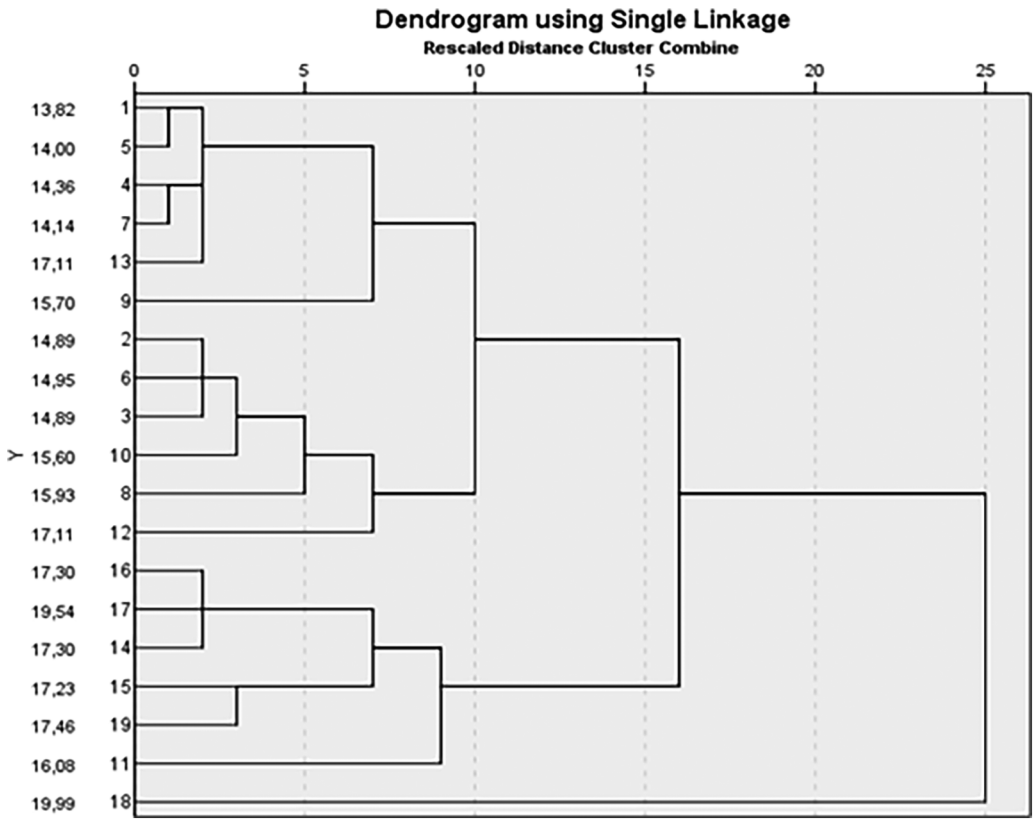

FIGURE 1
Dendrogram using Single Linkage for rescaled distance cluster combination.

compared to the CPPF variable is the ability to recruit muscle fibers and muscle tissue maturity. The application of maximum force, whether in an isometric form or any other regime of muscular contraction, demonstrates a very high dependence on the recruitment of muscular fibers (1, 36, 37). Thus, skeletal muscle tissue maturity occurs chronologically at a later stage and may not significantly interfere with this variable in which the recruitment of muscle fibers is a priority (1, 32).

TABLE 1 Age, body mass, height, concentric phase peak force, isometric maximal strength, and dynamic strength index from under 14 to under 20 soccer players.

Clusters		Age (years)	Body mass (Kg)	Height (cm)	Concentric phase peak force (*N*)	Isometric maximal strength (*N*)	DSI
Cluster A ($n = 6$)	Mean	14.86	66.53	178.67	1,431.60	1,845.24	0.78
	SD	1.29	3.94	6.68	63.36	149.25	0.09
	Min	13.82	61.00	166.0	1,371.64	1,715.29	0.65
	Max	17.11	71.20	186.0	1,550.84	2,114.41	0.90
Cluster B ($n = 6$)	Mean	15.56	77.80	187.83	1,773.98	2,111.45	0.85
	SD	0.88	3.78	3.55	98.61	203.45	0.11
	Min	14.89	72.50	183.0	1,610.08	1,863.83	0.68
	Max	17.11	88.20	192.0	1,872.37	2,369.51	0.98
Cluster C ($n = 6$)	Mean	17.48	80.50	186.33	1,965.65	2,972.61	0.66
	SD	1.13	4.87	4.03	142.02	231.15	0.04
	Min	16.09	75.00	180.0	1,830.78	2,692.20	0.60
	Max	19.54	88.20	192.0	2,174.34	3,336.60	0.70
Total ($n = 18$)	Mean	15.97	74.94	184.28	1,723.74	2,309.77	0.76
	SD	1.55	7.38	6.22	248.27	528.73	0.11
	Min	13.82	61.00	166.0	1,371.64	1,715.29	0.60
	Max	19.54	88.20	193.0	2,174.34	3,336.60	0.98

DSI, dynamic strength index; Max, maximum; SD, standard deviation.

TABLE 2 Significant peak force, isometric maximal strength, and dynamic strength index from under 14 to under 20 soccer players.

Variable	ANOVA				Pairwise comparison	
	M ± SD	F	*p*	η^2	*post hoc*	d Cohen
Age (years)	15.97 ± 1.55	8.99	0.003	0.96	A ↔ C* B ↔ C**	0.63 1.90
Body mass (Kg)	74.94 ± 7.38	5.92	0.013	0.90	A ↔ B* A ↔ C*	2.91 3.15
Height (cm)	184.28 ± 6.22	18.48	<0.001	0.72	A ↔ B* A ↔ C**	1.71 1.39
Concentric phase peak force (*N*)	1,723.74 ± 248.27	38.86	<0.001	0.91	A ↔ B* A ↔ C* B ↔ C**	4.13 4.86 1.57
Isometric maximal strength (*N*)	2,309.77 ± 528.73	53.38	<0.001	0.89	A ↔ B* A ↔ C*	1.49 5.79
DSI	0.76 ± 0.11	7.42	0.006	0.91	A ↔ B* B ↔ C**	0.70 2.30

Statistical differences were verified as: *$p < 0.001$; **$p < 0.05$.
DSI, dynamic strength index; M, mean; SD, standard deviation.

On the other hand, the DSI variable showed significant differences between groups A and B as well as between B and C, with the effect size between A and B being small and between B and C being very large. However, between the extreme groups A and C there was no such difference. It is known that DSI occurs due to a relationship between two variables that do not have the same morphofunctional dependencies. The CPPF occurs a lot because of the ability to produce force in the concentric action, which implies a morphological issue (18). On the other hand, IMS is primarily influenced by neural issues. Thus, fiber recruitment was stable between groups B and C as opposed to force production through concentric action (16).

Several collinear and multi-independent factors such as training history, skill level and the specific demands of the position can contribute to the variability of strength variables (DSI, CPPF and IMS) (38). Football player with a longer training experience within a regular and well-structured training programs tend to have better strength levels over time (16). Also, higher technical proficiency may be able to better translate their strength into sport-specific movements. Skilled young football often display more efficient neuromuscular coordination (39). Moreover, different playing positions in football have distinct physical demands (16). For example, defenders may benefit from isometric strength for physical challenges and stability, while forwards may require explosive strength for sprints and shots (16). However, the positional effect can be overlooked when reporting on young football players (40). However, the specificity of the goalkeeper position tends to differ from the other positional roles (8). This may partly explain the fact that CPPF and IMF variables had constant increases and distinct values with an increase according to age, whereas the DSI has not increased.

In the adult population, these variables can develop linearly and in parallel, however these adaptations of different natures (neural and morphological) occur asynchronously, that is, at different times in the young population (15, 19). Therefore, the DSI that is measured by a relationship between the two variables may show non-linear results of improvements. This observation resulting from the results presented points to the longitudinal follow-up of these variables to understand the cause-and-effect relationship in the performance of young athletes (41). In addition, the DSI is a variable that can be used as a reference for understanding training content needs after collections and over the years (18).

The practical applications of this study are as follows (8, 3): (1) stability and positioning: Isometric strength is crucial for goalkeepers to maintain stability and hold positions, especially when preparing for a shot or making a save. Developing IMF can contribute to improved body control and balance; (2) shot power: concentric strength is essential for explosive movements, such as diving to reach a ball or generating power in a throw or kick. Goalkeepers with higher CPPF may exhibit greater shot-stopping ability and efficiency in dynamic actions; (3) performance analysis: DSI, if used as a measure of dynamic force production, could be valuable for analyzing the goalkeeper's ability to generate force in real-game situations. This can aid in

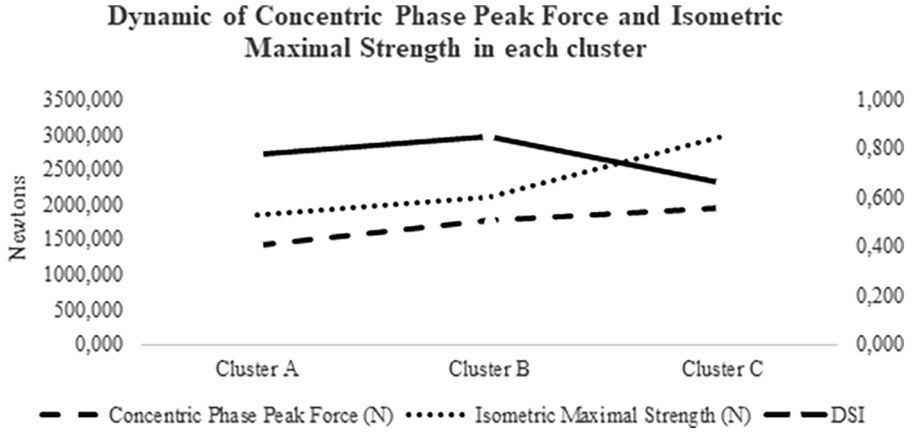

FIGURE 2
Dynamic evolution of concentric phase peak force and isometric maximal strength in each cluster group.

identifying strengths and areas for improvement in dynamic movements; (4) Integrated Training Programs that incorporates isometric and concentric strength training along with dynamic movements is beneficial. This can include exercises focusing on stability, power, agility, and reaction time; (5) Injury Prevention: understanding force variables can help identify potential muscular imbalances, allowing for targeted training to prevent injuries. Goalkeepers often engage in asymmetrical movements, and a balanced strength program can mitigate the risk of overuse injuries; (6) individualized Programs: Tailoring training programs based on assessments of IMF, CPPF, and DSI can help in creating individualized strength and conditioning plans. Periodic assessments can track progress and guide adjustments to the training regimen.

The present study brings the first analysis in the literature of the behavior of these variables in the young athlete population. This research has a prospective cross-sectional observational study design, which allows more hypotheses to be generated than tested. Furthermore, some methodological limitations should be considered when reading this article. Current training data reflect only Brazilian football goalkeepers and hence cannot be extended to other contexts. Hence, more analyses are required for this purpose, with a wider follow-up and comparing different competition level and age groups. In addition, it points to the importance of understanding the cause variables and not just looking at the outcome variables. Understanding the behavior for later use is an extremely positive point. For future studies, there is a need to include biological maturation as an adjustment variable to increasingly understand the behavior of force applications in young Brazilian football players. Also, the influence of plyometric training, SAQ or SSG strategies on the development of strength variables in young Brazilian football players should be studied from an intervention and clinical trial perspective, controlling for other variables such as the season phase (39), maturational variables (25) and the player's starting status (41).

5 Conclusions

The CPPF and IMF variables had constant increases and distinct values with an increase according to age, and this did not occur for DSI. The differences for DSI compared to CPPF and IMF bring to light the variability in dynamics and proportionality between muscular force in the concentric phase and maximal force in the isometric regime during the developmental process over chronological age in soccer goalkeepers.

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 humans were approved by University of São Caetano do Sul, Brazil. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

DL: Conceptualization, Formal analysis, Writing – original draft, Data curation. PJ: Methodology, Writing – review & editing. AD: Methodology, Writing – review & editing. GS: Conceptualization, Writing – review & editing. DM: Writing – review & editing. JT: Conceptualization, Formal analysis, Writing – original draft. LB: Writing – review & editing, Conceptualization. RF: Writing – review & editing. PF: Conceptualization, Writing – review & editing, Data curation, Formal analysis.

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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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Effects of golf instructors' professional certification levels on amateur golfers' perception of instructor expertise, instructor credibility, and lesson participation intention: testing placebo and nocebo effects

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This study investigated the differences in amateur golfers' perceptions of instructor expertise, instructor credibility, and lesson participation intention depending on the golf instructor's certification level to investigate whether placebo and nocebo effects exist depending on the certification level. Accordingly, the study analyzed 153 amateur golfers with at least 1 year of playing experience, and the results were as follows: First, there was a difference in the perception of instructor expertise among amateur golfers depending on the golf instructor's certification level. Specifically, there were significant differences in perceived performance and teaching skills but no differences in personality and emphasis on basic principles. Second, the participants reported significant differences in their perceptions of instructor credibility depending on the instructor's certification level. Instructor credibility of the tournament professional group was the highest, whereas that of the amateur group was the lowest. Third, the results showed differences in lesson participation intention among amateur golfers depending on the instructor's certification level. Lesson participation intention was higher for semi-professional and tournament professional instructors than for amateur instructors. These results verified the presence of psychological biases, such as placebo/nocebo effects, that result in differences in the perception of instructor expertise, instructor credibility, and lesson participation intention depending on the certification level of instructors. Additionally, based on the data obtained from this study, further research is required to improve the performance of golf instructors and create an efficient teaching environment.

KEYWORDS

golf, instructor expertise, instructor credibility, lesson participation intention, placebo, nocebo

1 Introduction

The golfing population in South Korea reached 4.69 million people in 2017, which is an increase of 860,000 from the previous year, and it has recorded a remarkable average growth rate of 11.6% for six consecutive years (Kim, 2018). Owing to the increase in the number of new golfers, the number of enthusiasts willing to take golf lessons is also increasing. Notably, among amateur golfers, nine out of ten have received golf lessons owing to the perception that "golf is difficult to master and basic posture is essential" (Shin, 2017).

Two significant implications can be drawn from this information. First, owing to the nature of golf, which is a sport that is difficult to master compared to other leisure sports, the instructor's role is critical. Kelly et al. (2010) stated that a good golf swing, which is essential in lowering the score, is made up of various aspects, such as flexibility and stability, thereby making it challenging to master within a short period. Additionally, amateur golfers recognize the challenge of correcting one's posture once a golf swing is off, which emphasizes the importance of receiving regular lessons from an instructor (Jang, 2019). Therefore, both well-known elite athletes and the general population who enjoy sports require instructors.

Efficient coaching in all sports fields, including golf, is recognized as a crucial issue in both the relevant academic and practical fields involving the coaching of athletes or students (Gould et al., 2002; Thelwell et al., 2008). Among the many factors required from a sports instructor, the most important is "expertise," which is a concept that is viewed differently across different fields and among scholars. Swanson (2001) defined expertise as having the best capabilities necessary to perform one's job in one's field. Hoffman et al. (1995) described the necessary components necessary to possess expertise as rich knowledge, competent skills, and the attitude necessary to perform a task. Moreover, field experience and problem-solving ability (Herling, 1998; Swanson and Holton, 2001), flexibility and an achievement-oriented attitude (Heijden, 2000), self-confidence or intuition, and efforts for self-improvement (Germain, 2006) are also considered components of expertise.

Instructor expertise in the field of sports can be analyzed from an integrated perspective that includes knowledge, game operation methods, tactics and strategy development, as well as specific coaching contexts for achieving the ultimate goal of performance improvement (Riemer and Chelladurai, 1995; Côté and Gilbert, 2009). Furthermore, encouraging active participation through motivation (Grant, 2006; Liljenstrand and Nebeker, 2008) and efforts for building mutual relationships (Gyllensten and Palmer, 2007) have also been mentioned. These characteristics of coaches with expertise have a significant impact on athletes' trust in their instructors (Zhang and Chelladurai, 2013).

Trust refers to one's faith and confidence in another being and the sense of physical and mental stability one experiences when they are with another person (Bede et al., 2021). Trust has been described as the degree to which one believes and fully accepts the words, actions, and behaviors of others (McAllister, 1995; Mcknight et al., 1998). Although it is difficult to find a standardized definition of trust, many people agree on its importance (Hosmer, 1995; Dirks, 2000). Ultimately, trust results in positive outcomes (Smyth et al., 2010) by fostering understanding and seamless interaction between two parties (Bstieler, 2006).

The positive effects of trust have been demonstrated in sports. According to Zhang and Chelladurai (2013), trusting the instructor is a precursor to being immersed in the instructions, which further helps to enhance performance. Conversely, even if an instructor possesses excellent coaching behaviors or strategies, if the athlete does not trust the instructor, the effectiveness of coaching is likely to be limited (Dirks, 2000; Furrer and Skinner, 2003).

This study selected people who genuinely enjoy golf as the study participants for two reasons. First, most research related to coaching behavior focuses on elite athletes, and research on coaching behavior related to amateurs is lacking, despite its importance. Second, golf was chosen based on the aforementioned characteristic of the sport as having a higher lesson rate than other sports. From a new perspective, this study verified the logical causality of the basic premise that "a great player makes a great coach" and investigated whether evaluating coaches based on this belief is a logical error.

Challenging the premise that "a great player makes a great coach," this study verified the psychological errors (placebo and nocebo effects) involved in judging one's ability based on one's background as an instructor. The findings of this study are meaningful in that they provide data for developing the practical abilities required among instructors and creating an efficient coaching environment as well as a satisfying lesson environment for golfers.

2 Methods

2.1 Participants

In this study, people from the Republic of Korea aged 20 years or older and with more than a year of golf experience or golf lessons experience were selected as the study population, and non-probability sampling and purpose sampling were applied. Those who had never played golf, had never taken lessons, or had not played golf for less than a year were excluded from this study. The study involved only the people who provided consent to participate. Online and offline data collection was conducted at an outdoor golf practice range, a university practice range, and a 4-year university located in the Republic of Korea through purposeful sampling. Detailed information is reported in Table 1. The Institutional Review Board (IRB) of Kyung Hee University provided ethical approval in accordance with the Declaration of Helsinki.

2.2 Study design and procedure

Before the filming of the lesson video, this study conducted a discussion involving the common issues amateur golfers may encounter regarding swing posture, which was handled by four professionals inform the Korean Professional Golf Association with over 3 years of teaching experience. Based on the issues regarding swing posture, the lesson content was structured in detail to ensure that the participants could determine the factors that would indicate instructor expertise. An instructor selected by the researchers filmed a 10-min lesson video (Table 2) featuring the amateur golfers' problems and the corresponding methods for improvement. During filming, the instructor followed the script without expressing their personal opinions or coaching methods. The lesson content was the same for all three groups of amateur golfers. Subsequently, the lesson video was sent to the amateur golfers who expressed interest in participating in the study, both online and offline (through golf practice facilities in C and S cities).

TABLE 1 Descriptive statistics by groups.

		Group 1 Amateur	Group 2 Semi-professional	Group 3 Professional
Sex	Male	37 (72.5%)	34 (66.7%)	41 (80.4%)
	Female	14 (27.5%)	17 (33.3%)	10 (19.6%)
Age	20 s	12 (23.5%)	6 (11.8%)	1 (2.0%)
	30 s	12 (19.6%)	17 (33.3%)	9 (17.6%)
	40 s	14 (27.5%)	12 (23.5%)	25 (49.0%)
	Over 50 s	15 (29.4%)	16 (31.4%)	19 (31.4%)
Golf lesson experience	Yes	37 (72.5%)	49 (96.1%)	44 (86.3%)
	No	14 (27.5%)	2 (3.9%)	7 (13.7%)
Golf experience	Less than 1 year	15 (29.4%)	7 (13.7%)	12 (23.5%)
	1–5 years	12 (23.5%)	31 (60.8%)	15 (29.4%)
	5–10 years	12 (23.5%)	6 (11.8%)	15 (29.4%)
	10–20 years	9 (17.6%)	5 (9.8%)	7 (13.7%)
	More than 20 years	3 (5.9%)	2 (3.9%)	2 (3.9%)
Golf handicap	Less than 10	4 (7.8%)	1 (2.0%)	5 (9.8%)
	10–15	13 (25.5%)	10 (19.6%)	11 (21.6%)
	15–20	14 (27.5%)	14 (27.5%)	19 (37.3%)
	More than 20	11 (21.6%)	14 (27.5%)	13 (25.5%)
	I do not know	9 (17.6%)	12 (23.5%)	3 (5.9%)
Frequency of golf practice	Less than once per month	2 (3.9%)	4 (7.8%)	5 (9.8%)
	Once or twice per month	16 (31.4%)	11 (21.6%)	14 (27.5%)
	Once per week	13 (25.5%)	10 (19.6%)	15 (29.5%)
	More than twice per week	12 (23.5%)	20 (39.2%)	15 (29.5%)
	Almost everyday	8 (15.7%)	6 (11.8%)	2 (3.9%)
Total		51 (100%)	51 (100%)	51 (100%)

To determine the sample size for this study, the analysis used G*Power 3.1.9.7. A medium effect size (0.07) and acceptable power (0.95) were set for the program. A total sample size of 153 participants was calculated after entering the number of groups (3) representing the participant groups, which were divided into two groups by one independent variable, and the response variables (3) representing the dependent variables (instructor expertise, instructor credibility, and lesson participation intention). The amateur golfers in the three groups (51 participants in each group) received the lesson video and were told that the coach was a tournament professional (tour pro) (Group 1), a semi-professional (semi-pro) (Group 2), and an aspiring pro (Group 3). After watching the lesson video, the participants completed a questionnaire regarding instructor expertise, instructor credibility, and lesson participation intention.

2.3 Instruments

The dependent variables used to compare and analyze the psychological errors of the golf participants were instructor expertise, instructor credibility, and lesson participation intention. For instructor expertise, this study modified the factors previously used by Kim D. H. (2013), Hwang (2019), and Lee (2009) to analyze participants' perceptions of instructor expertise. This study developed 14 survey questions based on four sub-factors (performance, teaching skills, personality and ethics, insight, and analytical ability). For instructor credibility, this study composed four survey questions by applying the factors used by Kim J. S. (2013) to analyze the causal relationships between controlling coaching behavior, group cohesion, instructor credibility, and exercise satisfaction as a single factor. Finally, for lesson participation intention, this study restructured the single factor revised by Jung (2008) based on the measurement methods of behavioral intention reported by McAuley (1993) and Wilson and Rodgers (2001) into five survey questions to fit this study. All the items were rated using a Likert scale ranging from 1 = *not at all* to 5 = *extremely*.

2.4 Data analysis

Based on SPSS/AMOS 23.0 for the data collected, this study conducted an exploratory factor analysis using a statistical criterion of eigenvalue 1.00 or greater to identify the structure of the factors used in the study. This study (a) derived basic socio-demographic results, including gender and age, using descriptive statistics and (b) used Cronbach's alpha coefficients to verify the reliability of the data, with a statistical criterion of >0.7, as suggested by Nunnally and Bernstein (1994). After analyzing the collected data, this study conducted the main data analysis to address the research problem. A one-way

TABLE 2 Golf lesson video contents.

Lesson script	Details
1. Opening	Instructor's self-introduction and purpose of the lesson
2. Problem: • Early extension • Maintaining spine and hip angles	• Explanation and cause of early extension • Compensations caused by early extension • Importance of maintaining spine and hip angles
3. Instructor's demonstration	Front/side swing
4. Correction of early extension	• Swing with hips against the wall • Swing while pressing a gym ball with hips
5. Problem: • Incorrect rotation during back swing • Back swing coiling	• Explanation of back swing coiling • Compensations and problems caused by incorrect rotation • Effects of back swing coiling
6. Instructor's demonstration	Front/side swing
7. Correct rotation and correction method for back swing	Rotate with the club on the right shoulder and extend arms after rotation
8. Closing	Summary of the lesson and importance of practice

TABLE 3 Results of EFA.

Factors	Survey items	1	2	3	4
Performance	This instructor has a great swing.	**0.871**	0.322	−0.025	0.115
	This instructor has a variety of swing techniques.	**0.870**	0.287	0.100	0.078
	This instructor is an outstanding athlete.	**0.859**	0.268	0.114	0.103
	This instructor does a great job of demonstrating the swing.	**0.842**	0.315	0.131	0.149
Teaching skills	This instructor effectively utilizes precise instruction.	0.264	**0.876**	0.155	0.110
	This instructor provides easy-to-follow instructions.	0.346	**0.821**	0.118	0.142
	This instructor encourages and motivates golfers.	0.358	**0.813**	0.174	0.146
	This instructor offers solutions for golfers.	0.356	**0.760**	0.218	0.134
Personality and ethics	This instructor is professional.	0.122	0.029	**0.850**	0.215
	This instructor is passionate about teaching.	−0.006	0.241	**0.839**	0.178
	This instructor is responsible.	0.132	0.232	**0.810**	0.245
Basic principle	This instructor emphasizes basic principle for the swing.	0.104	0.082	0.100	**0.869**
	This instructor emphasizes the principles of the swing.	0.059	0.177	0.285	**0.847**
	This instructor explains the basic swing movement.	0.188	0.136	0.301	**0.782**
Eigenvalues variance (%)		6.711	2.476	1.264	1.009
		47.935	17.688	9.027	7.207

Analysis results exceeding the statistical threshold of 0.40 are in bold.

multivariate analysis of variance (MANOVA) was performed to compare and analyze the differences in instructor expertise, instructor credibility, and lesson participation intention among the three groups (tour pro, semi-pro, and aspiring pro).

3 Results

3.1 Validity and reliability

Exploratory factor analysis (EFA) was implemented before the statistical analyses to verify the validity of the scale applied in this study. Specifically, sub-factors with an eigenvalue of 1.00 or greater were selected based on a Varimax rotation to determine the factor structure of the dependent variable (instructor expertise). Two factors (instructor credibility and lesson participation intention) were excluded from the EFA as single-scale factors. The detailed results of the EFA are listed in Table 3.

Additionally, reliability between the items was tested based on Cronbach's alpha coefficients, and a Cronbach's alpha of >0.7 was considered satisfactory: (a) expertise (basic principle), $\alpha = 0.857$; (b) expertise (personality & ethics), $\alpha = 0.855$; (c) expertise (performance), $\alpha = 0.941$; (d) expertise (teaching skills), $\alpha = 0.929$; (e) instructor credibility, $\alpha = 0.964$; and (f) lesson participation intention, $\alpha = 0.958$. The results showed that all the factors used in this study had satisfactory statistical reliability.

3.2 Multivariate analysis of variance

A factorial multivariate analysis of variance was conducted to investigate the differences among the groups (i.e., the group with an

TABLE 4 Results of the multivariate analysis of variance among three groups.

Variables	Sub-factors	*df*	*F*	*p*	η^2	*Post-hoc*
Expertise	Performance	2	16.544	0.000***	0.181	a < b < c
	Personality and ethics	2	2.487	0.087	0.032	–
	Teaching skill	2	7.216	0.001**	0.088	a < b, c
	Basic principle	2	0.479	0.620	0.006	–
Instructor credibility		2	14.661	0.000***	0.164	a < b < c
Lesson participation intention		2	12.592	0.000***	0.144	a < b, c

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

TABLE 5 Mean scores and standard deviations of dependent variables for each group.

	1	2	3	4	5	6
Group 1	3.015 (1.13)	4.163 (0.72)	3.304 (1.08)	4.000 (0.66)	3.304 (1.10)	3.010 (1.15)
Group 2	3.500 (0.99)	4.353 (0.66)	3.912 (0.93)	4.137 (0.84)	3.824 (1.02)	3.927 (0.89)
Group 3	4.083 (0.63)	4.065 (0.60)	3.882 (0.68)	4.078 (0.60)	4.314 (0.64)	3.716 (0.83)

Group 1, amateur; Group 2, semi-pro; Group 3, tour pro; 1, performance; 2, personality and ethics; 3, teaching skill; 4, basic principle; 5, instructor credibility; 6, lesson participation intention.

amateur teacher, the group with a semi-professional, and the group with a PGA professional) using three dependent variables (i.e., instructor expertise, instructor credibility, and lesson participation intention).

The Wilks' Lambda multivariate *F* statistic found a statistically significant main effect of age on the dependent variables [Wilks' $\Lambda = 0.387$, $F(12, 292) = 5.837$, $p < 0.05$]. Specifically, the univariate tests for performance, $F = 16.544$, $p < 0.001$, personality and ethics, $F = 2.487$, $p > 0.05$, teaching skills, $F = 7.216$, $p < 0.01$, basic principle, $F = 0.479$, $p > 0.05$, instructor credibility, $F = 14.661$, $p < 0.001$, and lesson participation intention, $F = 12.592$, $p < 0.001$ based on the independent variable were found. As mentioned previously, statistically significant differences were reported among the three groups. To verify the paired groups that were statistically significant, additional *post-hoc* analyses were performed. Detailed statistical results (MANOVA and *post-hoc* analysis) including the mean scores and standard deviations for each factor by group are listed in Tables 4–6.

TABLE 6 Results of *post-hoc* analysis.

		1	2	3	4	5	6
G1	G2	0.036*	0.354	0.004**	0.622	0.023*	0.000***
	G3	0.000***	0.756	0.007**	0.856	0.000***	0.001**
G2	G1	0.036*	0.354	0.004**	0.622	0.023*	0.000***
	G3	0.009**	0.094	0.987	0.916	0.034*	0.546
G3	G1	0.000***	0.756	0.007**	0.856	0.000***	0.001**
	G2	0.009**	0.094	0.987	0.916	0.034*	0.546

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; G1, amateur; G2, semi-pro; G3, tour pro; 1, performance; 2, personality and ethics; 3, teaching skill; 4, basic principle; 5, instructor credibility; 6, lesson participation intention.

4 Discussion

This study investigated the existence of placebo and nocebo effects according to the golf instructor's certification level, while focusing on the differences in the perception of instructor expertise, instructor credibility, and lesson participation intention among amateur golfers. The results found a partially significant difference in the perception of instructor expertise among amateur golfers, depending on the instructor's certification level. In terms of performance, the semi-pro group rated the instructor higher than the aspiring pro group, whereas the tour pro group rated the instructor higher than the semi-pro group. In terms of teaching skills, the semi-pro and tour pro groups rated the instructor higher than the aspiring pro group, but the semi-pro and tour pro groups showed no significant differences. This study also found no significant differences in terms of personality and basic principle according to the instructor's certification level.

These results suggest that the culture of academic elitism that values the certification level of an instructor over a career persists in Korea. In their analysis of the significant factors in selecting a golf instructor for members at a golf driving range, Hwang et al. (2008) reported that certification level (42.87%) is perceived as being far more important than experience (17.76%). Moreover, previous research (Park and Joo, 2008; Ko and Won, 2010) has shown that female golfers and high-income earners are rated higher, which are partially consistent with the findings of this study. However, Han and Seo (2020), who investigated the criteria for selecting instructors among professional Korean golfers, reported that communication skills, teaching methods, and instructor credibility are important factors. Therefore, unlike amateurs, professional golfers consider various factors when selecting instructors.

The participants of this study perceived instructors with a higher certification level as having higher levels of expertise, although instructor expertise does not necessarily mean having plenty of experience as a player (Kim, 2004). Bereiter and Scardamalia (1993) and Kuchinke (1997) argued that expertise cannot simply be defined by external status or extensive knowledge, and the process of developing expertise is poorly comprehended. Additionally, expertise can be developed through continuous effort, and it requires a combination of objective qualities, including knowledge and skills, as well as subjective qualities, such as personality, character, and temperament (Frensch and Sternberg, 1989; Ericsson and Smith,

1991; Germain and Tejeda, 2012). Therefore, to become a professional instructor, one must make constant efforts to build expertise in various aspects, rather than merely attain certification.

Perceiving an instructor's expertise based on certification affects instructor credibility and lesson participation intention. The results showed that the level of trust in a tour pro was the highest, followed by that in a semi-pro and an amateur. This study found a small difference in lesson participation intention between the tour and semi-pro groups. Meanwhile, the difference between the two groups and the amateur group was statistically significant. Although trust is accumulated through long-term interaction with students, in this short-term study, the tour pro group showed high levels of trust and willingness to learn.

In previous studies, the participants tended to show a higher level of trust in an instructor's teaching skills when the instructor held the Korea Professional Golfers' Association certification (Kim, 2011; Joo, 2020), who compared the perception of domestic and international floral design certifications, verified the difference in the level of trust and preference depending on certification acquisition by identifying learners' increased preference for and trust in international certifications compared to domestic certifications. These results indicate that perceiving expertise differently depending on certification levels affects lesson participation intention as well as instructor credibility. People trust and want to continue taking lessons from instructors they perceive as highly professional (McAllister, 1995). Furthermore, although trust is formed based on various factors apart from ability, such as sincerity and altruism (Hur, 2010), people tend to trust an instructor's qualifications the most.

These results imply that many people prioritize certification when choosing an instructor. Certification proves, to some extent, one's ability and is an objective criterion for judging expertise (Mayer et al., 1995). Janák (2015) stated that experience as a professional athlete or certification, rather than one's qualities or abilities as a coach, has been the criterion for selecting instructors. People who have this belief naturally assume that "a great player makes a great coach" and that a person with a strong athletic career will inevitably have strong coaching ability, thereby leading them to trust such instructors more because they perceive them as having a higher level of expertise. Such biases result in a psychological error that undervalues or overvalues the actual abilities of an instructor. However, sports instructors are not only trainers but also educators (Szabo, 2012) and leaders who manage and guide players for their health and happiness (Janák, 2015). Therefore, the aforementioned belief system is an error of hasty generalization. This problem stems from the academic elitism prevalent in Korean society. Jeon (2017) stated that students attending good universities prove their abilities simply by attending them, and this belief creates a social hierarchy based on educational background.

Relatively, in Western societies, these problems are less prevalent, and meritocracy is a standard practice (Brauns, 2013). Meritocracy does not consider factors other than one's abilities in their field (Son-Hing et al., 2011). For example, David Leadbetter, Hank Haney, and Mike Bender, who are considered the major coaches in the United States golf industry, did not achieve exceptional success as players, but they developed their talent early by studying their relative fields. They are recognized as capable coaches for producing many star players, developing coaching manuals and swing correction tools, and running golf academies. These coaches are recognized for their coaching skills rather than for their experience as players. Previous studies have also pointed out the problem of judging instructor expertise and selecting coaches based on their experience or certification. Many coaches selected based on these criteria are not capable instructors and lack the professional knowledge necessary to assist in the overall development of players (Côté and Gilbert, 2009; Janák, 2015).

This study verified the psychological errors involved in judging an instructor's abilities based on the instructor's background. Based on the results, this study suggests that academic elitism, which is the blind belief that an instructor with a superior certification background will also have good coaching ability, be avoided and that a coach's ability be observed and evaluated from many different angles. Furthermore, although coaching activities have been conducted based on a coach's certification thus far, future research should focus on the practical abilities that coaches must possess.

5 Conclusions and limitations

This study investigated whether placebo and nocebo effects exist based on the level of certification among golf instructors, focusing on differences in the perception of instructor expertise, instructor credibility, and lesson participation intention among amateur golfers. Based on the results of this study, the following conclusions were drawn: First, this study noted a difference in perceived instructor expertise among amateur golfers, depending on the instructor's level of certification. Specifically, the results indicated a significant difference in performance and teaching skills but not in personality and emphasis on basic principles. Second, the results revealed a significant difference in perceived instructor credibility among amateur golfers, depending on the instructor's certification level. The level of trust in the tour pro group was the highest, whereas that in the aspiring pro group was the lowest. Third, this study observed a difference in lesson participation intention among amateur golfers, depending on the instructor's certification level, which was higher in the semi-pro and tour pro groups than in the aspiring pro group.

Through this study, where the participants received the same lesson from the same instructor, this study verified the psychological error (placebo/nocebo effects) of perceiving instructor expertise, instructor credibility, and lesson participation intention differently, depending on the instructor's certification level. Blind faith and prejudice based on academic elitism, which is deeply rooted in Korean society, and the psychological error of undervaluing or overvaluing a person's ability should be avoided. A culture that judges a person based on abilities should be established. Additionally, based on the data obtained from this study, follow-up studies should be conducted to develop practical instructor capabilities and create efficient teaching environments.

The limitations of this study are as follows: First, the sample size of 153 participants may not be sufficient to generalize the results of this study. In future studies, the sample size should be increased. Second, this study involved amateur golfers, and there may be differences between amateur and professional golfers. Therefore, further studies should analyze the differences between the two groups. Third, this study was conducted to verify whether placebo or nocebo effects exist in the perception of instructor expertise, instructor credibility, and lesson participation intention among amateur golfers based on the instructor's certification background. Therefore, qualitative research on developing coaching abilities is necessary in the future.

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

The studies involving humans were approved by The Institutional Review Board (IRB) of Kyung Hee University provided ethical approval in accordance with the Declaration of Helsinki. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

HY: Conceptualization, Formal analysis, Investigation, Writing – original draft. J-HY: Conceptualization, Data curation, Investigation, Methodology, Writing – original draft. SJ: Conceptualization, Investigation, Writing – original draft. CC: Project administration, Supervision, Writing – review & editing. C-HB: Project administration, Supervision, Writing – review & editing.

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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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Development and validation of an interview guide for examining the effects of sports careers on the quality of life of retired Portuguese football players

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Introduction: Considering the importance of assessing the impacts resulting from a sport career, this study aimed at developing and validating a semi-structure interview guide suitable for quantifying the sociodemographic and epidemiological profile of former professional football players.

Methods: Based on the theoretical frameworks and several methodological procedures, an interview guide was developed, consisting of 3 areas of conceptual organization (A1. Biographical data; A2. Professional Career; and A3. Post-Career Transition) and 8 data collection categories (C1. Personal data; C2. Professional data; C3. Sociodemographic background; C4. Epidemiological pathway; C5. Moment of career retirement (career transition); C6. Post-career sociodemographic pathway; C7. Post-career epidemiological pathway; and C8. Perceptions of post-career planning). Thus, in procedural terms, four stages were considered for the construction and validation of the interview guide, namely the Ad hoc construction of the interview guide (i), the review of the interview guide by a panel of experts (ii), definition of procedures and protocol for the application of the interview (iii), and the application of the pilot study for the face validation of the interview guide (iv). The sample consisted of two former Portuguese professional players.

Results and discussion: To analyze and discuss the data, a content analysis was carried out on all the answers given to each question in the script by the interviewees. From them, matrices were created with the response references to each subcategory. In this way, it was possible to analyse the type of answers given by the interviewees and relate them to the theoretical perspectives of the topic being investigated. The results showed that the interview guide for the study of the impacts of the sports careers on the quality of life of Portuguese former football players shows reliability for the collection of qualitative and quantitative information from the respective content analysis. The use of the interview guide characterizes the path of former player, providing information and knowledge on the sociodemographic and epidemiological impact factors resulting from their post-career.

KEYWORDS

football (soccer), interview guide, former players, post-career, career impacts, well - being

1 Introduction

In recent decades, there has been a significant increase in research focused on understanding the long-term impacts of sports careers (Stambulova and Wylleman, 2019; Stambulova et al., 2021; Samuel et al., 2023).

Career transition for athletes is a pivotal juncture in their lives, occurring at an early stage compared to individuals in the general population, non-athletes (Vilanova and Puig, 2017; Wylleman, 2019; Yao et al., 2020). This timing complexity and adds layers of complexity to the process, making it a multidimensional, multilevel, and multifactorial experience (Martin et al., 2014). Consequently, there is an urgent imperative to cultivate specialized and interdisciplinary knowledge from various scientific domains to gain insights into a phenomenon that has far-reaching impacts on both society as a whole and individuals. In the realm of football, sports careers are marked by significant physical strain, considering the extensive depletion of motor energy resources (Barreira et al., 2015; Carapinheira et al., 2019; Silva et al., 2022; Nunes et al., 2023).

Engaging in the sport at the professional level comes with a heightened risk of injury (Roos, 1998; Ekstrand et al., 2011; Pfirrmann et al., 2016; Zech and Wellmann, 2017). Concurrently, the time constraints of an athlete's career compel them to form a deeper connection with their profession, encompassing matters like daily availability, the pursuit of enhanced earnings, the sacrifices of social life, dietary habits, and other facets that may not be as conspicuous in non-sporting occupations (Smismans, 2022). In addition to these considerations, football players often assume a role of social prominence, leading to their recognition and characterization through various descriptors. Moreover, this recognition situates them within a limited social circle (Drawer and Fuller, 2002; Arliani et al., 2016; Monteiro et al., 2021).

A career can be defined as a sequential series of attitudes and behaviors tied to an individual's experiences and activities related to their work over the course of their life (Hall, 2002). It represents a continually evolving process, consisting of distinct stages, each with its specific demands (Schlossberg, 1981; Wylleman et al., 1993; Wylleman, 2019). One of these stages is the transition to post-career life. In the context of football, this transition signifies the moment when a player departs from their professional career and enters a new phase of life (Wylleman et al., 1993; Stambulova et al., 2009, 2021). This situation is particularly delicate as it necessitates the player's emotional adaptation to a new social environment, a different status, and an altered lifestyle (Brandão et al., 2000; Kuettel et al., 2017).

The number of studies in this field, especially in football, is relatively limited. Therefore, it appears pertinent to identify, collect, and disseminate data related to various aspects such as the activity process, professional retirement, sociodemographic realities, health consequences, and longevity influenced by the careers of footballers, guided by existing literature (Rintaugu, 2011; Knights et al., 2016, 2019; Carapinheira et al., 2018a, 2019). To gain a more precise understanding of the patterns and requirements of these professionals, it is essential for research to concentrate on the specific sport and, if feasible, facilitate cross-cultural comparisons (Stambulova and Samuel, 2019; Stambulova et al., 2021). Building on theoretical models concerning careers and career transitions (Taylor and Ogilvie, 1994; Stambulova, 2003; Wylleman et al., 2004; Stambulova et al., 2006; Creswell and Poth, 2017;Wylleman, 2019; Stambulova et al., 2021), a research trajectory has emerged with the objective of examining the sociodemographic and epidemiological effects stemming from the professional football career of former players. Taking this viewpoint into consideration and employing qualitative methodology, we have developed and confirmed the validity of a semi-structured interview guide. This approach, in accordance with the perspectives of multiple authors (Wolcott, 1994; Gall et al., 2007; Turner, 2010; Creswell and Poth, 2017), is an established research method for acquiring comprehensive insights into participants' experiences, emotions, and interpretations.

Framed within the research paradigm on the theme of careers and sport transitions, specifically oriented toward research on the impacts resulting from the professional football career and its effects on the perception of post-career quality of live, as well as in the pursuit of scientific studies carried out in this area by several authors (Drawer and Fuller, 2001; Agresta et al., 2008; Curran, 2015; Sanders and Stevinson, 2017; van Ramele et al., 2017; Carapinheira et al., 2018b; Nunes et al., 2023), the main purpose was to build and validate a meta-evaluative instrument, in the form of a checklist, focused on the interpretivist paradigm, capable of characterizing the sociodemographic and epidemiological profile of former football players in Portugal, considering all the transitional phases of the career, namely from the beginning of the professional activity to the situational moment in the post-career.

The interview guide aims to description of career development stages and career pathways with prediction of normative transitions (Samela, 1994; Wylleman, 2019; Samuel et al., 2023). Simultaneously, aimed at description and explanation of a transition process and factors involved in terms of normative, non-normative and quasi-normative athletic transitions (Taylor and Ogilvie, 1994; Stambulova, 2003; Ryba et al., 2016).

The purpose of applying this interview is to develop several studies that holistically conceptualize the entire journey of former football players as a way of evaluating the career impact factors and the quality of life of this population in the post-career period. Used to this end, collecting data from this instrument will provide information on the sociodemographic and epidemiological idiosyncrasies experienced during the sport career, career transition and post-career.

The main objective of this study was to validate the Interview Guide for Examining the Effects of Sports Careers on the Quality of Life of Retired Portuguese Football Players. From the pilot study, we seek to ensure that the interview is carried out in an organized, methodical manner and, simultaneously, that the information collected is framed and directed to each area and specific thematic category. To this end, matrices will be created to characterizing all types of data to be collected through the application of the instrument.

2 Materials and methods

Before initiating the construction of this interview guide, the ethical committee at the University of Beira Interior was obtained (CE-UBI-Pj-2021-015). The quality assurance of an interview for application in the scientific field should respect a set of methodological procedures (Wolcott, 1994; Flick, 2005; Boni and Quaresma, 2005). The theoretical framework, the choice of the type of interview, the interview structure definition, the relevance and clarity of the questions, the validation process, the interview training, the interview

application and the data processing are some of the steps highlighted in the literature (Triviños, 1987; Wolcott, 1994; Flick, 2005; Boni and Quaresma, 2005; Aires, 2015).

Drawing upon the theoretical framework, which is informed by a comprehensive review of the literature concerning the effects of former footballers' professional careers, particularly within sociodemographic and epidemiological dimensions, we meticulously developed a semi-structured interview guide tailored to the research objectives. We opted for a semi-structured interview approach due to its capacity to incorporate relevant theories and hypotheses related to the research theme. This approach not only facilitates the description of social phenomena but also enables their comprehensive explanation and understanding (Triviños, 1987; Aires, 2015).

In terms of the procedural aspects, four distinct stages were considered for the creation and validation of the interview guide: (i) the *ad hoc* construction of the interview guide, (ii) a critical review of the interview guide by a panel of experts, (iii) the formulation of procedures and a protocol for administering the interview, and (iv) the execution of a pilot study to assess the face validity of the interview guide.

2.1 *Ad hoc* construction of the interview guide

To begin, we initiated our research process by exploring scientific articles centered about careers and post-career transitions in sports, with a particular emphasis on football. We conducted these searches using relevant keywords within popular search engines. Subsequently, we scrutinized the methodologies employed in both quantitative and qualitative studies that delved into career perspectives and career transitions within a sociodemographic and epidemiological framework. The intention was to utilize this analysis to structure the interview guide into thematic sections, aligning them with the overarching research objectives. This process was informed by insights from various sources (Agresta et al., 2008; Knights et al., 2016; Zech and Wellmann, 2017; Carapinheira et al., 2018b; Lelbach et al., 2020).

It is widely acknowledged that conceptual research on career transitions should embrace a comprehensive, continuous, and multifaceted approach (Taylor and Ogilvie, 1994; Wylleman et al., 2004; Stambulova et al., 2009). This entails recognizing the unique challenges that athletes face at different stages of their sporting journey, as well as in other aspects of their lives, including their interactions with coaches, parents, and friends (Côté, 1999; Wylleman et al., 2000; Côté et al., 2007). Moreover, it necessitates an understanding of the influence of macrosocial factors such as culture, context, and the personal development of the player (Stambulova et al., 2007). With this perspective in mind, the initial version of the interview guide was structured around three distinct areas, drawing support from relevant theoretical models (Taylor and Ogilvie, 1994; Stambulova et al., 2006; Wylleman, 2019). Subsequently, after considering insights from various sources (Turner et al., 2000; Drawer and Fuller, 2001; Uzunca et al., 2005; Agresta et al., 2008; Baron et al., 2012; Vann Jones et al., 2014; Gomes and Domingues, 2016; Gledhill et al., 2017; van Ramele et al., 2017; Carapinheira et al., 2019; Yao et al., 2020; Jones et al., 2021), we made the decision to incorporate eight research categories, each containing numerous questions organized into various subcategories.

As an initial premise, meticulous attention was given to the wording, structure, and sequence of the questions to ensure that they were framed objectively, in plain language, and without inadvertently suggesting any specific answers (Wolcott, 1994).

2.2 Evaluation of the interview guide by an expert panel

Following the creation of the initial draft of the interview guide, it underwent a face validation process by a panel of three experts from different institutions of Portuguese university institutions. These experts were experienced higher education teachers with a track record of research and published work in the relevant field (Scorsolini-Comin, 2020). After receiving their feedback, several modifications were made to the interview guide. Specifically, eight questions were removed, and the wording of seven other questions was revised, while keeping intact the originally defined categories and subcategories.

2.3 Procedures and protocol for applying the interview

To ensure a thorough and meticulous utilization of the instrument, a set of procedures was established for both preparation and implementation, particularly with regard to the form of contact and preparation for the interview (i. selection and provision of contacts; ii. checking participant availability; iii. Information about the scope and objectives of the research; iv. schedule for the day and location of the interview; v. preparation of a model with the interviewee's pre-defined CV) and, also, the development of a protocol covering the pre-interview, during-interview, and post-interview phases (i. explanation of the scope, objectives and organization of the interview; ii. clarification on the dissemination of results and their confidentiality; iii. Authorization to record the interview; iv. display of the summary of the interviewee's CV to confirm or change the information; v. reading of informed consent for subsequent signing in duplicate of the document; vi. definition of the starting and ending moments of the interview; vii. Reinforcement of the possibility of providing relevant information not mentioned during the interview; viii. Information about the possibility of providing the interview transcript; ix. final acknowledgment).

2.4 Execution of the pilot study

To assess the practical effectiveness of the interview we conducted a pilot study, including factors like its flow, duration, question clarity, and any unforeseen issues (Gall et al., 2007). The primary objective was to identify any constraints or shortcomings in the interview structure (Turner, 2010). The pilot study involved a sample of two retired Portuguese football players, each having accumulated over 8 years of professional experience.

Due to the constraints imposed by the SARS-CoV-2 pandemic, the interviews were conducted by videoconference (platform Zoom). This approach was chosen to maintain a desirable level of comfort for

the interviewees (Wolcott, 1994; Boni and Quaresma, 2005). It allowed them to participate from the comfort of their own environment while interacting with the interviewer in a quiet, confidential setting and having easy access to the interview guide. On average, the interviews lasted approximately 42 min, which was considered an appropriate duration for field application. Additionally, this phase served as a training opportunity for the interviewer, helping to assess the relevance of the topics covered and evaluate the clarity of the questions to eliminate any potential comprehension issues (Gomes and Domingues, 2016). In conclusion, the final version of the interview guide comprises three main areas and eight categories, encompassing a total of 27 questions more a general questionnaire with biographical and professional data.

2.4.1 Interviews transcription

The interviews were recorded in audio and video format and transcribed. The QSR International – Nvivo, version 11.0 software and SPSS Statistics was used for the information analysis and processing (Leitão, 2002; Bardin, 2007). Simultaneously, to make inferences and interpretations regarding the content analysis, the answers given by each interviewee were detailed, through a table, for each of the categories and subcategories identified in the interview guide.

2.4.2 Content analysis of the interviews

The social construction of an instrument must always be guided by the theoretical framework of the research (Bardin, 2016). Concomitantly, content analysis is a well-established qualitative research method used to interpret the meaning within textual content, aligning with the naturalistic paradigm (Scorsolini-Comin, 2020).

In this sense, the content analysis respected the different phases of analysis, namely pre-analysis (organization), exploration of the material (coding, categorization) and treatment of results (inference and interpretation) (Bardin, 2016). The validation of the interviews was conducted through conventional content analysis, wherein coding areas and categories were directly derived from the textual data. This approach aimed to extract meaning from the transcribed content by organizing it into discrete sections of information, each identified by specific codes (Creswell and Poth, 2017). By employing this method, we ensured the validation of the discourse by the individuals providing the information and upheld the quality of the procedural dialog inherent in the interview technique (Turner, 2010).

To define the codes for presenting and discussing the results, we analyzed phrases, expressions, and recurring ideas common among the selected interviewees. This process helped identify thematic categories and subcategories based on the interview protocol and the primary topics addressed during the interviews. Subsequently, a review of the initial structure of these categories and subcategories was undertaken, incorporating new criteria as additional response options emerged. This approach aligns with recommendations from other authors (Bardin, 2007) for a mixed methodology that simultaneously utilizes pre-defined categories and adapts to new subcategories that best suit the analyzed material (Creswell and Poth, 2017; Creswell and Plano, 2017).

At the same time, for which answer former players gave, argumentative and guidance lists were created about the way which question should be led, so that the quality and pertinence of the data in which category could be satisfied.

3 Results and discussion

The methodology employed, stemming from the content analysis conducted during the research, involved constructing a comprehensive matrix of responses for each of the categories outlined in the guide. This matrix facilitated the identification of all the subcategories and criteria that emerged. Subsequently, these findings were discussed in the context of the theoretical framework pertaining to careers and sports transitions.

3.1 Biographical data (area 1)

The collection of informative biographical data is common practice among severel retrospective studies (Drawer and Fuller, 2001; Vann Jones et al., 2014; Arliani et al., 2016; Carapinheira et al., 2019; Stambulova and Wylleman, 2019; Jones et al., 2021; García-García et al., 2023; Sun and Moon, 2023). In this regard, and firstly, through closed questions, the personal data of the former players were collected (Figure 1).

Both closed and open-ended questions were employed to enable the subsequent determination of dependent and independent variables based on the objectives and research questions posed in scientific studies. This approach aimed to enhance the identification and characterization of former players in relation to their professional careers (Figure 2).

The analyzed content revealed that the responses led to a distinct identification of the criteria for each of the subcategories. The interviewees displayed clarity in their understanding of the questions posed to them, facilitating the interpretation of each subcategory during the transcription of the interviews.

The essentially quantitative information collected in these two categories allow for the personal and professional characteristics of the interviewees.

3.2 Professional career (area 2)

The domain of professional careers encompasses two categories, each providing retrospective information about the sociodemographic and epidemiological aspects of former football players' careers. These categories aim to clarify the unique attributes of football players' careers, particularly within a systems perspective, which will be analyzed in the context of sports psychology (Stambulova et al., 2021). From the career models proposed by Stambulova (Stambulova, 2003) we opted for the guideline of the structural model, i.e., to develop questions that could originate data concerning the direction of sport development (e.g., motivation, quality and style) and, simultaneously, of the psychological determinants reflecting aspects of operational (e.g., psychological processes triggered), situational (e.g., activities and behaviors) and cultural (e.g., organization and lifestyle) scope.

Through the content analysis of interviews pertaining to category 3, which is focused on the sociodemographic aspect, six distinct subcategories have emerged as crucial for exploring and gathering information. These subcategories include the ability to balance professional commitments, the duration of time spent away from one's native area of residence, changes in family dynamics, the pursuit of

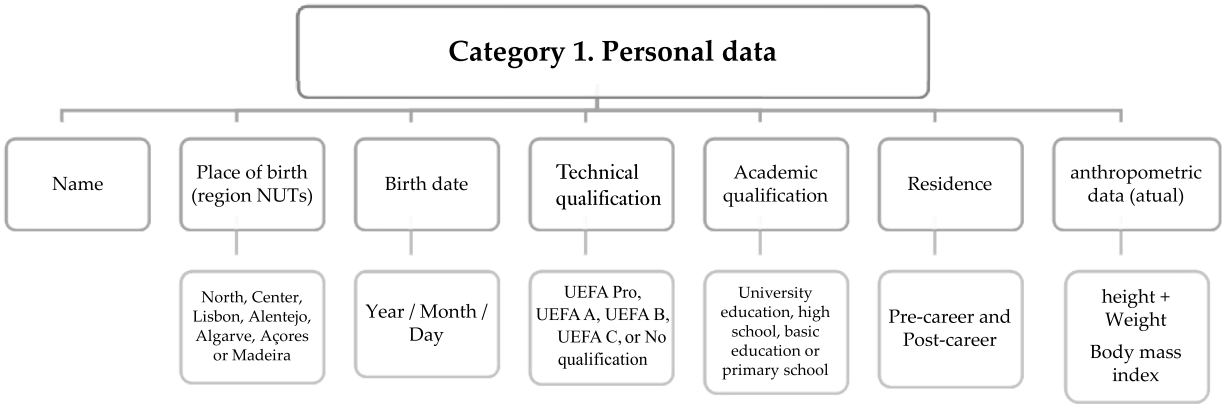

FIGURE 1
Matrix with codes for personal information.

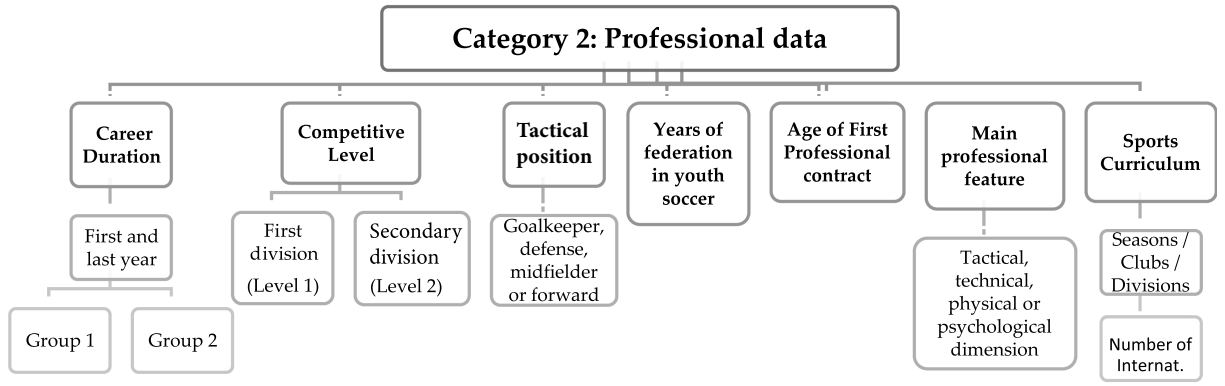

FIGURE 2
Matrix with response codes related to the career trajectory.

academic or technical education, and the perceived socio-economic status achieved during the career. These category are visually represented in Figure 3.

Regarding the content analysis of interviews in category 4 (see Figure 4), we have identified and grouped five subcategories for extracting relevant information. These subcriteria were designed to collect data concerning the occurrence of significant injuries, any surgeries undergone, assessments of the quality of sports medical care, opinions on methodological experiences, and the availability of psychological support during the players' careers. These criteria are aimed at investigating whether health issues experienced during the professional career are indeed factors that should be considered in assessing the quality of life for individuals' post-career. This aligns with findings from previous research studies (Agresta et al., 2008; van Ramele et al., 2017; Lelbach et al., 2020).

Content analysis shows that there is agreement between the researchers in identifying the number and type of injuries that former players considered to be serious during their career. A similar pattern emerges concerning both the quantity and nature of surgeries undertaken, alongside the recognition of the presence of psychological support. The findings suggest that it could be valuable to categorize timeframes during which injuries and surgeries occurred. Regarding the perceptions of sports medical care and the methodologies encountered, coding presented challenges because former players indicated having diverse practices and experiences throughout their careers. This diversity arose from interactions with different medical departments and technical teams, which naturally influenced their perceptions of the quality of experiences. To address this issue and ensure more straightforward coding, both questions should initially be structured with closed-answer options. In other words, former players should assess these criteria as positive, neutral, or negative when considering their entire career trajectory. Subsequently, in a follow-up open-ended question, they can provide justifications and explanations for their choices.

3.3 Transition to post-career (area 3)

The category addressing the termination of a sports career drew inspiration from two key models: the conceptual model of adaptation to retirement among athletes (Taylor and Ogilvie, 1994; Kuettel et al., 2017) and the Sport Career Transition model (Stambulova, 2003). The

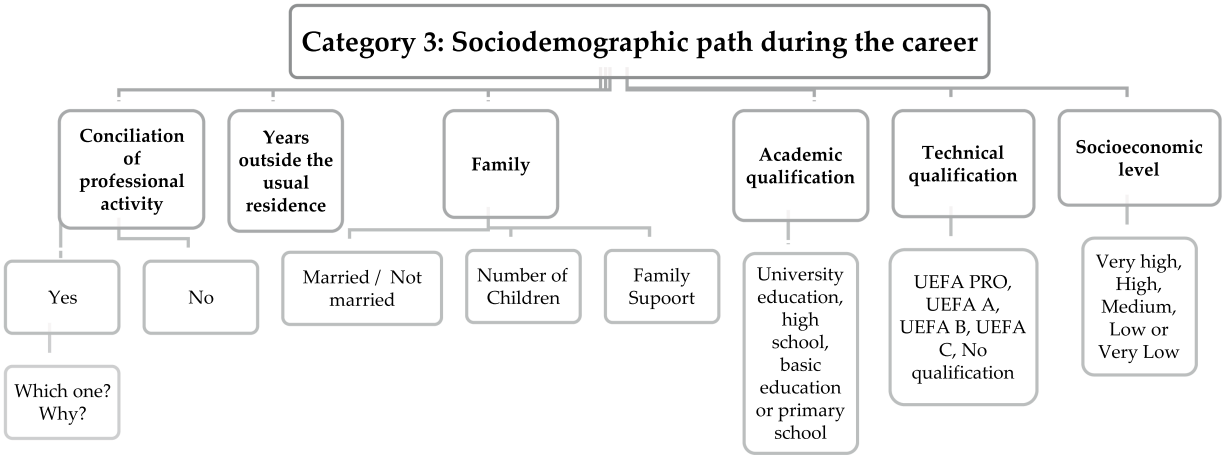

FIGURE 3
Matrix with response codes regarding the sociodemographic path during the career.

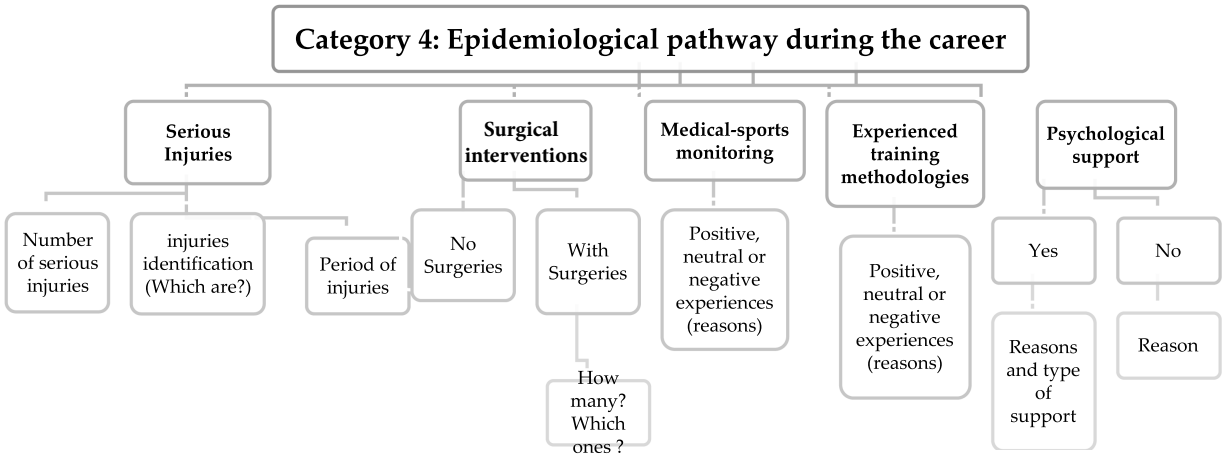

FIGURE 4
Matrix with response codes regarding the epidemiological pathway during the career.

questions posed inquired, from a comprehensive standpoint, about the variables that either influence or are associated with the professional career retirement process.

Through the results obtained (Figure 5), it seems that the contents of the answers present informative assumptions capable of inferring about the quality of the transition experienced by former players and, concomitantly, to understand which resources were used for this transition, which results in the effective identification of dependent variables t that define the conclusion of the careers within this population (Park et al., 2013; Carapinheira et al., 2018b; Samuel et al., 2023). The factors that determinate the quality of the transition to post-career are the voluntariness (or involuntariness) of the retirement, the time of acceptance, the athletic identity, the new professional orientation, and the life changes that arise at the moment of retirement. On the other perspective, and in relation to the resources used for this transition, the existence of coping strategies, the type of psychological support, the existence (or not) of a career retirement plan and also the use (or not) of support from programs are highlighted (Carapinheira et al., 2018b).

From the content analysis it is possible to identify the most significant positive and negative factors of transition quality and the resources available for the players which, by itself, helps in the implementation of specialized intervention models by levels (i.e., cognitive, behavioral, emotional, and social) that have purpose of helping athletes who had negative transitions (Wylleman et al., 2000; Sofie et al., 2021; Smismans, 2022). A higher degree of athletic identity related to valued sport correlates such as intrinsic motivation and the mastery goal orientation (Lochbaum et al., 2022) which means that the type of answers given by the interviewees can be analyzed in light of this paradigm.

However, building upon the concept that career and sport transitions should be examined considering the athlete as a holistic entity within a specific context (Stambulova et al., 2021), the answers given in category 6 and 7 (Figures 6,7) emphasize the quality factors and resources that are integral to the transition process, as well as they define the subsequent path of former football players post-career.

For the characterization of sociodemographic variables, the answers showed descriptions related to the experiences and

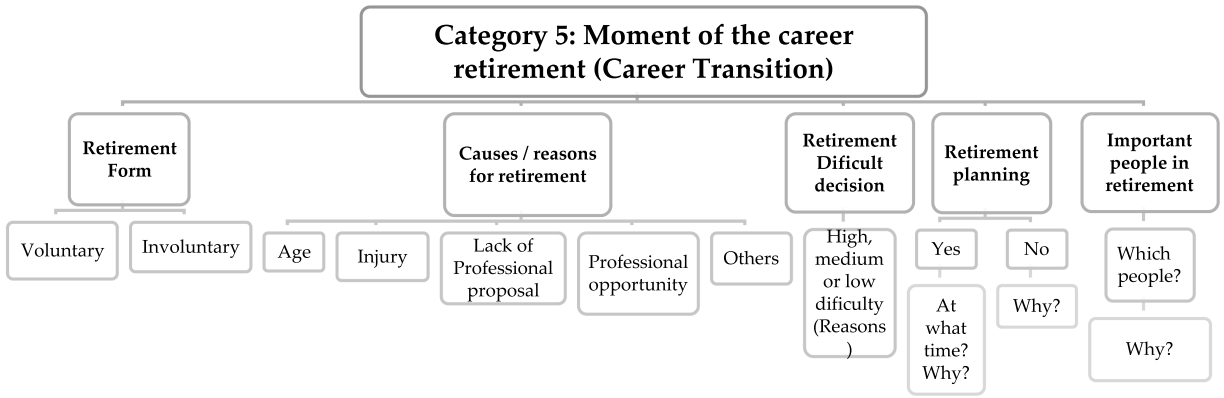

FIGURE 5
Matrix with response codes regarding the professional career retirement.

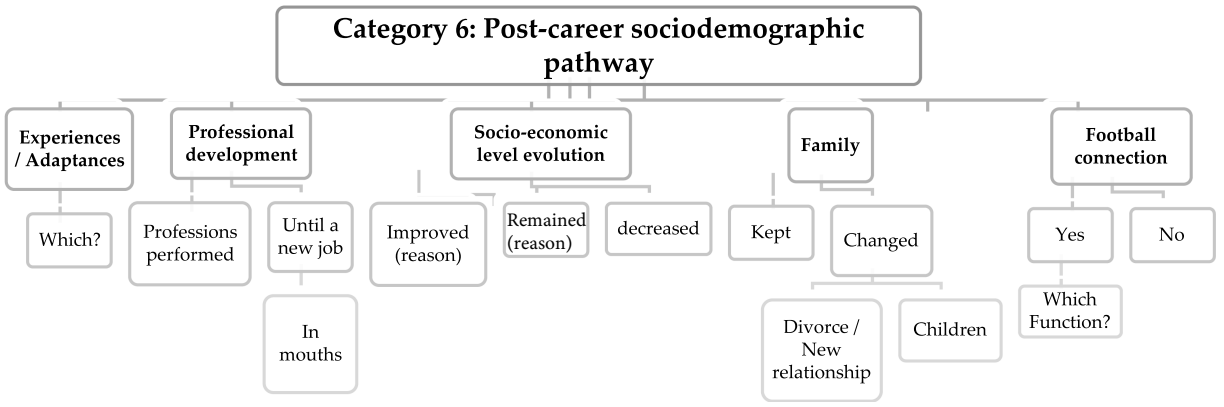

FIGURE 6
Matrix with response codes regarding post-career sociodemographic pathway.

adaptations in post-career period, the professional path, the changes at socio-economic level, the dynamics and development of the family, and the continuity (or discontinuity) related to the connection that former players maintained with football, as described and proposed in other studies (Grove and Stoll, 1999; Uzunca et al., 2005; Agresta et al., 2008; Rintaugu, 2011; Gazzaroli et al., 2017; Carapinheira et al., 2018b; Monteiro et al., 2021).

It's possible that the content of these questions could provide relevant information's because adaptive processes occur within specific contexts that may influence former sport performers' responses and outcomes (Schinke and Stambulova, 2017).

In the epidemiological characterization, the results allow us to recognize if there are (or have been) health problems, medical follow-up and medical-surgical interventions in the post-career period, aspects that are also highlighted in several scientific papers reviewed (Drawer and Fuller, 2001; Uzunca et al., 2005; Park et al., 2013; Vann Jones et al., 2014; Arliani et al., 2016; Sanders and Stevinson, 2017; Jones et al., 2021).

At the same time, by analyzing the criteria concerning perceptions of career impact, we gather the former players' overarching views regarding the positive and/or negative effects linked to their professional careers, encompassing physical, mental, and social dimensions. So, It will be important aimed to summarize the post-career effects of highly competitive football practice.

It was possible to develop the matrices proposed in Figure 7, where the possible response codes are presented. Through content analysis, the type of answers given by the interviewees allow us to understand the health problems that occurred in post-career, whether former players needed support or medical follow-up, whether there were surgical interventions and, especially, in the case occurrence of health problems, their perception of whether this could be related to their professional career.

In summary of the two categories (post-career sociodemographic and epidemiological pathway), the length of the adaptation process is a factor that can be investigating. Adaption is a dynamic process, the interplay between appraisals, decision-making and active coping may change depending on the course of the transition (Samuel et al., 2023).

In this regard, analyzing the sociodemographic and epidemiological information of former players during their retirement could provide clues about the impact of their careers, the planification of career transition and, at the same time, understand the profiles, life choices and the type of social, professional and health reality that these former players face.

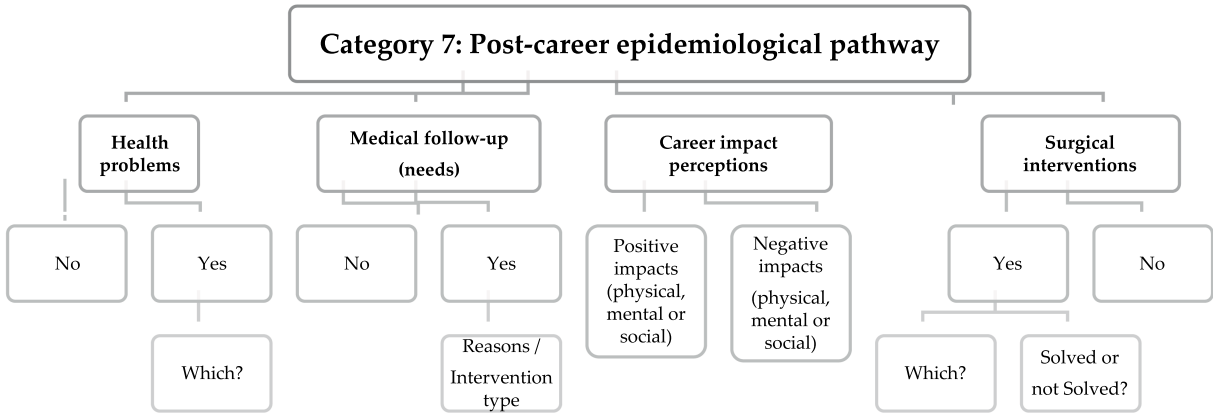

FIGURE 7
Matrix with response codes for the post-career epidemiological pathway.

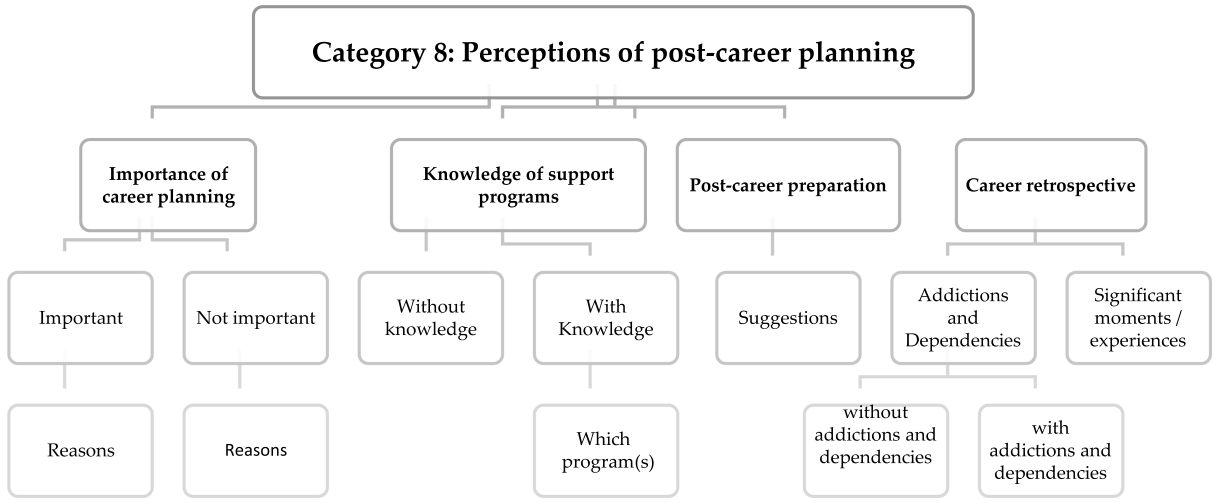

FIGURE 8
Matrix with response codes regarding former players perceptions of post-career planning.

The last category of the interview guide aims to gather the former players opinions regarding the importance of post-career planning, the knowledge and importance of support programs, their suggestions on the topic and, also, from a retrospective, the identification of key moments and possible addictions or dependencies experienced during their life path (Stambulova et al., 2009; Dimoula et al., 2013; Park et al., 2013; Carapinheira et al., 2018b; Jones et al., 2021; Samuel et al., 2023).

From the content analysis of the research, it is possible to create response codes from four subcategories (Figure 8). In this perspective, it seems relevant to assess the set of opinions and suggestions of former professional players that may contribute to the transfer of recommendations to support programs for career transition (McKnight and Kashdan, 2009), in order to help players to get involved in life after sport, helping them to understand the skills they need to succeeded in other areas of activity. Adaptation and professional support associated with change events must consider age and identity as part of the process (Samuel et al., 2023).

The lives of sport performers have tremendously changed in last years as a result of the globalization process, social media, and migration (Samuel, 2021). Analyzing the responses from former players, we expect that the collection of information from these subcategories will bring new perspectives and visions about the strategies that can be adopted in this research area.

4 Conclusion

The use of the investigative technique of interview survey is an important research instrument that allows achieving a deep knowledge of the object of study, to the extent that it allows, based on the information provided by the interviewees, to (re) construct meanings and senses.

Under this premise, the objectives of this work aimed at the construction, development and validation of an interview guide based on several methodological procedures that would ensure a

TABLE 1 Areas, categories, and subcategories of the interview guide.

Area 1: biographical data	
Category 1: personal data	**Category 2: professional data**
Full name / sport name	Year of beginning and end of career
Place of birth / date of birth	Internationalisations / tactical position
Academic and thecnical qualifications	Start of federated practice (formation)
Residency (pree-carreer and post-carreer)	Characteristics of professionalisation
Height and weight (current)	Curriculum vitae summary
Area 2: professional career	
Category 3: sociodemographic backgroud	**Category 4: epidemiological pathway**
Conciliation of professional activity	Serious injuries
Years of living outside the usual residence	Surgical interventions
Family	Medical-sports monitoring
Academic and thechnical habilitations	Experienced training methodologies
General socio-economic level	Psychological suport
Area 3: transition for post-career	
Category 5: moment of career retirement (carreer transition)	**Category 6: post-career sociodemographic pathway**
Retirement form	Experiences and adaptations
Causes or reasons for retirement	Professional development
Retirement decision	Socio-economic level evolution
Retirement planning	Family
Important people in the retirement	Football connection
Category 7: post-career epidemiological pathway	**Category 8: perceptions of post-career planning**
Health problems	Importance of post-career planning
Medical follow-up (needs)	The knowledge of support programmes
Career impact perceptions	Post-career preparation (sugestions)
Surgical interventions	Career retrospective (significant or problematic experiences)

TABLE 2 Characterization of the interviewed individuals for the pilot study.

	Former player 1	Former Player 2
Career time	1983–1999	1982–1993
Tactical position	Midfielder	Defense
Competitive level	Level 1 (first division)	Level 2 (second division)

robust theoretical framework, a justification for the definition of the primary research areas and, through content analysis of two interviews with former football players, systematize the information model to be generated through the application of the interview (Table 1). Therefore, attached to this article is the complete interview guide with all the questions written in Portuguese language.

The interview guide designed to investigate the impacts of a sports career on the quality of life of Portuguese former football players has proven effective in collecting both qualitative and quantitative data through content analysis (Table 2).

The instrument demonstrate efficiency as it delves deeply into the situational context of former players, facilitating a comprehensive understanding and interpretation of their experiences as conveyed by the diverse research participants. This is relieved in the matrices developed for each of the guide's areas, categories, and subcategories. The instrument seems pertinent regarding data collection for the scope of research oriented toward the study of sociodemographic and epidemiological impacts arising from a professional football career, with transcultural characteristics, focused on individual and multidimensional perception in assessing quality of life in specific context.

Data availability statement

The original data contributions presented are included in the Supplementary material. Further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the Ethical committee at the University of Beira Interior (CE-UBI-Pj-2021-015).

The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

ET: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. CS: Data curation, Formal analysis, Software, Supervision, Validation, Visualization, Writing – review & editing. AV: Conceptualization, Investigation, Methodology, Supervision, Validation, Visualization, Writing – review & editing.

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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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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2024.1374784/full#supplementary-material

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A study on the impact of systematic desensitization training on competitive anxiety among Latin dance athletes

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Objective: In the domain of competitive events, Latin dance athletes have always suffered competitive anxiety, which is a prevalent and prevailing psychological facet, in pre-, intra-, and post-competitive engagements. Usually, the implementation of systematic desensitization training is an efficacious approach to reduce competitive anxiety levels in routine sports to fortify psychological resilience of athletes (like swimming, volleyball, and basketball). This study focuses on the effect of systematic desensitization training on competition anxiety in the training of Latin dancers to establish good mental ability and promote the competitive ability of athletes.

Methodology: The "Sports Competition Anxiety Test Questionnaire" was used to evaluate and classify the competitive anxiety levels of 150 Latin dance athletes. Then, the top 48 participants were selected (24 in the intervention cohort and 24 in the non-intervention cohort) as the study participants after stratifying anxiety score levels from the highest to the lowest. The intervention group was treated with an 8-week psychological intervention by employing systematic desensitization training techniques (encompassing imagery desensitization and *in vivo* desensitization). The anxiety levels of the subjects were quantified by employing the "Sport Competition Trait Anxiety Inventory" (CCTAI-C) and the "Competitive State Anxiety Inventory" (CSAI-2) to scrutinize the efficacy of systematic desensitization training in regulating competitive anxiety levels among Latin dance athletes.

Results: After applying systematic desensitization training, the intervention group displayed a notable reduction in sport cognitive trait anxiety. Specifically, there was a decrease of 29.37% in social evaluation anxiety, 20.31% in competition preparation anxiety, 16.98% in performance anxiety, 25.16% in failure anxiety, 34.47% in opponent's ability anxiety, and 25.16% in injury anxiety. Moreover, for competitive state anxiety, cognitive state anxiety and somatic state anxiety decreased by 39.19 and 21.43%. The state self-confidence increased by 14.42%.

Conclusion: The result indicated that systematic desensitization training not only mitigates anxiety but also positively intervenes in sports-related anxiety. Moreover, systematic desensitization training can significantly diminish competitive anxiety among Latin dance athletes to bolster confidence during competitions. Integrating desensitization training into the regular regimen of

Latin dance practice has the potential to fortify dancers' psychological resilience against anxiety.

KEYWORDS

systematic desensitization training, psychological intervention, Latin dance training, sport, competitive anxiety

1 Introduction

Anxiety is usually conceptualized as an adverse emotional state to result in distress, anger, muscular tension, and hypertension (Farber, 1948; Davies et al., 2023). Nevertheless, moderate anxiety can induce physiological responses in the body and brain, amplifying vigilance and ameliorating performance and reaction time in competitive arenas or sporting contexts (Belon, 2019). Moreover, moderate anxiety also can incite more attention of dancers in competitions, which can empower them to surmount challenges and attain peak performance (Hovenkamp-Hermelink et al., 2019).

Competitive anxiety is the stress and apprehension of athletes while they suffered worrisome occurrences before or during competitions (Butt et al., 2003). Based on Spielberger's anxiety taxonomy, Martens classified competitive anxiety into state anxiety and trait anxiety (Martin and Hall, 1997). State anxiety denotes a transient emotional state typified by fluctuations (Endler and Kocovski, 2001). However, the trait anxiety represents a relatively enduring personality trait (Jiang et al., 2022). For athletes proficient in skill, the level of competitive anxiety will dramatically affect game outcomes (De Pero et al., 2016). During the Olympic Scientific Congress in 1984, Gruppo underscored that the psychological aspects accounted for 80% of an athlete's success or failure in performance (Birrer and Morgan, 2010). Consequently, psychological factors and the regulation of competitive anxiety wield a pivotal role in an athlete's performance (Binboga et al., 2012). For example, Shao et al. used imagery and systematic desensitization to adjust the competitive trait anxiety of high-level athletes at Inner Mongolia Normal University. The result showed that systematic desensitization can reduce the competition trait anxiety level of university student-athletes with serious anxiety (Guohua, 2012). Furthermore, the Venezuelan national football team has achieved remarkable results with sports psychology strategies such as systematic desensitization, relaxation, and stress coping. It can be seen that systematic desensitization training has a positive effect on competition anxiety (D'Amico and Hernández, 2017).

While competition anxiety is prevalent across various sports, its impact is particularly pronounced in skill-intensive disciplines such as Latin dance, which require a combination of physical prowess and esthetic performance (Chen, 2011). Latin dancers not only confront physical skill challenges during competition but must also navigate the effects of nervousness (Shaffer et al., 2015). The level of competition anxiety directly correlates with athletes' performance outcomes, a phenomenon observed in Latin dance competitions as well. Thus, comprehension and regulation of competition anxiety are imperative for Latin dancers, representing a pivotal determinant of victory or defeat (Adilogullari, 2014).

Up to now, the academic field extensively deployed cognitive and behavioral intervention techniques to regulate athletes' psychological states (Birrer and Morgan, 2010). A prominent cognitive approach includes imagery and suggestion training (Xuan, 2020; Kulshrestha et al., 2021). The behavioral strategies encompass progressive relaxation, biofeedback, and systematic desensitization methodologies (Huang et al., 2019). Systematic desensitization (Rachman, 1967), also acknowledged as systematic desensitization therapy or reciprocal inhibition (Rabinovich, 2016), represents a behavioral intervention method that gradually mitigates neurotic anxiety patterns. The hinting language and physical and psychological relaxation are used to fight against the anxiety of each level step by step under the guidance of the intervenor to achieve the purpose of relieving and eliminating anxiety. Desensitization training includes two ways of imaginary desensitization and realistic desensitization (Xiaoling et al., 2008). The basic procedure consists of three parts: muscle relaxation training, establishing fear event hierarchy, and implementation of systematic desensitization (O'Neil and Howell, 1969; Morrow et al., 1992; McGlynn et al., 2004).

This study integrates systematic desensitization training into the training regimen of Latin dance participants to investigate the effectiveness in managing competitive anxiety by randomized controlled trial. The 48 highly anxious Latin dance participants underwent psychological intervention via systematic desensitization training to employ a sports-related anxiety questionnaire. The result indicated that systematic desensitization training can effectively reduce competition state anxiety and trait anxiety of Latin dancers. The main objective of this study was to determine whether systematic desensitization training is effective in reducing competition state anxiety and trait anxiety in Latin dancers. This study bridges the gap in the application of systematic desensitization training within the realm of Latin dance, providing valuable psychological intervention insights to alleviate competitive anxiety among Latin dancers across diverse age groups.

2 Methods

2.1 Experimental subjects

The "Sport Competition Anxiety Test Questionnaire" (Appendix A) was employed to evaluate the competition anxiety among 150 participants (75 men and 75 women). Following the sorting based on anxiety scores, 48 Latin dance participants were selected for the research. All the participants were aged between 23 and 25 years. Among them, 24 men and 24 women were evenly distributed in the intervention group and the non-intervention group (12 men and 12 women in each group). Preceding the intervention, the subjects were classified into two cohorts: recipients of systematic desensitization training (intervention group of 24) and individuals lacking such training (non-intervention group of 24). An 8-week

desensitization program, involving 16 sessions over the period (twice a week), was implemented in this study. All the subjects were recruited from the Latin Dance Elective Class after rigorous review and approval by the Ethics Committee of the Harbin Institute of Physical Education. During the recruitment process, we publicized the program through classroom announcements, posters, and emails. This study is a randomized controlled trial. All the intervention data were meticulously documented. The study visit procedure is demonstrated in Figure 1.

2.2 Measurement tools

Dr. Ye developed the CCTAI-C (Appendix B) to establish standardized Chinese values derived from the original scale (Ping et al., 2000). It encompasses 6 dimensions and 33 analytical indicators, individually: social evaluative anxiety, competition preparation anxiety, competitive performance anxiety, fear of failure, anxiety regarding opponents' abilities, and injury-related anxiety. The CSAI-2 (Appendix C) was revised by Beili (1994), which was transformed by the anxiety theory by American sports psychologist Spielberger (Beili, 1994). The CSAI-2 consists of three dimensions to assess anxiety: individually, cognitive state anxiety, somatic state anxiety, and state self-confidence (with a comprehensive total of 27 assessment indicators).

2.3 Intervention process

2.3.1 Establishment of the "fear event level scale"

Before applying psychological intervention, the tester interviews the athletes, ranking the athletes' fears from lowest to highest (Akeb-Urai et al., 2020). They are assessed by the Fear Event Level Scale to arrange the triggers in ascending order from mild to severe. Interventions were executed based on the anxiety-provoking incidents to identify in the scale. Then, every anxiety-inducing circumstance was systematically addressed until reaching the athletes' peak anxiety level to alleviate their competition anxiety (Lazarus and Rachman, 1957; Table 1).

2.3.2 Muscle relaxation exercises combined with imagery systematic desensitization

The second phase of systematic desensitization is muscle relaxation training. Initially, the participants recline on a mat to foster a serene environment. The athlete is then asked to imagine the situation on the anxiety stimulus scale (Ujihara et al., 1987). Mental

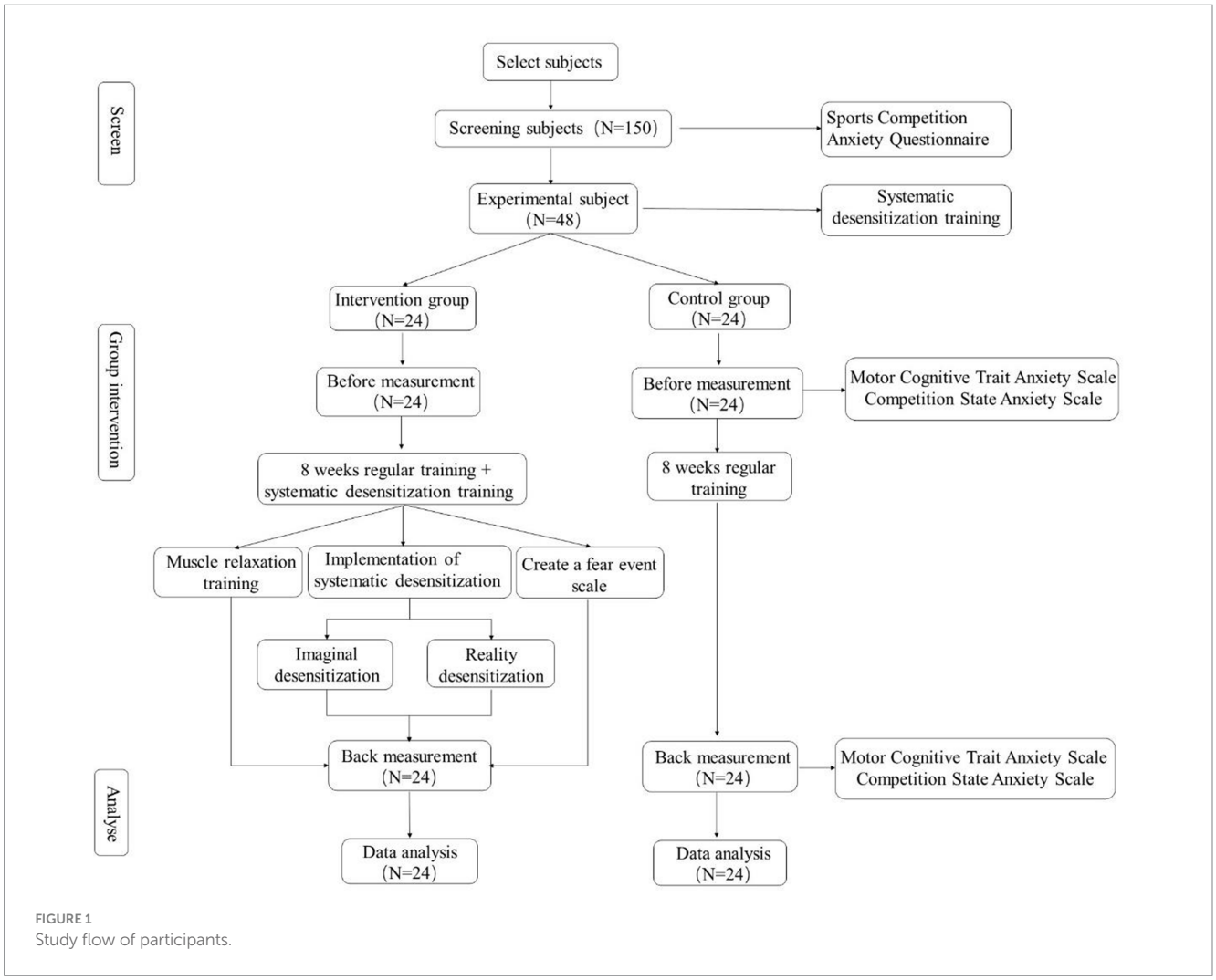

FIGURE 1
Study flow of participants.

TABLE 1 Fear event scale.

Serial number	Event	Level
1	Think of a lot of spectators and contestants	10
2	Think of the atmosphere at the stadium	20
3	Think of the strength of the opponent	30
4	Thinking about how unprepared you might be	40
5	Thinking that the referee may be biased	50
6	Thinking about the possibility of unexpected results	60
7	Thinking about the possibility of injury in the game	70
8	The thought of not getting good grades facing partners and coaches	80

relaxation and progressive relaxation training combined with suggestive language were used to relax the muscles until the subjects were free of anxiety and fear of the imaginary situation and then moved to the next level (Liang et al., 2021).

2.3.3 Mental relaxation method mental relaxation method

Step 1: The athlete needs to adopt a proper preparation position, such as sitting or standing, feet shoulder width apart, arms naturally down, and legs naturally upright.

Step 2: The athlete closes his eyes and mentally imagines that he is riding a "roller coaster at a constant speed." Athletes imagine themselves starting at the beginning of the "roller coaster" and sliding along the lower end to the upper end. At this time, the athlete inhales slowly, silently saying "relax" in his heart. While the athlete appears to be at the top, he holds his breath for 3–5 s. Subsequently, the athlete begins to slide down on his own with the exhalation to reach the bottom end of the "roller coaster." The athlete pauses and relaxes when he reaches the bottom end.

Step 3: The athlete repeats the above imaginary exercise 3 times until the tension disappears or reduces in the body. Moreover, the athlete needs to be consciously focused so that he or she can remain relaxed during practice.

2.3.4 Progressive relaxation training

Step 1: The athlete needs in a supine preparatory position (lying flat on the bed, legs naturally straight, arms naturally placed in front of the body, palming facing down, and eyes gently closed).

Step 2: The athlete first makes a fist with his right hand and feels the tension for 5–8 s and then relaxes for 6–10 s to experience the relaxation. Then, the athlete makes a fist with his left hand for 5–8 s and then relaxes for 6–10 s. The above movements were repeated for 3–5 times.

Step 3: The athlete flexes the right forearm, contracting the biceps, and relaxing the body. Then, the athlete flexes his left forearm, contracting the biceps brachii, and relaxing the body. The above movements were repeated for 3–5 times.

Step 4: First, the athlete gritted his teeth and kept the tension for 5–8 s and then exhaled for 6–10 s to relax the body. Second, the athlete shrugs his shoulders, contracts his shoulder muscles to maintain tension for 5–8 s, and then exhales for 6–10 s to relax his body. Finally, the athlete takes a deep breath and holds the breath for 5–8 s and then exhales slowly to relax his body to experience the feeling of relaxation. The above movements were repeated for 3–5 times.

Step 5: The athlete contracts the abdominal muscles to maintain tension for 5–8 s and then exhales for 6–10 s to relax the body. The athlete tenses his toes for 5–8 s and then exhales for 6–10 s to relax his body. The athlete extends the ankle and holds the tension for 5–8 s and then exhales for 6–10 s to relax his body. The athlete uses abdominal breathing to hold tension for 5–8 s to bulge the abdomen, followed by exhalation for 6–10 s to relax the body and groove the abdomen. The above movements were repeated for 3–5 times.

2.3.5 Relaxation training with added suggestions

After the physical relaxation exercises, the athlete begins to have an imaginary desensitization exercise with suggestive words (20–30 min each). First, the athlete adjusts himself to a comfortable sitting position, keeping the body upright. At the same time, the athlete slowly closes his eyes and takes 3–5 deep breaths. Subsequently, the athlete inhales softly to the accompaniment of light music, feeling the cool air enter the body along the nasal passages. The athlete then exhales slowly, feeling like spitting out all the tension, restlessness, and anxiety.

Step 1: The athlete imagines the situation in the first and second levels of anxiety. When the athlete feels nervous and uncomfortable, the experimenter gives the athlete a corresponding suggestion. At the same time, the athlete engages in autosuggestion ("Now focus your attention on your head, feel your scalp, forehead, and temples, be aware of your eyes, cheeks, ears, and chin. I feel very relaxed in my whole head and face. Give this relaxation to your neck, to your shoulders, to feel these areas," "Breathe calmly and slowly, breathe very slowly and deeply," "I feel quiet," "I feel relaxed" and other suggestive words to intervene).

Step 2: The athlete imagines the situation of the third- and fourth-level anxiety events. The instructor gives the athlete a cue. ("Shift your attention to the arms, to your upper arms, elbows and forearms and wrists, palms and fingers, the entire shoulders and arms are completely noticed by you." "My whole body is relaxed." "I feel peaceful, comfortable and relaxed all over." "I feel a kind of inner peace").

Step 3: The athlete imagines the situation of the anxiety event in grades 5 and 6. The instructor gives the athlete a corresponding suggestion. ("Now focus your attention on your chest, your back expands as you inhale and contracts as you inhale." "Pay attention to your abdomen, which expands as you inhale and contracts as you exhale." "Put your attention on the spine, relax the muscles around the spine completely, release all the tension completely, and experience this feeling of relaxation," "My mind is quiet, I do not feel anything around me." "My arms are heavy and warm").

Step 4: The athlete thinks of the situation of the anxiety event in grades 7 and 8. The instructor gives the athlete a cue. ("Focus on the pelvis and hips, thighs, knees, and calves." "Bring your breath into these places and relax slowly, slowly relax." "Continue to bring your breath to your feet and toes, the whole leg and both feet are very relaxed." "Then focus on the whole body and imagine yourself as a scanner, from head to toe, everywhere you notice." "Your head, torso and limbs are completely relaxed." "The light warmth flows into my hands, my hands are warm and heavy." "My abdomen, the middle part of my body, felt heavy and relaxed").

2.4 Reality-based systematic desensitization

After the desensitization training of the imaginary system, the realistic desensitization training is carried out in the way of simulated competition. This comprehensive approach will integrate diverse influential factors encompassing audience dynamics, venue specifics, the presence of referees, and the diverse dynamics involving opponents. The experimental group felt the anxiety situation caused by the competition before the match by simulating the competition field.

Simulated Competitions Organization: Scheduled at a biweekly interval, simulated competitions will be meticulously arranged. Each preparatory phase will involve the meticulous recreation of an authentic competitive environment. This will include the utilization of a standard 12 m*12 m Latin dance competition floor, completing with requisite sound and lighting infrastructure. An approximate audience of 200 individuals will be invited to each simulated contest, aiming to replicate the ambiance characteristic of a genuine audience atmosphere. The presence of professional referees will ensure on-site evaluations, thereby safeguarding fairness and impartiality. Attire conformity to the standards of official competitions will be mandatory for all participants, because of both intervention and control group members, alongside additional participants, will be randomly assigned competitive roles for the first time. This progress will be devised for each simulated competition, including tailoring schedules, encompassing award allocations, to strive to emulate the ambiance characteristic of official competitive engagements.

Monitoring Competitors' Anxiety Levels: A comprehensive examination of competitors' competitive anxiety levels will be conducted both before and after the simulated competitions. Upon the conclusion of each simulated event, participants within the intervention group will receive ongoing imaginative desensitization interventions until their competitive anxiety is a successful resolution.

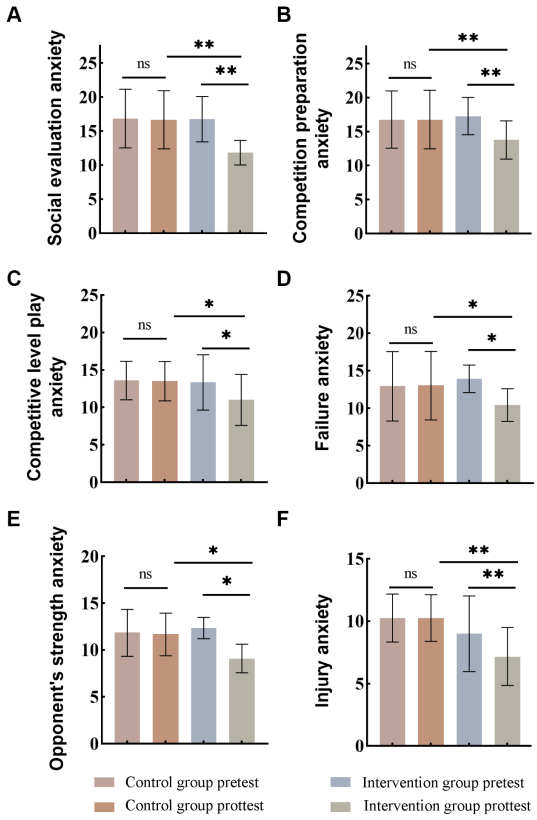

FIGURE 2
After the intervention of systematic desensitization training, the analysis of the cognitive trait anxiety in the intervention group is as follows: **(A)** Social evaluation anxiety. **(B)** Competition preparation anxiety. **(C)** Competitive level play anxiety. **(D)** Failure anxiety. **(E)** Opponent's strength anxiety. **(F)** Injury anxiety. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

2.5 Statistical analysis

All data were measured as mean ± standard deviations. Statistical analysis was conducted by the one-way ANOVA test, considering the values with $p \leq 0.05$ as indicating a significant difference. GraphPad Prism 8 software was used for data analysis.

3 Result

3.1 Sports cognitive trait anxiety intervention

Compared with conventional training approaches, this study implemented systematic desensitization training within athletes' schedules to alleviate the impact of competitive anxiety associated with cognitive traits in sports. Figure 2A demonstrates a comparison of social evaluative anxiety data before and after the intervention. Initial results unveiled that the pre-test social evaluative anxiety score within the intervention group was 16.75 ± 0.96. After systematic desensitization training, the intervention group experienced a substantial reduction in anxiety levels, with the post-test score notably decreasing to 11.83 ± 0.51, indicating a significant 29.37% decline. Conversely, the control group maintained consistent pre- and post-test social evaluative anxiety values of 16.83 ± 1.24 and 16.66 ± 1.29, respectively, without statistically significant variance. Figure 2B illustrates a comparative assessment of anxiety levels associated with competition preparation before and after the intervention experiment. The intervention group exhibited a decline from 17.25 ± 0.78 to 13.75 ± 0.80, representing a reduction of 20.31% in anxiety levels. Similarly, anxiety related to on-field performance decreased from 13.25 ± 1.10 to 11.00 ± 0.98 post-intervention, indicating a reduction of 16.98% (Figure 2C). Furthermore, post-intervention failure anxiety reduced from 13.91 ± 0.52 to 10.41 ± 0.62, illustrating a decrease of 25.16% in anxiety levels (Figure 2D). Anxiety associated with the opponent's capabilities decreased from 12.33 ± 0.33 to 8.08 ± 0.28 post-intervention, demonstrating a significant reduction of 34.47% (Figure 2E). Furthermore, the anxiety related to injuries post-intervention decreased from 9.00 ± 0.87 to 7.16 ± 0.67, signifying a notable 31.56% decrease in anxiety levels (Figure 2F). Additionally, in terms of sports cognitive trait state anxiety, initial values in the intervention group spanned from 106 to 62, with an average of 82.5. After intervention, sports cognitive trait anxiety ranged from 83 to 46, averaging 63.25. Post-assessment data showed significant statistical differences between the experimental and control groups, indicating a 23.33% average reduction in anxiety levels after post-intervention. These results indicated that systematic desensitization training has remarkable efficacy in significantly mitigating sports cognitive trait

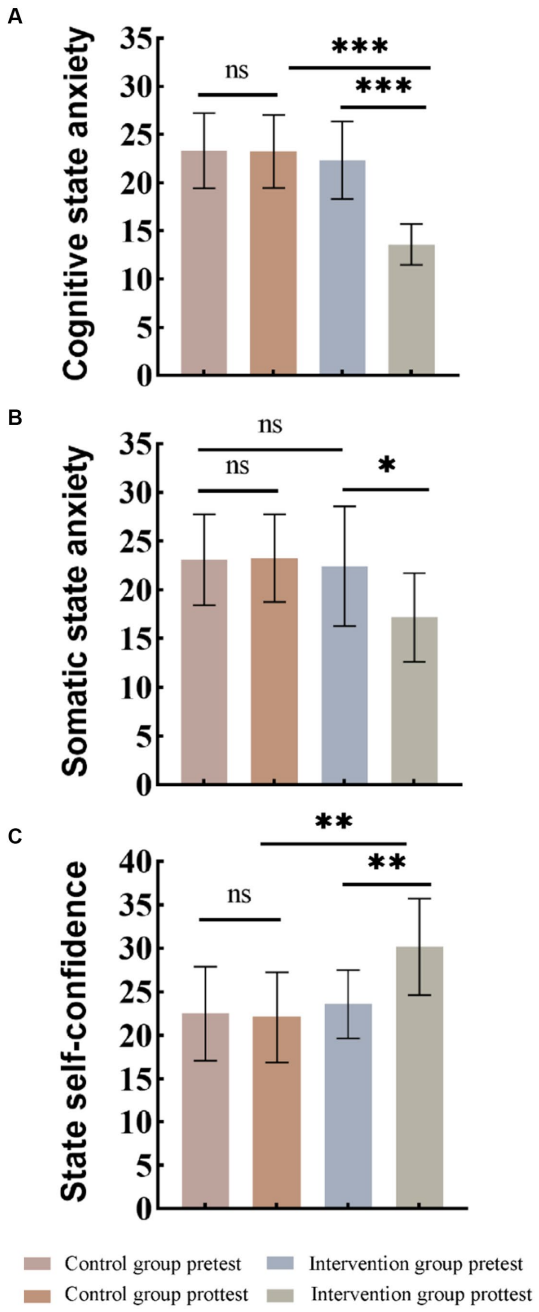

FIGURE 3
After system desensitization training intervention, the anxiety levels of the intervention group in competition were analyzed as follows: **(A)** Cognitive state anxiety. **(B)** Somatic state anxiety. **(C)** State self-confidence. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

anxiety of athletes, specifically in addressing anxiety linked to opponents' capabilities.

3.2 Intervention for competition state anxiety

Systematic desensitization training addresses athletes' competitive state anxiety by regulating their cognitive state, somatic responses, and self-confidence, thereby impacting their performance in competitive settings. Figure 3A illustrates a comparative analysis of cognitive state anxiety levels before and after intervention. The results indicated that the initial cognitive state anxiety value in the intervention group was 22.33 ± 1.15. After the intervention, this value notably decreased to 13.58 ± 0.60, reflecting a remarkable reduction of 39.19% in cognitive state anxiety. In contrast, the control group showed pre-test cognitive state anxiety values of 23.33 ± 1.12 and post-test values of 23.08 ± 1.11, indicating minimal variation. Figure 3B illustrates a comparative analysis of somatic state anxiety levels before and after the intervention. The findings showed that the intervention group's initial somatic state anxiety value was 22.41 ± 1.77, which notably decreased to 17.16 ± 1.31 after the intervention, indicating a considerable reduction of 21.43% in somatic state anxiety. Conversely, the control group exhibited pre-test values of 23.08 ± 1.34 and post-test values of 22.75 ± 1.25, indicating no statistically significant disparities. Figure 3C presents comparative analyses of state self-confidence before and after the intervention. The results suggested that the state self-confidence of intervention group initially measured 24.83 ± 1.62, rising to 28.41 ± 1.25 after the intervention, representing a notable 14.42% increase in state self-confidence. In contrast, the control group's pre-test and post-test values were 22.50 ± 1.55 and 22.41 ± 1.57, respectively. This study emphasizes the efficacy of systematic desensitization training in alleviating cognitive state anxiety and somatic state anxiety among athletes, augmenting their self-assurance. Moreover, systematic desensitization training exhibits a more substantial impact on alleviating athletes' cognitive state anxiety under similar conditions.

The total anxiety value in the control group decreased by 0.19% after 8 weeks, which was considered to be unchanged within the statistical error range. Conversely, the competition anxiety of athletes could be reduced by 26.17% after the systematic desensitization training intervention (Eq1). To sum up, compared to the control group, the results of the systematic desensitization training intervention reveal a notable reduction in exercise cognitive trait anxiety within the experimental group implying a favorable alteration in exercise cognitive trait anxiety attributed to systematic desensitization training.

The calculation process of the effect size of the interventions is as follows:

$$\left[\left(I_f - I_b\right)/I_f - \left(C_f - C_b\right)/C_f\right] \times 100\% \quad (1)$$

wherein I_f is the total anxiety before the intervention, I_b is the total anxiety after the intervention, C_f is the total anxiety before the intervention of the control group, and C_b is the total anxiety of the control group after 8 weeks.

4 Discussion

The primary aim of this study is to amalgamate psychological intervention methodologies with Latin dance exercise, thereby investigating the impact of systematic desensitization training on competition state anxiety and exercise cognitive trait anxiety

among Latin dance athletes. The physical activity intervention administered in this research endeavors not only to optimize individual physical function and form but also to regulate individual competition anxiety levels through a series of scientifically grounded training modalities and psychological counseling sessions. Concurrently, by bolstering self-efficacy and self-assurance, athletes are better equipped to confront competitions with heightened composure and confidence, thereby mitigating the adverse effects of competition anxiety. Furthermore, significant alterations in competition state anxiety (comprising cognitive state anxiety, somatic state anxiety, and state self-confidence) were observed within the experimental group post-intervention, underscoring the beneficial influence of systematic desensitization training on competition state anxiety among Latin dance athletes.

This study employs a systematic desensitization training strategy to address competition anxiety among Latin dance athletes (Tanguy et al., 2018). Compared to alternative intervention methods, systematic desensitization training can yield positive outcomes within 8 weeks. This advantage is chiefly attributed to the unique mechanism of action inherent in the intervention method. Systematic desensitization training facilitates anxiety alleviation by systematically exposing athletes to anxiety-inducing scenarios, thereby assisting them in cultivating resilience to anxiety (Chirivella and Esquiva, 2011).

In the investigation of systematic desensitization training as an intervention for competition anxiety among Latin dance athletes, several limitations persist. First, the limited participant pool of the study may impede the generalizability and reliability of the findings as they may not fully represent the diversity within the Latin dance athlete population. Secondly, while the measurement methods were underwent rigorous translation and validation processes, they predominantly relied on self-reporting, rendering them susceptible to subjective biases from participants and potentially compromising the objectivity and accuracy of the data. Future research endeavors should focus on establishing the long-term stability of the effectiveness of systematic desensitization training in reducing competition anxiety among Latin dance athletes. Initial research signals suggest the feasibility of such stability, instilling optimistic prospects for future investigations.

5 Conclusion

Systematic desensitization training, a psychological intervention method in psychiatry, is predominantly employed in clinical settings for psychological therapy among patients. Specifically, this method exhibits remarkable effectiveness in anxiety-related emotions. This study innovatively employs systematic desensitization training in the sports realm, investigating psychological alterations in competitive anxiety among Latin dance performers subjected to this intervention. The results suggested that the psychological intervention substantially can reduce competitive anxiety levels among Latin dance performers and significantly enhance competitive skills and achievements. Furthermore, this study also plays a significant role in guiding and reference for other sports.

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

The studies involving humans were approved by Harbin Sport University Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

JC: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis. DZ: Writing – review & editing, Formal analysis. DG: Writing – review & editing, Investigation. SW: Writing – review & editing, Visualization, Supervision, Resources, Methodology, Conceptualization. WC: Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis.

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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

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2024.1371501/full#supplementary-material

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Psychological correlates of physical activity among adults living in rural and urban settings

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Middle-aged and older adults living in rural settings have been consistently less likely to report regular physical activity (PA) than those living in urban settings. While past literature has identified sociodemographic and environmental correlates of PA that may contribute to these differences, consideration of psychological correlates has been limited. A total of 95 rural and urban adults ≥50 years old provided self-reported sociodemographic information, PA level, and psychological correlates of PA including measures assessing motivation, self-efficacy, social support, and attitudes related to PA. The average participant age was 68.6 years, and most were female (62.1%) and married (70.5%). While PA level did not differ significantly between the rural and urban groups, different psychological correlates contributed significantly to separate rural and urban linear regression models considering PA status. Among rural adults, more positive attitudes toward PA, and greater PA self-efficacy and social support were associated with greater amounts of PA while for urban adults, no psychological correlates were significantly associated with PA. Psychosocial factors may be key considerations in developing more effective PA interventions in middle-aged and older adults living in rural areas.

KEYWORDS

older adults, physical activity, psychological factors, rural health, urban health

Introduction

The benefits of regular physical activity (PA) are well documented in middle-aged and older adults (Langhammer et al., 2018; Centers for Disease Control and Prevention, 2023a). PA has an important role in helping adults preserve independence, control weight, prevent or manage chronic disease, and maintain muscle, joint and bone health (Sun et al., 2013; Langhammer et al., 2018; Eckstrom et al., 2020). PA has also been used in the prevention and management of many chronic health conditions affecting a substantial proportion of middle-aged and older adults, including cardiovascular disease, diabetes, and cancer (Anderson and Durstine, 2019). Although they can benefit from PA, middle-aged and older adults are the least physically active of any age group in the United States (Elgaddal et al., 2020), and there are further inequities in PA across many sociodemographic factors, including geographic location (Whitfield et al., 2023). Compared to urban or metropolitan older adults, fewer rural adults participate in regular PA (Cohen et al., 2018; Pelletier et al., 2021; Whitfield et al., 2023).

Several studies suggest that rural middle-aged and older adults are consistently less active than their urban counterparts (Parks et al., 2003; Martin et al., 2005; Cohen et al., 2018;

Pelletier et al., 2021; Whitfield et al., 2023). However, other studies have noted higher levels of specific types of PA among adults living in more rural environments, such as recreational cycling (Arnadottir et al., 2009; Van Dyck et al., 2011; Fan et al., 2014). PA may be particularly important in rural communities, as rural adults are more likely to die from a variety of chronic diseases associated with physical inactivity including heart disease, cancer, and chronic lower respiratory disease (Centers for Disease Control and Prevention, 2023b). PA has been associated with health-related quality of life and mental health among adults living in rural areas (Hart, 2016; Smáradóttir et al., 2020). Limitations in the built environment and other structural barriers may be key drivers of rural–urban differences in PA (Brownson et al., 2009; Ferdinand et al., 2012; Sallis et al., 2020). However, improving the built environment in rural areas may not be sufficient to increase PA participation; other cultural, social, or psychological factors must be considered (Brownson et al., 2000; Trost et al., 2002; Wilcox et al., 2003; Koeneman et al., 2011; Perrin et al., 2016). Participating in regular PA is a complex behavior influenced by many factors (Trost et al., 2002; Park et al., 2015; Pelletier et al., 2021). In addition to the built environment, psychological determinants of PA, such as attitudes, expectations, beliefs, and knowledge of PA, are powerful predictors of long-term participation in PA among middle-aged and older adults (Harris et al., 2009; van Stralen et al., 2009; Kosteli et al., 2016).

While the built environment has been extensively considered in the context of PA differences between rural and urban adults, the associations of psychological factors in these contexts are unclear (Schutzer and Graves, 2004; Newson and Kemps, 2007; Kosteli et al., 2016). Psychological correlates of PA have been identified among older adults, including motivation for PA, social support for PA, and PA self-efficacy (Booth et al., 2000; Shores et al., 2009; Ayotte et al., 2010). However, comparisons of psychological correlates of PA between rural and urban adults may allow determination of specific psychological correlates that may be particularly beneficial in each setting. Identifying specific psychological correlates of PA in rural and urban older adults would allow targeted PA promotion programs for these individual populations. Thus, the purpose of this study is to assess psychological correlates of PA among rural and urban adults.

Methods

Participants

Participants were adults ≥50 years old who attended mobile health screening clinics at various locations across Iowa. Participants were invited to complete an optional PA questionnaire while waiting for their health screening. The survey probed PA participation and primary theoretical constructs underlying PA behavior (i.e., socio-ecological model, social cognitive theory, theory of planned behavior, and motives for PA). This study was approved by the Institutional Review Board and participants provided informed consent prior to data collection. Questionnaires were provided in the same order to each participant, and the questionnaires took approximately 10–15 min to administer. Participants were encouraged to contact the research team with any questions or concerns.

Rural or urban designation

The U.S. Health Resources and Services Administration guidelines (U.S. Health Resources and Services Administration, 2022), which combine US Census, Office of Management and Budget, and Rural–Urban Commuting Area classifications, were used to identify rural areas as described in previous studies (Chrisman et al., 2014; Abildso et al., 2021). Participants living in zip codes identified to be rural were assigned a "rural" label while those outside of these zip codes were assigned an "urban" label.

Primary outcome

Physical activity

The PA was measured using the Physical Activity Scale for the Elderly (PASE) (Washburn et al., 1993). The PASE is a brief instrument designed specifically to assess PA in older people over the past week. PASE is a reliable and valid measure of PA in older adults ($\alpha = 0.75$) (Washburn et al., 1993, 1999).

Perceptions of an individual's neighborhood were assessed with the Neighborhood Environment Walkability Scale (NEWS) (Saelens et al., 2003; Cerin et al., 2006). Three subscales of this measure were utilized including residential density, land use mix-access, and neighborhood satisfaction. Residential density was measured using six items inquiring about the types of buildings in an individual's neighborhood rated on a 5-point Likert scale ("none" to "all"). Land use mix-access was assessed with seven items inquiring about access to various locations in their neighborhood (i.e., local stores, transit stops). These items are rated on a 4-point Likert scale ranging from "strongly disagree" to "strongly agree." Finally, general neighborhood satisfaction was measured with a 17-item 5-point Likert scale. Items assessing perceptions of an individual's neighborhood were rated from "strongly dissatisfied" to "strongly satisfied." Internal consistencies were acceptable in the current sample (residential density $\alpha = 0.68$; land use mix-access $\alpha = 0.73$; neighborhood satisfaction $\alpha = 0.94$).

Primary predictors

We assessed numerous psychological variables that have previously been shown to be associated with PA. We included psychological questionnaires, described in more detail below, that assessed motivation, intention, self-efficacy, barriers, enablers, social support, perceptions, and attitudes toward PA. Given the theoretical similarities between the psychological scales, a principal components analysis (PCA) was used to identify distinct psychological correlates of PA and the resulting components used as the primary predictors are described below.

Component 1: motivation for PA

Motivation for PA was assessed using the Motives for Physical Activity Measure - Revised (MPAM-R) (Ryan et al., 1997). The five motives assessed were (1) fitness, or being physically active out of the desire to be physically healthy, strong, and energetic; (2) appearance, or being active to become more physically attractive, to have defined muscles, to look better, and to achieve or maintain a desired weight;

(3) competence/challenge, or being physically active because of the desire to improve at an activity, to meet a challenge, and to acquire new skills; (4) social, or being physically active in order to be with friends and meet new people; and (5) enjoyment, or being physically active because it is fun, increases happiness, and is interesting, stimulating, and enjoyable (Ryan et al., 1997). Internal consistencies were acceptable in the current sample (fitness $\alpha = 0.95$; appearance $\alpha = 0.91$; competence $\alpha = 0.94$; social $\alpha = 0.90$; enjoyment $\alpha = 0.94$).

Decisional balance, or the pros and cons of PA, was determined using a 16-item questionnaire, with 10 items pertaining to pros of PA while 6 items measured cons of PA (Marcus et al., 1992). Participants rated how each item affected their decision to engage in regular PA. The pros items were summed to produce raw scores that could range from 10 to 50, while the cons items were summed to produce raw scores that could range from 6 to 30. Internal consistency was adequate in our sample (pros $\alpha = 0.97$; cons $\alpha = 0.76$).

Component 2: PA self-efficacy

Intention to engage in PA and perceived behavioral control of PA, concepts of the Theory of Planned Behavior, were measured using questions from a previous study involving older adults (Gretebeck et al., 2007). Perceived behavioral control was measured with 3 items rating the ease or difficulty and amount of control they had over performing PA on a Likert scale. Internal consistency was adequate in our sample ($\alpha = 0.80$). Intention was measured with 2 items in which participants rated their likelihood and intention of being physically active for 30 min, 3 days/week. Higher ratings reflected greater intention to participate in PA. Internal consistency was acceptable in our sample ($\alpha = 0.91$).

Self-efficacy was assessed through two measures. The Exercise Self-Efficacy Scale (McAuley, 1993) is an 8-item measure that considers the participant's beliefs in their ability to continue exercising at a moderate intensity for 3 times/week for 40 min or more over the next month. Internal consistency was acceptable in our sample ($\alpha = 0.96$). Barrier self-efficacy for PA was assessed using a 12-item scale (McAuley and Mihalko, 1998) investigating adults' perceived capabilities to exercise three times/week for the next 3 months in the face of barriers (e.g., bad weather, lack of interest/boredom, pain, and discomfort). Internal consistency was adequate in our sample ($\alpha = 0.97$).

Component 3: social support for PA

Social support for PA was assessed using a 20-item questionnaire in which participants rated how often family (5 items) and friends (15 items) engaged in acts that were supportive of PA in the past 3 months, from 1 (never) to 5 (very often) (Sallis et al., 1987). The mean of the scores were calculated, with higher scores indicating greater social support. Internal consistency was adequate in the current sample (family $\alpha = 0.94$; friends $\alpha = 0.93$).

Component 4: attitudes toward PA

Instrumental attitude and affective attitude regarding PA, concepts of the Theory of Planned Behavior, were measured using questions from a previous study involving older adults (Gretebeck et al., 2007). The attitude toward PA scales were measured with 8 items using a 7-point semantic differential bipolar adjective scale (from −3 to 3). Positive scores indicated a more optimistic attitude toward PA. Internal consistency was acceptable in our sample ($\alpha = 0.94$).

Covariates

Participants self-reported sociodemographic and health characteristics including age, gender, education, marital status, health rating, height, and weight.

Statistical analysis

Given the theoretical similarities between the psychological scales, a principal components analysis (PCA) was used to identify distinct psychological correlates of PA. Missing data were addressed at the individual measure level, with individual measure scores imputed from the average of completed rural and urban scales. The number of imputations varied by scale: PASE: 1 (1.1%), barriers self-efficacy: 3 (3.2%), PA self-efficacy: 4 (4.2%), instrumental attitude: 9 (9.5%), affective attitude: 10 (10.5%), perceived behavioral control: 2 (2.1%), intention: 2 (2.1%), pros: 4 (4.2%), social support- family: 7 (7.4%), social support- friends: 8 (8.4%), motives- interest: 4 (4.2%), motives-competence: 3 (3.2%), motives- appearance: 4 (4.2%), motives- fitness: 4 (4.2%), and motives-social: 4 (4.2%). Imputation was performed prior to PCA analysis. As our sample size precludes inclusion of numerous covariates, demographic and health-related variables were examined for inclusion as covariates in the linear regression models based on relationships with PA using bivariate correlations. Following PCA analysis, individual linear regression models assessing the associations of the PCA components with PA level (PASE) were performed for the combined group, as well as separate rural and urban subgroups.

Results

Preliminary analysis

A PCA was performed with the summary scores of 16 measures of hypothesized correlates of PA in 95 participants. The cons of PA subscale and subjective norm item were dropped from the analysis as neither had a correlation coefficient >0.3 with any other scale, leaving 14 measures in the final PCA. The data was assessed for suitability of PCA prior to analysis. The correlation matrix demonstrated that all remaining measures had at least one correlation coefficient greater than 0.3 and the overall Kaiser–Meyer–Olkin (KMO) value was 0.84. Bartlett's test of sphericity was statistically significant ($p < 0.001$), indicating data factorizability. The PCA reported four components with eigenvalues greater than one which explained 45.91, 11.32, 10.00, and 9.33% of the total variances, respectively. Scree plot visualization suggested the retention of four components (Cattell, 2023). Therefore, four components were retained.

The four-component model explained 76.56% of the total variance. A Varimax with orthogonal rotation assisted with interpretation. The interpretation of the data was consistent with identified correlates of PA with strong loadings of motivation for PA on Component 1, PA self-efficacy on Component 2, social support for PA on Component 3, and attitudes toward PA on Component 4. PCA results can be found in Table 1.

Bivariate correlations between PA and age, gender, education, marital status, overall health, and body mass index (by calculating

TABLE 1 Principal components analysis results role of psychological correlates in explaining PA in combined, rural, and urban older adults.

	Factor 1	Factor 2	Factor 3	Factor 4
Motivation- fitness	**0.84**	0.31	−0.03	0.14
Motivation- appearance	**0.81**	0.25	0.11	0.09
Motivation- competence	**0.81**	0.22	0.32	0.13
Motivation- interest or enjoyment	**0.78**	0.17	0.34	0.25
Exercise pros	**0.74**	0.26	−0.08	0.05
Motivation- social	**0.62**	−0.16	0.51	0.28
Perceived behavioral control	0.16	**0.83**	0.05	0.23
Intention to exercise	0.19	**0.83**	0.04	0.20
PA self-efficacy	0.45	**0.76**	0.27	−0.07
Barriers self-efficacy	0.35	**0.62**	0.28	0.20
Social support- friends	0.09	0.06	**0.84**	0.07
Social support- family	0.12	0.30	**0.80**	0.04
Affective attitude	0.17	0.18	0.12	**0.88**
Instrumental attitude	0.17	0.21	0.04	**0.88**

Factor 1 represents motivation for PA, Factor 2 represents PA self-efficacy, Factor 3 represents social support for PA, and Factor 4 represents attitudes toward PA. Motivation- fitness, Motivation – appearance, Motivation- competence, Motivation- social, and Motivation- interest or enjoyment measured by Motives for Physical Activity Measure-Revised (MPAM-R). Exercise pros measured by decisional balance items described in Marcus et al. (1992). Perceived behavioral control, Intention to exercise, Instrumental attitude, and Affective attitude measured as described in Gretebeck et al. (2007). PA self-efficacy measured by Exercise Self-Efficacy Scale. Barriers self-efficacy measured as described by McAuley and Mihalko (1998). Social support-friends and social support- family measured as described by Sallis et al. (1987).
Bolded items indicate the PCA Factor with which each item loads on the most.

weight (kg)/height (m^2)) were each assessed, but only age was significantly correlated with PA [$r(95) = -0.44$, $p < 0.001$]. Therefore, only age was included as a covariate in the primary regression models.

Primary analyses

Table 2 lists baseline characteristics of the rural and urban participants. In general, urban participants were more likely to be male with greater educational attainment than rural participants. Rural participants were more likely to be married, while urban participants were more likely to be widowed. There was no significant difference in PA levels between urban and rural adults [urban $M(SD) = 175.12$ (82.65); rural $M(SD) = 168.70$ (105.69); $t(93) = -0.33$; $p = 0.742$]. Middle aged adults (<65 years old) reported higher levels of PA compared to older individuals (≥65 years old) [$t(94) = 4.09$; $p < 0.001$]. Rural adults reported more positive attitudes toward PA than urban adults, as assessed by Component 4 of the PCA [$t(92) = 3.90$; $p < 0.001$] and affective attitude [$t(93) = 3.14$; $p = 0.002$] and instrumental attitude [$t(93) = 2.17$; $p = 0.032$] subscales. Urban adults reported significantly greater PA self-efficacy [$t(93) = -2.22$; $p = 0.029$]. All other individual scale comparisons were not significant between rural and urban groups.

Results of the combined final model indicated that age [$\beta = -0.39$, $t(93) = -4.24$, $p < 0.001$] and PA self-efficacy [$\beta = 0.29$, $t(93) = 3.36$, $p = 0.001$] significantly contributed to PA level (Table 3). For the rural sample, age [$\beta = -0.31$, $t(46) = -2.54$, $p = 0.015$], self-efficacy [$\beta = 0.28$ $t(46) = 2.41$, $p = 0.020$], social support [$\beta = 0.34$, $t(46) = 2.78$, $p = 0.008$], and attitudes toward PA [$\beta = 0.29$, $t(46) = 2.50$, $p = 0.017$] were each significantly associated with PA level. In the urban sample, only age [$\beta = -0.51$, $t(47) = -3.63$, $p < 0.001$] was significantly associated with PA level. Detailed regression results can be found in Table 3.

Sensitivity analyses

Gender and education were explored as covariates in conjunction with age in the regression models given their established association with physical activity (Plotnikoff et al., 2004). With these added covariates, the attitudes toward PA component was also significantly associated with PA ($p = 0.021$) in the combined model. There were no significantly different conclusions in the rural or urban stratified models.

In an additional sensitivity analysis, we assessed associations of available neighborhood environment-related subscales with PA. Neighborhood Environment Walkability Scale (Saelens et al., 2003; Cerin et al., 2006) subscales were available for a subset of participants in our sample (residential density $n = 78$; land use mix-access $n = 60$; neighborhood satisfaction $n = 89$). Neither residential density, described as the perceived density of residences in an area, or land use mix-access, defined as the perceived ability to access places nearby through PA, differed between rural and urban groups [$t(76) = 0.06$, $p = 0.949$; $t(58) = -0.60$, $p = 0.552$]. However, rural adults reported greater neighborhood satisfaction than urban adults [$t(87) = 2.45$, $p = 0.016$]. Therefore, neighborhood satisfaction was included in a regression model with age and the PCA components. In the combined model, social support was significantly associated with PA in addition to age and self-efficacy. Social support ($p = 0.012$) and attitudes toward PA ($p = 0.028$) remained significant in the rural model. There were no significant predictors in the urban subsample ($ps > 0.05$).

Discussion

PA among rural and urban adults

This study aimed to identify psychological correlates of PA in rural and urban middle aged and older adults. Middle aged adults

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TABLE 2 Descriptive characteristics of the sample.

	Total (*N* = 95)	Urban (*N* = 48)	Rural (*N* = 47)
Age, *M* years (*SD*)	68.55 (11.2)	67.63 (11.5)	69.49 (11.0)
Gender, *N* (%)			
Female	59 (62.1)	26 (54.2)	33 (70.2)
Male	36 (37.9)	22 (45.8)	14 (29.8)
Education*			
High school or less	40 (42.5)	16 (33.4)	24 (52.2)
Trade school	12 (12.8)	3 (6.3)	9 (19.6)
Some college	10 (10.6)	8 (16.7)	2 (4.3)
College degree or higher	32 (34.1)	21 (43.9)	11 (23.8)
Marital status, *N* (%)			
Never married	2 (2.1)	1 (2.1)	1 (2.1)
Married	67 (70.5)	36 (58.3)	31 (66.0)
Divorced or separated	10 (10.5)	5 (10.4)	5 (10.6)
Widowed	16 (16.8)	6 (12.5)	10 (21.3)
Overall health, *N* (%)			
Excellent	15 (15.8)	11 (22.9)	4 (8.5)
Good	62 (65.3)	28 (58.3)	34 (72.3)
Fair	16 (16.8)	8 (16.7)	8 (17.0)
Poor	2 (2.1)	1 (2.1)	1 (2.1)
BMI, *M* (*SD*)	27.95 (4.9)	27.93 (5.1)	27.98 (4.6)
PASE, *M* (*SD*)	171.94 (94.3)	175.12 (82.6)	168.70 (105.7)
Motivation- fitness, *M* (*SD*)	26.87 (8.1)	27.38 (7.5)	26.35 (8.7)
Motivation- competence, *M* (*SD*)	28.67 (11.6)	29.39 (11.7)	27.93 (11.6)
Motivation- interest or enjoyment, *M* (*SD*)	28.99 (12.0)	28.88 (11.9)	29.09 (12.3)
Motivation- appearance, *M* (*SD*)	27.47 (9.6)	28.30 (8.8)	26.62 (10.4)
Exercise pros, *M* (*SD*)	36.95 (10.5)	37.89 (9.5)	35.99 (11.6)
Motivation- social, *M* (*SD*)	16.19 (8.3)	15.19 (7.7)	17.21 (8.9)
Perceived behavioral control, *M* (*SD*)	3.55 (1.1)	3.62 (1.1)	3.47 (1.2)
Intention to exercise, *M* (*SD*)	3.47 (1.4)	3.53 (1.3)	3.41 (1.5)
PA self-efficacy, *M* (*SD*)*	41.47 (33.0)	48.75 (33.4)	34.04 (31.3)
Barriers self-efficacy, *M* (*SD*)	38.09 (26.7)	37.85 (26.7)	38.34 (27.00)
Social support- friends, *M* (*SD*)	1.69 (0.9)	1.73 (0.9)	1.65 (0.85)
Social support- family, *M* (*SD*)	2.10 (1.0)	2.09 (1.0)	2.11 (1.1)
Instrumental attitude, *M* (*SD*)*	2.13 (1.2)	1.87 (1.36)	2.39 (0.9)
Affective attitude, *M* (*SD*)*	1.68 (1.4)	1.26 (1.5)	2.10 (1.0)

*Indicates significant difference ($p < 0.05$) between groups. BMI, body mass index. PASE, Physical Activity Scale for the Elderly. Motivation- fitness, Motivation – appearance, motivation- competence, motivation- social, and motivation- interest or enjoyment measured by Motives for Physical Activity Measure-Revised (MPAM-R). Exercise pros measured by decisional balance items described in Marcus et al. (1992). Perceived behavioral control, Intention to exercise, Instrumental attitude, and Affective attitude measured as described in Gretebeck et al. (2007). PA self-efficacy measured by Exercise Self-Efficacy Scale. Barriers self-efficacy measured as described by McAuley and Mihalko (1998). Social support- friends and social support- family measured as described by Sallis et al. (1987).

reported higher levels of PA compared older adults, fitting with prior literature (Spartano et al., 2019). We found similar levels of PA in rural and urban participants, which contrasts with other studies reporting that rural residents engage in less PA than their urban counterparts (Cohen et al., 2018; Pelletier et al., 2021; Whitfield et al., 2023). Possible reasons for similar PA levels in our rural and urban participants include similar perceived residential density and land use mix-access, as well as greater neighborhood satisfaction among rural participants although this was not associated with PA in any final regression models. Lack of perceived differences in location accessibility and residential density, as well as greater neighborhood satisfaction may have caused our rural subset to be more active than rural groups in previous literature (Stronegger et al., 2010; Wang et al., 2019). Age was also the strongest predictor of PA levels, and age was

TABLE 3 Role of psychological correlates in explaining PA in combined, rural, and urban older adults.

Variable	*B*	*SE*	*β*	*t*	*p*	
Combined						$R^2 = 0.37$**
Age	**−3.34**	**0.79**	**−0.39**	**−4.24**	**<0.001**	
Motivation for PA	8.95	8.09	0.10	1.11	0.272	
Self-efficacy	**27.45**	**8.16**	**0.29**	**3.36**	**0.001**	
Social support	15.56	8.43	0.17	1.85	0.068	
Attitudes toward PA	15.54	8.01	0.17	1.95	0.056	
Rural						$R^2 = 0.49$**
Age	**−3.01**	**1.18**	**−0.31**	**−2.54**	**0.015**	
Motivation for PA	1.48	11.38	0.02	0.13	0.897	
Self-efficacy	**28.66**	**11.89**	**0.28**	**2.41**	**0.020**	
Social support	**34.63**	**12.47**	**0.34**	**2.78**	**0.008**	
Attitudes toward PA	**44.30**	**17.75**	**0.29**	**2.50**	**0.017**	
Urban						$R^2 = 0.36$**
Age	**−3.83**	**1.06**	**−0.51**	**−3.63**	**<0.001**	
Motivation for PA	17.06	11.47	0.20	1.49	0.144	
Self-efficacy	20.86	11.12	0.24	11,88	0.068	
Social support	−4.20	10.84	−0.05	−0.39	0.701	
Attitudes toward PA	5.21	9.16	0.07	0.57	0.572	

**$p < 0.001$. Physical activity as assessed through PASE is the outcome measure for each model. Motivation for PA representing Factor 1, self-efficacy representing Factor 2, social support representing Factor 3, and attitudes toward PA representing Factor 4. Bolded items contribute significantly to the model.

similar between our urban and rural samples, which has not always been the case in previous studies (Parks et al., 2003; Martin et al., 2005). Finally, while we followed HRSA rural–urban definitions, the range of populations for the rural and urban locales may not have been as extreme as in other studies. For example, the 'urban' zip codes in this study had an average population of 211,754 people while the rural areas averaged 25,934 people (US Census Bureau, 2010; U.S. Health Resources and Services Administration, 2022). Previous work reporting on rural–urban differences in PA has included much larger metro areas of 1–5+ million residents (US Census Bureau, 2010; Cohen et al., 2018). Thus, it is quite possible that Iowa is relatively more homogenous in its population density, which could contribute to less separation in rural and urban characteristics.

Psychological correlates of PA

Despite finding no differences in self-reported PA levels, different psychological correlates of PA were identified in stratified analyses performed with rural and urban participants. Among rural participants, greater social support, and self-efficacy, as well as more positive attitudes toward PA were associated with greater amounts of PA. This finding aligns with reports of social support barriers associated with lower PA levels among rural adults, while not urban adults (Pelletier et al., 2022). Among urban participants, however, none of the psychological correlates were significantly associated with PA. These results suggest that the association between psychological correlates and PA may differ based on rural or urban residence. Resources targeting psychological correlates of PA may be particularly impactful among rural adults, while PA may be more affected by other factors in urban adults such as the individual's physical health and environment (Weiss et al., 2007; Sallis et al., 2012).

Interestingly, motivation for exercise, while the leading component identified by the PCA analysis accounting for nearly half of the total variance, was not significantly associated with PA in the combined, rural, or urban models conflicting with findings in prior rural and urban samples (Pelletier et al., 2022). This finding suggests that motivation, which has been viewed as a vital predictor of PA performance and public health promotion target (Teixeira et al., 2012; Molanorouzi et al., 2015), may not be the primary driver of PA behavior in middle-aged and older adults. However, our results do fit with other literature demonstrating that motivation is a weaker predictor of PA than other psychological correlates, perhaps because motivation can be transient (Ryan and Deci, 2000; Braver et al., 2014). Social cohesion has been noted among many rural communities (Avery et al., 2021), and considering group attitudes and social support may be particularly important among individuals living in rural areas. On the other hand, urban areas may have more built-in support for PA with extensive infrastructure for PA, making social support and group attitudes less important in predicting PA level among urban adults. Our results indicate that considering the environment and characteristics of the targeted population and targeting self-efficacy, social support, and attitudes toward PA may produce more effective health promotion campaigns. While many PA promotion programs have targeted the built environment and motivation for PA (Brownson et al., 2009; Ferdinand et al., 2012; Sallis et al., 2020), our findings indicate that interventions targeting self-efficacy, social support, and attitudes toward PA may be more impactful, particularly among rural adults. Further research is needed to develop these intervention programs.

Limitations

There were limitations to the present study. The study was cross-sectional, and it is possible that higher levels of PA may exert reciprocal influences on positive psychosocial correlates of PA, distinct from the impact of rural or urban setting. The sample size was limited, and our findings cannot be extrapolated to all rural and urban middle-aged and older adults. PA was self-reported, which is prone to reporting bias.

Conclusion

In summary, rural middle-aged and older adults have been consistently noted to perform less PA than their urban peers and while sociodemographic and environmental correlates have been considered in prior work, there has been little investigation of potential psychological considerations. Our findings suggest that self-efficacy, social support, and positive attitudes toward PA are significantly associated with PA in rural populations, while psychological correlates were not significantly associated with PA in urban populations. Considering these findings in identifying those at risk of low PA levels and while developing more effective and specific PA campaigns may assist in improving health in these populations. Future studies could investigate interventions targeting distinct, specific psychological correlates in rural and urban areas to assist middle-aged and older adults in increasing PA levels and health. Intervention development in improving self-efficacy, social support, and attitudes toward PA among rural adults may be particularly impactful future research. Receiving community input through focus group discussions and an iterative study design may allow identification of community factors to consider in intervention development and implementation. Evaluating community factors will allow identification of important considerations prior to implementation of costly built environment or other intensive intervention. Our results indicate that considering psychological variables rather than solely the built environment may provide impactful PA interventions, particularly among rural adults.

Data availability statement

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

Ethics statement

This study involving humans was approved by the Iowa State University Institutional Review Board. The study was conducted in accordance with local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

ZS: Formal analysis, Methodology, Writing – original draft. AB: Formal analysis, Methodology, Supervision, Writing – review & editing. AH: Conceptualization, Investigation, Methodology, Writing – original draft. AW: Data curation, Investigation, Supervision, Writing – review & editing. JM: Methodology, Writing – review & editing. WF: Conceptualization, Data curation, Methodology, Supervision, Writing – review & editing.

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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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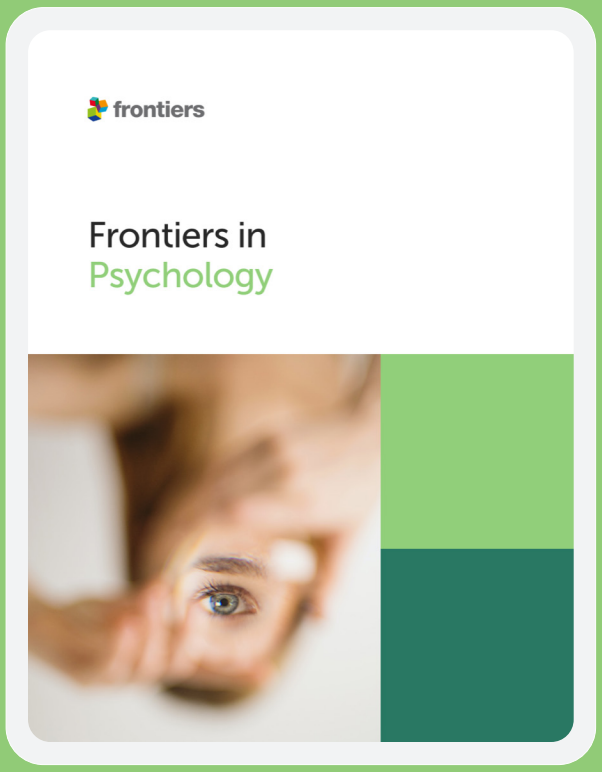

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