Psychological factors in physical education and sport,
volume III

Edited by
Manuel Gómez-López, Carla Maria Chicau Costa Borrego, Marianna Alesi
and David Manzano Sánchez

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Psychological factors in physical education and sport, volume III

Topic editors

Manuel Gómez-López — University of Murcia, Spain

Carla Maria Chicau Costa Borrego — School of Sports of Rio Maior, Polytechnic Institute of Santarém, Portugal

Marianna Alesi — University of Palermo, Italy

David Manzano Sánchez — University of Extremadura, Spain

Table of
contents

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Editorial: Psychological factors in physical education and sport, volume III

David Manzano-Sánchez[1], Carla Chicau Borrego[2], Marianna Alesi[3] and Manuel Gómez-López[4]*

[1]Department of Didactic of Plastic, Musical, and Body Expression, Faculty of Education and Psychology, University of Extremadura, Badajoz, Spain, [2]Sport Sciences School of Rio Maior, Polytechnic Institute of Santarém, Research Center in Life Quality, Rio Maior, Portugal, [3]Department of Psychology, Educational Sciences, and Human Movement, University of Palermo, Palermo, Italy, [4]Department of Physical Activity and Sport, Faculty of Sports Sciences, University of Murcia, Murcia, Spain

Editorial on the Research Topic
Psychological factors in physical education and sport, volume III

This Research Topic has compiled a large part of the scientific evidence that focuses on psychology and its influence on physical education and sports.

Currently, sports psychology and in the field of Physical Education, is being widely studied, especially due to the relevance it has for both the physical and cognitive development of people.

Thus, it is not surprising that studies such as that of Mira et al. conclude that aspects such as social support from influencers (parents, friends, and coaches) can help athletes with disability to improve their resilience and thus their ability to cope. The study by Dong et al. shows how it is necessary in the short and long term to work on the psychological aspect of athletes to avoid the dreaded "burnout" and to do so, variables such as gratitude, alongside a supportive coach-athlete relationship and elevated levels of hope, may play crucial roles in mitigating burnout symptoms in this case with a sample of 483 active team sports athletes. Linked to the previous study, Cao and Lyu conclude that in addition to adequate psychology on the part of athletes, a high capacity for perseverance on the part of instructors is necessary, above all, promoting more autonomous (self-determined) motivation and reducing demotivation and it is also vital to teach personal and cultural values to improve sports commitment. The study by Huard and Lemoyne also takes on special relevance, given that according to their research, proposals and recommendations must be made for coaches in order to promote positive development in players, with sports competition influencing factors such as early specialization or even the position and age of the players, in this case, as ice hockey players.

Another key point of the present Research Topic, once some of the challenges that athletes have at a cognitive level have been addressed, is that not only is it necessary to have adequate cognitive capacity for the present and future of athletes, but the research by Amoroso et al. indicates the special interest in being able to evaluate the ethical

behavior and self-control of athletes, specifically with a sample of elite Ultimate Championships players, allowing the self-referencing to improve ethical behavior across divisions and age groups. The study by Shuai et al. indicates the influence of personality on sport performance. Their review in competitive sports shows how the so-called "five models," made up of the variables of extraversion, agreeableness, conscientiousness, neuroticism, and openness to new experiences, are transcendental in terms of getting to know athletes and hence the importance that coaches should promote personality screening and personality development programs.

Going into another of the pillars of this Research Topic, it is essential to study not only adult populations, but also the influence of all these factors on children and adolescents. Thus, Hao et al. show how in 126 students aged 4–5 years, functional physical training with or without cognitive intervention could promote physical fitness and cognitive development, this being a fundamental aspect when seeing not only physical, but also cognitive improvements in the population. In reference to somewhat older athletes, Haug et al. reflecting on more than 2,000 participants, the importance of motivation as a mediating role in understanding the factors related to Physical Education and cognitive development, considering the research results the importance of developing autonomous motivation to increase participation of adolescents in Physical Education classes. In the same paradigm, Tapan et al. show how adolescents and children must also work on technical and cognitive skills such as attention focus, especially when working on individual sports disciplines with an opponent such as tennis, showing, as in the case of tennis, instructions children to focus their attention externally to facilitate the learning of the groundstroke technique (forehand-backhand).

On the other hand, all research requires data analysis and in the science of psychology, the use of questionnaires is frequent, their validation being necessary to the context being worked on. The study by Su and Zhao allowed us to validate and develop a scale to measure the interpersonal style of coaches. The main findings of their research were that benevolent coaching behaviors held significant explanatory weight in the Chinese cultural context; controlling and autonomy-supportive coaching styles were culturally congruent among both Eastern and Western athletes; and benevolent and autonomy-supportive coaching behaviors positively impacted athletes, whereas controlling coaching behaviors had a negative impact. Finally, Wang et al. examined the properties of the Coach-Athlete Relationship Questionnaire in basketball players. This study supports the reliability and validity of this questionnaire, allowing the results to be extensible despite the existence of cultural differences in the place of validation of the

initial questionnaire (Spain) and that of the study (China), being transcendental to contextualize all the variables when analyzed according to the place and objective of the study.

In conclusion, the work of every coach and teacher lies in ensuring that their athletes and students achieve adequate psychological strength in order to improve sports adherence and have a better quality in their sports life. Furthermore, in order to carry out studies, it is essential to have validated tools and diversify the study sample to generalize the results and seek the advancement of sports psychology.

Author contributions

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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

Body-related concerns and participation in physical education among adolescent students: the mediating role of motivation

Ellen Haug[1,2]*, Isabel Castillo[3], Oddrun Samdal[1] and
Otto Robert Frans Smith[2,4]

[1]Department of Health Promotion and Development, University of Bergen, Bergen, Norway,
[2]Department of Teacher Education, NLA University College, Bergen, Norway, [3]Department of Social
Psychology, University of Valencia, Valencia, Spain, [4]Department of Health Promotion, Norwegian
Institute of Public Health, Bergen, Norway

Background: There is a need to understand better factors influencing participation in physical education (PE) and the mechanisms involved. The adolescent years are characterised by increasing levels of body-related concerns. In PE, the body is judged for its physical abilities and subject to social comparisons and body judgements. Grounded in the Self-Determination Theory, this study aimed to explore whether body-related factors were associated with adolescents' involvement in PE and whether types of motivation mediated this relationship.

Methods: The study involved 2,140 (54.5% girls) secondary students (15–16-year-olds) from Norway participating in the nationally representative "Health Behaviour in School-aged Children (HBSC) study: a WHO collaborative cross-national study." Body-related factors included Body Mass Index (BMI), health complaints, body perception and dietary behaviours. Gender, age, and socioeconomic status (family affluence) were control variables. Motivation for PE was assessed with the Perceived Locus of Causality (PLOCQ) scale measuring three distinct factors: autonomous motivation, controlled motivation and amotivation. PE involvement was self-reported as weekly participation in PE classes and time spent in moderate-to-vigorous physical activity (MVPA) during PE.

Results: Gender (girl), family affluence, health complaints, not being on a diet but wanting to lose weight, and body perception (too fat) were negatively associated with weekly PE participation when adjusting for other variables. This association was largely explained by students' autonomous motivation in the case of health complaints and partly in the case of dietary behaviour and body perception. Similar results were observed for MVPA during PE lessons. Additionally, gender was associated with MVPA through amotivation.

Conclusion: The study adds new knowledge to the understanding of the relationship between body-related factors and PE, supporting that autonomous motivation is a central mechanism and an avenue for further research. The results should be considered in planning high-quality PE classes and suggest that an autonomous supportive learning climate sensitive to body-related concerns should be a priority to increase adolescent involvement in PE.

Introduction

A physically active lifestyle is associated with numerous physical and mental health benefits for adolescents (Chaput et al., 2020). It is recommended for this age group to do at least an average of 60 min per day of moderate-to-vigorous physical activity (MVPA), primarily aerobic, across the week (World Health Organization, 2020). However, existing data suggest that a minority of adolescents are sufficiently physically active, and the activity level decreases with increasing age (Inchley et al., 2020; World Health Organization, 2022). The school setting, and in particular the physical education (PE) context, has been given an essential role in providing enjoyable, educational physical activity that can foster the development of motor skills and introduce students to a variety of activities that can be performed in a life-time perspective (World Health Organization, 2018a,b). The PE setting has the potential to offer a structured environment and learning activities that can influence students' physical activity (PA) behaviours in PE lesson time and during leisure time (Owen et al., 2014; Castillo et al., 2020; Vasconcellos et al., 2020). It has also been documented that positive attitudes towards PE can upheld over time (Ladwig et al., 2018) and predict future PA participation (Rhodes and Kates, 2015).

Nevertheless, available data suggest that students' time spent in MVPA during PE classes varies substantially, with a decrease observed from middle school to high school (Hollis et al., 2017). The age-related decrease co-occurs with an overall decline in motivation for PE (Papaioannou et al., 2006; Yli-Piipari et al., 2009). Motivational processes in PE are multifaceted and complex, with motivational influences divided into internal and external aspects (Kretschmann, 2014). Internal factors comprise individual characteristics (e.g., gender, physical attributes), dispositional variables (e.g., perceived competence and autonomy), and individual situational variables (e.g., sports involvement). External factors include environmental, situational variables (e.g., teachers' skills and teaching style) and contextual variables (e.g., PE curriculum, PE activities) (Kretschmann, 2014). Thus, to develop quality PE programmes, there is a need to better understand factors at multiple levels associated with students' engagement and participation.

So far, research efforts on motivation and participation in PE have primarily focused on addressing the subject from a social-psychological perspective, with the Self-Determination Theory (SDT) (Deci and Ryan, 1985, 2000) as the most used theoretical framework (Lindahl et al., 2015). In this regard, much of the existing research has investigated the role of autonomy-supportive environments on motivational processes, focusing on teachers' role in creating a motivational climate (Vasconcellos et al., 2020). However, in PE classes, the body is at the centre of curricular outcomes. It is being judged for physical abilities and positioned in ways that open for social comparisons and body judgements (Kerner et al., 2018). Thus, the current study aims to extend the existing research by examining the link between individual characteristics and PE participation, focusing on body-related concerns among adolescents. Grounded in the SDT, special attention is given to the mediation pathway of motivation forms.

SDT distinguishes between different types of motivations varying on a continuum from controlled to more autonomous forms, with an increasing degree of self-determination present (Ryan and Deci, 2017). According to SDT, *intrinsic motivation* is described as the inherent propensity to develop skills actively, engage in challenges,

and take an interest in new activities (Deci and Ryan, 1985). Extrinsic motivation is divided into four types of regulation: integrated, identified, introjected and external (Ryan and Deci, 2017). *Integrated regulation* represents the most self-determined form and refers to behaviours executed out of choice to harmonise and bring coherence to different parts of the self. *Identified regulation* refers to a situation when the behaviour is highly valued by the individual and, therefore performed with less pressure, even if it is not particularly pleasant. *Introjected regulation* refers to behaviour starting to be internalised but not entirely self-determined. This kind of behaviour may be performed to gain social recognition or avoid feelings of guilt. *External regulation* is behaviour regulated through external means, such as punishment or rewards. The last category is amotivation which refers to the absence of motivation.

SDT proposes that intrinsic motivation and the more autonomous types of extrinsic motivation will lead to constructive functioning, better learning and improved psychological health and well-being (Ryan and Deci, 2017). Literature from the PE context has demonstrated that self-determined forms of motivation towards PE are positively associated with several desirable responses in physical education, such as greater concentration, effort, and persistence (Ntoumanis, 2001; Standage et al., 2005), higher levels of positive affect (Ntoumanis, 2005; Standage et al., 2005; Zamarripa et al., 2016), physical activity in PE (Owen et al., 2014), participation in PE (Owen et al., 2014; Ulstad et al., 2019), and higher levels of leisure time PA as well as greater intention to continue to be physically active (Castillo et al., 2020). Also, introjected regulation has been weakly associated with PA in PE lessons (Owen et al., 2014). Amotivation has, on the other hand, been positively associated with unhappiness, negative affect, and boredom in PE (Ntoumanis, 2001; Standage et al., 2005; Zamarripa et al., 2016; White et al., 2021).

Physical perceptions and experiences in PE can be impediments to students' motivation towards PE (Papacharisis and Goudas, 2003), and several qualitative studies have identified body-related issues as obstacles to participating in PE and sports (Allender et al., 2006; Martins et al., 2021). Many studies suggest that embarrassment, body image concerns, physical discomfort and body insecurity are barriers to PE and PA participation and are more frequently reported among girls than boys (Martins et al., 2021; White et al., 2021). Body image is a multidimensional construct that includes how one sees, thinks, feels, and behaves related to the body's appearance and function (Cash and Smolak, 2011). An enhanced body image has been positively associated with engagement in PE (Bevans et al., 2010) and with physical activity (Sabiston et al., 2019; Martins et al., 2021). The adolescent years are characterised by body changes taking place and the internalisation of the society-imposed aesthetic model (Paxton et al., 2005). The cognitive dimension of body image, body dissatisfaction, is reflected in the desire of someone to lose weight or to gain weight (Laus et al., 2011). Body dissatisfaction reaches high levels in this period, especially among females (Fernández-Bustos et al., 2019), with clear gender differences observed (Laus et al., 2011; Sanchez-Miguel et al., 2021). In a time of high prevalence of body image disturbances among adolescents (Dion et al., 2016), it is pertinent to understand better how body-related factors are associated with physical activity in the PE context.

In addition to gender, weight status, BMI, and physical ability have been identified as key variables for body dissatisfaction (Dion et al.,

2016; Fernández-Bustos et al., 2019; Molina-García et al., 2019). Evidence suggests that many overweight students report negative experiences of PE, such as bullying and embarrassment, along with other barriers to participation (Fox and Edmunds, 2000; Cardinal et al., 2014). As a result, this may lead to maladaptive coping behaviours, such as avoiding PA and PE (Li et al., 2017). However, improving body shape, physical appearance and weight management have also been reported as reasons for participation in physical activities, especially among girls', suggesting that more external forms of regulations may drive involvement in PE (Martins et al., 2021). For example, some qualitative studies have reported that pressure to conform to popular beauty ideals is important reason for teenage girls to be physically active (Allender et al., 2006). Restrictive dieting and weight control are also frequently used by adolescents attempting to achieve an internalised image of an ideal body (Krowchuk et al., 1998).

Other body-related aspects that can affect the individual student and may be related to participation in PE are subjective health complaints. Such complaints can have both a somatic (e.g., headache and backache) and a psychological (e.g., feeling low and feeling nervous) dimension that is not explained by an underlying illness (Brown, 2007). Subjective health complaints have become progressively prevalent in children, increase with age (Inchley et al., 2020) and have been related to absenteeism in school (Saps et al., 2009) and lower PA levels (Marques et al., 2015; Keane et al., 2017). The impact of health complaints in the PE context has to our knowledge, not been examined. As the PE lessons might demand a well-functioning body focusing on performing in front of others, competition, grading and unrealistic standards (White et al., 2021), such complaints may be an impediment to experiencing autonomous motivation and thus impact involvement in PE.

SDT and motivational processes have been suggested as a potential avenue for further research to explain the relationship between body-related factors and PA (Vani et al., 2021). Based on a relatively large Norwegian nationally representative sample of secondary school students, the current study aimed to test a model of the relationship between body-related factors (i.e., BMI, health complaints, body perception, weight control behaviours) and measures of PE involvement, examining the mediating role of motivation in this relationship.

Materials and methods

Participants and procedure

The data stem from a national sample ($n = 2,140$) of Norwegian lower and upper secondary school students aged 15 and 16 years (59%) participating in the 2013/2014 survey of the "Health Behaviour in School-aged Children (HBSC) study: a WHO collaborative cross-national study." The participants had a mean age of 16.3 ± 0.7 years, and 51% was a girl. This correlational study with a non-experimental, quantitative, and cross-sectional design had school class as the primary sampling unit. The classes were chosen from a geographically stratified list to ensure a nationally representative sample. The Norwegian Western Regional Ethical Committee (REK) approved the study and the use of passive consent (2013/1494/REK vest). A detailed information letter was given both

in paper form and electronically to parents or custodians. Those who did not want their child to participate had to sign and return a form to the teacher. Approval of the child's participation was assumed if the form was not returned. The class teachers administered the survey between January 2014 and May 2014. Participation was voluntary, and the anonymity, as well as the confidentiality of the participants, were ensured. The participants could withdraw from the study at any time.

Measures

Exposures

BMI was calculated (in kilogram per square meter) based on self-reported weight and height measured by the questions: "How much do you weigh without clothes?" and "How tall are you without shoes?" Self-reported height and weight are considered suitable measures for detecting valid relationships in epidemiological studies (Spencer et al., 2002; Aasvee et al., 2015).

Health complaints were assessed with the HBSC Symptom Checklist (HBSC-SHC) (Haugland and Wold, 2001; Ravens-Sieberer et al., 2008). The participants were asked how often they had experienced the following during the past 6 months; headache, stomach-ache, feeling dizzy, feeling low, irritability or bad temper, feeling nervous, and difficulties in getting to sleep. The first four health complaints are defined as somatic and the latter four as psychological health complaints. The response options were "about every day," "more than once a week," "about every week," "about every month," and "rarely or never any symptoms." For the present study, health complaints were modelled as a mean sum score. The HBSC-SHC has adequate test–retest reliability and validity properties (Haugland and Wold, 2001).

Body perception, an appearance facet of body image (Vani et al., 2021), was assessed with the question "Do you think your body is: "much too thin," "bit too thin," "about the right size," "bit too fat" or "much too fat." The latter two response options were recoded as "too fat" and the first two responses where coded as "too thin." The test–retest stability in self-perceived weight has been found to be excellent (ICC = 0.81; 95% CI = 0.76–0.85) (Currie et al., 2001).

To identify weight control behaviours, participants were asked to indicate if they were at present on a diet or doing something to lose weight. Possible responses were "Yes"; "No, but I should lose some weight"; "No, my weight is fine"; and "No, because I need to put on weight".

As control variables, family affluence, a dimension of socioeconomic status, was assessed using the family affluence scale (FAS-III) (Hartley et al., 2016). FAS is a measure of material affluence derived from the characteristics of the family's household and consists of six items (family car, number of computers, own bedroom, family holidays, number of bathrooms, dishwasher in home). A sum score was calculated to range from 0 (low material affluence) to 13 (high material affluence). Gender was measured as either boy or girl. The participant also reported the month and year of birth, which was then calculated based on the survey completion time. After rounding to the nearest age group, they were subsequently grouped as 15- and 16-year-olds.

Mediators

The Perceived Locus of Causality (PLOCQ) (Aasvee et al., 2015) was employed to examine students' motivational regulations towards PE at a contextual level. Each motivational regulation comprised four items following the heading "Why do you participate in Physical Education?" and the stem "I take part in PE classes." The subscales in the questionnaire intended to measure intrinsic motivation (e.g., "because PE is fun"), identified regulation (e.g., "because it is important for me to do well in PE"), introjected regulation (e.g., 'because I would feel bad about myself if I did not), external regulation (e.g., 'because I'll get into trouble if I do not), and amotivation (e.g., 'but I do not see why we should have PE'). Responses were reported on a seven-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). The scale was translated into Norwegian, and then back-translated to English following the procedures from the HBSC-study protocol (Currie et al., 2014). The reliability and validity of the subscale scores of the PLOCQ have generally been supported. However, there have been concerns regarding internal consistency and discriminant validity for some of the subscales. More specifically, the self-determined motives (i.e., intrinsic motivation and identified regulation) have not been distinguishable by youth across several studies and cultures (Ntoumanis, 2005; Lonsdale et al., 2011). In line with previous studies (Koestner et al., 2008; Alvarez et al., 2021), we adopted a 3-factor model in which the items reflecting intrinsic and identified regulation were combined into a sum scored autonomous motivation factor, and the items reflecting introjected and external regulation were combined into a sum scored controlled motivation factor. The third factor we used was sum scored amotivation. For estimation purposes the sum scores were transformed to mean scores ranging from 1 to 7.

Outcomes

Frequency of weekly physical education classes was assessed with the question, "How many times in a regular week do you participate in physical education classes? (also include elective classes, e.g., sports and outdoor life"). This was followed by the specification, "A one 90-min class should count as two times." The response categories were (1) 0–1 time, (2) 2 times, and (3) more than two times.

Duration of MVPA in physical education was a measure of physical activity of moderate to vigorous intensity derived from the HBSC-item on overall MVPA (Prochaska et al., 2001). The wording was "How many minutes in a single PE class (45 min) do you usually perform physical activity in a way that makes you warm and out of breath?." The response categories were labelled from (1) 0 min, (2) 1–10 min, (3) 11–20 min, (4) 21–30 min, and (5) more than 30 min. In the analysis, these were reduced to three categories: (1) less than or equal to 20 min, (2) 21–30 min, and (3) more than 30 min.

Ethical considerations

The study was conducted according to the guidelines of the Declaration of Helsinki and the Norwegian Western Regional Ethics Committee (REK) approved the study and the use of passive consent. A detailed information letter was given in paper form and

electronically to parents or custodians. Those who did not want their child to participate had to sign and return a form to the teacher. Approval of the child's participation was assumed if the form was not returned. Participation was voluntary, and the anonymity, as well as the confidentiality of the participants, were ensured. The participants could withdraw from the study at any time.

Statistical analyses

The mediation model (see Figure 1) was estimated by a series of regression equations. The three mediators were regressed on the exposure variables using linear regression, whereas the outcome variables were regressed on the mediators and the exposure variables using ordinal regression. The outcome variables were also regressed on the exposure variables without the inclusion of the mediator variables to examine more directly the total effects of the exposure variables on PE participation and MVPA. Indirect effects were calculated by Mplus as the product of the exposure-mediator regression coefficient and the mediator-outcome regression coefficient. As the outcomes were ordinal, Mplus uses their underlying latent response variables to calculate the (in)direct effects. Robust full information maximum likelihood with Monte Carlo integration was used as estimator in Mplus version 8.8.

Results

Descriptive statistics

Descriptive statistics for the study's variables are presented in Table 1. The participants exhibited the highest average scores of autonomous motivation and the lowest average scores of amotivation. The participants reported most frequently participating in PE classes twice a week and MVPA levels during PE of more than 30 min.

Mediation model for body-related factors, motivation, and participation in physical education

In the model in which the outcome variables were regressed on the exposure variables without the inclusion of the mediator variables, the following variables were significantly associated with PE participation: Age, family affluence, being on a diet, not being on a diet but wanting to lose weight and health complaints. The exposures age, family affluence, and health complaints were associated with MVPA (see Table 2).

After including the mediator variables in the outcome model, most of the associations mentioned above became smaller, with the expectation of the association with age. As shown in Table 2, students with higher levels of autonomous motivation reported participating in PE classes more often and with higher levels of MVPA when controlling for gender, age, family affluence, body-related factors and other specific forms of motivation. Similarly, controlled motivation was positively associated with MVPA during PE, whereas students with higher levels of amotivation reported lower levels of MVPA. However, these associations were weaker than for autonomous

FIGURE 1
Conceptual diagram of the proposed parallel multiple mediator model.
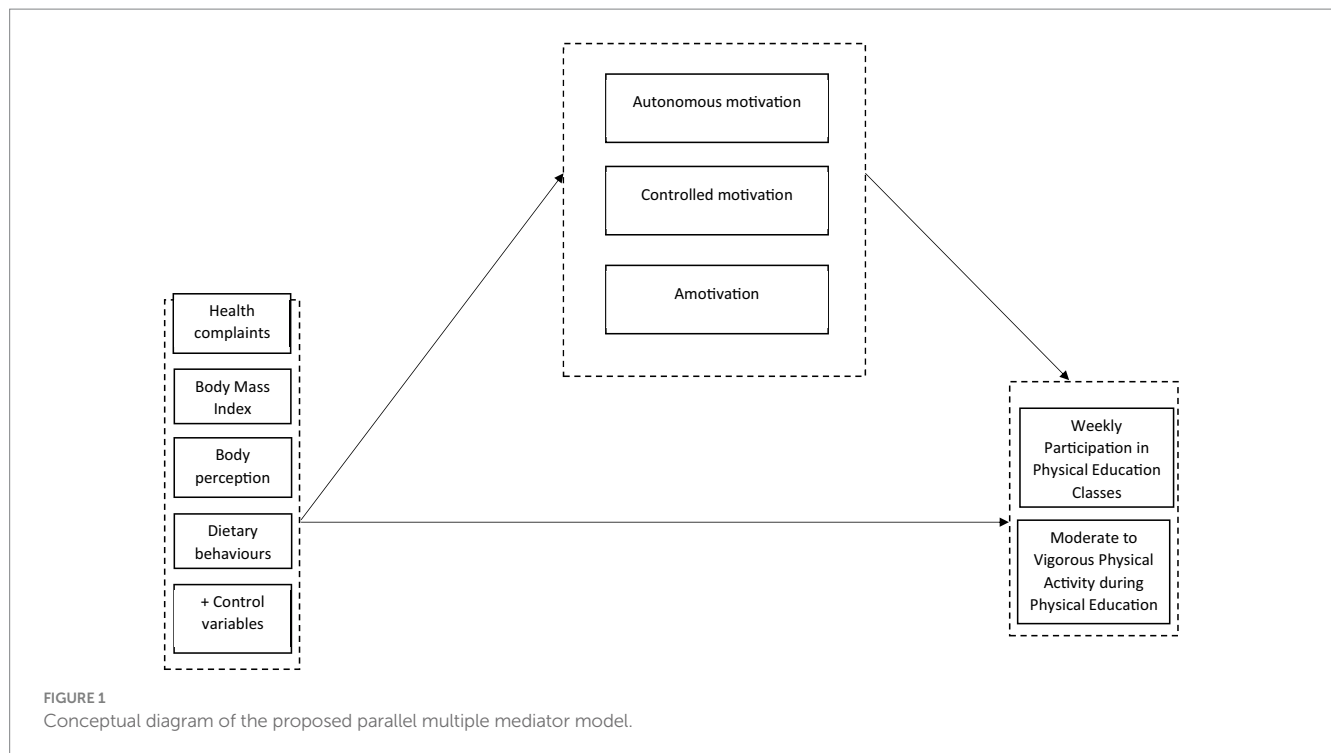
motivation. Table 2 shows that being a girl, having lower family affluence, having more health complaints, not being on a diet but wanting to lose weight, and perceiving the body as too fat were associated with lower levels of autonomous motivation. On the other hand, 16-year-olds reported higher levels of controlled motivation than 15-year-olds. Being on a diet and having higher family affluence was also associated with higher levels of controlled motivation. A higher BMI, more health complaints, not being on a diet but wanting to lose weight, and perceiving the body as too fat were associated with lower levels of controlled motivation. Finally, females reported lower levels of amotivation, whereas students with higher levels of health complaints reported higher levels of amotivation.

Examination of indirect effects suggested that gender, family affluence, dietary behaviour, perceiving the body as too fat and health complaints were associated with PE participation through autonomous regulation motivation (see also Table 3). For perceiving the body as too fat and health complaints, the indirect effect explained most of the total effect of these variables on PE participation. The results were largely similar for MVPA, but additionally, gender was associated with MVPA through amotivation. Age group was the only exposure variable with a statistically significant total effect that was not explained at all by any form of motivation.

Discussion

This study aimed to increase our understanding of the link between body-related concerns and involvement in PE, with forms of motivation as the mediating pathway. In line with the tenets of SDT (Ryan and Deci, 2017), students with autonomous motivation attended PE classes more frequently and reported higher levels of MVPA during PE lessons when other factors were adjusted for. Controlled motivation was positively and amotivation

negatively associated with MVPA during PE. The results indicated that the associations between body-related concerns and PE participation/MVPA were partly explained by autonomous motivation. More specifically, we found that the association between health complaints and PE participation/MVPA was almost fully explained by autonomous motivation, whereas the association with dietary behaviour (not on a diet but wanting to lose weight) and body perception (too fat) were partly explained by autonomous motivation.

The study finding of positive associations between autonomous motivation with both weekly participation in PE and MVPA during PE lessons adds to studies that have demonstrated adaptive outcomes of autonomous motivation in the PE context (Ntoumanis, 2005; Standage et al., 2005; Owen et al., 2014; Zamarripa et al., 2016; Lonsdale et al., 2019; Vasconcellos et al., 2020). For weekly participation in PE, the students were asked to report mandatory PE and self-selected optional PE courses. This might partly reflect a self-selection for optional PE courses among those reporting higher levels of autonomous motivation. This would align with the prospective study by Ntoumanis (2005), which found that students who chose to enrol in optional PE courses reported higher levels of self-determined motivation and lower levels of amotivation than those who decided not to enrol.

Controlled motivation was, in addition, a positive predictor and amotivation a negative predictor of MVPA during PE lessons, suggesting partly differential motivational processes for attending PE classes and MVPA during PE. In Owen et al. (2014) meta-analysis, a weak positive effect was also found between introjected regulation and PA in PE lessons. According to the SDT, the more controlled regulations (i.e., introjected and external regulations) are either driven by external demands to avoid negative reactions or for rewarding reasons (Ryan and Deci, 2017). A positive link between controlled motivation and MVPA during PE lessons could therefore be explained

TABLE 1 Descriptive statistics.

Gender, % (n)	
Boys	45.5 (973)
Girls	54.5 (1167)
Age group, % (n)	
15-year-olds	41.0 (878)
16-year-olds	59.0 (1262)
Family affluence scale, mean (SD)	10.0 (1.6)
Health complaints, mean (SD)	2.1 (8.4)
Body Mass Index, mean (SD)	21.4 (3.3)
Dieting variable, % (n)	
On a diet	25.8 (521)
Not on a diet, need to lose weight	14.4 (291)
Not on a diet, need to put on weight	12.0 (241)
Not on a diet, weights fine	47.8 (963)
Body perception, % (n)	
Too fat	41.0 (821)
Too thin	13.3 (268)
About right	45.6 (912)
Motivation form, mean (SD)	
Autonomous motivation	4.9 (1.8)
Controlled motivation	4.4 (1.4)
Amotivation	2.5 (1.6)
Weekly participation in PE Classes, % (n)	
0–1 time	17.4 (336)
Twice	53.0 (1023)
More than twice	29.6 (572)
MVPA during PE, % (n)	
≤ 20 min	25.8 (493)
21–30 min	26.6 (508)
> 30 min	47.6 (911)

by the fact that students are being graded based on their accomplishments and efforts.

Ratelle et al. (2007) propose that the extrinsic controls and rigid constraints entailed in school could explain why students developed controlled forms of motivation. In line with this reasoning, these authors identified a student profile with high autonomous and controlled motivation as the most favourable for outcomes such as high persistence and achievement, low absenteeism, and high cognitive and affective functioning. Nevertheless, the effects on PA of more controlled regulations in PE are not likely to be upheld over time (Haerens et al., 2010). A weak negative association between amotivation and MVPA in PE is also in accordance with the meta-analysis of Owen et al. (2014) and the tenets of SDT (Ryan, 2017). Amotivation has been positively associated with unhappiness, negative affect, and boredom in PE (Ntoumanis, 2001; Standage et al., 2005; White et al., 2021), which may directly impact students' efforts and intensity levels during PE, and, therefore, their MVPA levels.

Health complaints, not being on a diet but wanting to lose weight, and body perception (too fat) were negatively associated with weekly participation in PE when adjusting for other variables. This association was largely explained by students' autonomous motivation in the case of health complaints and partly in the case of dietary behaviour and body perception. Similar results were observed for MVPA during PE lessons. The mechanisms involved in the observed relationships can be understood in light of a central proposition within the SDT, postulating that self-determined forms of motivation depend on the fulfilment of three innate basic psychological needs; the needs for competence, relatedness and autonomy (Ryan and Deci, 2017). Empirical work within the PE context has shown that the three needs predict autonomous motivation independently and combined (Standage et al., 2007). Within the SDT, Cognitive Evaluation Theory (Deci and Ryan, 1985) states that social factors perceived as controlling for the individual are likely to influence the basic psychological needs and, consequently, levels of self-determined motivation. Although not thoroughly studied, it has been suggested that different dimensions of body-related concerns may impact motivation in PE by undermining the psychological need satisfaction (Gillison et al., 2011). For instance, previous studies have found perceived competence satisfaction to be the strongest predictor of autonomous forms of motivation in PE compared to perceived autonomy and relatedness (Standage et al., 2005; Taylor et al., 2010). It is likely that with increased somatic or psychological health complaints, students might feel unable to meet PE demands, which can cause other adverse affective outcomes (White et al., 2021). It is also likely that the relationship between health complaints and physical activity is bidirectional (Marques et al., 2015). Nevertheless, experiencing somatic and psychological symptoms may impact the evaluation of the body's physical features and the capacity to perform in PE. Overall, the findings add to previous research that has demonstrated an inverse relationship between health complaints and physical activity among adolescents (Marques et al., 2015; Keane et al., 2017).

Also, perceived external pressure on body image could compromise the need for autonomy, whereas the concern that others are judging one's body shape negatively compromises the need for relatedness (Pelletier et al., 2001). Avoidance has been identified as one key coping strategy for managing negative experiences of the body (Li et al., 2017). It has been suggested that the PE non-participants, or those students who regularly disengage with PE, undertake such avoidance strategies to reduce the risk of body image disruption (Kerner et al., 2018). Past studies have also demonstrated that students with high BMI report lower perceptions of physical competence and social relatedness than those with lower BMI (Carissimi et al., 2017; Gråstén and Watt, 2017). Interestingly, BMI was not a unique predictor of motivation forms or PE in the current study that also included dietary behaviours and body perception.

Ideally, the PE context could serve as an arena to increase body appreciation (Vani et al., 2021). An enhanced body image has been positively associated with engagement (Bevans et al., 2010) and PA (Sabiston et al., 2019; Martins et al., 2021) in PE. However, it has been argued that aspects related to different dimensions of body image in PE may appear to be like the 'elephant in the room': obvious yet overlooked or ignored, not only in research but also in practice (Kerner et al., 2018). Nevertheless, if the learning climate in PE supports rather than thwarting basic psychological needs through teaching style and activities (White et al., 2021), it could make a

TABLE 2 Unstandardized regression coefficients of the proposed mediation model (adjusted estimates).

Exposures	Mediators			Outcomes			
	Autonomous motivation b (se)	Controlled motivation b (se)	Amotivation b (se)	PE participation b (se)		MVPA during PE b (se)	
	–	–	–	Not controlled for motivation	Controlled for motivation	Not controlled for motivation	Controlled for motivation
Gender: girl	−0.23 (0.09)*	0.05 (0.07)	−0.39 (0.10)***	−0.19 (0.12)	−0.15 (0.12)	−0.13 (0.10)	−0.10 (0.10)
16 -year-olds	−0.07 (0.11)	0.19 (0.08)*	0.06 (0.10)	−0.91 (0.18)***	−0.93 (0.18)***	0.27 (0.12)*	0.31 (0.11)**
Family affluence	0.10 (0.03)**	0.07 (0.02)**	0.03 (0.03)	0.09 (0.03)*	0.06 (0.03)	0.08 (0.03)**	0.05 (0.03)
Health complaints	−0.51 (0.06)***	−0.11 (0.05)*	0.19 (0.05)***	0.24 (0.07)***	−0.07 (0.06)	0.24 (0.06)***	−0.07 (0.07)
BMI	−0.03 (0.02)	−0.03 (0.01)*	−0.00 (0.01)	−0.00 (0.02)	0.01 (0.02)	0.00 (0.02)	. 02 (0.02)
On a diet	−0.21 (0.11)	0.28 (0.10)**	0.17 (0.10)	−0.29 (0.12)*	−0.26 (0.12)*	−0.14 (0.13)	−0.07 (0.15)
Not on a diet, need to lose	−0.60 (0.13)***	−0.16 (0.09)**	0.21 (0.12)	−0.50 (0.14)***	−0.34 (0.14)*	−0.34 (0.15)	−0.15 (0.15)
Not on a diet, need to put on	−0.30 (0.16)	0.01 (0.15)	0.20 (0.16)	−0.00 (0.20)	0.07 (0.29)	0.02 (0.18)	0.13 (0.19)
Body perception, too thin	−0.11 (0.16)	−0.04 (0.15)	−0.13 (0.15)	−0.33 (0.18)	−0.34 (0.18)	−0.09 (0.17)	−0.07 (0.18)
Body perception, too fat	−0.61 (0.17)***	−0.40 (0.17)*	0.27 (0.16)	−0.15 (0.20)	0.05 (0.20)	−0.30 (0.18)	−0.13 (0.19)
Autonomous motivation					0.31 (0.05)***		0.31 (0.03)***
Controlled motivation					0.04 (0.05)		0.07 (0.03)*
Amotivation					−0.03 (0.04)		−0.07 (0.03)*
R-square	0.14	0.04	0.03	0.10	0.17	0.04	0.12

PE, physical education; MVPA, moderate-to-vigorous physical activity. BMI, body mass index. Reference categories: gender; boy, age; 15-year-olds, dietary behaviour; Not on a diet the weight is just fine, body perception; about the right size. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

TABLE 3 Unstandardized indirect, direct, and total effects†.

Exposure	Mediator	Outcome	Indirect effect (95% CI)	Direct effect (95% CI)	Total effect (95% CI)
Gender girl	Autonomous	Weekly PE participation	−0.07 (−0.13, −0.01)*	−0.15 (−0.38, 0.08)	−0.21 (−0.45, 0.03)
Family affluence	Autonomous	Weekly PE participation	0.03 (0.01, 0.05)**	0.06 (−0.01, 0.12)	0.09 (0.02, 0.16)*
Health complaints	Autonomous	Weekly PE participation	−0.16 (−0.23, −0.09)***	−0.07 (−0.20, 0.05)	−0.24 (−0.38, −0.11)***
Not on a diet, need to lose	Autonomous	Weekly PE participation	−0.19 (−0.29, −0.09)*	−0.34 (−0.62, −0.07)*	−0.55 (−0.84, −0.25)***
Body perception, too fat	Autonomous	Weekly PE participation	−0.19 (−0.32, −0.06)**	0.05 (−0.33, 0.43)	−0.16 (−0.58, 0.25)
Gender girl	Autonomous	MVPA during PE	−07 (−0.13, −0.01)*	−0.10 (−0.30, 0.11)	−0.14 (−0.34, 0.07)
Gender girl	Amotivation	MVPA during PE	0.03 (0.00, 0.05)*	−0.10 (−0.30, 0.11)	−0.14 (−0.34, 0.07)
Family affluence	Autonomous	MVPA during PE	0.03 (0.01, 0.05)**	0.05 (−0.01, 0.11)	0.08 (0.02, 0.15)*
Health complaints	Autonomous	MVPA during PE	−0.16 (−0.21, −0.10) ***	−0.07 (−0.19, 0.06)	−0.24 (−0.38, −0.11)***
Not on a diet, need to lose	Autonomous	MVPA during PE	−0.19 (−0.27, −0.10)***	−0.15 (−0.45, 0.16)	−0.36 (−0.67, −0.04)*
Body perception, too fat	Autonomous	MVPA during PE	−0.19 (−0.30, −0.07)**	−0.13 (−0.51, 0.25)	−0.36 (−0.75, 0.03)

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, †only pathways with statistically significant indirect effects are displayed.

difference for students with various body-related concerns. A recent review of qualitative studies has elucidated our understanding of how the satisfaction and frustration of different needs in the PE context can affect multiple outcomes, such as participation in PE (White et al., 2021). A qualitative study of Norwegian 15-year-old girls supports the association between body perceptions and PE participation (Walseth et al., 2017). Therefore, more research is needed to advance conceptual and theoretical understanding of the complex relationship between body-related factors, gender, age, motivation forms and participation in PE.

The examination of indirect effects suggested that also gender and family affluence were associated with PE participation through autonomous motivation. The results were largely similar for MVPA during PE, but additionally, gender was associated with MVPA through amotivation. PE in Norway is a coeducational setting, with both girls and boys attending the same class. In coeducational settings, girls have reported feeling that their bodies are under inspection by boys, leading to increases in body anxiety (Flintoff and Scraton, 2001). Studies have also found that girls place a higher value on their physical appearance in the coeducational context (O'Donovan and Kirk, 2008). Similar findings of girls' body discomfort in PE classes were identified by Walseth et al. (2017) in the Norwegian qualitative study of 15-year-old girls. In the review of White et al. (2021), several factors were listed as contributes to amotivation. These were boredom from repeatedly doing the same activities, teacher-created performance climate, dominance of peers, and grades, all of which can thwart the need for competence, relatedness and autonomy. Overall, the findings suggest that teacher-created learning climates that nurture autonomous motivation and are sensitive to gender preferences seem relevant. Interestingly, the age group was the only exposure variable with a statistically significant total effect that was not explained at all by any of the motivation variables. The negative association with weekly PE participation can be explained by fewer mandatory PE classes from lower to upper secondary school. Also, upper secondary is not compulsory schooling in Norway. It could also be that 16-year-olds may have stronger interest in the health outcomes of being physically active. However, the positive association between age and MVPA during PE classes was unexpected and should be further explored but could relate to curriculum content.

Strengths and limitations

A strength of the current study is the use of a representative national sample of adolescent students and established and validated measures on body-related factors, including health complaints, family affluence and motivation in PE. However, some limitations should be acknowledged. First, the measure included to assess MVPA levels during PE was self-reported, known to have recall and reporting bias (Nigg et al., 2020). Almost half of the students reported MVPA "more than 30 min", which may suggest an overestimation, as other studies using more objective methods of measuring PA have found that the level of MVPA in a 45- minutes PE lesson is usually less than 50% of the lesson time duration (Owen et al., 2014). Thus, future studies should include objective measures of physical activity (e.g., accelerometers) to help confirm the current findings. Also, research suggests that MVPA in PE lessons depends on the type of activities

during PE and the intensity profiles of the PE lessons (Zhou and Wang, 2019). This information was not available in the current study. Such differentiation could have given more detailed knowledge of the impact of motivation on the relationship between body-related aspects and adolescent PE behaviour across PE lesson contexts. Further, given the cross-sectional design, although the hypothesised relationship direction aligns with motivation theory, causal inferences cannot be drawn. Finally, additional research directions within the framework of SDT could have offered a more fine-grained understanding of how body-related aspects are associated with adolescent PE behaviour, for example, by including the sequence of BPB in the model. However, measures of BPN in PE were not included in this survey.

Conclusion

This study extends the research on factors influencing adolescents' engagement in PE by demonstrating an indirect relationship between gender, dietary behaviours, body perception, health complaints and PE, with, to a large extent, autonomous motivation as the mediating pathway. The study supports using SDT as a promising avenue for further research on body-related factors and PA participation in the PE context. The findings suggest that need supportive and a motivational learning climate sensitive to body-related aspects should be a priority when planning high-quality PE classes, especially during the adolescent years, a critical period for bodily concerns. As students with lower levels of autonomous motivation participate less often in PE, this group can potentially miss out on the educational, developmental, and health-related outcomes that school-based PE may provide.

Data availability statement

The datasets presented in this article are not readily available. The University of Bergen is the data-bank manager for the international HBSC study. The data from the 2013/2014 survey is open access and available upon request. Requests to access the datasets should be directed to https://www.uib.no/en/hbscdata/113290/open-access.

Ethics statement

This study involving humans were approved by The Norwegian Western Regional Ethics Committee (REK). The study was conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Author contributions

EH: Conceptualization, Investigation, Methodology, Writing – original draft. IC: Writing – review & editing. OS: Data curation, Writing – review & editing. ORFS: Formal analysis, Writing – review & editing, Conceptualization, Investigation.

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Examining the psychometric properties of the Coach-Athlete Relationship Questionnaire (CART-Q) with basketball players in China and Spain

Jingfei Wang[1]*, Carlos Cordente-Martínez[1] and Jonathan Ospina-Betancurt[2,3]

[1]Departamento de Deportes, Facultad de Ciencias de la Actividad Física y del Deporte (INEF), Universidad Politécnica de Madrid, Madrid, Spain, [2]Departamento Didáctica de la Expresión Musical, Plástica y Corporal, Facultad de Educación, Universidad de Valladolid, Valladolid, Spain, [3]Valoración del Rendimiento Deportivo, Actividad Física y Salud, y Lesiones Deportivas (REDAFLED), Universidad de Valladolid, Soria, Spain

The study examines the complex interactions between coaches and athletes in federative basketball in two different cultural contexts: China and Spain. The paper examines the interpersonal psychological dimensions from a direct viewpoint and a meta-perspective, drawing on the Coach-Athlete Relationship Questionnaire (CART-Q) and guided by the 3Cs model (Closeness, Commitment, and Complementarity). The CART-Q was translated and modified for use in both nations' federative basketball organizational systems to guarantee cross-cultural applicability. Careful translation techniques were used to achieve semantic homogeneity between the Spanish and Chinese versions of the questionnaire, including talks with knowledgeable linguists. The translated versions improved response comparability and kept the same item numbers as the original 2012 instrument. Out of the 771 distributed questionnaires, 763 legitimate answers were gathered via online surveys conducted using secure platforms (Google Forms for Spain and Wenjuanxing for China). The research included a three-step mediation study using structural equation modeling, which allowed for a thorough investigation of the concurrent validity of the modified CART-Qs. The findings indisputably support the reliability and validity of the CART-Qs translated into Chinese and Spanish. The research shows small but significant cultural disparities in the comprehensive perspective of coach-athlete interactions. These results have extensive ramifications for the sport and highlight how crucial it is to consider cultural differences when coaching and developing athletes.

KEYWORDS

closeness, commitment, complementarity, validity, reliability, culture

1. Introduction

The quality of the coach-athlete relationship is a vital component of sports coaching since it significantly impacts athletes' performance, success, and general happiness. In this setting, Yang and Jowett's (2012) Coach-Athlete Connection Questionnaire (CART-Q) and the 3Cs paradigm (Closeness, Commitment, and Complementarity) have emerged as crucial instruments for assessing and comprehending this connection. Despite their usefulness, there are still uncertainties about the universality and applicability of these models in many cultural contexts. Recent studies, such as one by King (2021), highlight the crucial part that the coach-athlete relationship plays in determining an athlete's motivation, commitment, and performance outcomes. The 3Cs model provides a strong framework that fully reflects this relationship's complex nature and includes proximity, commitment, Complementarity, and co-orientation. Based on this paradigm, the CART-Q has been created as a reliable instrument for evaluating the caliber of interactions between coaches and athletes.

Giulianotti (2015) points out that much validation research for these models has mostly focused on British coaches and players. Therefore, looking at how the coach-athlete relationship shows itself in various cultural contexts is crucial. There may be considerable regional differences in coaching methods, athlete communication, and the importance of interpersonal relationships. The paper focuses on two different cultural contexts–China and Spain–each offering unique social and cultural aspects that might significantly impact the dynamics of coach-athlete interaction.

Draw attention to the study results of Lupo et al. (2017) to emphasize the relevance of coach-player interactions and the possibility of various perspectives within this dynamic. Lupo et al. (2017) highlight the complex nature of coach-athlete interaction by demonstrating how athletes might view basic components of their training experiences differently from their instructors. Their research focused on top young female basketball players. The 3Cs, or closeness (emotions), commitment (cognitions), and complementarity (behaviors) are the three separate aspects that make up the CART-Q.

The emotional aspects of the athlete-coach connection are explored in depth by the Closeness dimension, which includes things like shared understanding, support, and trust. By examining this factor, researchers learn more about the strength of the relationship and rapport developed between athletes and their coaches, revealing the degree of emotional closeness within the dyad. The Commitment component, on the other hand, examines the athlete's commitment and faith in the knowledge and experience of the coach. It explores the cognitive components of the partnership, such as how the athlete views the coach's skill and dedication to the coaching process. Insights on the coach's influence on motivation, attitude, and belief in training and performance may be gained by understanding the athlete's degree of commitment.

The last component, Complementarity, evaluates the behavioral aspects of the athlete-coach connection. It examines how athletes and coaches cooperate and coordinate their efforts to achieve shared objectives. This dimension provides important information on cooperation and understanding between people, two factors that greatly impact how well training tactics work

and how well people perform. Researchers have found the CART-Q's standardized framework to be very helpful in conducting thorough examinations into how the coach-athlete relationship affects performance- and wellbeing-related outcomes. The validity and reliability of its measures have been confirmed via prior research (Yang and Jowett, 2012), solidifying its status as a reliable evaluation tool in studies examining the dynamics of coach-athlete interaction.

This research aims to expand knowledge of the 3Cs paradigm and the application of the CART-Q across various cultural settings, acquiring insights into culturally sensitive coaching techniques. It also intends to assess the internal reliability and factorial validity of the CART-Q in samples of top athletes from China and Spain. To assess the concurrent validity of the CART-Q, the relationship between athletes' levels of sport pleasure is also examined. Additionally, consideration is given to how, in various cultural circumstances, empathy could help clarify how coaches and players interact. The research also aims to considerably expand understanding of the coach-athlete relationship, its evaluation, and its effects on athlete performance via a thorough cross-cultural investigation. The research will help design coaching tactics attentive to cultural differences to improve athletic performance and general wellbeing among different racial and ethnic groups.

2. Methodology

2.1. Participants

Total responses of 763 federated players, 384 (50.3%) represent China (55.6% men and 44.4% women), and 379 (50.3%) from Spain (61.4% men and 37.6% women). The participants were between 14 and 35 years, with a mean age of 22.39 (SD = 4.74). This range is justified because the sample size is generally considered the population required to obtain meaningful and statistically significant results with a 95% confidence level and no more than a 5.03% margin of error (Brysbaert, 2019).

2.2. Procedure

The research began by obtaining player contact information from various sports organizations and leagues. To ensure privacy and compliance with data protection regulations, personalized invitation letters were sent to potential participants, emphasizing the voluntary nature of participation. Each participant provided informed consent after reviewing a comprehensive consent form detailing the research objectives and confidentiality measures. The questionnaire was then distributed online through secure platforms, using Google Forms for participants in Spain and Wenjuanxing for those in China.

Out of the 771 questionnaires received, 763 valid responses were identified and included in the dataset after careful review to ensure data accuracy. Data collection followed a sequential batch approach, efficiently managing many participants and facilitating organized analysis. Rigorous data analysis was conducted using the Statistical Package for the Social Sciences (SPSS), allowing various statistical tests to explore relationships and patterns within the data.

Secondary data analysis focused on reputable sources published within the last 10 years to complement the primary findings and provide a broader context for the research. By following these comprehensive steps, the study generated valuable insights and knowledge that contributed to the sporting community and advanced the understanding of relevant topics within the field.

2.3. Instrument

In this study, the Coach-Athlete Relationship Questionnaire (CART-Q), developed by Yang and Jowett (2012), played a crucial role in assessing the athlete-coach relationship. This questionnaire allowed participants to rate their perceptions of the relationship on a Likert-type scale, ranging from 1 (Strongly Disagree) to 7 (Strongly Agree).

Translation of Instruments: The exacting translation of the research tool, the Coach-Athlete Relationship Questionnaire (CART-Q), created by Yang and Jowett (2012), and was a crucial component of this study. The translation procedure tried to maintain the semantic homogeneity of the questionnaire about the two different cultural and linguistic contexts of Spain and China.

The following steps were taken throughout the translation process:

(1) Forward Translation: A multilingual translator fluent in both languages performed the first translation of the CART-Q from its native language (English) into Spanish. This process aims to preserve cultural relevance and clarity while capturing the intended meanings of the questionnaire questions.

(2) Back Translation: A second bilingual translator unfamiliar with the original English version back translated the Spanish version of the CART-Q into English. This back translation ensured that the Spanish version's semantic equivalent and substance stayed true to the original English text.

(3) Expert Review: To further improve the accuracy of the translations, linguists and scholars with extensive knowledge of the coach-athlete connection conducted a thorough analysis. This expert group evaluated the translated texts for clarity, cultural appropriateness, and semantic precision.

(4) Pilot Testing: A small group of people proficient in both languages (Spanish and Chinese) were used for the pilot test before the translated questionnaires were given to the participants (Diotaiuti et al., 2021). This pilot test aimed to identify and address any possible difficulties with understanding and cultural relevance.

Linguist Consultations: The linguists, academics, and cultural specialists engaged in the project had regular meetings and discussions throughout the translation process. Through these discussions, it was certain that the translated versions of the CART-Q appropriately reflected the subtleties of the constructions relating to the coach-athlete interaction in the Spanish and Chinese cultural settings (Yang, 2011).

2.4. Data analysis

Descriptive data is presented as mean ± standard deviation (SD). Also, frequencies and percentages were calculated. The reliability of the questionnaire in this survey was assessed using Cronbach's alpha coefficient, yielding a value of 0.871, indicating good reliability. Thresholds were employed to determine the quality of reliability, with $\alpha \geq 0.8$ considered good, $0.8 > \alpha \geq 0.7$ relatively good, $0.7 > \alpha \geq 0.6$ acceptable, and $\alpha < 0.6$ poor. T-tests, analysis of variance (ANOVA), and multivariate analysis of variance (MANOVA) were conducted to compare mean scores across different groups or conditions. Correlations between variables were examined quantitatively and qualitatively to understand their relationship comprehensively. Effect sizes were considered to assess the practical significance of findings. The significance level was set at $p < 0.05$, and the Statistical Package for the Social Sciences (SPSS) version 26 was utilized for analysis. These rigorous statistical procedures enhance the credibility and validity of the study's findings, providing comprehensive insights into the coach-athlete relationship.

3. Results

The interpretation of the results is contextualized within the intricate interplay of Chinese and Spanish cultural frameworks. This study adopts a rigorous comparative approach, taking into account the cultural nuances inherent to China and Spain. These distinctive cultural frames can significantly influence the coach-athlete relationship, particularly in terms of closeness, commitment, and complementarity.

A thorough instrument validation procedure was rigorously carried out prior to data analysis to guarantee that the translated instruments were acceptable in both the Chinese and Spanish cultural settings. This validation process included several crucial procedures. A pilot testing phase was first conducted with several individuals from both cultures. This early evaluation might reveal any possible language and cultural understanding problems. Expert linguists and cultural specialists then worked together to conduct a detailed analysis of the translated instruments. Their priceless advice and input were very helpful in modifying the instruments so that they perfectly matched the distinctive language and cultural characteristics of both China and Spain. A thorough fit assessment confirms the validity and dependability of the instruments employed in this cross-cultural investigation, underscoring the dedication to thorough data collecting.

Significant differences were observed among age groups in the dimensions of closeness and complementarity (Table 1), as revealed by one-way analysis of variance (ANOVA). *Post hoc* LSD tests indicated that coaches and athletes in the age group over 21 achieved higher scores on all items than the ages of 14–16 and 17–20, suggesting an upward trend in scores as age increases. However, no significant differences were found among the age groups in the dimension of commitment, as indicated by a p-value of 0.124.

Examining the descriptive statistics in this part is vital because they provide a better understanding of the observed changes in the characteristics of the coach-athlete interaction between age groups. For each proximity and complementarity dimension, mean scores and standard deviations have been determined as part of the descriptive analysis. These data reveal subtle trends in the interaction between coaches and athletes. These

TABLE 1 One-way ANOVA analysis of variance for age group and each dimension.

Dimensions	Sum of squares	Mean square	Df	F	P	LSD
Closeness	17.334	8.667	2**	5.57	0.004*	3 > 2 > 1
Commitment	9.133	4.567	2**	2.09	0.124	3 > 2 > 1
Complementarity	24.405	12.203	2**	10.38	0.000	3 > 2 > 1

*1 = 14–16, **2 = 17–20, and **3 = over 21.

descriptive measurements allow us to understand how the coach-athlete connection changes as athletes mature. In particular, mean scores provide a general picture of the main trends, while standard deviations show the degree of variation within each age group. This in-depth investigation complements the more general conclusions drawn from the ANOVA study by improving the understanding of how age affects the closeness and complementarity characteristics.

The results show that questions 3, 4, 5, 7, and 11 significantly differ between age groups (Table 2), while questions 1, 2, 6, 8, 9, and 10 do not. Additionally, looking at the means in Table 3, athletes from both countries over 21 scored higher on each question than those in the 14–16 and 17–20 age groups. This indicates that the scores on each question increase as the age group increases.

3.1. Multivariate analysis of variance (MANOVA)

The analysis of the data from Table 4 demonstrates a highly significant influence of country differences on the variables of "closeness," "commitment," and "complementarity." These findings indicate notable disparities in the values of these variables between China and Spain, specifically regarding the closeness, commitment, and complementarity exhibited between coaches and athletes. Significant differences in the level of closeness across different age groups among coaches and athletes are evident. However, the impact of age grouping variables on "commitment" and "complementarity" is only significant at a 10% level. Moreover, the interaction between country and age grouping variables significantly affects "closeness," suggesting that country differences substantially influence intimacy when accounting for different age groups. These findings are consistent with the descriptive analysis results. Gender grouping variables do not show a significant impact on "closeness," "commitment," and "complementarity" at a 5% level. However, at a 10% level, gender-grouping variables significantly influence the "complementarity" variable. Thus, gender is not a prominent factor influencing the relationship of "closeness," "commitment," and "complementarity" between coaches and athletes.

It is crucial to note that even though the mediation analysis and structural equation model are mentioned in the abstract, this particular analysis was not part of the current investigation. Instead, the findings from the ANOVA and MANOVA analyses are the main emphasis of this study. It was decided not to undertake the mediation analysis for practical reasons, such as practical restrictions and sample size. Although the mediation study was abandoned, the impactful results from the ANOVA and MANOVA studies will be discussed in the following sections,

TABLE 2 One-way ANOVA analysis of age group and each question.

Item	df	F	P
3. I like my coach	2	11.32	0.000
4. I am at ease	2	11.42	0.000
5. I trust my coach	2	4.59	0.010
7. I am responsive to his/her efforts	2	10.36	0.000
11. I adopt a friendly stance	2	6.28	0.002

providing important insights into the dynamics of the coach-athlete interaction within the examined cultural frameworks.

3.2. Multiple comparison

The following multiple comparison Table 5 provides the results of the comparisons based on the age group variable. From the table, the following are the observations:

Firstly, regarding the impact on "Closeness," there is a significant difference in the effects of the age group "14–16" compared to the age group "21 and above" on the closeness between coaches and athletes. Additionally, there is a significant difference in the impact of the age group "17–19" compared to the age group "21 and above" on closeness. However, the distinction in the effects of the age group "14–16" compared to "17–19" on closeness between coaches and athletes is not very pronounced. Secondly, concerning the impact on "Commitment," there is a significant difference in the effects of the age group "14–16" compared to the age group "21 and above" on the commitment between coaches and athletes. Lastly, regarding the impact on "Complementarity," there is a significant difference in the effects of the age group "14–16" compared to the age group "21 and above" on the complementarity between coaches and athletes.

4. Discussion

Enhancing athlete contentment and general wellbeing requires a thorough understanding of the dynamics of the coach-athlete interaction. In federated basketball, an athlete's success and performance depend on their connection with their coach. The Coach-Athlete Relationship Questionnaire (CART-Q) was used in this research to assess the emotional resemblance, dedication, and complementary nature of coaches and athletes in China and Spain.

In reviewing the main outcomes of this research, it is important to note that, especially in the context of federated basketball, improving player happiness and general wellbeing requires an awareness of the dynamics of the coach-athlete relationship. The

TABLE 3 Score differences of each question across age groups.

Item	Age Group	N	Mean	SD
3. I like my coach	14–16	77	4.17	1.824
	17–20	232	4.25	1.927
	over 21	462	4.89	1.87
4. I am at ease	14–16	77	3.94	1.765
	17–20	232	3.99	1.754
	over 21	462	4.58	1.707
5. I trust my coach	14–16	77	4.31	1.887
	17–20	232	4.28	1.759
	over 21	462	4.69	1.813
7. I am responsive to his/her efforts	14–16	77	4.78	1.804
	17–20	232	5.54	1.318
	over 21	462	5.52	1.31
11. I adopt a friendly stance	14–16	77	4.68	1.743
	17–20	232	5.19	1.479
	over 21	462	5.32	1.434

Coach-Athlete Relationship Questionnaire (CART-Q) was used in this research to assess the emotional compatibility, dedication, and complementarity between coaches and athletes in China and Spain.

This research aims to further shed light on the influence of cultural and contextual variables on coaching methods and player-coach interactions, building on the insightful findings of Freire et al. (2023), who examined the coach-athlete connection in two different nations. The results are comparable with Zhang et al. (2020), who examined the data and found that Spanish athletes regularly outperformed athletes from an unidentified nation in all three aspects of the coach-athlete interaction. This finding shows that interactions between coaches and athletes in Spain are more solid and encouraging than those in the unnamed nation.

The coaching methods used by Spanish coaches, a phenomenon well-documented in earlier studies, provide one tenable explanation for these disparities. A friendly and supportive coaching atmosphere is fostered by Spanish coaches' player-centred and collaborative coaching methods. Building mutual respect, open communication, and trust between coaches and athletes is emphasized in this method (MacLennan, 2017). In Spain, coaches routinely include players in decision-making processes and value their feedback on training plans and game strategy. These activities give athletes ownership and accountability, strengthening their dedication to their growth and the team's success.

Additionally, the larger Spanish culture significantly shapes the connection between the coach and the player. Spanish culture places a strong priority on personal connections, and this concept naturally permeates sports. Spanish coaches are more likely to consider players as different persons with specific needs and goals. As a result, they often provide more specialized coaching and assistance. On the other hand, the study's undisclosed nation could have distinct cultural standards and coaching culture that affect how coaches and players interact (Flaherty, 2022). Consequently, interactions may become less encouraging and cooperative and

adopt a more hierarchical or authoritarian coaching style with less space for athlete input and specialized care.

These results provide insightful information regarding the coaching environment in China, particularly in light of the lower scores shown among Chinese athletes across all three aspects of the coach-athlete relationship. These differences, in conjunction with the findings of Giulianotti (2015), highlight the significant influence that cultural differences have on coaching methods and relationships between athletes and coaches. Cultural variations profoundly affect how players communicate, interact with coaches, and see authoritative figures.

People often value collective peace and conformity in collectivist countries like China, which might affect the dynamics of coach-athlete interaction. Without expressing, their feelings aloud, athletes may be more likely to comply with instructions, and collaboration with coaches may be shown by compliance and adherence to set rules (Jowett, 2017). While deference to authority is important, coaches must also provide a loving and encouraging atmosphere where players feel free to express themselves and offer suggestions. The coaching experience and athlete performance may be improved through better communication and mutual understanding between coaches and athletes.

Coaches, sports organizations, and officials in China must be aware of these cultural impacts. Putting techniques into practice that improve the coach-athlete connection and cross-cultural divides is crucial. Chinese coaches may foster a more collaborative and player-focused atmosphere by highlighting the advantages of open communication, shared trust, and personalized attention. Coaches may allow players to share their thoughts and ideas with the training and competition processes to encourage ownership and engagement.

The study's research on how age affects the connection between coaches and athletes sheds important light on how players' viewpoints and interactions with coaches change as they age and acquire experience. According to research by Kalén et al. (2020), coach-athlete interactions tend to become tighter and more cooperative as athletes develop and improve. Higher ratings for complementarity and intimacy among adult athletes demonstrate this (Wachsmuth et al., 2017). Due to variables including enhanced trust, a better grasp of one another's viewpoints, and a stronger alignment of aims, older athletes often demonstrate improved attitudes toward their instructors (Gorgulu, 2019). A more robust and encouraging coach-athlete connection may arise when players become more receptive to collaborative efforts with their coaches as they acquire experience and confidence in their talents.

The study found that commitment ratings did not significantly change among age groups, which is interesting. This implies that players of all ages continue to show the same commitment and devotion to their coaches, highlighting the lasting relationship between athletes and their instructors regardless of age or degree of expertise. Another important result is the lack of significant gender variations in the parameters of coach-athlete relationships in China and Spain (Hong and Li, 2023). This suggests equal coaching methods since it shows that male and female athletes have similar closeness, commitment, and complementarity with their coaches (Fransen et al., 2017). This gender equality is heartening because it shows supportive coaching settings that appreciate and assist athletes of both sexes (Maguire, 2010).

TABLE 4 Between-subjects effects test.

Source	Dependent variable	Type III Sum of squares	Degrees of freedom	Mean square	F	Significance
Effect	Closeness	497.71[a]	11	45.24	36.33	0.000
	Commitment	354.76[b]	11	32.25	26.34	0.000
	Complementarity	195.38[c]	11	17.76	18.40	0.000
Intercept	Closeness	7908.28	1	7908.28	6350.43	0.000
	Commitment	8923.70	1	8923.70	7290.50	0.000
	Complementarity	11339.51	1	11339.51	11751.81	0.000
Country	Closeness	129.76	1	129.76	104.20	0.000
	Commitment	119.08	1	119.08	97.29	0.000
	Complementarity	51.68	1	51.68	53.56	0.000
Age group	Closeness	23.37	2	11.68	9.38	0.000
	Commitment	6.25	2	3.12	2.55	0.078
	Complementarity	5.31	2	2.65	2.75	0.064
Gender	Closeness	1.09	1	1.09	0.88	0.348
	Commitment	0.54	1	0.54	0.44	0.503
	Complementarity	3.56	1	3.56	3.69	0.055
Country × age group	Closeness	33.60	2	16.80	13.49	0.000
	Commitment	15.29	2	7.64	6.24	0.002
	Complementarity	12.54	2	6.27	6.50	0.002
Country × gender	Closeness	2.19	1	2.19	1.76	0.184
	Commitment	3.90	1	3.90	3.19	0.074
	Complementarity	6.99	1	6.99	7.24	0.007
Age group × gender	Closeness	0.60	2	0.30	0.24	0.786
	Commitment	2.65	2	1.32	1.08	0.338
	Complementarity	3.88	2	1.94	2.01	0.134
Country × age group × gender	Closeness	7.10	2	3.55	2.85	0.058
	Commitment	11.74	2	5.87	4.79	0.009
	Complementarity	10.79	2	5.39	5.59	0.004
Error	Closeness	935.23	751	1.24		
	Commitment	919.23	751	1.22		
	Complementarity	724.65	751	0.96		
Total	Closeness	17154.87	763			
	Commitment	18521.66	763			
	Complementarity	22483.81	763			
Corrected total	Closeness	1432.94	762			
	Commitment	1274.00	762			
	Complementarity	920.03	762			

a. R-squared = 0.347 (Adjusted R-squared = 0.33).
b. R squared = 0.278 (Adjusted R-squared = 0.26).
c. R squared = 0.212 (Adjusted R-squared = 0.20).

The findings of this inquiry have important ramifications for the basketball associations in China and Spain. Sports organizations may better meet the requirements of players and provide a healthy coaching environment by taking into account the variations in the coach-athlete interaction between the two nations (Sugden and Tomlinson, 2018). Leveraging the positive aspects of Spain's player-focused and cooperative coaching methods may be a springboard

TABLE 5 Multiple comparison.

Dependent variable	(I) age group	(J) age group	Mean difference (I-J)	Standard error	Significance	95% Confidence interval	
						Lower bound	Upper bound
LSD							
Closeness	14–16	17–19	−0.15	0.14	0.30	−0.44	0.13
		Over21	−0.60*	0.13	0.00	−0.87	−0.32
	17–19	14–16	0.15	0.14	0.30	−0.13	0.44
		Over21	−0.44*	0.09	0.00	−0.62	−0.26
	Over21	14–16	0.60*	0.13	0.00	0.32	0.87
		17–19	0.44*	0.09	0.00	0.26	0.62
Commitment	14–16	17–19	−0.18	0.14	0.20	−0.47	0.10
		Over21	−0.35*	0.13	0.01	−0.62	−0.08
	17–19	14–16	0.18	0.14	0.20	−0.10	0.47
		Over21	−0.16	0.08	0.06	−0.34	0.01
	Over21	14–16	0.35*	0.13	0.01	0.08	0.62
		17–19	0.16	0.08	0.06	−0.01	0.34
Complementarity	14–16	17–19	−0.23	0.13	0.07	−0.48	0.02
		Over21	−0.34*	0.12	0.00	−0.58	−0.10
	17–19	14–16	0.23	0.13	0.07	−0.02	0.48
		Over21	−0.10	0.07	0.17	−0.26	0.04
	Over21	14–16	0.34*	0.12	0.00	0.10	0.58
		17–19	0.10	0.07	0.17	−0.04	0.26

The error term is the Mean Square (Error) = 0.96 based on the observed mean values.
*The significance level of the mean difference is.05.

for further initiatives to strengthen the encouraging coach-athlete connection, eventually improving athlete happiness and performance.

Despite these significant findings, it is essential to acknowledge the limitations of this study. The stratification of the participant sample is one restriction. Although the research focused on the coach-athlete connection in the federated basketball community, a more thorough sample segmentation would provide more insightful results. Comprehension of the interaction between coaches and athletes may be improved by considering several subcategories of athletes regarding their ages, competition levels, kinds of sports, and training loads.

Particularly, the element of training load has the potential to significantly increase heterogeneity, perhaps resulting in varying views across athletes, even within the same sport. Variations in training loads may have a big influence on relationships between athletes and coaches, as Lupo et al. (2017) show in their study on female basketball players. This emphasizes the need for more studies to thoroughly examine how training load affects coach-athlete interactions.

The coach-athlete connection aspects' lower ratings in China suggest areas for improvement. These results should not be seen as limitations but as catalysts for more research into coaching approaches and cultural factors. These assessments may shed light on the causes of discrepancies and provide information on what needs to be done to address them. The theory and practices of coaching in China are a topic that needs more investigation. Understanding how coaches approach motivating, enhancing, and developing athletes may help identify areas where beneficial changes can be made (Tan and Bairner, 2011). Coaches may consider using strategies that put players' needs and viewpoints first, encouraging teamwork, honest communication, and developing trust and respect between coach and athlete.

Understanding how the coach-athlete connection affects performance, motivation, and general wellbeing. Within federated basketball and other sporting contexts, coaches have a crucial role in determining player development and pleasure. Coaches can help players feel valued, understood, and inspired to reach their greatest potential by fostering a pleasant and encouraging atmosphere. A systematic and trustworthy tool for evaluating the closeness, commitment, and complementarity in the coach-athlete connection is the Coach-Athlete Connection Questionnaire (CART-Q). The all-encompassing approach has made it easier to gather insightful information on the psychological, cognitive, and behavioral components of interactions between athletes and coaches, leading to a full knowledge of this phenomenon.

The observed differences in coach-athlete relationships between China and Spain highlight the importance of cultural and environmental elements in coaching tactics. Coaches may successfully connect with athletes from various cultural backgrounds by being aware of cultural nuances and adapting their coaching strategies appropriately. The greater performance of Spanish athletes demonstrates the value of coaching strategies that emphasize each player individually and promote teamwork. The relatively lower results among Chinese athletes provide a chance for growth and improvement in China's coaching industry. These results must be catalysts for additional in-depth research into coaching approaches and cultural factors rather than limitations. These assessments may shed light on the causes of discrepancies and provide information on what needs to be done to address them.

For coaches, sports organizations, and legislators, comprehending the coach-athlete connection's effects is crucial. Accepting cultural diversity and using coaching techniques that are appropriate for the situation may improve an athlete's performance. Coaches should modify their teaching strategies as players go through their sports careers to match each athlete's specific needs and goals while establishing a supportive and welcoming coaching atmosphere (López de Subijana et al., 2021).

This research helps comprehend the coach-athlete connection in federated basketball in China and Spain's cultural and environmental differences. Cultural and coaching methods influence athlete-coach relationships, as seen by the inequalities. Sports organizations may improve athlete happiness and performance by recognizing these variations and using culturally sensitive coaching methods. Coaches, sports organizations, and politicians must understand the coach-athlete interaction. Cultural diversity and context-specific coaching improve athlete happiness, motivation, and performance. In positive and inclusive coaching settings, coaches should adapt to players' specific needs and expectations at various phases of their athletic experiences.

5. Conclusion

In this particular investigation, the Coach-Athlete Relationship Questionnaire (CART-Q) was utilized to examine the dynamics of interactions between players and coaches and the relationships among players from China and Spain in the context of basketball. The findings revealed significant differences between the two nations, indicating that cultural and contextual factors are pivotal in shaping the coach-athlete relationship dynamics.

Notably, athletes from Spain exhibited higher scores, indicating stronger and more supportive associations with their coaches. In comparison, their counterparts from China obtained lower scores, signaling the potential for enhancing development opportunities. Additionally, the research discovered that older athletes tended to experience higher levels of closeness and complementarity with their coaches, which suggests a positive evolution in players' attitudes toward their coaches. Noteworthy, too, is that the unwavering dedication across various age groups implies that athletes of all ages are equally committed to their coaches.

An intriguing discovery from the study was the absence of significant gender differences in the coach-athlete relationship dimensions in both China and Spain. This suggests that male and female athletes receive equal coaching support, regardless of gender. The findings emphasize the importance of cultivating positive and supportive coach-athlete relationships while considering cultural and age-related factors. The implications of this finding underscore the importance of developing positive and supportive coach-athlete relationships while considering cultural and age-related aspects.

Addressing these factors and promoting equitable coaching practices can profoundly affect the athlete's experience and development. To more effectively and promote equitable coaching practices, there is a clear need for a thorough analysis of the athlete sample. This necessitates a comprehensive stratification of participants, taking into account various subcategories of athletes based on factors such as age, competition level, type of sport, and training load. This nuanced approach has the

potential to reveal disparities in the perception of training load, even among individual athletes during different training sessions, a phenomenon previously underscored in research by Lupo et al. (2017) and further substantiated by their 2020 investigation into female basketball players.

The insights gleaned from this study hold significant value as practical guidance for sports organizations seeking to refine their coaching strategies and cultivate an environment that is both inclusive and supportive for athletes. Looking ahead, future research in the realm of federated basketball and other sporting contexts can build upon these findings. This research should explore additional variables that influence the coach-athlete relationship while also examining coaching practices across diverse sporting cultures. In this endeavor, drawing inspiration from the body of work by Lupo et al. (2020) is highly relevant.

Practical interventions based on these research findings can be implemented to enhance coach-athlete relationships within sports organizations. Prioritizing the development of cultivating healthy and effective connections between coaches and athletes is pivotal, as it can culminate in a positive and enriching athletic experience. Ultimately, this has a ripple effect, benefiting not only the athletes but also coaches and the sports institutions they are affiliated with.

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 Polytechnic University of Madrid. 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

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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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Functional physical training improves fitness and cognitive development in 4~5 years old children

Lei Hao[1], Yongzhao Fan[2], Xiaojuan Zhang[3], Xiangjiang Rong[3], Youping Sun[1]*† and Kun Liu[4,5]*†

[1]College of Physical Education and Health, East China Normal University, Shanghai, China, [2]Department of Physical Education, Henan Normal University, Xinxiang, Henan, China, [3]Graduate School, Capital University of Physical Education and Sports, Beijing, China, [4]Department of Psychiatry, Yale School of Medicine, New Haven, CT, United States, [5]Brain Peace Science Foundation, New Haven, CT, United States

Background: Development of physical and cognitive function is very critical in 4~5 years children. It has been addressed in this research if the 18 weeks of specific functional training with or without cognitive training can be effective on improving fitness and cognitive development in 4~5 years preschool children.

Methods: A total of 126 preschool children in the 4~5 age range were selected as participants and randomly assigned to one of four groups: the control group (C), the functional physical training group (P), the cognitive training group (CT), and the functional physical training combined with cognitive training group (PCT).

Results: The results revealed significant pre/post differences in body height and weight among all four groups of children. Furthermore, there was no significant difference in physical fitness between the C group and the CT group after the intervention. However, the children in the P group and the PCT group showed significant improvements in three indicators including standing long jump, continuous jump, and 10-meter shuttle running. Additionally, the children in P group, CT group, and the PCT group demonstrated significant improvement in simple reaction time, attention, and spatial memory. No significant cognitive improvement was found in C group.

Conclusion: Functional physical training with or without cognitive intervention can promote both physical fitness and cognitive development in children aged 4~5 years. Cognitive training alone can significantly improve cognitive function but not physical. Therefore, functional physical training can be used alone to improve the physical and cognitive abilities for aged 4~5 years old children.

KEYWORDS

functional physical training, fitness development, cognitive development, preschool children, physical and cognitive abilities

1. Introduction

Childhood is a critical period for the rapid development of physical fitness and cognitive function (Westfall et al., 2018; Wick et al., 2021). Physical fitness serves as an important indicator of health and has been positively linked to cardiovascular health, fitness levels, cognitive function, mental well-being, and academic achievement (Ortega et al., 2008; Chu et al., 2019;

Wassenaar et al., 2019). Additionally, studies have shown a positive correlation between cognitive function and academic performance, as well as overall task performance in children (Fonteyne et al., 2017; Luong et al., 2017). Moreover, this period of childhood is characterized by high behavioral plasticity and sensitivity in both physical and brain development (Pascual-Leone et al., 2005; Lenroot et al., 2009; Chaddock et al., 2012). Thus, it is crucial to implement effective measures to promote physical health and cognitive development in preschool children.

Previous research has implied that excess weighted preschool children, who lack physical exercise, have deficient executive function (Likhitweerawong et al., 2022). The association between physical activity and executive functions also has been found in low-income South African preschool children (Cook et al., 2019). Furthermore, a meta-analysis also suggested that chronic physical exercise could be a promising way to promote multiple aspects of cognitive function, including executive function (Song et al., 2023). The different effectiveness of different intervention on cognitive function has been fully investigated (Diamond and Ling, 2020). Although the previous research suggested that the chronic physical exercise can improve executive functions, some recent systematic reviews argued that the causal relation between chronic exercise training interventions and children's cognitive functioning is not well established (Diamond and Ling, 2016; Hillman et al., 2018).

For exploring the effect of more differentiated physical exercise on executive function, a specifically designed functional physical exercise, which focuses on enhancing lower body strength, agility, balance, and stability with physical movement games and aerobic exercise volume, had been used in this study in preschool children.

Physical activity has been shown to have numerous benefits for both physical and cognitive development in children (Tucker, 2008). Conversely, insufficient physical activity can lead to weight gain and a decline in cognitive function among children (Ren et al., 2017; Anderson and Durstine, 2019; Fang et al., 2020). However, existing research in this area has primarily focused on school-aged children, with less emphasis on preschool-aged children (Fan and Cao, 2017). The limited research available indicates that preschoolers, including those in China, also experience low levels of physical activity (Barbosa and Oliveira, 2016). Two studies support this finding, with one study revealing that only 35.3% of children in Shanghai met the recommended levels of physical activity, and the other study indicating that only 20–35 min were allocated for physical activities in Hong Kong (Chung et al., 2019; Quan et al., 2019). These time allocations fall far below the minimum recommendations set by the World Health Organization (WHO; Ansari, 2019). Additionally, studies have demonstrated that physical activity patterns in preschool children tend to persist into later childhood (Hardie et al., 2017). Furthermore, emerging evidence suggests that early childhood physical activity is associated with improved cognitive outcomes in later life (Gao et al., 2019a; Daimiel et al., 2020; Lidegaard et al., 2020; Yoong et al., 2020). Therefore, there is a pressing need for physical interventions specifically designed for preschoolers.

Functional physical training is a contemporary training approach that encompasses specialized movement training systems involving incremental, multi-joint, multi-planar, and proprioceptive movements performed under specific load and speed conditions (Zhixiong, 2017). Originally developed for competitive sports, this training method has gained popularity among schoolchildren due to its advanced training concept and engaging techniques (Zhixiong et al., 2018). Additionally,

research has indicated the presence of a bidirectional relationship between motor abilities and cognitive skills during early childhood (Nan et al., 2017). Cognitive training has been shown to enhance cognitive function development in school-aged children (Wexler et al., 2016). However, the impact of this physical/cognitive combined training program on the development of physical and cognitive function in preschool children has not been extensively investigated yet. To investigate the synchronized effect of physical and cognitive training on pre-school children development, this study also incorporated a cognitive training component with functional training.

In summary, the physical fitness and cognitive development of preschool children have garnered significant attention, yet there is a lack of structured physical activities aimed at fostering their development. Consequently, this research aims to investigate the impact of functional physical training with or without cognitive training on the physical fitness and cognitive function of preschoolers. The findings of this study will provide valuable insights for enhancing appropriate development for preschool children.

2. Materials and methods

2.1. Study design and participants

A total of 126 preschool children aged 4 to 5 years (mean age 4.26 ± 0.41, girls: 50%) were selected from various kindergartens in Xicheng District, Beijing, for this research. The kindergartens were randomly selected with coordination by the Xicheng District Education Administration. All the children were randomly divided into four groups: control group (C, $n = 32$), functional physical training group (P, $n = 31$), cognitive training group (CT, $n = 32$), and functional physical training combined with cognitive training intervention group (PCT, $n = 31$). The children in C group did not receive any intervention but participated in regular kindergarten activities. The other three groups underwent an 18-week intervention consisting of functional physical training (40 min), cognitive training (40 min), and a combination of functional physical training (20 min) with cognitive training (20 min), with each training session lasting 40 min, three times per week. The physical training, cognitive training or physical together with cognitive training were performed in outdoor exercise time sections and recess time sections according to the curriculum of the kindergartens. The group-based intervention of the functional physical training and the cognitive training were performed in the indoor gym in the kindergartens by 4 well-trained graduate instructors together with 8 pre-trained preschool teachers. All the instructors and the teachers are female. Each group of preschoolers had one instructor and two teachers in charge of the training to get full engagement.

3. Research methods

3.1. Morphological and physical fitness tests

The physical fitness assessment in this study was primarily based on the Chinese National Student Physical Fitness Standard for preschool-age children. The assessment consisted of two main parts: morphological tests and physical fitness tests, which included the following prescribed tests: standing long jump (explosive power), sit

and reach (flexibility), continuous hop (lower limb strength and coordination), 10-meter shuttle run (agility), balance beam walking (balance), and tennis throw (upper limb and abdominal strength; The State General Administration of Sports, 2003; Liu et al., 2018). The testers involved in the assessment were well-trained and equipped with the necessary knowledge and skills for conducting physical fitness tests. Additionally, all testing instruments were calibrated to ensure accuracy and consistency. Brief descriptions of each test method are provided below.

1. Morphological tests included in this study focused on measuring height and weight. Height and weight were assessed separately using scales with an accuracy of 0.1 cm. These tests provide important morphometric data that contribute to understanding the physical characteristics of the preschool children participating in the study.
2. Physical fitness tests consisted of the following assessments:

① Standing long jump: The distance between the starting line and the nearest heel was measured in a straight line.
② Sit and reach: The subject extended their arms forward and pushed a cursor as far as possible along a measuring scale, and the maximum value achieved was recorded.
③ Continuous hop: The test measured the time it took for the subject to complete 10 consecutive hops over soft squares.
④ 10-meter shuttle run: The test measured the shortest time it took for the subject to run a 10-meter distance and return to the starting point.
⑤ Balance beam walking: The test measured the shortest time it took for the subject to walk across a 3-meter balance beam.
⑥ Tennis throw: The valid score was measured as the straight-line distance between the throwing line and the point where the tennis ball landed.

Each of the physical fitness test measurements was conducted twice, and the results were recorded to one decimal point. These tests provided objective data on the physical capabilities and performance of preschool children.

3.2. Cognitive task test

Three cognitive tasks, namely simple reaction time, attention, and spatial location memory breadth, were chosen to evaluate the impact of the intervention program on the cognitive development of preschoolers (Meiling, 2020). These tasks were specifically selected to measure different aspects of cognitive function and provide insights into the cognitive improvements resulting from the intervention. By assessing the performance of preschool children in these tasks before and after the intervention, the study aimed to determine the effects of the program on their cognitive development.

1. Simple reaction time test: This test aims to assess the rapid response ability of children to a fixed and singular visual stimulus. When a green circle appears in the center of the screen, participants are required to press the green button as quickly as possible in response. The test was conducted in groups of 5, with a total of 30 trials using the Psykey Psychometric Test System from Beijing Mind Ark Technology

Co. If there was an early button press, the test result would be considered invalid, and the computer would emit a warning tone. The mean value of the valid results was calculated as the simple reaction time.

2. Attention test: The Schulte Table test was utilized primarily to evaluate attentional focus and cognitive stability. This test involves a 3×3 square grid with randomly arranged numbers from 1 to 9. Participants are instructed to arrange the numbers in ascending order (1, 2, 3, 4, … 9) as quickly as possible, aiming for a shorter completion time. If the order of the clicks is incorrect, an auditory tone is triggered until the participant selects the correct order. The test was repeated three times consecutively, and the average value of the valid results was calculated as the attention time.

3. Spatial position memory test: During the test, a 5×3 square grid is presented on the computer screen, and the animal will successively show its head from the hole in the ground and then retract again. The subject is asked to look carefully and remember the position and order of the animals. A message will appear at the bottom of the screen, asking the subject to click on the squares in the order in which the animals appear. When the number of animals showing their heads is the same as the number of animals that just appeared, you can click the "OK" button to enter. After 3 attempts of a certain breadth, if not all of them are wrong, the breadth will be increased by 1 and continued until 3 consecutive errors or 12 tasks of a certain breadth are completed.

3.3. Functional physical training intervention

The physical fitness intervention for preschool children was developed based on principles of functional physical training and tailored to the characteristics of preschoolers by incorporating gamification elements. The goals of our functional physical training are increasing strength, agility, balance and stability of lower limbs with different incremental, multi-joint, multi-planar, and proprioceptive movements. Furthermore, we designed the fun games gradually using the different difficulty levels of all the movements and performed the physical intervention under specific load and speed conditions. To enhance the enjoyment, novelty, and challenge of the exercises, small and portable equipment was utilized. The intervention lasted for 18 weeks, aiming to maintain appropriate exercise intensity and density for young children while considering their physiological characteristics.

To monitor the heart rate during exercise, a Likang PC-608 finger pulse oximeter was used, with the target heart rate set at 120 to 140 beats per minute (Hengchan et al., 2014). It is important to note that the heart rate was not continuously monitored throughout the exercise to ensure the effectiveness of the training. The main training contents and methods are outlined in Table 1.

3.4. Cognitive training intervention

The cognitive games included in the intervention program comprise four different games (Wexler et al., 2016). Each game has a

TABLE 1 Training content and methods.

Training time (week)	Training content	Methods (Examples)
1 ~ 4	Strength and core stability	Bugs Bunny straight legs jumping, Little horse crossing the river (Obstacle Jump), Winnie the Pooh crawling (hand walk), Two-handed food throwing to fish
5 ~ 6	Balance and core stability	Crossing the Flaming Mountain (Durian ball walking), Bugs Bunny single-leg jump, Crocodile climbing, Crab crawling
7 ~ 8	Speed and aerobic capacity	Bugs Bunny carrying radish, Relay Run, Backward Running
9 ~ 10	Reactivity and flexibility	Multi-directional movement, GO/NO GO, Listen to the password - walk and run alternately, Knee Hug, leg Cradle
11 ~ 18	Functional and cognitive training	Comprehensive Exercises (Combination of the above training methods and cognitive games)

duration of 20 min. After each game session, the software automatically saves the game progress in the background and adjusts the subsequent cognitive games based on each child's individual performance.

Game 1: In this game, children track a moving light and click on it when it transforms into a red gem. If the response is correct, the light speeds up, while errors result in a slower pace. As the game progresses, blue gems appear, which should not be clicked. Eventually, the target randomly switches between red and blue gems. To complete the game, children need to identify and click only on the gems that match the previous ones, creating complete gem sequences. Game 2: In this game, pirates throw various objects into the air from a box, and children must click on items belonging to a specific category before they disappear from the screen. Correct responses lead to faster-moving objects, and as the game advances, the difficulty increases by adding six flying objects simultaneously. Game 3: In this game, children are presented with three objects in a row and must choose the correct object from a set of three options to complete the pattern. Game 4: In this game, children are challenged to remember the order in which a group of pirates sitting on a beach raise their hands. The objective is to recall and reproduce the correct sequence of hand raises. The game starts with two pirates, and the level of difficulty increases with successful completions while decreasing with mistakes.

3.5. Statistical analysis

The data were reported as the mean ± STDEV and analyzed using SPSS 22.0 software. Initially, normal distribution and homogeneity of variance tests were conducted on the data. The data of every group follow the normal distribution and satisfy the homogeneity of variance. Subsequently, a two-way analysis of variance (ANOVA) with repeated measures was performed to analyze the effects of the intervention and time on the groups. Post-hoc multiple comparisons among the different groups were carried out using the least-significant difference (LSD) test. A significance level of $p < 0.05$ was considered statistically significant.

4. Results

4.1. Morphological indices of the children

The body heights of the children were 108.9 ± 5.98 cm in C group, 108.35 ± 4.12 cm in P group, 108.00 ± 4.79 cm in CT group,

and 108.72 ± 5.53 cm in PCT group at baseline (pre-test). The body height had increased to 109.61 ± 6.02 cm in C group, 109.96 ± 3.93 cm in P group, 109.08 ± 5.29 cm in CT group, and 109.69 ± 5.46 in PCT group after 18 weeks of intervention (post-test). The body weight of the children were 18.19 ± 4.17 kg in C group, 18.29 ± 2.14 kg in P group, 18.11 ± 2.23 kg in CT group, and 18.30 ± 2.90 in PCT group at the baseline. The body weight has increased to 18.66 ± 4.21 kg in C group, 18.96 ± 2.24 kg in P group, 18.87 ± 2.47 kg in CT group and 18.93 ± 2.91 kg in PCT group after 18 weeks of intervention. The BMI of the children were 15.39 ± 1.90 in C group, 15.60 ± 1.87 in P group, 15.47 ± 1.02 in CT group and 15.41 ± 1.25 in PCT group at the baseline and there was no significant change after 18 weeks intervention. All the data above has been shown in Figure 1.

As depicted in Figure 1, the time factor had a significant effect on height and weight [height: $F(1, 122) = 61.637$, $p < 0.01$; weight: $F(1, 122) = 242.274$, $p < 0.01$], but not on BMI [$F(1, 122) = 0.075$, $p > 0.05$]. There were no group effects observed for height, weight, and BMI. Additionally, there were no significant differences in height, weight, and BMI between the groups before and after the intervention [height: $F(3, 122) = 0.493$, $p > 0.05$; weight: $F(3, 122) = 0.025$, $p > 0.05$; BMI: $F(3, 122) = 0.065$, $p > 0.05$]. Moreover, no interaction effect was found between time and group [height: $F(3, 122) = 0.257$, $p > 0.05$; weight: $F(3, 122) = 0.58$, $p > 0.05$; BMI: $F(3, 122) = 0.283$, $p > 0.05$].

4.2. The result of the physical fitness test

The standing long jump scores were 92.31 ± 12.71 cm in C group, 92.84 ± 14.79 cm in P group, 93.06 ± 14.12 cm in CT group and 91.94 ± 15.13 cm in PCT group at baseline (pre-test). The standing long jump scores were 92.66 ± 13.10 cm in C group and 93.64 ± 14.73 cm in CT group without significant changes, and had improved to 103.69 ± 11.59 cm in P group and 103.56 ± 16.41 in PCT group after 18 weeks intervention (post-test). The continuous hop scores were 6.76 ± 1.40 s (s) in C group, 6.93 ± 1.39 s in P group, 6.63 ± 1.48 s in CT group and 6.70 ± 2.22 s in PCT group at baseline (pre-test). The continuous hop scores were at 6.58 ± 0.76 s in C group and 6.60 ± 1.64 s in CT group without significant change, and decreased to 5.65 ± 1.18 s in P group and 5.46 ± 0.86 s in PCT group after 18 weeks of intervention (post-test). The 10-meter shuttle run of the children were 7.74 ± 0.57 s in C group, 7.62 ± 0.95 s in P group, 7.56 ± 0.94 s in CT group and 7.42 ± 0.77 s in PCT group at the baseline (pre-test). The 10-meter shuttle run scores has decreased to

FIGURE 1
Morphological indices. Note: The four groups were designated as follows: C (control group), P (functional physical training group), CT (cognitive training group), and PCT (functional physical training combined with cognitive training group). Significance levels were indicated as **$p < 0.01$, denoting a statistically significant difference compared to the pre-test and post-test results in all four groups.

7.54 ± 0.57 s in C group and 7.33 ± 0.70 s in CT group without significant change, and decreased significantly to 6.63 ± 0.91 s in P group and 6.74 ± 0.92 s in PCT group after 18 weeks of intervention (post-test). The sit and reach scores of the children were 11.87 ± 3.36 cm in C group, 11.37 ± 5.56 cm in P group, 11.84 ± 4.04 cm in CT group, and 10.32 ± 5.12 cm in PCT group at baseline (pre-test). The sit and reach scores were 11.44 ± 4.39 cm in C group, 11.05 ± 5.23 cm in P group, 11.70 ± 3.99 cm in CT group, and 10.17 ± 4.14 cm in PCT group after 18 weeks of intervention (post-test). There was no significant change after the intervention. The balance beam walking scores of the children were 8.47 ± 4.52 s in C group, 7.87 ± 4.06 s in P group, 7.76 ± 4.99 s in CT group, and 7.65 ± 3.66 s in PCT group at the baseline (pre-test). The balance beam walking scores of the children were 8.12 ± 3.56 s in C group, 7.80 ± 3.45 s in P group, 7.49 ± 3.49 s in CT group and 7.40 ± 3.15 s in PCT group after 18 weeks of intervention (post-test). There was no significant change after the intervention. The tennis throw scores of the children were 4.19 ± 1.14 m in C group, 4.15 ± 1.58 m in P group, 4.13 ± 1.18 m in CT group, and 4.29 ± 1.16 m in PCT group at baseline (pre-test). The tennis throw scores were 4.01 ± 0.96 m in C group, 4.49 ± 1.95 m in P group, 4.06 ± 1.10 m in CT group, and 4.33 ± 1.12 m in PCT group after 18 weeks of intervention (post-test). There was no significant change after the intervention. All the data above has been shown in Figure 2.

As shown in Figure 2, the time effects were found to have a significant impact on the standing long jump, continuous hop, and

10-meter shuttle run [standing long jump: $F_{(1, 122)} = 42.257$, $p < 0.05$; continuous hop: $F_{(1, 122)} = 20.26$, $p < 0.05$; 10-meter shuttle run: $F_{(1, 122)} = 28.986$, $p < 0.05$]. However, there were no significant time effects observed for the sit and reach, balance beam, and tennis throw tests [sit and reach: $F_{(1, 122)} = 0.483$, $p > 0.05$; balance beam: $F_{(1, 122)} = 0.365$, $p > 0.05$; tennis throw: $F_{(1, 122)} = 0.08$, $p > 0.05$] in the P and PCT groups. Similar effects were observed for the grouping effect [standing long jump: $F_{(3, 122)} = 12.871$, $p < 0.05$; continuous hop: $F_{(3, 122)} = 1.61$, $p > 0.05$; 10-meter shuttle run: $F_{(3, 122)} = 6.638$, $p < 0.05$; sit and reach: $F_{(3, 122)} = 0.94$, $p > 0.05$; balance beam: $F_{(3, 122)} = 0.345$, $p > 0.05$; tennis throw: $F_{(3, 122)} = 0.38$, $p > 0.05$].

A significant interaction effect between time and group was observed for the standing long jump, continuous hop, and 10-meter shuttle run tests [standing long jump: $F_{(3, 122)} = 12.871$, $p < 0.05$; continuous hop: $F_{(3, 122)} = 4.761$, $p < 0.05$; 10-meter shuttle run: $F_{(3, 122)} = 11.035$, $p < 0.05$]. However, there were no significant interaction effects observed for the sit and reach, balance beam, and tennis throw tests [sit and reach: $F_{(3, 122)} = 0.081$, $p > 0.05$; balance beam: $F_{(3, 122)} = 0.106$, $p > 0.05$; tennis throw: $F_{(3, 122)} = 0.944$, $p > 0.05$].

4.3. The result of the cognitive test

The reaction time scores were 0.62 ± 0.13 s (s) in C group, 0.63 ± 0.13 s in P group, 0.62 ± 0.17 s in CT group and 0.60 ± 0.17 s in
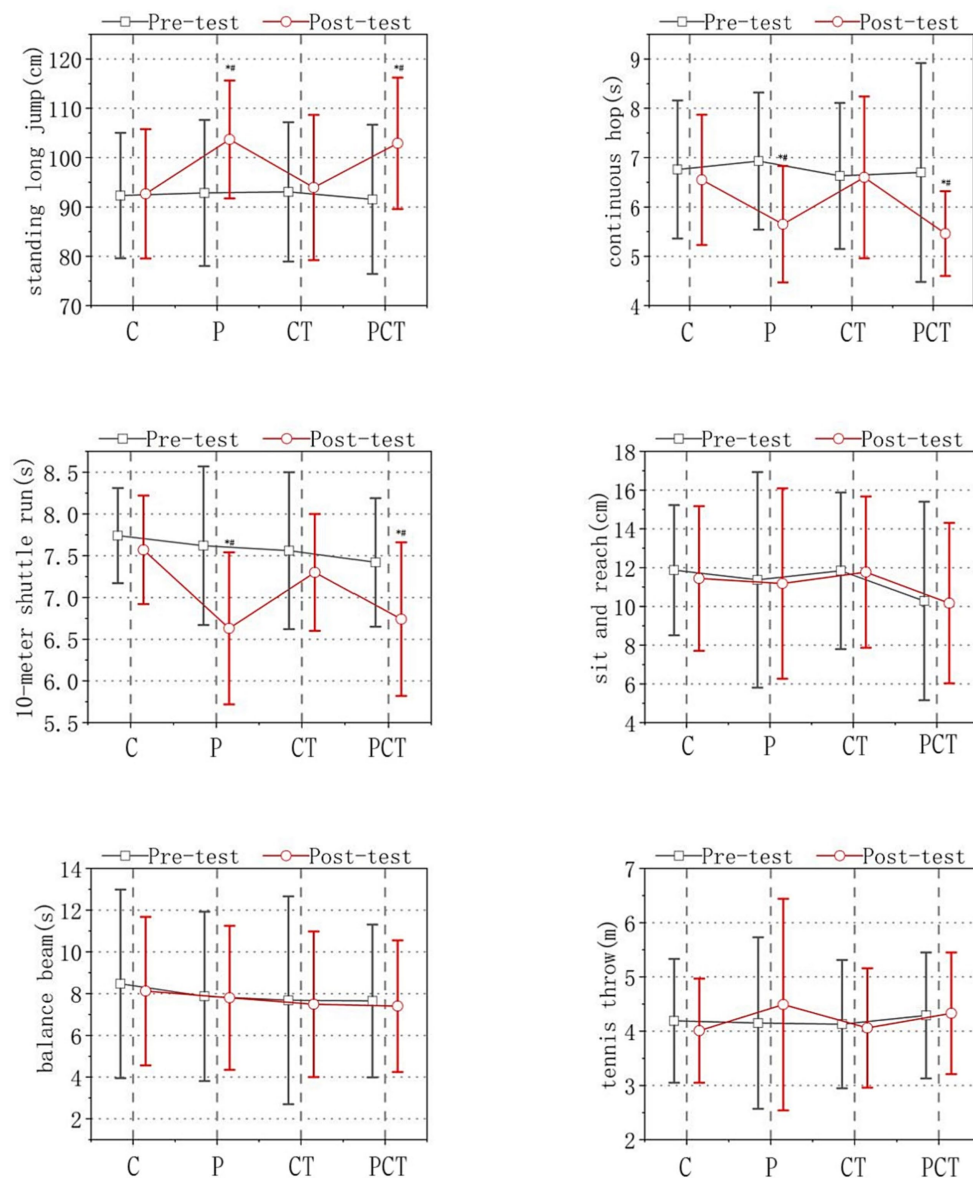
FIGURE 2
Results of physical fitness test. Note: The four groups were designated as follows: C (control group), P (functional physical training group), CT (cognitive training group), and PCT (functional physical training combined with cognitive training group). Significance levels were indicated as *$p < 0.05$, denoting a statistically significant difference compared to the pre-test and post-test results in all four groups.

PCT group at baseline (pre-test). The reaction time score had no significant change to 0.60 ± 0.15 s in C group, and had improved to 0.50 ± 0.12 s in P group, 0.49 ± 0.12 s in CT group and 0.51 ± 0.15 s in PCT group after 18 weeks intervention (post-test). The attention scores were 16.50 ± 4.99 s in C group, 16.67 ± 4.16 s in P group, 16.02 ± 4.31 s in CT group and 16.93 ± 4.04 s in PCT group at the baseline (pre-test). The attention score had no significant change at 16.13 ± 4.28 s in C group, and had decreased to 13.66 ± 4.76 s in P group, 12.55 ± 5.08 s in CT group and 12.92 ± 4.04 in PCT group after 18 weeks of intervention (post-test). The memory test scores were 3.67 ± 1.30 in C group, 3.88 ± 1.10 in P group, 3.67 ± 1.59 in CT group and 3.59 ± 1.26 in PCT group at the baseline (pre-test). The memory score had no significant change at 3.56 ± 1.12 in C group, and had

improved to 4.59 ± 1.31 in P group, 4.50 ± 1.47 in CT group and 4.50 ± 1.12 in PCT group after 18 weeks of intervention (post-test). All the data above has been shown in Figure 3.

As shown in Figure 3, the time effects had a significant impact on reaction time, attention, and memory [reaction time: $F_{(1, 122)} = 39.781$, $p < 0.05$; attention: $F_{(1, 122)} = 51.761$, $p < 0.05$; memory: $F_{(1, 122)} = 248.129$, $p < 0.05$]. The group effect also had a significant impact [reaction time: $F_{(3, 122)} = 2.068$, $p < 0.05$; attention: $F_{(3, 122)} = 2.568$, $p > 0.05$; memory: $F_{(3, 122)} = 1.792$, $p > 0.05$]. A significant interaction effect was observed between time and group in reaction time, attention, and memory tests [reaction time: $F_{(3, 122)} = 2.529$, $p > 0.05$; attention: $F_{(3, 122)} = 4.511$, $p < 0.05$; memory: $F_{(3, 122)} = 22.408$, $p < 0.05$].
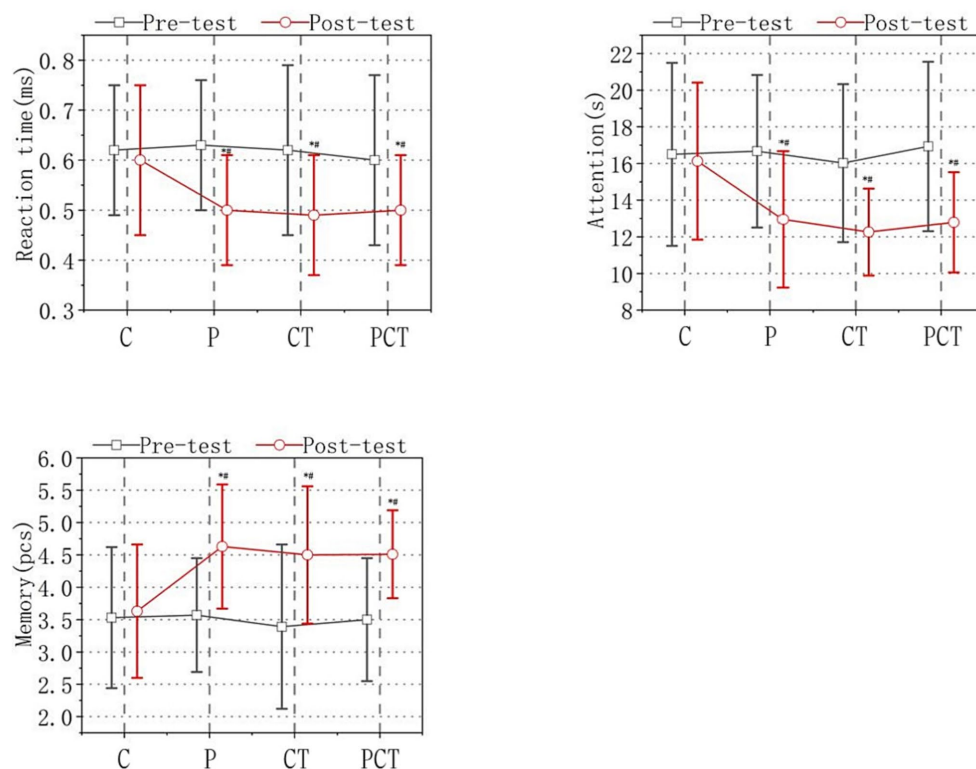
FIGURE 3
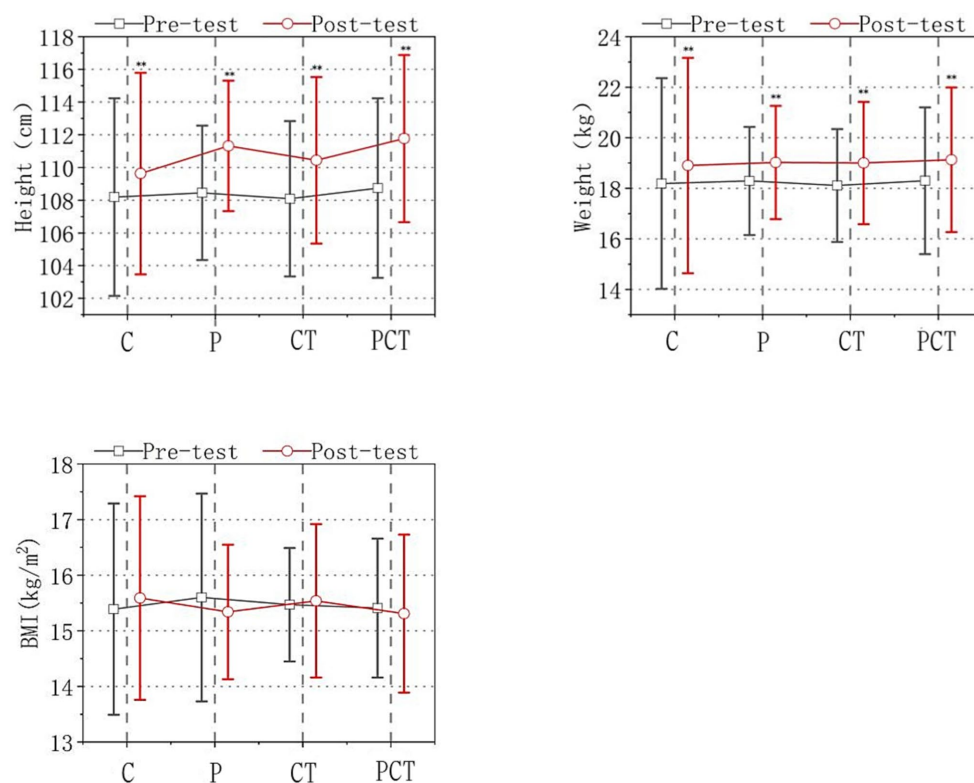Results of cognitive test. Note: the four groups were designated as follows: C (control group), P (functional physical training group), CT (cognitive training group), and PCT (functional physical training combined with cognitive training group). Significance levels were indicated as $*p < 0.05$, denoting a statistically significant difference compared to the pre-test and post-test results in all four groups.

5. Discussion

Childhood is a critical period characterized by significant physiological, structural, and functional changes (Teicher et al., 2016; Gilmore et al., 2018). Physical fitness plays a crucial role in child development and is considered a predictor of health outcomes. The physical fitness has been found to have a positive association with cognitive function and brain health (Esteban-Cornejo et al., 2017; Haga et al., 2019). While physical fitness is influenced by various factors, it is particularly influenced by physical activity habits (Daimiel et al., 2020). Insufficient physical activity has been linked to negative effects on the healthy development of preschool children (Gao et al., 2019b). On the other hand, well-designed physical activity interventions have been shown to significantly promote both physical and cognitive development in school-age children (Mead et al., 2017). Therefore, implementing appropriate intervention is essential to promote the healthy development of preschool children.

The initial measurements of height and weight in the four groups showed no significant differences, indicating that the groups were initially comparable. After the 18-week intervention, there was a significant increase in both height and weight across all four groups of children. These findings are consistent with previous studies that have also observed significant changes in height and weight following interventions (Eliakim et al., 2007). It is worth noting that the age range of 5–6 years corresponds to a rapid stage of growth and development in children, which further supports the observed

increases in height and weight (WHO Multicentre Growth Reference Study Group and de Onis, 2006).

However, there was a notable difference in the results of this study compared to a previous experiment. Specifically in the previous experiment, the weight of children in the experimental group was significantly lower than that of the control group (Bocca et al., 2012). This discrepancy can be attributed to the implementation of a dietary intervention in the study, which effectively reduced body fat levels in children. It is likely that the dietary intervention played a significant role in influencing the weight outcomes and accounts for the different results between the two studies.

Physical fitness encompasses various aspects of the human body, including its morphological structure, physiological functions, and psychological factors. It is influenced by both genetic factors and acquired characteristics (Roy et al., 2010). Physical fitness is closely associated with numerous health benefits and behavioral outcomes (Bouchard et al., 2012). Certain components of physical fitness have been identified as particularly important indicators of various health outcomes in young individuals (Ortega et al., 2008). In this study, advanced functional physical training was employed to promote the development of physical fitness in preschool children. The results indicated that the standing long jump, continuous hop, and 10-meter shuttle run performance of the P group and the PCT group were significantly better than those of the C group and the CT group. This suggests that the 18-week functional physical training can effectively enhance explosive force, lower limb muscle strength, coordination,

and agility in preschoolers. These findings are consistent with similar studies that have demonstrated significant improvements in body composition after more than 6 weeks of physical activity interventions (Puder et al., 2011; Foulkes et al., 2017). Moreover, changes in cardiorespiratory fitness, lower limb muscle strength, and speed agility have been found to be associated with changes in body composition in preschool children (García-Hermoso et al., 2020).

The experimental groups in this study engaged in regular moderate-to-vigorous physical activity, which has been shown to be positively correlated with muscle strength, explosive power, balance, agility, and aerobic fitness in preschoolers (Fang et al., 2017). Additionally, numerous studies have established a positive correlation between physical fitness and motor ability in children (Aadland et al., 2017; Nan et al., 2017). One study specifically confirmed that functional physical training, as a novel form of training, is highly beneficial in improving the fundamental motor skills of preschool children (Zhexiao et al., 2016). Therefore, the results of this study are reliable and in line with existing evidence.

Cognitive function encompasses various sub-functions such as response, attention, memory, learning, language, perception, and executive function (Fiocco and Yaffe, 2010). Among these, response time is an important indicator for assessing brain function, attention processes, cognitive flexibility, behavior, and performance (Stuss et al., 2005; Hillman et al., 2014; Ángel et al., 2018). The development of attention and working memory skills is closely related to children's health and behavioral performance (Conklin et al., 2007; Oberauer, 2019). In this study, these indicators were chosen to evaluate the cognitive function of school-age children. The results of the study revealed that simple reaction time, attention, and spatial memory were significantly better in the P group, CT group, and PCT group compared to the C group, with no significant differences observed among the three intervention groups. The cognitive games used in this study were designed based on the principle of neuroplasticity, and previous research has demonstrated that playing such games can significantly improve focused attention, response inhibition, working memory, and cognitive flexibility in school-age children (Klingberg et al., 2005). By engaging in these cognitive games, preschool children in the experiment were able to dynamically reconfigure their neural systems, leading to the observed improvements in cognitive function. Furthermore, childhood is a period characterized by rapid structural and functional development of the central nervous system and brain, and the brain appears to be particularly responsive to exercise during this stage (Schacter et al., 2004; Khan and Hillman, 2014; Hillman and Biggan, 2017). Studies have shown that children with higher aerobic capacity and agility exhibit larger brain volumes in the gray matter, frontal lobes, hippocampus, and caudate nucleus, as well as more efficient neuroelectric processing during cognitive tasks. These differences in brain structures and functions contribute to variations in working memory, cognitive control, and attention among children (Donnelly et al., 2016; Santana et al., 2017). Additionally, physical activity-induced increases in cerebral blood flow and the release of neurotrophic factors may also contribute to the observed changes in cognitive function (Alfini et al., 2019; Tari et al., 2019).

Generally based on our research results, we have demonstrated that the specially designed functional physical training can improve both physical fitness and cognitive function in 4~5 years old preschool children. At the same time, the cognitive training can improve the cognitive function but not the physical fitness. Furthermore, the enhanced cognitive function is possibly induced by more improvement of lower limbs' function such as jumping, hopping, and shuttle running. Although our previous research (Ortega et al., 2008) had suggested that lower limb strength and balance are correlated with executive functions such as processing speed and attention, it is the first time in this controlled study that we have demonstrated that the functional training aiming at lower limbs strength, agility and rhythm can improve the cognitive functions such as processing speed, attention and spatial memory. The underlying mechanisms might be related to more sensory stimulation induced by better physical activity space and more neurotrophic factors releasing with better physical exercise with lower limbs. However, since the limitation of the research design in this study, such as the physical intervention mostly focused on lower limbs movements, the cognitive assessment mostly focused on executive function, and no cognition correlated biological samples or brain images had been addressed in our research, the more specific underlying mechanisms still need to be further investigated.

6. Conclusion

Combining functional physical training and cognitive training has shown to be effective in promoting physical fitness and cognitive development. Cognitive training alone significantly improves cognitive function, while functional physical training significantly enhances both physical fitness and cognitive function in children aged 4~5 years.

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 institutional ethical committee of the Capital University of Physical Education and Sports, Beijing, China (2017A03). 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

LH: Conceptualization, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. YF: Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft. XZ: Investigation, Project administration. XR: Project administration. YS: Supervision, Writing – review & editing. KL: Conceptualization, Methodology,

Project administration, Resources, Validation, 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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The effect of internal and external focus of attention on tennis skill acquisition in children

Tuncay Tapan[1], Asuman Şahan[2]* and Kemal Alparslan Erman[2]

[1]Institute of Medical Science, Akdeniz University, Antalya, Turkey, [2]Faculty of Sport Sciences, Akdeniz University, Antalya, Turkey

Objective: The aim of this study was to examine the effect of internal and external focus attention instructions on learning the tennis groundstroke (forehand–backhand drive) for children.

Methods: A total of 60 (30 girls, 30 boys) children aged 10.24 ± 0.48 years were included in the study. Children were randomly divided into three groups: External Focused Group (EFG), Internal Focused Group (IFG), and Control Group (CG).

Results: In the pre-training tests of tennis skill (TST) and tennis transfer (TTT), there was no significant difference between the three groups (EFG, IFG, and CG) according to one-way ANOVA results ($p > 0.05$). Significant interaction was determined between groups and measurements in a repeated-measures ANOVA analysis (three groups, three measurements) and TST and TTT ($p < 0.01$). According to the post-hoc analysis, it was determined that the TST results increased significantly in the EFG compared to the IFG and CG, and there was no significant difference in the TTT between the EFG and IFG, but both groups showed significant improvements compared to the CG.

Conclusion: Instructions to children to focus attention externally facilitate learning the groundstroke (forehand–backhand) technique, which is one of the basic tennis techniques.

KEYWORDS

tennis, focus attention, instruction, children, skill

1 Introduction

Tennis is an open skill sport that involves complex movement and high levels of coordination. However, important cognitive and perceptual characteristics affect learning and performance in tennis (Tsetseli et al., 2016). Planning how to develop these essential characteristics in tennis during the learning process is of great importance for coaches and sports educators. Our research aimed to contribute to the literature by determining the effect of different approaches and reporting the effect of attention-focusing instructions on motor learning on effective and efficient learning in tennis.

Herein, the effect of internal and external attention focuses on tennis skill acquisition in children new to tennis was examined by comparing performance, learning, and transfer test results with a control group.

It is a common practice for coaches and teachers to give instructions during the learning of motor skills. These instructions can be associative (i.e., focusing on bodily sensation) or dissociative (i.e., blocking out sensations resulting from physical effort), broad or narrow, and

external (i.e., on the effect of the movement) or internal (i.e., toward the body movement) (Niźnikowski et al., 2022).

There is evidence in the literature that instructions given toward the intended effect of the movements (external focus) rather than the movement itself (internal focus) provide more advantages for performance and learning (Wulf et al., 1999; Asadi et al., 2021). Many studies suggest that instructions with cues for the external focus of attention are better for athletes' performance of motor skills than cues for internal attention focus (Wulf et al., 1998, 2000, 2007; Vance et al., 2004; Jackson and Holmes, 2011; Chiviacowsky et al., 2013).

It has been suggested that the athlete will use their decision-making abilities to choose the best motor response because the external focus of attention cues reduces the burden of working memory (Poolton et al., 2006). In a study that aimed to find the link between the breadth of attention and tactical decision-making, it was suggested that the reason team players could not find the most appropriate tactical solution in a game situation was that the coaches focused their attention in a certain direction by giving restrictive instructions (Memmert and Furley, 2007). It has also been suggested that the focus of attention during motor execution not only affects learning and performance but also increases movement productivity and efficiency (Wulf et al., 2010). In studies investigating the effects of using internal and external focus of attention on technical skill performance in vertical jump performance (Wulf and Dufek, 2009), jump performance (Chow et al., 2009), golf swing (Perkins-Ceccato et al., 2003), darts (Lohse et al., 2010), and basketball shooting performance (Al-Abood et al., 2002) external attention instruction conditions were found to have positive effects for external focusing.

The results of internal and external focus instructions for learning the dart throwing task were examined for 8- to 9-year-olds and 22- to 36-year-olds and a significant difference in performance between external focus and internal focus was found in the younger group. However, it was indicated that there was no difference between the groups that performed repetitions with internal and external focus instructions in children (Emanuel et al., 2008). However, in a recent study on table tennis players (12 females and 39 males with a mean age of 22.9 ± 1.8), it was stated that internal and external focus of attention had a similar effect on backhand accuracy on the development of low-skill players who had basic understanding and skills of table tennis strokes (Niźnikowski et al., 2022).

When physical education teachers teach forward somersault skills to primary school children aged 7 to 8, it has been observed that the skill develops more when they apply external-oriented instructions (Koufou et al., 2013). Abd Elahi states that boys between the ages of 8 and 14 were superior in terms of external focus of attention in performing a dribbling task under stressful conditions (Abdollahpour et al., 2008).

The participants of a study conducted by Porter et al. (2012) were 35 male university students with an average age of 22 and who had not engaged in athletics in their past or while at university. In the study, instructions were given to the external group to jump as close to a cone as possible; instructions for the internal group were to jump as far from the starting line as possible. The control group was instructed to make their best jump. The study suggested that the external group improved more in standing long jump performance compared to the internal and control groups.

Makaruk et al. (2013) examined the effect of external and internal focusing instructions on shot-put distance in their study on 30 national-level sprinters, jumpers, and shooters with an average age of 22. The results showed that the externally focused group achieved better results than the internally focused group. Milley and Ouellette (2021), in their study on 9 male and 16 female basketball players aged 18 to 24, investigated the effect of focus of attention during basketball free throw training. In this study, the use of verbal instruction produced better free throws in EFA imagery conditions than in IFA technique conditions.

In Silva et al. (2017) determined that the external group outperformed the internal group in the implementation, retention, and transfer stages in a study they conducted with 38 female athletes with an average age of 9.5 who were interested in ballet.

In another study, Hadler et al. (2014) conducted research with 21 girls and 24 boys with an average age of 11, asking them to hit the tennis ball forehand and backhand with their dominant arm. Participants had no previous tennis experience. The aim was to hit a target placed on the opposite side of the tennis court. The study examined the effect of external and internally oriented instructions and suggested that the forehand and backhand strokes of the external group showed better results than the other groups in the transfer tests.

Agar et al. (2016) included children aged 5–8 and 9–12 in their study on shuffleboard athletes. Their findings suggested that the group of older children performed better than the younger participants, but there was no significant difference between the externally focused and internally focused focus group performances during retention or transfer.

When the studies on the use of internal and external focus of attention and tennis are examined, it has been suggested that training using an external focus of attention increases the tennis game performance of children (Tsetseli et al., 2016). In a study examining the effect of internal and external focusing instructions on game performance in real match situations in 8–9-year-old tennis players, it was suggested that the externally focused group showed a significant improvement in decision-making compared to both the internally focused group and the control group. The study also said that the externally focused group showed better improvement than the other two groups in game performance and tennis-specific skills (Tsetseli et al., 2016).

Our study differed from that of Tsetseli and colleagues, in that internal and external focus instructions were given to children who were learning tennis for the first time, and specifically for instructions for each phase of the groundstroke technique. To determine the impact of attention, with a focus on motor learning, tennis targeting tests were used as the measurement method for all groups in the study to assess performance, learning, and transfer scores.

Our study aimed to examine the effect of internal and external focus of attention on groundstroke learning in tennis. We hypothesized that instructions given with an external focus of attention during tennis training would increase learning more than an internal focus of attention and training without instructions. To determine the effect of different focus of attention instructions on technical tennis learning, a control group (no instruction) was included in the study.

2 Materials and methods

2.1 Participants

A total of 60 children (30 boys and 30 girls) aged between 9 and 10 (10.24 ± 0.48 years) participated in the study. Participants had

received tennis training for 2 months before the study. After obtaining permission from the University's Ethics Committee, children and their families were informed about the purpose of the study and written consent was obtained. All children participating in the study were informed that taking part was voluntary and that they could leave the study whenever they wanted. The children were randomly divided into three groups, the IFG internal focus group (n = 10 boys, n = 10 girls), the EFG external focus group (n = 10 boys, n = 10 girls), and the CG control group (n = 10 boys, n = 10 girls).

2.2 Variables, instruments, and procedures

2.2.1 Experiment design

All groups participated in tennis training for 60 min, 3 days a week for 8 weeks. All groups had the same 10-min warm-up and 10-min cool-down phases. Training that included forehand and backhand drive basic techniques was given to the EFG with instructions to focus their attention outward and to the IFG with instructions to focus their attention inward. The CG was not instructed to focus any attention during the tennis training.

In accordance with the rules of the International Tennis Federation for the age group of the children taking part (International Tennis Federation, 2012), training was given on an orange tennis court (18 × 6.5 m) with an 80 cm high net, and with low-pressure balls (red, orange, and green). During the training, we ensured the rackets used by the children were of an appropriate size for their age. The instructions given during the training were designed to teach the five phases of the groundstroke (handling, preparation, footwork, contact point with the ball, and finishing) (Christmas and Elliott, 2001). The training was in accordance with Gentile's 2 × 2 matrix of skills classification (Gentile, 2000) and included ball-feeding and skills of increasing difficulty, given in four different contexts. Ball feeds were made as a transition from forehand and backhand hits made in a stationary position (closed), where the ball was dropped from the same height in each trial to forehand and backhand hits made in positions where the ball had various features (open). The same exercises were given to the children in all groups and with the same number of repetitions. All training was given by a Level 3 experienced tennis coach. A tennis skill test (TST) and tennis transfer test (TTT) were given to all groups pre- and post-training and after 2 weeks of having had no training (the retention test).

The internal and external attention-focusing instructions given for the teaching stages of the groundstroke technique are shown in Table 1.

Instructions were given at the beginning of each movement and remained the same for four training sessions for each phase of the movement. Immediately after the instructions, all players were required to perform 10 forehand or 10 backhand strokes.

2.2.2 Instruments

TST: A total of 20 tennis balls were thrown by the coach to 10 forehands and 10 backhands of the player standing at the T point on the service line. The player hit these balls from 1 × 1 m and 2 × 2 m nested targets placed in counter service boxes to the highest scoring target by making 10 forehand and 10 backhand down-the-line hits. If the balls went out or were caught in the net, 0 points were awarded; if they fell inside, 3, 2, or 1 point were awarded according to the areas shown in Figure 1. The test was video recorded by the researcher and scored for each participant. If the balls landed on the border between two points, the higher score was recorded.

TTT: A total of 20 tennis balls were thrown by the coach to 10 forehands and 10 backhands of the player standing at the T point on the service line. The player hit these balls from 1 × 1 m and 2 × 2 m nested targets placed in counter service boxes to the highest scoring target by making 10 forehand and 10 backhand cross-court hits. If the balls went out or got caught in the net, 0 points were awarded. If they fell inside, then 3, 2, or 1 point were awarded as shown in Figure 2; each hit was scored live by a researcher. If the balls landed on the border between two points, the higher score was recorded.

The difficulty index of the 1×1 m and 2×2 m targets used in the TST and TTT was calculated with the formula developed by Paul Fitts (Fitts, 1954). Fitts' law is an equation used to represent the time it takes for a target to reach an object. D is the distance from the starting point to the centre of the target, which is used to calculate the difficulty index, W is the width of the target, giving:

$$\text{Difficulty Index} = \log 2 \ (2D/W).$$

TABLE 1 Teaching stages of the groundstroke.

Stroke phase	Instructions (External focus)	Instructions (Internal focus)
Grip	For forehand and backhand grip teaching, the child is asked to hold the racket by matching the line drawn on their hand to the line drawn on the handle of the racket.	Forehand grip: the child is asked to point their palm in the direction they will strike. Backhand grip: they are asked to point the palm down.
Shoulder rotation	The child is asked to turn their shoulder toward the net pole.	The child is asked to take their shoulder back.
Preparation	Before hitting the ball, the child is asked to draw the racket circle movement by opening the racket over the slalom pole placed in a T shape and bringing it under it. (slalom pole)	Before hitting the ball, the child is asked to draw the racket circle movement in the form of the letter C with their palm.
Footwork	The child is asked to step diagonally on the strip placed in front of them.	The child is asked to place their cross step forward.
Meeting the ball with the racket	The player is asked to hit the ball with the racket when it comes over the mini net placed in front of them.	They are asked to hit the ball at waist level in front of their step.
Finish	The child is asked to pull their racket up to the back after meeting with the ball and extend it.	After hitting the ball, they are asked to bring their elbow to eye-level.
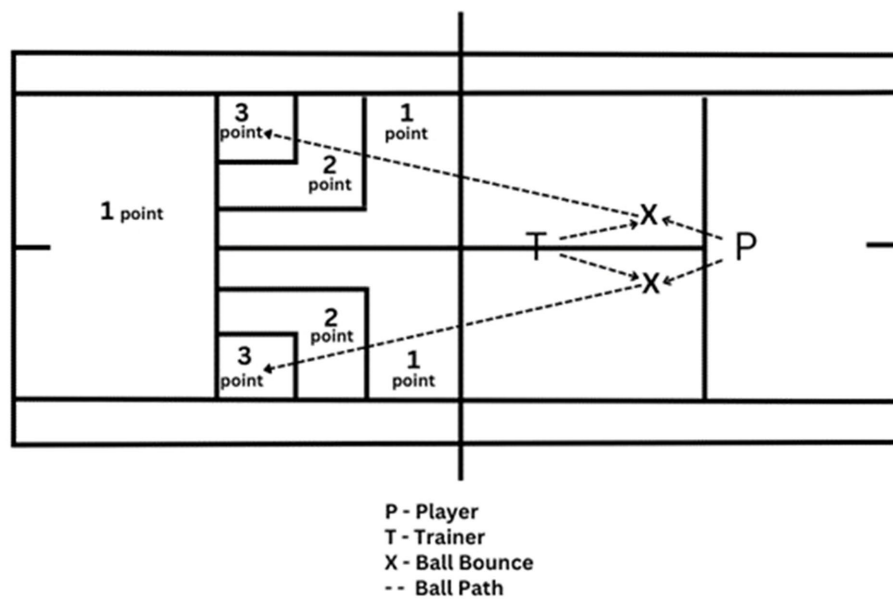
FIGURE 1
The tennis skill test.
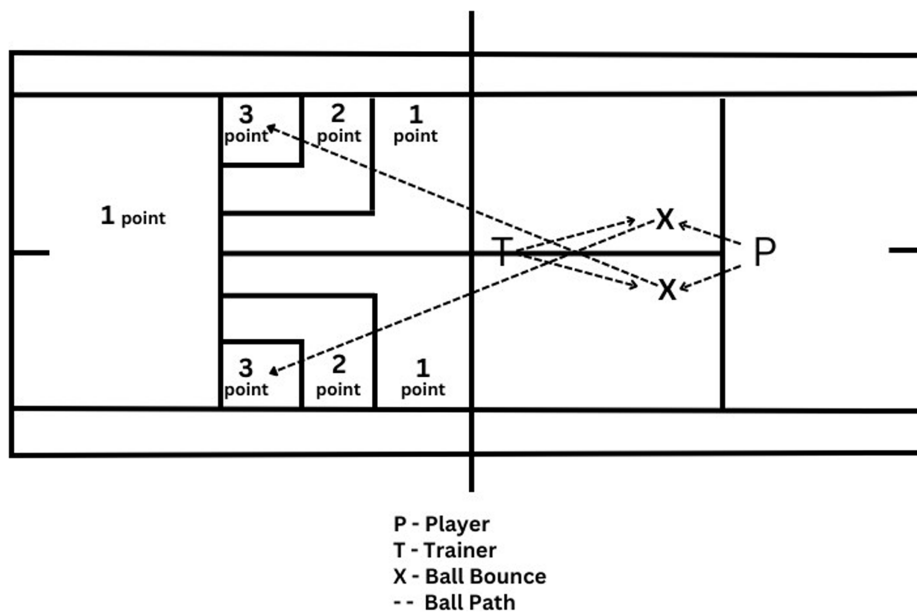
FIGURE 2
The tennis transfer test.

Retention Test: As a retention test, TST (including parallel shots) and TTT (including cross shots) were administered to all groups 2 weeks after the post-training tests.

2.3 Data analysis

Statistical analysis was carried out using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY). Descriptive statistics and in-group distribution characteristics of the groups included in the study were examined. Time-dependent changes of the groups were determined by one-way in the comparisons of the pre, post, and retention tests between the groups, with the repeated-measures ANOVA test (three groups x three measurements) for more than two repeated measurements within the group. The significance level was taken as $p < 0.05$ and $p < 0.01$. The effect size was evaluated as $\eta^2 = 0.01$ low, $\eta^2 = 0.06$ medium, and $\eta^2 = 0.14$ large effect level (Cohen, 1988).

3 Results

Overall, the children participating in the study were 10.24 ± 0.48 years, 132.35 ± 8.06 cm tall, weighed 34.42 ± 7.15 kg, and had an average BMI of 34.42 ± 7.15 kg/m^2.

In the EFG: 10.19 ± 0.47 years, height 127.45 ± 6.80 cm, weight 29.80 ± 4.60 kg, and BMI 29.79 ± 4.60 kg/m^2.

In the IFG: 10.18 ± 0.48 years, height 135.70 ± 7.93 cm, weight 36.74 ± 7.50 kg, and BMI 36.74 ± 7.51 kg/m^2.

In the CG: 10.33 ± 0.50, height 133.90 ± 7.29 cm, weight 36.72 ± 6.89 kg, and BMI 36.72 ± 6.89 kg/m^2.

Table 2 shows there was no significant difference between the groups when comparing the scores obtained from the TST and TTT pre-tests of the children in the EFG, IFG, and CG ($p > 0.05$).

Table 3 shows a significant difference in time-dependent changes in repeated measurements for the TST – F $(1.52, 86.73) = 56.81$, $p < 0.01$.

When evaluated after ignoring the measurement variable, a significant difference between the groups was found – F $(2, 57) = 8.54$, $p < 0.01$.

When the group and measurement interaction was examined, a significant difference was found between the groups – F $(3.04, 86.73) = 29.61$ ($p < 0.01$).

As a result of the post-hoc analysis performed on the TST parameter, a significant difference was found between the EFG and IFG – $p = 0.04$ ($p < 0.05$). A significant difference was found between the EFG and CG – $p = 0.0001$ ($p < 0.01$). There was no significant difference between the IFG and CG – $p = 0.39$ ($p > 0.05$).

According to the results obtained from the ANOVA test based on the comparison of groups in the post-test for the TST, there was a significant difference between the EFG and IFG with $p = 0.016$ ($p < 0.05$). There was a highly significant difference between the EFG and CG with $p = 0.0001$ ($p < 0.01$). However, there was no significant difference between the IFG and CG with $p = 0.273$ ($p > 0.05$).

For the retention tests, a highly significant difference was found between the EFG and IFG with $p = 0.0001$ ($p < 0.01$). A highly significant difference was found between the EFG and CG $p = 0.0001$ ($p < 0.01$). However, there was no significant difference between the IFG and CG with $p = 0.197$ ($p > 0.05$).

Table 4 shows a significant difference in time-dependent changes in repeated measurements in TTT – F $(1.70; 96.72) = 39.84$, $p < 0.01$.

When evaluated after ignoring the measurement variable, a significant difference between the groups was found – F $(2; 57) = 9.45$ $p < 0.01$.

When the group and time interaction was examined, a significant difference was found between the groups – F $(3.39, 96.72) = 13.87$, $p < 0.01$.

As a result of post-hoc analysis performed in TTT, no significant difference was found between the EFG and IFG – $p = 0.24$ ($p = 0.01$). A significant difference was found between the EFG and CG – $p = 0.0001$ ($p < 0.01$). A significant difference was found between the IFG and the CG – $p = 0.04$ ($p < 0.05$).

According to the results obtained from the ANOVA test based on the comparison of groups in the post-tests for the TTT, there was no significant difference between the EFG and IFG with $p = 0.101$ ($p > 0.05$). There was no significant difference between the IFG and CG with $p = 0.050$ ($p > 0.05$). However, there was a highly significant difference between the EFG and CG with $p = 0.0001$ ($p < 0.01$).

TABLE 2 Pre-test performance results of the tennis skill and transfer tests.

Variable	Group	M ± SD	F	p
TST (points)	EFG ($n = 20$)	22.35 ± 4.64	0.61	0.55
	IFG ($n = 20$)	22.35 ± 4.80		
	CG ($n = 20$)	20.95 ± 4.45		
TTT (points)	EFG ($n = 20$)	21.40 ± 5.65	2.77	0.07
	IFGG ($n = 20$)	22.00 ± 4.24		
	CG ($n = 20$)	18.70 ± 4.12		

According to one-way ANOVA $p < 0.05$.

TABLE 3 Performance scores of groups for the tennis skill test pre-, post-, and retention tests.

TST (point)	EFG	IFG	CG
Pre-test	22.35 ± 4.64	22.35 ± 4.80	20.95 ± 4.54
Post-test	28.10 ± 4.22	24.15 ± 4.72	21.80 ± 4.01
Retention test	27.05 ± 3.66	21.30 ± 3.97	19.20 ± 2.89
Measurement	$F_{(1,52;86,73)} = 56.81$	$p = 0.0001^{**}$	$\eta^2 = 0.50$
Group	$F_{(2;57)} = 8.54$	$p = 0.0001^{**}$	$\eta^2 = 0.23$
Measurement X group	$F_{(3,04;86,73)} = 29.61$	$p = 0.0001^{**}$	$\eta^2 = 0.51$

According to repeated-measures ANOVA analysis *$p < 0.05$; **$p < 0.01$.

TABLE 4 Performance scores for the tennis transfer test pre-, post-, and retention tests.

TTT (point)	EFG	IFG	CG
Pre-test	21.40 ± 5.65	22.00 ± 4.24	18.70 ± 4.12
Post-test	26.35 ± 5.10	23.35 ± 3.38	19.95 ± 4.42
Retention test	24.75 ± 4.14	20.55 ± 2.09	17.85 ± 2.87
Measurement	$F_{(1,70;96,72)} = 39.84$	$p = 0.0001^{**}$	$\eta^2 = 0.41$
Group	$F_{(2;57)} = 9.45$	$p = 0.0001^{**}$	$\eta^2 = 0.25$
Measurement X group	$F_{(3,39;96,72)} = 13.87$	$p = 0.0001^{**}$	$\eta^2 = 0.33$

According to the repeated-measures ANOVA analysis *$p < 0.05$; **$p < 0.01$.

Regarding the retention test, there was a highly significant difference between the EFG and IFG with $p = 0.0001$ ($p < 0.01$). A highly significant difference was found between the EFG and CG with $p = 0.0001$ ($p < 0.01$). There was a significant difference between the IFG and CG with $p = 0.027$ ($p < 0.05$).

4 Discussion

This study aimed to examine the effect of internal and external focus of attention instruction on the learning of the groundstroke technique in tennis. Herein, tennis targeting, retention, and transfer tests were applied at the beginning and end of the study to examine the learning of the tennis groundstroke technique of a control group and groups that trained with different instructions.

We found no statistically significant difference in the TST and TTT pre-test comparison results between the three groups (EFG, IFG, and CG) ($p = 0.55$ and $p = 0.07$). At the end of 8 weeks of training, the EFG showed significant improvement in TST compared to the IFG

FIGURE 3
TST graph.
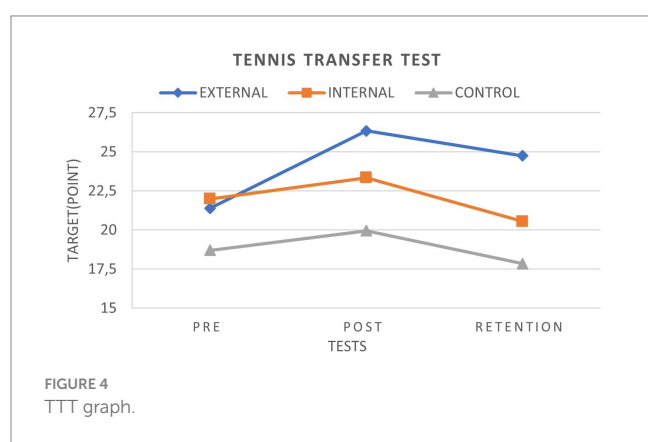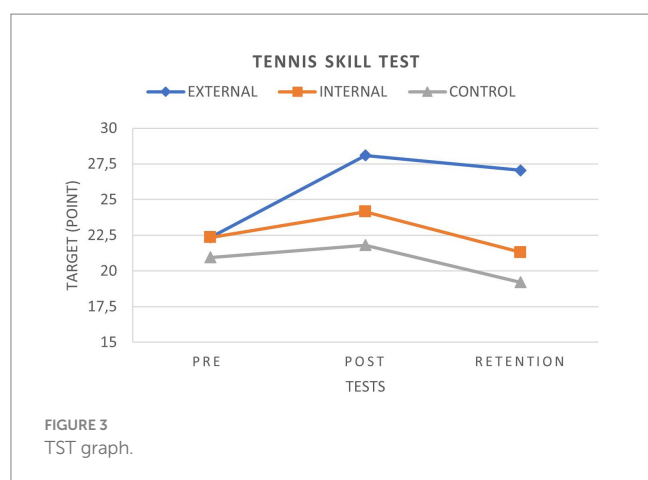
FIGURE 4
TTT graph.

and CG. There was no significant difference in the development shown by the TST between the IFG and CG (Figure 3).

We found no significant difference between the EFG and IFG for the TTT. However, there was a significant difference between the EFG and CG for the TTT. There was a significant difference between the IFG and CG in TTT (Figure 4).

At the end of the study, it was determined that the attention-directing instructions externally increased the learning and performance of the groundstroke technique more than the internal instructions and those who did not receive any instruction in child tennis players between the ages of 9 and 10. It was determined that there was no significant difference between the groups that received external and internal instruction in the transfer test, but both groups achieved significantly higher performance than the group that was not instructed (control group). According to these results, it can be said that focusing attention in tennis increases targeting performance, skill learning, and skill transfer. Furthermore, in this study, it was determined that the use of external focus instructions in tennis technical learning training in children improved performance and learning more than children who received internal focus instruction and did not receive instruction.

Our study does have some limitations. The results cannot be generalized to other sports, but this would be another avenue for future research. Future studies could explore the effect of externally and internally focused instruction on different tennis techniques. Future studies should include playing tennis in different age groups and ability levels.

5 Conclusion

The findings of this study indicate that external focus is more effective than internal focus in learning the tennis groundstroke for players who are new to tennis. These results suggest that tennis coaches and practitioners should make greater use of instructions that focus attention externally to facilitate motor 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 present study received ethical approval from the T.C. Akdeniz University Sports Sciences Ethics Committee, as per their decision dated 19 June 2020, and designated with the reference number 377. 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

TT: Writing – original draft. AŞ: Writing – original draft. KE: Methodology, 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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Exploring the relationship between social support, resilience, and subjective well-being in athletes of adapted sport

Tânia Mira[1,2,3], Miguel Jacinto[3,4,5], Aldo M. Costa[1,6],
Diogo Monteiro[3,4,6], Susana Diz[1], Rui Matos[3,4] and
Raúl Antunes[3,4]*

[1]Department of Sport Sciences, University of Beira Interior, Covilhã, Portugal, [2]ISCE—Higher Institute of Lisbon and Vale do Tejo, Ramada, Portugal, [3]ESECS—Polytechnic of Leiria, Leiria, Portugal, [4]Life Quality Research Centre (CIEQV), Rio Maior, Portugal, [5]Faculty of Sport Sciences and Physical Education, University of Coimbra, Coimbra, Portugal, [6]Research Centre in Sports Sciences, Health Sciences and Human Development (CIDESD), Vila Real, Portugal

Introduction: Sports participation of people with disabilities provide an improvement in their skills, especially on access to social support, which could improve resilience and well-being. This study aims to analyze the association between types of social support (parents, coach, friend, and best friend), resilience and positive and negative affect, in 105 Portuguese athletes with disabilities aged between 13 and 61 years (32 $\pm$ 12.35 years).

Methods: Participants answered a short sociodemographic questionnaire, the Portuguese version of the Positive and Negative Affect Schedule, and the Brief Resilience Scale, and a scale for assessing social support from parents, coach, friend, and best friend.

Results: Social support provided by the best friend, coach, friends, and parents had a direct effect on resilience and positive and negative affect. Results showed a positive and significant association between resilience and positive affect ($r = 0.28$; $p = 0.004$) and a negative association between resilience and negative affect ($r = -0.37$; $p \leq 0.001$). A strong relationship was found between resilience and affect, with no relationship being verified between the sources of social support and resilience or affect, as hypothesized.

Discussion: For this group of athletes with disability, more than the social support they may have or may feel, resilience proved to be very important for the consequence of sports practice in terms of subjective well-being.

KEYWORDS

subjective well-being, resilience, social support, affect, disability

Introduction

Sport is recognized as an essential toll in the education of children and young people, for the added value of physical and psychological condition provided (Conroy and Coatsworth, 2007; Macnamara and Collins, 2013). Likewise adapted sport promotes health, quality of life and social integration of people with disabilities (Blauwet and Willick, 2012; Frank et al., 2013).

The practice of sports by people with disabilities involves, in most cases, third parties (parents, friends, team-mates, coaches, among others). Social support for sport practice has proven to be fundamental. Social support is essential for well-being, it allows better integration into society and better goal realization (Banack et al., 2011). Social support refers to the

providing of assistance, comfort and/or support to other people to help them cope with biological, psychological and social stress. This social support can come from any interpersonal relationship in an individual's social network (family, friends, colleagues, coaches, among others). It can be provided in a practical (e.g., doing tasks, providing advice), tangible (e.g., giving money or other materials) and emotional way (American Psychiatric Association, 2022). Social support means an exchange of resources that takes place between at least two people, the provider, and the recipient, with the aim of improving the recipient's well-being (Shumaker and Brownell, 1984).

Previously studies showed a positive association between the practice and the social support of parents, which have been widely studied in children, adolescents and young people (Dowda et al., 2007; Ornelas et al., 2007; Beets et al., 2010; Edwardson and Gorely, 2010; Loucaides and Tsangaridou, 2017), as well as the social support of friends (Stewart, 1993; Rodriguez and Cohen, 1998; Cheng et al., 2014; Loucaides and Tsangaridou, 2017). These two sources of social support have been presented as essential in the practice of physical activity, however the role of support coming from friends seems to have more impacting influence in this context (Cheng et al., 2014; Loucaides and Tsangaridou, 2017). The Cheng et al. (2014) study reported that the physical activity of adolescents is directly associated with the physical activity of their friends. Friendship is considered an important source of social support and influence for physical activity. Those who do physical activity tend to make friends with those who do similar amounts of physical activity, eventually imitating behaviors, creating a mutually dependent relationship between physical activity and friendship networks (Haye et al., 2011). Recent studies have looked at the social support provided by the best friend and its influence on adolescent's practical physical activity and perceived benefits (Martin and Smith, 2002; Martin, 2006; Stearns et al., 2018; Kandola et al., 2020; Monteiro et al., 2021). On the other hand, in sports for people with disabilities context, social support is also considered to be a positive influence (Swanson et al., 2008; Machida et al., 2013; Crawford et al., 2015; Fiorilli et al., 2016; Haslett et al., 2017; Powell and Myers, 2017; Cardoso et al., 2018; Atkinson and Martin, 2020; Aitchison et al., 2021; Mira et al., 2022; Monton et al., 2022).

Coaches, parents, and friends are extremely important for their positive influence on various factors. The coach has proven to be an indispensable source of social support, offering support and guidance that results in strong relationships (Greendorfer, 2002; Jones et al., 2002; Sheridan et al., 2014; Gillham et al., 2015; Lu et al., 2016; Mira et al., 2022). Friendship is, also, considered an important source of social support and influence for sports practice. Children with disabilities usually have less friends and sport offers ample opportunity for promoting social connections (Martin and Smith, 2002; Martin, 2006). The pattern of support for athletes throughout their career should be adjusted as their needs change (Rees and Hardy, 2000).

Although social support is essential for athletes with disabilities, it is not the solution to all the challenges these athletes face, not only in their social and personal life but also in their sport, training and competition life. With many hours of training often repetitive and with implications in stress levels, time to recover from injuries that prevent them from performing and competitive anxiety with the agony of failure, athletes need not only physical resistance and talent but also mental resistance (Vallerand and Losier, 1999; Jones et al., 2002). Many studies have addressed the topic of resilience in athletes

with disabilities (Machida et al., 2013; Cardoso and Sacomori, 2014; Martin et al., 2015; Porto et al., 2016; Powell and Myers, 2017; Sikorska and Gerc, 2018; Atkinson and Martin, 2020; Martin et al., 2022; Mira et al., 2022). Fletcher and Sarkar (2012) presented resilience as the set of mental and behavioral processes that promote personal assets and, in turn, protect the individual against the potential negative effects of stress. How a person reacts to adversity in a positive way depends on the adversity they have been subjected to and their own adaptation to it (Morgan et al., 2013).

Sports participation of people with disabilities has shown implication on resilience, especially on access to social support, opportunities, and meaningful social experiences (Machida et al., 2013). In a recent systematic review conducted by Mira et al. (2023), a few studies demonstrated a relationship between social support and resilience in athletes with disabilities (Machida et al., 2013; Powell and Myers, 2017; Mira et al., 2022). These results are in line with the conceptual model of sport resilience previously developed by Galli and Vealey (2008) which argues that sociocultural influences are crucial for the resilience in athletes. Just as the social support from family, coach, colleagues, and those around them, resilience is crucial to their responses to the adversity they face (Bicalho and Noce, 2019).

Fontes and Brandão (2013) reinforce the idea that resilience manifests itself throughout life from the interaction between risk and protection factors and because high performance sport is an environment that exposes athletes to risk and stress, athletes strengthen their positive personal characteristics and network of social and affective support in an effective way to overcome adversities and not abandon the career prematurely.

On the other hand, several studies have proven the role of physical activity and sport in increasing well-being (Smith et al., 2011; Mack et al., 2012; Caddick and Smith, 2014; Hogan et al., 2015) and specifically, subjective well-being (Ku et al., 2007; Downward and Rasciute, 2011; Moraes et al., 2012; Ku et al., 2014; Olsson et al., 2014). Subjective well-being is defined as the search in life for pleasure (Waterman, 2008), which represents what the person feels in relation to his/her own life (Kashdan et al., 2008). With a hedonic premise and a complex and multifaceted nature, it evaluates life cognitively and affectively, being subdivided into three components: positive affect, negative affect and satisfaction with life (Ryff and Keyes, 1995; Diener et al., 1999, 2003). Cognitive appraisals are characterized by life satisfaction and sense of personal fulfilment; affective appraisals presuppose the presence of positive affect (positive emotions and moods) and the lack of negative affect (negative emotions and moods) (Diener, 2000; Ryan and Deci, 2001; Diener et al., 2003; Diener and Ryan, 2009). People with disabilities have poorer well-being due to their characteristics and may experience anxiety and depressive disorders more often than people without disabilities (Puce et al., 2023a,b). Studies show that people with disabilities who practice sport have greater life satisfaction and well-being compared to people with disabilities who do not practice sport (Blauwet and Willick, 2012; Yazicioglu et al., 2012; Frank et al., 2013; Puce et al., 2023a,b). In a review study on this topic, it was possible to verify that the studies that analyzed subjective well-being in athletes with disabilities revealed high positive affect and low negative affect (Mira et al., 2023).

Social support and well-being are two important constructs in athletes with disabilities and their relationship has been evidenced in several studies (Crawford et al., 2015; Fiorilli et al., 2016; Haslett et al., 2017; Atkinson and Martin, 2020; Aitchison et al., 2021; Mira et al.,

2022; Monton et al., 2022). Waldinger and Schulz (2016) argues that social connections are very important, people who are more socially connected are happier, healthier, and live longer. The quality of close relationships is very important and healthy relationships protect our body and brain. Good relationships keep us happier and healthier, or, in other words, a good life is built on good relationships (Waldinger and Schulz, 2016). The association between positive affect and social support from parents and friends has reinforced the importance that this support seems to have on the emotional states of athletes (VaezMousavia et al., 2013; Shapiro and Malone, 2016). The social support provided to athletes with disabilities is very important, as improvement of their career and well-being (Crawford et al., 2015; Fiorilli et al., 2016; Haslett et al., 2017; Atkinson and Martin, 2020; Aitchison et al., 2021; Mira et al., 2022; Monton et al., 2022).

At the same time, the literature has also shown a strong association between resilience and well-being in athletes with disabilities (Machida et al., 2013; Martin et al., 2015; Sikorska and Gerc, 2018; Atkinson and Martin, 2020; Martin et al., 2022; Mira et al., 2022). As argued by Fredrickson (1998), positive emotions operate as resources for coping with adversity. Subjective well-being and resilience associated with positive emotions may lead to the creation of lasting psychological resources and, consequently, greater emotional strengthening from the reinforcement of positive emotions (Fredrickson, 1998; Jaafar et al., 2014). Positive emotions lead to higher levels of resilience in the future and resilience also achieves its effects, in part, through the conception of positive emotion (Jaafar et al., 2014). Well-being sometimes results from active combat with adversity. Experiences with obstacles, failures and disappointments are necessary to know one's own limitations and vulnerability, find internal strengths and renew resources (Fredrickson, 1998). In each risk situation, a person may react vulnerably, with a negative affect response, or resiliently, with a positive affect response.

In summary, social support is noted as one of the most important factors in coping with challenges and recovering from adversity (Mira et al., 2023). Sports participation of people with disabilities has shown implication on resilience, especially on access to social support, opportunities and meaningful social experiences (Machida et al., 2013). Social support for athletes with disabilities is extremely relevant to improving their career and well-being. Sport experiences provide an improvement in social skills, which in turn consequently improves well-being and social support (Crawford et al., 2015; Fiorilli et al., 2016; Haslett et al., 2017; Atkinson and Martin, 2020; Aitchison et al., 2021; Mira et al., 2022; Monton et al., 2022). Thus, the aim of our study is to understand the association between social support, resilience and positive affect and negative affect, satisfaction with life, in athletes with disabilities who play federated sport.

Present study

Social support from parents, friends, best friend, and coach is fundamental for the sport practice of people with disabilities (Galli and Vealey, 2008; Mira et al., 2022, 2023). These social supports are crucial for the resilience process of these athletes as social support has been pointed out as one of the most important factors to deal with challenges and recover from adversity (Bicalho and Noce, 2019; Mira et al., 2022, 2023). Additionally, the association between resilience and well-being in athletes with disabilities has been demonstrated

(Machida et al., 2013; Martin et al., 2015; Sikorska and Gerc, 2018; Atkinson and Martin, 2020; Martin et al., 2022; Mira et al., 2022). Although these variables have already been studied with disabled athletes, this study tries to analyze the relationships of these variables in four models. This study is part of a global project that, in a previous study (Mira et al., 2022), already characterized the Portuguese team present at the Tokyo Paralympic Games, regarding these variables (social support, resilience and affect). However, that study only sought to characterize and analyze associations between the variables, and in a very specific sample of high-performance athletes with disabilities. Thus, the present study intends to analyse the association between types of social support, resilience, and subjective well-being (life satisfaction, positive affect, and negative affect) in a sample of athletes with disabilities who play federated sport (with different competitive levels and sporting experience), according to the model shown in the figure below. This study will allow us to understand the importance of the role that parents, coaches, friends and best friends can have in the practice of sport for people with disabilities (Figure 1).

Based on this assumption, this study aimed to analyze the following hypotheses:

a. Parental social support is positively associated with resilience in athletes with disabilities, as suggested by the literature (Machida et al., 2013; Powell and Myers, 2017; Atkinson and Martin, 2020; Mira et al., 2022, 2023);
b. Coach social support is positively associated with resilience in athletes with disabilities, as previously reported in the literature

FIGURE 1
Hypothesized model applied to four types of social support.
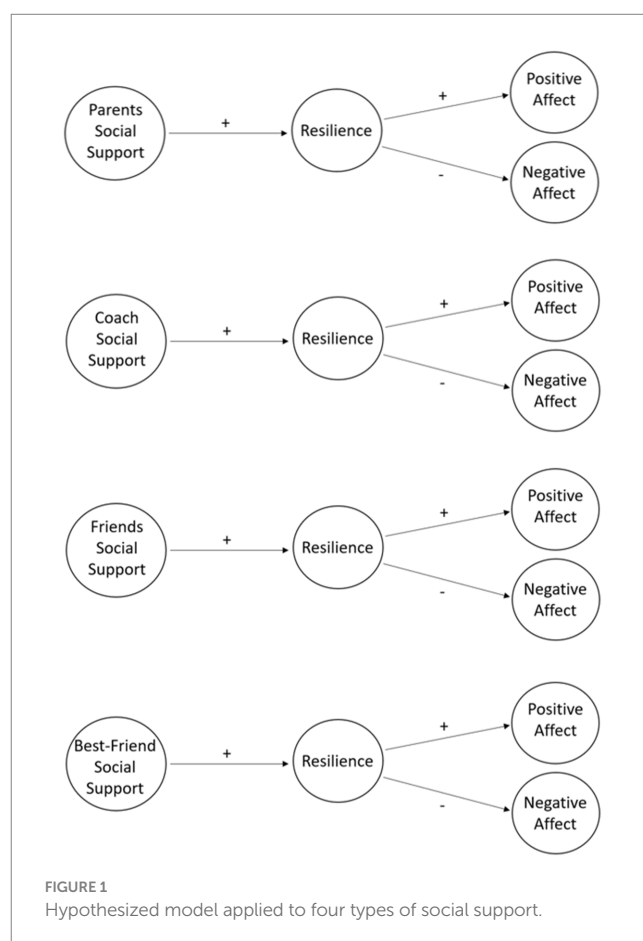
(Machida et al., 2013; Powell and Myers, 2017; Atkinson and Martin, 2020; Mira et al., 2022, 2023);

   c. Social support from friends is positively associated with resilience in athletes with disabilities, as suggested in previous studies (Machida et al., 2013; Powell and Myers, 2017; Atkinson and Martin, 2020; Mira et al., 2022, 2023);

   d. Best friend social support is positively associated with resilience in athletes with disabilities, in line with previous literature indicators (Martin and Smith, 2002; Martin, 2006; Atkinson and Martin, 2020; Mira et al., 2023);

   e. Resilience is positively associated with levels of positive affect in athletes with disabilities, as suggested in previous studies with this population (Mira et al., 2022, 2023);

   f. Resilience is negatively associated with negative affect levels in athletes with disabilities, as suggested by the literature (Mira et al., 2022, 2023).

Materials and methods

Study design and procedures

For present study, it was defined, as an inclusion criterion, athletes with disabilities who practice competitive sports in Portugal.

The study protocol explained the objectives of the study, guaranteed the principle of confidentiality, and assumed the acceptance of informed consent to proceed with the application of the questionnaires. Respondents were fully informed about the aim of the study, the procedures for data the voluntary participation. They were also informed that could quit from the study at any time. Participants did not receive compensation for their participation.

The questionnaires were applied in one go via a Google form (between October 2021 and January 2022) and disseminated by athletes with the support of sports federations, clubs, and coaches. Coaches of athletes with visual impairments and with intellectual disabilities were asked to help athletes complete the questionnaires.

After applying the questionnaires, we collect the information and process the data in the computer programs (IBM SPSS STATISTICS v.27.). Each questionnaire evaluated four domains: sociodemographic data, life satisfaction, positive and negative affect, resilience, and social support. The sociodemographic questions were developed specifically for this study, having been reviewed by 4 experts. The other 4 questionnaires are instruments already validated for the Portuguese population.

This study was approved by the ethics committee of the University of Beira Interior (CE-UBI-Pj-2018-076).

Participants

The study involved 105 athletes with disability from the Portuguese teams aged between 13 and 61 years, mean age of 32 ± 12.35 years, with 78 men (74.3%) with a mean age of 34 ± 13.13 years and 27 women (25.7%) with mean age 30 ± 9.28 years.

Of the 105 athletes, 75 have physical disabilities, 23 have intellectual disabilities, 5 have visual impairments and 2 have multiple disabilities, diagnosed according to the criteria of the International Classification of Functioning (World Health Organization, 2001).

The sample consists of athletes from 13 modalities: 1 of futsal, 1 of goalball, 1 of judo, 1 of ballet, 1 of paradressage, 2 of paracanoeing, 2 of badminton, 3 of table tennis, 10 of athletics, 14 of Boccia, 17 of wheelchair basketball, 18 of wheelchair handball and 34 of paraswimming.

The number of weekly trainings of these athletes varies between one training per week (5.7%), two training per week (20%), three training per week (20%), four training per week (10.5%), five workouts per week (7.6%) and more than five workouts per week (36.2%).

Of these athletes, 29.5% have been practicing the sport for 4 to 7 years, 22.9% for 8 to 11 years and 47.6% have been practicing the sport for 12 years or more. Most athletes (42.9%) train between 2 and 6 h a week, followed by those who train between 11 and 14 h (21.9%), those who train between 7 and 10 h (16.2%), between 15 and 18 h (10.5%), between 19 and 22 h (5.7%) and, finally, those who train more than 22 h (2.9%). Power of sample size has been calculated through Soper (2023) online calculator, following Westland (2010) recommendations. At the same time, based on imput parameters were included: anticipated effect size: 0.4; desired statistical power level: 0.8; number of latent variables: 4; number of observed variables: 20; probability level: 0.05; recommended minimum sample size: 100.

Measures

Sociodemographic characterization

Participants were invited to a sociodemographic questionnaire that focuses on the characterization of issues such as gender, age, time of practice, modality, weekly frequency, weekly training volume and reasons for practicing.

Social support

We measured athletes' with disabilities perceptions of the social support provided by parents, coach, friends and best friend with an adaptation of the Friend Support Scale ($\alpha > 0.7$) (Jago et al., 2009). Four items were created according to support group as follows: "how often your parents?"; "how often your coach?"; "how often your friends?" and "how often your best friend?"

Participants responded to these four statements: (1) encourage you to exercise or play sports, (2) exercise or play sports with you, (3) tell you that you are doing well in exercise or sports and (4) watch you take part in exercise or sports?." All items were answered on a four-point scale ranging from 1 ("Strongly disagree") to 4 ("Strongly agree").

The scale of support from friends has been used previously in other studies, with acceptable reliability for the same age and language group (Lopes et al., 2015; Monteiro et al., 2021). A confirmatory factor analysis (CFA) of this scale provided an acceptable fit to the data as follows: Coach: ($\chi^2 = 16.50$; SRMR = 0.031; B-Sp = <0.001; RMSEA = 0.075 [90%CI = 0.059, 0.086]; TLI = 0.946; CFI = 0.976); Parents: ($\chi^2 = 52.10$; SRMR = 0.062; B-Sp = <0.001; RMSEA = 0.056 [90%CI = 0.049, 0.076]; TLI = 0.916; CFI = 0.926); Friends: ($\chi^2 = 7.19$; SRMR = 0.034; B-Sp = <0.001; RMSEA = 0.059 [90%CI = 0.038, 0.816]; TLI = 0.978; CFI = 0.989); Best-Friend: ($\chi^2 = 10.15$; SRMR = 0.057; B-Sp = <0.001; RMSEA = 0.061 [90%CI = 0.047, 0.961]; TLI = 0.939; CFI = 0.953).

Subjective well-being

The Positive and Negative Affect Shedule (for positive affect α = 0.85; for negative affect α = 0.91) (PANAS; Watson et al., 1988) in the reduced Portuguese version, by Galinha et al. (2013), consisting of 10 items (five items for positive affect: "inspired," "alert," "excited," "enthusiastic" and "determined" and five items for negative affect: "fear," "worried," "nervous," "scared" and "perturbed") that are answered on a Likert-type scale, with 5 levels, ranging from 1 ("Not at all or very slightly") to 5 ("Extremely").

Resilience

Finally, to assess resilience, we used the Brief Resilience Scale (BRS, α = 0.80–0.91) (Smith et al., 2008), in its Portuguese version by da Silva-Sauer et al. (2021). Consisting of 6 items (e.g., "I tend to recover quickly after difficult situations") that are answered on a Likert-type scale, with 5 levels, ranging from 1 ("I totally disagree") to 5 ("I totally agree"). A confirmatory factor analysis (CFA) of this scale provided an acceptable fit to the data as follows: ($\chi2$ = 78.99; SRMR = 0.061; B-Sp = <0.001; RMSEA = 0.07 [90%CI = 0.067, 0.112]; TLI = 0.909; CFI = 0.922).

Data analysis

Means, standard deviation and Pearson's r bivariate correlations were calculated for all studied variables in IBM SPSS STATISTICS v.27. In terms of Pearson's bivariate correlation the following cut-off values were used to check the strength of associations: small effect (0.1–0.3); medium effect (0.3–0.5) and large effect (>0.5) (Cohen, 1988). In addition, as suggested by Kline (2016), a two-step approach trough maximum likelihood estimation method was performed in IBM SPSS AMOS (version 27.0). First, the Confirmatory Factor Analysis (CFA) was performed to test the psychometric properties and data adjustment of the measurement model. Therefore, convergent validity was assessed via average variance extracted (AVE), considering values higher than or equal 0.50 as adequate (Fornell and Larcker, 1981). Discriminant validity was estimated through the square correlations between factors, and it was considered adjusted when the square correlations were below the AVE of each factor (Hair et al., 2019). Additionally, the internal consistency of each of the latent variables under study was calculated, from the composite reliability (Raykov, 1997), assuming as a cut-off value for adequacy coefficients, ≥0.70 (Raykov, 1997; Hair et al., 2019). Second, a structural model was established to test the hypothesis. The model's fit for both the measurement model and the structural model was observed through the traditional goodness-of-fit indexes. Specifically, we used the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) and the absolutes of the Standardized Root Mean Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA) with a confidence interval (CI 90%), as recommended by several authors (Marsh et al., 2004; Byrne, 2016; Kline, 2016; Hair et al., 2019) and with the following adopted cut-off values: CFI and TLI ≥ 0.90; RMSEA and SRMR ≤0.08 (Marsh et al., 2004; Byrne, 2016; Kline, 2016; Hair et al., 2019). Standardized direct and indirect effects on the dependent variable were also analyzed. The independent variables are social support provided by the friend, best-friend, parents, and coaches. Dependent variables are positive and negative affect and resilience operate as a possible mediator. The significance of direct and indirect

effects was analyzed using a bootstrap resampling procedure (1,000 bootstrap samples), through a 95% CI. The indirect effect was considered significant (≤ 0.05) if the 95% CI did not include zero (Williams and MacKinnon, 2008). We chose to consider confidence intervals rather than the probability of significance (value of p) due to recent evidence of mediation without a significant relationship between variables (Hayes, 2018).

Results

An inspection of the data revealed that no missing values or outliers, univariate and multivariate were detected. Item-level descriptive statistics indicated no deviations from univariate normality because skewness and kurtosis assumptions of the data distribution were comprised between −2 and +2 and −7 and +7, respectively (Hair et al., 2019). Mardia's coefficient for multivariate kurtosis exceeded expected values (5.0) for all models under analysis in terms of assumption of multivariate normality (Byrne, 2016). Therefore, the Bollen-Stine bootstrap on 2000 samples was employed for subsequent analysis (Nevitt and Hancock, 2001).

Descriptive statistics showed that the participants presented scores above midpoint for all variables, except negative affect in all models under analysis. Looking at bivariate correlations, positive and negative significant associations were found between resilience and positive and negative affect, respectively. These associations were consistent in all models. It is important to note that, in models of SS-C and SS-F a positive and significant association was observed between social support and positive affect. As seen by the composite reliability (CR) coefficients, each factor showed scores above the cut-off (>0.70), revealing adequate internal consistency. Based on the results of the measurement model and reliability analysis, convergent and discriminant validity were calculated. Convergent validity was achieved, since the AVE scores were above the acceptable cut-off values, as seen in Table 1. According to the squared correlations and AVE scores, all factors demonstrated adequate discriminant validity since the squared correlations of each latent variable were lower than the AVE scores in each latent variable. The results provide preliminary support to conduct Structural Equation Model (SEM) analysis and examine the direct effects of social support provided by best-friends, coach, friends and parents on resilience and positive and negative affect. In addition, indirect effect between social support provided by best-friend, coach, friends and parents and positive and negative affect via resilience can also be analyzed in this way.

The CFA measurement model including the social support provided by the best friend, coach, friends and parents, resilience and positive and negative affect displayed adequate fit to the data in each sample (see model 1, 2, 3, and 4 in Table 2).

The results from the SEM analysis showed that the structural model in each model provided acceptable fit to the data as seen in Table 2 (see model 5, 6, 7, and 8 in Table 2). Positive and significant associations were observed among resilience and positive affect and a negative and significant associations were observed between resilience and negative affect. The associations between social support from best-friends, coach, friends, and parents were not significant. In addition, the indirect effects between social support from best-friends, coach, friends, and parents and positive and negative affect via resilience were not significant, as seen in Table 3.

TABLE 1 Descriptive statistics, bivariate correlations, average variance extracted, and composite reliability coeffcients.

Variables	M	SD	1	2	3	4	AVE	CR
Model SS-BF								
1. SS-BF	3.17	0.80	1	–	–	–	0.67	0.87
2. Resilience	3.42	1.02	−0.11	1	–	–	0.57	0.76
3. PA	3.78	0.86	0.18	0.28**	1	–	0.62	0.79
4. NA	1.71	0.73	0.08	−0.37**	0.09	1	0.58	0.78
Model SS-C								
1. SS-C	3.48	0.55	1	–	–	–	0.69	0.85
2. Resilience	3.42	1.02	0.05	1	–	–	0.58	0.82
3. PA	3.78	0.86	0.22*	0.28**	1	–	0.61	0.82
4. NA	1.71	0.73	−0.03	−0.37**	0.09	1	0.57	0.73
Model SS-F								
1. SS-F	3.13	0.76	1	–	–	–	0.69	0.87
2. Resilience	3.42	1.02	−0.03	1	–	–	0.57	0.74
3. PA	3.78	0.86	0.30**	0.28**	1	–	0.62	0.65
4. NA	1.71	0.73	0.18	−0.37**	0.09	1	0.59	0.75
Model SS-P								
1. SS-P	2.81	0.84	1	–	–	–	0.66	0.88
2. Resilience	3.42	1.02	−0.19	1	–	–	0.56	0.87
3. PA	3.78	0.86	0.13	0.28**	1	–	0.66	0.72
4. NA	1.71	0.73	0.06	−0.37**	0.09	1	0.68	0.74

M, mean; SD, standard deviation; SS-BF, social support provided by best friend; SS-C, social support provided by coach; SS-F, social support provided by friends; SS-P, social support provided by parents; PA, positive affects; NA, negative affects; AVE, average variance extracted; CR, composite reliability. *$p < 0.05$; **$p < 0.01$.

TABLE 2 Goodness-of-fit indexes.

Model	χ^2	df	χ^2/df	B-Sp	CFI	TLI	SRMR	RMSEA	CI90%
1. CFA – SS-BF	136.41	105	1.29	0.313	0.947	0.935	0.076	0.061	0.034–0.085
2. CFA – SS-C	116.93	105	1.11	0.566	0.971	0.964	0.062	0.043	0.001–0.070
3. CFA – SS-F	126.05	105	1.20	0.355	0.959	0.950	0.066	0.052	0.018–0.077
4. CFA – SS-P	124.03	105	1.18	0.372	0.962	0.954	0.067	0.051	0.012–0.076
5. SEM – SS-BF	145.13	108	1.34	0.263	0.939	0.927	0.071	0.065	0.039–0.087
6. SEM – SS-C	130.46	108	1.20	0.436	0.954	0.946	0.072	0.053	0.020–0.077
7. SEM – SS-F	142.35	108	1.31	0.224	0.928	0.939	0.080	0.063	0.036–0.086
8. SEM – SS-P	132.83	108	1.22	0.299	0.954	0.945	0.077	0.055	0.024–0.079

CFA, confirmatory factor analysis; SEM, structural equation modeling; χ^2, chi-square; df, degrees of freedom; gl/df, normalized chi-square; B-Sp, Bollen-Stine level of significance; CFI, comparative fit index; TLI, Tucker Lewis Index; SRMR, standardized root mean square residual; RMSEA, root mean square error of approximation; CI90%, confidence interval at 90% for RMSEA.

Discussion

This study aimed to analyze the associations between types of social support, resilience, and subjective well-being (life satisfaction, positive affect, and negative affect) in a sample of athletes with disabilities. The model was analyzed for the four actors of social support studied, the coach, parents, friends, and best friend.

According to the results, athletes with disabilities presented values above the midpoint for the scales that assess resilience and positive affect and values below the midpoint for the scale that assesses negative affect in the four models of social support analyzed. These results seem to agree with the literature, particularly by Mira et al. (2022), that found that Portuguese Paralympic athletes have high values of life satisfaction, high positive affect, low negative affect, and good levels of resilience.

The results reveal that hypotheses (a), (b), (c), and (d) are not confirmed, since the associations between social support and resilience levels were not significant for any of the sources (parents, friends, best friend, and coach). In addition, the indirect effects between social support from parents, friends, best friend and coach and positive affect and negative affect through resilience were not significant. Contradictory to some studies that have analyzed these

TABLE 3 Direct and indirect regression paths.

Regression path	Direct				Indirect		
	β	CI95%	p		β	CI95%	p
Model SS-BF				*Model SS-BF*			
SS-BF → RESIL	0.06	−0.272–0.327	0.766	SS-BF → PA	0.01	−0.063–0.152	0.685
RESIL → PA	0.30	0.050–0.565	0.020	SS-BF → NA	−0.02	−0.154–0.096	0.676
RESIL → NA	−0.38	−0.619; −0.145	0.005	–	–	–	–
Model SS-C				*Model SS-C*			
SS-C → RESIL	0.04	−0.236–0.271	0.845	SS-BF → PA	0.01	−0.051–0.120	0.728
RESIL → PA	0.30	0.055–0.569	0.017	SS-BF → NA	−0.01	−0.121–0.089	0.760
RESIL → NA	−0.38	−0.630; −0.147	0.005	–	–	–	–
Model SS-F				*Model SS-F*			
SS-F → RESIL	0.14	−0.049–0.340	0.894	SS-BF → PA	−0.04	0.027–0.118	0.063
RESIL → PA	0.29	0.043–0.548	0.020	SS-BF → NA	0.06	0.069–0.327	0.074
RESIL → NA	−0.39	−0.622; −0.142	0.003	–	–	–	–
Model SS-P				*Model SS-P*			
SS-P → RESIL	0.01	−0.251–0.308	0.149	SS-BF → PA	0.003	−0.063–0.146	0.847
RESIL → PA	0.30	0.044–0.559	0.024	SS-BF → NA	−0.004	−0.125–0.108	0.867
RESIL → NA	−0.38	−0.621; −0.144	0.004	–	–	–	–

SS-BF, social support provided by best friend; SS-C, social support provided by coach; SS-F, social support provided by friends; SS-P, social support provided by parents; PA, positive affects; NA, negative affects; RESIL, resilience; β, standardized coefficient; CI95%, confidence interval at 95%; p, level of significance.

variables and argue that to develop mentally strong characteristics and behaviors, athletes in general may benefit from exposure to highly demanding situations in a supportive environment (Powell and Myers, 2017). These include social support from family, coach, peers, and those around them, crucial to their responses in the face of the adversities they encounter (Bicalho and Noce, 2019). Which, in turn, are necessary to know their own limitations and vulnerabilities, finding their own internal strengths and improving levels of well-being through actively combating these adversities (Fredrickson, 1998). Concerning the found associations the results show that, in the models of social support of the coach and friends, a positive and significant association was observed between social support and positive affect. In a previous study conducted in paralympic athletes, positive affect was associated with social support from parents and friends, although the coach presented the value of greatest influence on the athlete, followed by friends, best friends and at last, parents (Mira et al., 2022). These results seem to demonstrate that coach support is more important for federated disabled athletes than specifically for elite (Paralympic) athletes, in contrast to parents. The support of friends has a consensus in its importance for both federated athletes with disabilities and paralympic athletes, which is in line with the literature that considers friendship an important source of social support and influence for the practice of sports (Haye et al., 2011). The origin of social support is extremely important for access to sports practice. However, it does not necessarily have to be positively and significantly associated with resilience or subjective well-being.

The results also show that for the four models analyzed (parents, coach, friends and best friend), there is a direct effect of the types of social support provided with resilience, positive and negative affect. There is also an indirect effect between types of social support and affect (positive and negative) through resilience. Therefore, contrary to what we had considered [hypotheses (a), (b), (c), and (d)], the different types of social support did not show a significant association with the levels of resilience. These results do not seem to be in line with some with the literature, that highlight sociocultural influences as crucial for the resilience process in athletes (Galli and Vealey, 2008). In the study by Li et al. (2021) investigating the main and interactive relationships of social support and resilience on individual mental health during the COVID-19 pandemic across three age groups: emerging adults, adults, and older adults, they identified five social support profiles, and the patterns of potential profiles were similar across all groups. However, the distribution of the categories in the five profiles was significantly different between the age groups. Considering the different age groups presented in our sample, this could be a possible explanation. It would be interesting to explore these data by age group and a much larger sample. On the other hand, it is important to remember the role that types of social support plays in the participation in sport by people with disabilities, as evidenced by different studies (Machida et al., 2013; Crawford et al., 2015; Aitchison et al., 2021; Mira et al., 2022). In the same sense, the origin of this types of social support, it is important the standard adjustment of the athlete's support throughout his/her career according to his/her changing needs, be it accessibility, disability condition, challenges inherent to the practice of sport (Rees and Hardy, 2000).

Hypotheses (e) and (f) were confirmed, with a positive and significant association between resilience and positive affect and a negative association between resilience and negative affect. The results show that, more than the perceived social support itself, resilience seems to have a preponderant weight in the consequence of sports practice, in this case subjective well-being, in its emotional component (positive and negative affect). This result is particularly relevant if we consider the importance of this emotional dimension of

well-being, since the literature has shown, in general, that positive emotions can function as resources for coping with adversity (Fredrickson, 1998; Jaafar et al., 2014). Fredrickson (2001) explains the importance of positive affect in predicting resilience through the broaden-and-build theory. The author argues that an emotion begins with a person own conscious or unconscious appraisal of the significance of an antecedent event for him or her. People with experiences of positive affect are better able to engage and participate in activities in their environment. Affect represents accessible conscious feelings. According to this theory, certain discrete positive emotions, such as joy, interest, satisfaction, pride and love, share the ability to momentarily broaden the thought/action repertoire and build lasting personal resources, evolving from physical and intellectual resources to social and psychological resources. Positive emotions make people feel good in the present, and their effects broaden thinking, increasing the likelihood that people will feel good in the future. They increase people thought/action repertoire, undo persistent negative emotions, stimulate psychological resilience and, by building psychological resilience, trigger upward spirals that increase well-being.

The literature tells us that the study of resilience has been widely carried out with parents and family members of people with disabilities and that the findings have been quite positive although they are not directly related to people with disability. However, the sources of social support are crucial actors in the access to sports practice of these people (Palancı, 2017; Halstead et al., 2018; Mohan and Kulkarni, 2018; Rajan et al., 2018). Therefore, it would be interesting to analyze the levels of resilience of parents, friends, best friend, and coach in the models themselves.

These results of our study agree with the study previously conducted in a sample of paralympic athletes (Mira et al., 2022), where it was noted that the negative association between resilience and negative affect seems to indicate a possible blocking effect of resilience to emotionally negative experiences of athletes (Ryff and Singer, 2003; Hammond, 2014; Hariharan et al., 2014; Mira et al., 2022). Other studies have proven the association between resilience and subjective well-being in athletes with disabilities (Martin et al., 2015; Sikorska and Gerc, 2018; Atkinson and Martin, 2020; Silva et al., 2020; Mira et al., 2023), which is in accordance with the importance of this variable in this population that, in a given risk situation, one can react in a vulnerable way, with a negative affect response, or in a resilient way, with a positive affect response (Fredrickson, 1998).

The analysis of all models of social support showed a direct effect on resilience and positive and negative affect. Literature tells us that exposure of disabled athletes to highly demanding and socially supported situations benefits them in developing resilient characteristics and behaviors (Machida et al., 2013; Mira et al., 2023).

The results of the present study may constitute an important contribution to practice, particularly for all those working in the context of adapted sport, as they highlight the importance of monitoring these variables throughout the process. It becomes fundamental that types of social support acts as a teamwork that supports in the various challenges and tasks inherent and adjusted to the characteristics and needs of athletes with disabilities (Crawford et al., 2015) and, therefore, the sources of types of social support should be multiple, from family, therapists, colleagues, coaches, among others (Machida et al., 2013). Types of social support provided by a multidisciplinary team presents an essential role in the development and improvement of athletes' training and performance. The social support of family, friends and other performance agents are considered the necessary and indispensable support for the provision of mental health care and happiness in general (Sheridan et al., 2014). Resilience seems to play an extremely relevant role and to have an impact on the well-being perceived by athletes, and should be the subject of attention and should be a variable to be enhanced in the context of sport. Sport as an environment that exposes athletes to the risk, needs and stress inherent in the competitive environment, allows athletes with disabilities to strengthen their personal and social resources, as well as their positive characteristics and social support network, which will allow them to overcome adversity successfully, with above-average levels of resilience.

Despite the results of this study, there are some limitations that should be taken into account in future studies. Although our sample fulfils the criteria, it is relatively small, and future studies should consider recruiting larger samples. On the other hand, other variables that could play an important role in this process were not analyzed, such as the type of disability or sport played and the effect of age. A longitudinal analysis would also be important. At the same time, it will also be important to try in order to try to validate the Brief Resilience Scale for this population in the future.

Conclusion

The present findings seem to indicate that the effect of social support provided by the best friend, coach, friends, and parents had a direct effect on resilience and positive and negative affect. We also found a positive and significant association between resilience and positive affect and a negative association between resilience and negative affect. The strongest relationship in the variables studied was found between resilience and affect, with no relationship being verified between the sources of social support and resilience or affect, as hypothesized. For this group of athletes with disability, more than the social support they may have or may feel, resilience proved to be very important for the consequence of sports practice in terms of subjective well-being.

Transparency statement

This study is part of a global research project on Portuguese athletes with disabilities. Thus, in a first study we sought to characterize the population of high-performance athletes, namely the Portuguese team that was present at the Tokyo 2020 Paralympic Games (Mira et al., 2022), that aimed characterize the Portuguese delegation at the Tokyo 2020 Paralympic Games through sociodemographic and psychosocial variables (positive and negative affect, life satisfaction, resilience, and social support). However, with the present work we aimed to reach a larger sample with different characteristics. Thus, keeping the paralympic athletes already studied, we also added athletes with different years of practice and with different competitive

levels. Moreover, in this work, we did not seek only a descriptive analysis but an analysis in a single model that could explain the associations between the different variables.

Data availability statement

All relevant data is contained within the article: The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the Ethics committee of the University of Beira Interior (CE-UBI-Pj-2018-076). 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

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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Development and validation of the Chinese coaches' interpersonal style scale

Wen Su[1] and Daliang Zhao[1,2]*

[1]Public Courses Teaching Department, Guangzhou Sport University, Guangzhou, China, [2]College of Leisure and Digital Sports, Guangzhou Sport University, Guangzhou, China

Purpose: Coaches' behaviors and coaching styles play a critical role in influencing athletes' psychological experiences and performance. According to the self-determination theory (SDT), coaches' interpersonal behaviors are commonly categorized as autonomy-supportive and controlling. Due to less focus on the unique behaviors of Chinese coaches, this study incorporated coaches' parental care for athletes, referred to as paternalistic benevolence, in their interpersonal styles in the context of the Chinese culture.

Methods: Exploratory factor analyses were used in studies 1 and 2 to find items associated with benevolent coaching behaviors and items to create the Chinese Coaches' Interpersonal Style Scale. Study 3 used the constructed scale, as well as the Subjective Vitality Scale and Athlete Burnout Questionnaire, with a sample of athletes to examine scale reliability. The 15-item Chinese Coaches' Interpersonal Style Scale contained three dimensions: benevolent, autonomy-supportive, and controlling coaching styles.

Results: The findings showed that: (1) benevolent coaching behaviors held significant explanatory weight in the Chinese cultural context; (2) controlling and autonomy-supportive coaching styles were culturally congruent among both Eastern and Western athletes; and (3) benevolent and autonomy-supportive coaching behaviors positively impacted athletes, whereas controlling coaching behaviors had a negative impact.

Conclusion: The measure showed strong validity and reliability, making it useful for future practice and research on the interpersonal style of Chinese coaches.

KEYWORDS

coach, interpersonal style, benevolent style, autonomy-supportive style, controlling style

1 Introduction

The psychological experiences and performance of players in sports are profoundly influenced by coaches' behaviors (Lemelin et al., 2022). Coaches' styles are generally classified into two categories based the self-determination theory (SDT): autonomy-supportive and controlling (Vallerand and Losier, 1999). Previous studies have consistently demonstrated that coaches' interpersonal styles have a significant impact on athletes' basic psychological need, motivation, and well-being in competitive sports (Mageau and Vallerand, 2003; Balaguer et al., 2012; Curran et al., 2014; Healy et al., 2014). Autonomy-supportive coaches promote freedom, encourage autonomy, and involve athletes in decision-making processes. Conversely, coaches

with controlling styles demonstrate coercive, authoritarian, and pressure acts. Athletes' perception of their coaches' interpersonal styles predict changes in the psychological need satisfaction or thwarting, impacting their subjective vitality and burnout (Balaguer et al., 2012). In particular, perceiving an autonomy-supportive environment is positively correlated with subjective vitality and need satisfaction and negatively correlated with burnout and need thwarting (Stebbings et al., 2012; Amorose and Anderson-Butcher, 2015; Mossman et al., 2022). In contrast, perceiving a controlling environment is positively correlated with need thwarting and burnout and negatively correlated with subjective vitality (Bartholomew et al., 2011b; Amorose and Anderson-Butcher, 2015; González et al., 2017; Ntoumanis et al., 2017).

Several surveys have analyzed coaches' interpersonal behavior. The short version of the Sport Climate Questionnaire (SCQ) has been used to examine players' experiences with their coaches' autonomy-supportive behavior (Amorose and Anderson-Butcher, 2007; Amorose et al., 2016). This six-item scale, derived from the Health Care Climate Questionnaire (Williams et al., 1998), assesses whether coaches support athletes' psychological needs (Standage et al., 2006). Example items include "I feel that my coach provides us choices and options" and "I feel understood by my coach." Moreover, the Autonomy-Supportive Coaching Questionnaire, developed by Conroy and Coatsworth (2007), examines autonomy support in two dimensions: interest in athlete's input and praise for autonomous behavior. Other scales adapted from various domains include the Perceived Autonomy Support Scale for Exercise Setting (Gillet et al., 2010), Interpersonal Supportiveness Scale-Coach (Wilson et al., 2009), and Problem in Sports Questionnaire (Carpentier and Mageau, 2013). Conversely, the Controlling Coach Behavior Scale (CCBS) assesses negative features of coaching styles through four aspects: controlling use of rewards, negative conditioned regard, intimidation, and excessive personal control (Bartholomew et al., 2010). Numerous studies have evaluated coaches helping and hindering actions. The SDT and achievement goal theory serve as the theoretical foundation of the Empowering and Disempowering Motivational Climate Questionnaire-Coach, which includes the dimensions of task-involving, autonomy-supportive, socially-supportive, ego-involving, and controlling coaching. However, this questionnaire has several problematic items, despite having been tested with a variety of methodologies (Appleton et al., 2016). Furthermore, the Interpersonal Behaviors Questionnaire and Coaches' Interpersonal Style Questionnaire examines basic psychological needs. Both of these scales have six components: autonomy support, autonomy thwarting, competence support, competence thwarting, relatedness support, and relatedness thwarting (Rocchi et al., 2017; Pulido et al., 2018).

Most existing coaching-style scales have been developed for Western cultural contexts. It is crucial to understand how cultural factors impact coaching behaviors in a range of cultural situations. Several cross-cultural studies have demonstrated that the SDT is applicable to athletes from various countries; however, pathway size and degree of variance explained in outcome variables vary (Jowett et al., 2017). For instance, the satisfaction of basic psychological needs was found to explain changes in autonomous motivation among the majority of Chinese athletes, a moderate number of Greek and Swedish athletes, and a small proportion of Spanish and British athletes (Jowett et al., 2017). Furthermore, the relatedness of psychological needs may vary across nations and cultures (Maulana

et al., 2013). Focusing on autonomy may be beneficial in highly individualistic Western societies that emphasize autonomy (Oishi, 2000). In contrast, in cultures focused on authority, such as China and Greece, a lack of autonomy may not always be detrimental (Miller, 2014). In addition, self-determined motivation was found to have a stronger impact on Chinese and Greek athletes than on Spanish and British athletes (Jowett et al., 2017). This cross-cultural disparity is considerable in both collectivist (e.g., China) and individualist societies (Hofstede and Hofstede, 2001; Maulana et al., 2013).

Moreover, perceptions of the coach-athlete relationship differ, with Western athletes perceiving it as a partnership, and Chinese athletes often equating it to a parent–child relationship. Moreover, under the supervision of their coaches, Chinese athletes have limited control over their private lives, whereas Western athletes have greater personal freedom and autonomy (Li et al., 2015). An old Chinese proverb, "A day as a teacher, a lifetime as a parent," implies that even a teacher who imparts knowledge for only one day should be treated as a lifetime parent. This is especially essential for Chinese athletes, many of whom begin their athletic careers at an early age. Therefore, coaches in China not only offer their expertise but also play a parental role in athletes' lives. Paternalistic benevolence has emerged as a distinguishing trait of coaches' parental responsibilities in the coach-athlete relationship (Farh et al., 2000). Benevolence is defined by an explicit distinction between superior and subordinate roles, in which the superior accepts the obligation to care for the inferior, who reciprocates with appreciation, loyalty, and obedience. Benevolence is effective in contexts with a significant gap between superiors and subordinates, whereas autonomy support thrives in an egalitarian environment (Farh et al., 2000). Benevolence extends beyond athletic expertise in the coach-athlete relationship to encompass the personal care and protection of athletes.

The universal applicability of the SDT across cultures has been established, with coaching styles playing a critical role in promoting athletic well-being worldwide (Jowett et al., 2017). The influence of an autonomy-supportive coaching style on athletes is consistent and independent of culture and sport type (Mossman et al., 2022). Efforts have also been made to adapt the CCBS to the Chinese culture, with findings indicating that dimensions such as excessive personal control and negative conditioned regard retain cross-cultural congruence across Eastern and Western athletes (Zhao and Zhou, 2022). Hence, this study aimed to establish and validate a scale to examine coaches' interpersonal styles in the Chinese cultural context.

2 Study 1

2.1 Methods

2.1.1 Participants

The participants ($N = 148$) comprised 77 men and 71 women aged 13–30 years ($M = 20$, $SD = 3.079$), including age groups of 13–15 ($n = 8$), 16–20 ($n = 87$), 21–25 ($n = 47$), and 26–30 years ($n = 6$). Their training experience was 0–23 years ($M = 6.66$, $SD = 4.033$), with training periods including 0–5 ($n = 75$), 6–10 ($n = 49$), 11–15 ($n = 20$), 16–20 ($n = 3$), and 21–23 years ($n = 1$). The athletes participated in three sports: athletics ($n = 100$), martial arts ($n = 39$), and gymnastics ($n = 9$). All procedures were approved by the Institutional Review

TABLE 1 Descriptive statistics and factor loadings based on the exploratory factor analysis (Study 1).

Item	M	SD	Skewness	Kurtosis	F1	F2
Individual care						
1. Beyond training, my coach expresses concern about my daily life	3.97	0.94	−0.38	−0.77	**0.79**	0.30
3. My coach meets my needs according to my personal requests	3.67	0.92	−0.09	−0.38	**0.84**	0.18
4. My coach handles what is difficult to do or manage in everyday life for me	3.84	0.94	−0.37	−0.34	**0.87**	0.22
Understanding and forgiveness						
6. My coach tries to understand the cause if I do not perform well	4.35	0.76	−0.79	−0.53	0.27	**0.85**
7. When I make mistakes, my coach gives me the opportunity to make amends	4.41	0.65	−0.65	−0.57	0.29	**0.81**
8. My coach avoids embarrassing me in front of my teammates	3.78	1.02	−0.33	−0.71	0.14	**0.79**

Items were modified from the Paternalistic Leadership Scale (Farh et al., 2000). F1 = Individual care, F2 = Understanding and forgiveness. The primary factor loadings are in bold.

Board of Guangzhou Sport University. All participants or their parents provided written informed consent forms.

2.1.2 Measures

We used the benevolent leadership subscale of the Paternalistic Leadership Scale (PLS; Farh et al., 2000). This subscale consisted of 11 items distributed across two dimensions: individual care, which included six items (e.g., "The leader expresses concern about my daily life"), and understanding and forgiveness, which included five items (e.g., "The leader encourages me when I encounter arduous problems"). Responses were rated on a five-point Likert scale (1 = never; 5 = always).

We modified the PLS by transferring it from an enterprise leadership context to a sports environment. During the revision phase, we improved the benevolence dimension by deleting three items that were irrelevant to the Chinese sports context. Benevolence yielded a final set of eight items.

2.1.3 Data analysis

Data analysis was conducted using SPSS 20.0, and each item was examined using an exploratory factor analysis (EFA). Items with factor loadings greater than 0.40 were considered acceptable (Guadagnoli and Velicer, 1988; Samuels, 2017). Items with factor loadings less than 0.4 and significant cross-loadings (two or more factor loadings more than 0.40) were excluded (Ferguson and Cox, 1993).

2.2 Results

2.2.1 Exploratory factor analysis

The EFA and extraction used the principal component analysis and identified two co-factors. Varimax rotation was used to examine benevolent coaching behaviors. The sample suitability test (Kaiser-Meyer-Olkin, KMO = 0.86) and spherical test ($\chi^2 = 620.29$, $p < 0.001$) revealed that the sample was adequate for factor analysis. All items had factor loadings greater than 0.40, and one item in the individual care ($\lambda = 0.62$) had a cross-loading greater than 0.40 ($\lambda = 0.44$) in the understanding and forgiveness (e.g., "My coach often shows concern about me"). Moreover, in the understanding and forgiveness dimension, one item ($\lambda = 0.55$) had a greater cross-loading ($\lambda = 0.63$) for individual care (e.g., "My coach encourages me when I encounter arduous problems"). Based on the principal component loadings, these two items were eliminated in turn.

Subsequently, each factor had an eigenvalue greater than 1, and the cumulative contribution accounted for 73.52% of the total variance. The eigenvalue of individual care was 2.25, explaining 37.49% of the interpretable variance, whereas the eigenvalue of understanding and forgiveness was 2.16, explaining 36.04% of the interpretable variance. Item factor loadings varied from 0.79 to 0.87. Thus, benevolent coaching style was divided into two dimensions (individual care and understanding and forgiveness), with three items each (Table 1).

3 Study 2

3.1 Methods

3.1.1 Participants

A total of 241 athletes from Guangdong Province participated in Study 2, including 132 men and 109 women aged 11–30 years ($M = 18.76$, $SD = 3.700$), with age groups including 11–15 ($n = 43$), 16–20 ($n = 125$), 21–25 ($n = 61$), and 26–30 years ($n = 12$). Their training experience was 1–20 years ($M = 8.49$, $SD = 4.024$), with training periods including 1–5 ($n = 61$), 6–10 ($n = 113$), 11–15 ($n = 55$), and 16–20 years ($n = 12$). The athletes were engaged in various sports: fencing ($n = 49$), weightlifting ($n = 28$), badminton ($n = 27$), water polo ($n = 26$), swimming ($n = 24$), athletics ($n = 17$), gymnastics ($n = 17$), artistic swimming ($n = 17$), table tennis ($n = 15$), sanda ($n = 10$), tennis ($n = 6$), and Wushu ($n = 5$). All procedures were approved by the Institutional Review Board of Guangzhou Sport University. All participants or their parents provided written informed consent forms.

3.1.2 Measures

The Benevolent coaching style measure developed in Study 1 was used. The scale contained two dimensions: individual care, which contained three items (e.g., "Beyond training, my coach expresses concern about my daily life"), and understanding and forgiveness, which comprised three items (e.g., "My coach tries to understand the cause if I do not perform well"). Responses were rated on a seven-point Likert scale (1 strongly disagree; 7 = strongly agree).

In addition, we used the six-item SCQ to assess athletes' perceived autonomy support of coaches. This questionnaire was originally designed for the health domain but was later modified for the sports domain (Reinboth et al., 2004), with items such as "I feel that my coach provides me choices and options." The redesigned measure

demonstrated good psychometric properties in a sample of young athletes (Reinboth et al., 2004). Responses were rated on a seven-point Likert scale (1 = strongly disagree; 7 = strongly agree).

The CCBS is a self-report scale based on the SDT (Ryan and Deci, 2002) and developed to evaluate coaches' controlling behaviors (Bartholomew et al., 2010). This scale consists of four factors: controlling the use of rewards, negative conditioned regard, intimidation, and excessive personal control. Previous studies using linear mixed models found that the perception of autonomy-supportive coaching behaviors were associated with basic need satisfaction and well-being, whereas controlling coaching behaviors (negative conditioned regard and excessive personal control) were associated with basic need frustration and poor well-being (Cheval et al., 2017). Therefore, these two factors are significant predictors of athletes' well-being. The CCBS has been modified for the Chinese culture. Studies have shown that Eastern and Western athletes shared similar experiences of negative conditioned regard and excessive personal control (Zhao and Zhou, 2022). Therefore, Study 2 used the CCBS designed for Chinese athletes, which consisted of six items distributed across two dimensions (Zhao and Zhou, 2022). Negative conditioned regard included three items (e.g., "My coach is less supportive of me when I am not training and completing well"), and excessive personal control included three items (e.g., "My coach tries to control what I do in my free time"). Responses were rated on a seven-point Likert scale (1 = strongly disagree; 7 = strongly agree).

3.1.3 Data analysis

SPSS 20.0 was used to analyze the data, and EFA was used to evaluate each item. Items with factor loadings less than 0.4 and high cross-loadings were eliminated (Guadagnoli and Velicer, 1988; Ferguson and Cox, 1993).

3.2 Results

3.2.1 Exploratory factor analysis

We used the EFA with principal component analysis to identify three cofactors, followed by varimax rotation. The sample's fitness for factor analysis was validated using the sample suitability test (KMO = 0.91) and spherical test (χ^2 = 3241.98, p < 0.001). All items showed factor loadings above 0.40, except for one item ("My coach tries to understand the cause if I do not perform well") in the benevolent coaching style dimension (λ = 0.65), which also displayed a cross-loading exceeding 0.40 in autonomy-supportive coaching style (λ = 0.41). Therefore, this item was excluded from the analysis.

Subsequently, the eigenvalues of the obtained factors were greater than 1, resulting in a cumulative contribution of 68.65%. In particular, the eigenvalue of benevolent coaching style was 2.92, which accounted for 17.17% of the interpretable variance. Autonomy-supportive coaching style had an eigenvalue of 4.65 and explained 27.33% of the interpretable variance. The eigenvalue of controlling coaching style was 4.11, and the explained variance was 24.15%. Items in these three factors had factor loadings ranging from 0.55 to 0.87. Thus, benevolent, autonomy-supportive, and controlling coaching styles were included as three components in the Chinese Coaches' Interpersonal Style Scale (CCISS), with five, six, and six items, respectively (Table 2).

4 Study 3

We conducted a confirmatory factor analysis (CFA) of the CCISS to determine the suitability of the three-dimensional division based on Schumann's seven-point guide (Schumann et al., 2022).

4.1 Methods

4.1.1 Participants

A total of 531 athletes from Guangdong Province, including 268 men and 263 women, participated in Study 3. The participants' ages ranged from 10 to 31 years (M = 18.68, SD = 3.973), with the age groups including 10–15 (n = 103), 16–20 (n = 275), 21–25 (n = 127), and 26–31 years (n = 26). The participants' training periods were 1–26 years (M = 7.98, SD = 4.155), including ranges of 1–5 (n = 172), 6–10 (n = 232), 11–15 (n = 107), 16–20 (n = 17), and 21–26 years (n = 3). The sports represented covered a diverse range: athletics (n = 86), volleyball (n = 47), fencing (n = 46), gymnastics (n = 42), basketball (n = 41), trampolining (n = 39), water polo (n = 35), swimming (n = 33), table tennis (n = 30), weightlifting (n = 27), badminton (n = 25), artistic swimming (n = 21), diving (n = 21), Wushu (n = 21), sanda (n = 14), and tennis (n = 3). All procedures were approved by the Institutional Review Board of Guangzhou Sport University. All participants or their parents provided written informed consent forms.

4.1.2 Measures

Based on the results of Study 2, the CCISS, which consists of 15 items divided into three coaching styles, was created. Benevolent coaching style was divided into two dimensions: individual care, which included three items (e.g., "Beyond training, my coach expresses concern about my daily life"), and understanding and forgiveness, which included two items (e.g., "My coach avoids embarrassing me in front of my teammates"). Understanding and forgiveness was eliminated from further analyses, as it contained only two items (Suhr, 2006). Thus, benevolent coaching style contained three items. Autonomy-supportive coaching style comprised six items, such as "I feel that my coach provides us choices and options." Controlling coaching style included six items in two dimensions: negative conditioned regard, which included three items (e.g., "My coach is less supportive of me when I am not training and completing well"), and excessive personal control, which included three items (e.g., "My coach tries to control what I do in my free time"). The mean values of negative conditioned regard and excessive personal control were used as observation variables of controlling coaching style in the CFA. Responses were rated on a seven-point Likert scale (1 = strongly disagree; 7 = strongly agree).

The seven-item Subjective Vitality Scale Ryan and Frederick (1997) evaluates individuals' perceptions of their vitality (e.g., "I feel alive and vital right now"). Responses were rated on a seven-point Likert scale (1 = not at all true; 7 = very true). The Chinese version of the scale exhibited an internal consistency of 0.87 and was found reliable in the context of exercise (Liu and Chung, 2014).

The 15-item Athlete Burnout Questionnaire was developed to evaluate athlete burnout (Raedeke and Smith, 2001), with three factors: reduced sense of accomplishment (5 items; e.g., "I am not achieving much in sports"), emotional or physical exhaustion (5 items; e.g., "I feel so tied from my training that I have trouble finding energy

TABLE 2 Descriptive statistics and factor loadings based on the exploratory factor analysis (Study 2).

Item	M	SD	Skewness	Kurtosis	F1	F2	F3
Benevolent coaching style							
1. Beyond training, my coach expresses concern about my daily life	4.82	1.39	−0.09	−0.53	**0.72**	0.29	0.07
3. My coach meets my needs according to my personal requests	4.50	1.38	0.03	−0.07	**0.80**	0.20	0.03
4. My coach handles what is difficult to do or manage in everyday life for me	4.93	1.46	−0.29	−0.45	**0.76**	0.37	−0.10
7. When I make mistakes, my coach gives me the opportunity to make amends	4.50	1.53	−0.11	−0.51	**0.55**	0.25	−0.32
8. My coach avoids embarrassing me in front of my teammates	5.54	1.15	−0.62	−0.04	**0.61**	0.27	−0.33
Autonomy-supportive coaching style							
9. I feel that my coach provides us choices and options	5.20	1.29	−0.32	−0.47	0.29	**0.77**	−0.15
10. I feel understood by my coach	4.92	1.43	−0.34	−0.31	0.24	**0.85**	−0.10
11. My coach conveyed confidence in my ability to do well at athletics	5.20	1.25	−0.26	−0.41	0.32	**0.84**	−0.22
12. My coach encouraged me to ask questions	5.52	1.25	−0.46	−0.57	0.30	**0.74**	−0.20
13. My coach listens me to how I would like to do things	5.18	1.40	−0.35	−0.62	0.26	**0.87**	−0.23
14. My coach tries to understand how I see things before suggesting a new way to do things	4.94	1.45	−0.35	−0.25	0.29	**0.80**	−0.21
Controlling coaching style							
15. My coach is less supportive of me when I am not training and competing well	3.07	1.54	0.26	−0.71	−0.13	−0.36	**0.69**
16. My coach pays me less attention if I have displeased him/her	3.33	1.52	0.21	−0.53	−0.03	−0.32	**0.71**
17. My coach is less accepting of me if I have disappointed him/her	3.48	1.54	0.11	−0.63	−0.07	−0.22	**0.78**
18. My coach tries to control what I do in my free time	2.75	1.50	0.80	0.24	−0.04	−0.08	**0.84**
19. My coach tries to interfere in aspects of my life outside of my sport	2.71	1.37	0.64	0.17	−0.11	−0.08	**0.82**
20. My coach tries to control everything I did	2.50	1.35	0.92	0.71	−0.09	0.00	**0.84**

Items of the Autonomy-supportive coaching style were derived from the Sport Climate Questionnaire (Reinboth et al., 2004). Items of the Controlling coaching style were derived from the Controlling Coach Behavior Scale (Bartholomew et al., 2010; Zhao and Zhou, 2022). F1 = Benevolent, F2 = Autonomy-supportive, F3 = Controlling. The primary factor loadings are in bold.

to do other things"), and devaluation (5 items; e.g., "The effort I spend on sports would be better spent doing other things"). Responses were rated on a five-point Likert scale (1 = almost never; 5 = almost always). Research has supported the reliability (Lemyre et al., 2006), structural validity (Raedeke and Smith, 2001), and convergent and discriminant validity (Cresswell and Eklund, 2006) of the scale.

4.1.3 Data analysis

SPSS 20.0 and AMOS 28.0 were used for data analysis. The CFA was used to assess the structural validity of the CCISS. We utilized χ^2/df, comparative fit index (CFI), Tucker-Lewis index (TLI), parsimony normative fit index (PNFI), and root mean square error of approximation (RMSEA) as model fit indices. The criteria for excellent fit are CFI ≥ 0.95, TLI ≥ 0.95, and RMSEA ≤0.06 (Hu and Bentler, 1999). Acceptable fit is indicated by CFI ≥ 0.90, TLI ≥ 0.90, RMSEA ≤0.080 (Browne and Cudeck, 1992; Hu and Bentler, 1999), and PNFI ≥0.60 (Netemeyer et al., 1990). In addition, for a larger sample size, the χ^2/df should ideally be ≤4, with a lower index suggesting a better model fit (Hotchkiss and Cook-Cottone, 2019). A correlation analysis was used to test the validity of the results.

4.2 Results

4.2.1 Confirmatory factor analysis

The CFA revealed a relatively good fit to the data, with room for some improvement: χ^2/df = 6.004, RMSEA =0.097, CFI =0.949, TLI =0.931, and PNFI =0.700. Larger modification indices indicate

possible residual correlations among certain items. Two rounds of residual correlations were performed. Items 13 and 14, belonging to autonomy-supportive coaching style, were the subject of the first modification, whereas items 12 and 13 were the focus of the second. The final model, which included 15 items in three dimensions (benevolent coaching style, three items; autonomy-supportive coaching style, six items; and controlling coaching style, six items), produced a substantially better fit to the data: χ^2/df = 3.430, RMSEA = 0.068, CFI = 0.976, TLI = 0.967, and PNFI = 0.686 (Figure 1).

4.2.2 Structural stability

Separate CFA was conducted for male and female participants to evaluate the stability of the CCISS structure. For female participants, three latent variables representing benevolent, autonomy-supportive, and controlling coaching styles were included. The results revealed the following fit indices: χ^2/df = 3.470, RMSEA = 0.097, CFI = 0.951, TLI = 0.934, and PNFI = 0.696. Model fit indices after modification were: χ^2/df = 2.695, RMSEA = 0.080, CFI = 0.968, TLI = 0.955, and PNFI = 0.674. For male participants, three latent variables indicating benevolent, autonomy-supportive, and controlling coaching styles were included. The results show the following fit indices: χ^2/df = 4.377, RMSEA = 0.112, CFI = 0.930, TLI = 0.906, and PNFI = 0.680. The model fit indices improved after modifications: χ^2/df = 2.575, RMSEA = 0.077, CFI = 0.969, TLI = 0.956, and PNFI = 0.674.

In addition, we divided sports into closed (e.g., athletics, gymnastics, trampolining, swimming, weightlifting, artistic swimming, diving, and Wushu) and open (e.g., volleyball, fencing, basketball, water polo, table tennis, badminton, sanda, and tennis)

FIGURE 1
Results of the 3-factor confirmatory factor analysis of the Chinese coaches' interpersonal style scale.
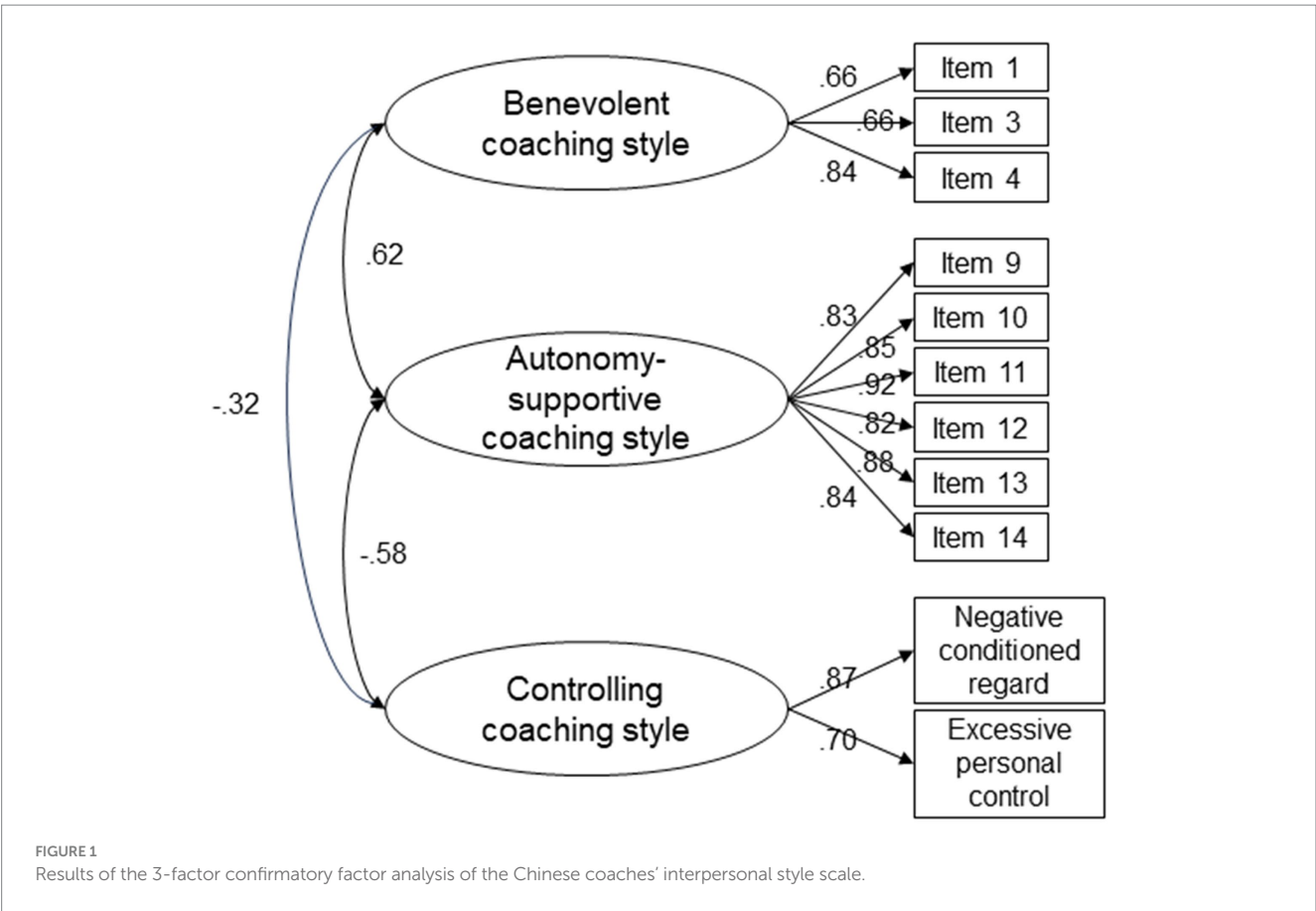
TABLE 3 The convergent and divergent validity of the Chinese coaches' interpersonal style scale.

	Benevolent			Autonomy-supportive			Controlling		
	Total	Sample 1	Sample 2	Total	Sample 1	Sample 2	Total	Sample 1	Sample 2
Subjective vitality	0.315**	0.319**	0.312**	0.505**	0.468**	0.534**	−0.322**	−0.267**	−0.366**
Reduced sense of accomplishment	−0.194**	−0.142*	−0.244**	−0.421**	−0.364**	−0.474**	0.344**	0.249**	0.431**
Emotional or physical exhaustion	−0.158**	−0.188**	−0.134*	−0.378**	−0.350**	−0.401**	0.400**	0.304**	0.461**
Devaluation	−0.192**	−0.202**	−0.185**	−0.408**	−0.361**	−0.444**	0.417**	0.305**	0.491**

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

types. The CFA for the open sports were used as latent variables. The results showed the following fit indices: $\chi^2/df = 3.652$, RMSEA = 0.105, CFI = 0.945, TLI = 0.926, and PNFI = 0.690. After the modifications, the model fit indices improved to: $\chi^2/df = 2.493$, RMSEA = 0.079, CFI = 0.970, TLI = 0.958, and PNFI = 0.675. The three dimensions were used as latent variables in the closed sports. The results revealed the following fit indices: $\chi^2/df = 4.012$, RMSEA = 0.102, CFI = 0.941, TLI = 0.921, and PNFI = 0.688. After adjustment, the model fit indices improved: $\chi^2/df = 2.658$, RMSEA = 0.076, CFI = 0.969, TLI = 0.956, and PNFI = 0.675.

4.2.3 Correlation analysis

The results of the correlation analysis (Table 3) showed a strong relationship between coaching style and players' subjective experience.

Specifically, subjective vitality had a substantial negative relationship with controlling coaching style and a significant positive relationship with autonomy-supportive and benevolent coaching styles. Reduced sense of accomplishment was positively correlated with controlling coaching style and negatively correlated with autonomy-supportive and benevolent coaching styles. Furthermore, emotional or physical exhaustion and devaluation showed the same pattern as reduced sense of accomplishment.

The 531 participants were randomly divided into two groups to test the stability of the divergent and convergent validity of the CCISS. Samples 1 and 2 comprised 266 and 265 participants, respectively. Both groups demonstrated the same relationship between coaching style and other factors (Table 3), indicating that the scale had a robust and stable level of divergent and convergent validity.

TABLE 4 Internal consistency of the Chinese coaches' interpersonal style scale.

Benevolent	Autonomy-supportive	Controlling
0.761	0.944	0.885

4.2.4 Internal consistency

As an alternative method for evaluating the validity of the CCISS, the results showed adequate internal consistency for all three factors via Cronbach's alpha, ranging from 0.761 to 0.944 (Table 4).

5 Discussion

This study aimed to develop and evaluate a scale designed for Chinese coaches' behaviors based on the SDT. Most frequent coaching styles were autonomy-supportive and controlled. The autonomy-supportive style exhibited cross-cultural consistency (Mossman et al., 2022). Meanwhile, the Chinese version of CCBS demonstrated that cultural moderation had no appreciable impact on negative conditioned regard and excessive personal control (Zhao and Zhou, 2022). Furthermore, our study included the benevolent factor in understanding of the influence of the special parent–child relationship between Chinese coach and athletes on coaching style. Items of the benevolent coaching style were eliminated after conducting the EFA in Studies 1 and 2. Moreover, Study 3 adopted the CFA to determine whether the benevolent, autonomy-supportive, and controlling coaching styles were consistent with the behaviors usually observed in Chinese coaches. Consequently, this study revised the CCISS for the Chinese cultural background. The final 15-item CCISS, which included benevolent (three items), autonomy-supportive (six items), and controlling (six items) coaching styles, demonstrated good reliability and validity.

Moreover, analyses of convergence, discrimination, stability, reproducibility, and generalizability indicated that the scale usage could be further expanded. The correlation analysis in Study 3 showed a consistent relationship between all samples and subjective vitality, reduced sense of accomplishment, emotional or physical exhaustion, and devaluation. Study 3 demonstrated robust stability, as the scale's results remained steady regardless of the sample's gender or the type of sport in which they engaged (open or closed sports). The participants were randomly divided into two groups. The findings showed that the relationship between the three coaching styles and the other variables was constant across all samples. Notable similarities in the overall patterns of reliability, correlations, and stability were evident across all samples.

Benevolent coaching style items were improved using the EFA in Studies 1 and 2. Items of benevolent leadership in the enterprise context were modified for the sports context, and items with high cross-loading were deleted. In line with the theory of high cross-loading (Ferguson and Cox, 1993), an item might contribute to individual care and understanding and forgiveness, limiting a clear distinction between two factors. Individual care is generally characterized by coaches' paternal concern or considerateness for their athletes, whereas understanding and forgiveness is

characterized by sensitive to players' needs or opinions. The items "My coach often shows concern about me" and "My coach encourages me when I encounter arduous problems" did not adequately capture the distinction between individual care and understanding and forgiveness, resulting in a total of three items for each dimension. The CCISS was examined in Study 2. The item associated with understanding and forgiveness exhibited a high cross-loading in autonomy-supportive coaching style, making it difficult to separate different Chinese coaches' behaviors, as it explained benevolent coaching style and overlapped with autonomy-supportive coaching style. The warmth, caring, and support provided by an autonomy-supportive coach encourages athletes to express themselves (Iachini, 2013; Gaudreau et al., 2016), which is akin to understanding and forgiveness. Benevolent leadership primarily manifests as individual care (Farh and Cheng, 2000). Furthermore, understanding and forgiveness was reduced to two items, falling short of the minimal criteria of three items with acceptable factor loadings and low cross-loadings (Samuels, 2017). Thus, understanding and forgiveness dimension was excluded from the analysis. Three items of individual care were retained in the benevolent coaching style dimension.

Our results were in line with previous studies (Amorose and Anderson-Butcher, 2007; Conroy and Coatsworth, 2007; Bartholomew et al., 2010; Stebbings et al., 2011; Zhao and Zhou, 2022), which found that controlling coaching style is positively correlated with negative affect and negatively correlated with positive affect. In contrast, autonomy-supportive coaching style has a positive relationship with positive affect and a negative relationship with negative affect. The basic psychological needs theory holds that people succeed when their basic psychological needs for relatedness are satisfied (Deci and Ryan, 2000), and the interpretation of these results is consistent with this theory. Consequently, subjective vitality and burnout are affected by the satisfaction or frustration of psychological needs, which have a significant mediating effect on the quality of athletes' participation in sports (Bartholomew et al., 2011a; Balaguer et al., 2012; González et al., 2017). In particular, the satisfaction and frustration with athletes' basic psychological needs were significantly predicted by their perceptions of an autonomy-supportive environment. Moreover, needs satisfaction is a strong predictor of subjective vitality and athlete burnout. However, according to athletes' perceptions of the controlling environment, need thwarting was positively associated with an increase in athlete burnout (Balaguer et al., 2012). Furthermore, our findings indicated a positive relationship between benevolent coaching style and positive affect, and a negative relationship existed with negative affect. Previous research has shown that benevolence improves athletes' psychological capital and reduces burnout (Firebaugh, 1980). A study that examined college baseball players discovered that benevolent behavior was negatively correlated with athlete burnout (Tseng and Lun, 2008). In addition, people in benevolent contexts often have higher level of energy and vitality (Martela et al., 2016). This could be a result of benevolence in supporting athletes' needs and inspiring them to express appreciation to the coach (Kao and Chen, 2006). From a practical standpoint, this study emphasizes the value of fostering an environment that is autonomy-supportive and benevolent while

taking precautions to avoid a controlling environment. Coaching behavior is crucial for improving athletes' perceived vitality and reducing burnout. Coaches must reduce control and foster a supportive and benevolent environment to boost athletes' subjective vitality and reduce burnout.

A study of paternalistic leadership in Eastern commercial organizations produced the concept of the benevolent dimension (Farh et al., 2000). In contrast, transformational leadership is frequently mentioned in Western leadership theories (Brown and Keeping, 2005). Despite some similarities (Bedi, 2020), Western transformational leadership and Eastern paternalistic leadership, which developed in different cultural contexts, have certain distinctions. Both types of leadership exhibit individual care. However, transformational leadership focuses on individual considerations in the work environment. In Western cultures, subordinates perceive a leader's involvement in their private lives as an invasion of privacy (Aycan, 2006). Conversely, paternalistic leadership, which is more common in Eastern cultures, extends individual concern to both work and private aspects of subordinates' lives (Cheng et al., 2004; Erben and Güneşer, 2008; Chen et al., 2014). These discrepancies in coach-athlete relationships between Eastern and Western countries may be attributed to this cultural distinction. Western societies place a greater emphasis on individualism, and the gap between leaders and subordinates is smaller, encouraging an equal relationship between coaches and players. In contrast, the emphasis on collectivism in China creates a wider difference in power between upper and lower levels, which results in a parent–child relationship between coaches and athletes (benevolent coaching style). While several studies have attempted to incorporate coaches' helping and hindering behaviors (Rocchi et al., 2017; Pulido et al., 2018), these efforts have not focused on China. Thus, this study added the benevolent coaching style dimension to consider cultural variations. Relatedness includes the need to connect with others and desire to experience and receive love and care (Deci and Ryan, 2000). This study integrated the coaching style of Chinese coaches, broadening the coach-athlete relatedness need within the SDT, particularly in the context of the distinct superior-subordinate relationships between Chinese coaches and athletes.

5.1 Limitations and future research directions

The three dimensions in this scale were created based on existing scales (Farh et al., 2000; Reinboth et al., 2004; Zhao and Zhou, 2022). The items were not directly drawn from the interview data, which may have resulted in a limited understanding of the coaching behaviors employed by Chinese coaches. To address this issue, future research should incorporate expert interviews with Chinese coaches and players. By generating localized items for the three factors relevant to the Chinese context, this method would refine the dimensions of Chinese coaches' styles. The circumplex model, which includes four types (autonomy support, control, structure, and chaos), has recently been used to characterize coaches' (de)motivating practices in a more thorough and nuanced way (Delrue et al., 2019). Not all types were incorporated into the Chinese coaching styles in this study due to the lack of appropriate supporting data. Future research should

concentrate on including more pertinent coaching styles based on the circumplex model, thus capturing a wider variety of Chinese coaches' behaviors.

6 Conclusion

This study found that (1) the benevolent coaching style occupied a significant explanatory weight in the Chinese cultural context; (2) the controlling (negative conditioned regard and excessive personal control) and autonomy-supportive coaching styles were culturally compatible with both Eastern and Western athletes; and (3) the benevolent and autonomy-supportive coaching styles had a positive impact on athletes, whereas the controlling coaching style had a negative impact. This study demonstrated that benevolence, exhibited in the coaches' parental care for their athletes, is an important coaching style in China, in addition to autonomy-supportive and controlling coaching styles. In light of previous research, this study developed the CCISS. To establish the distinctive cultural characteristics of benevolence, more research should be conducted on how benevolence affects athletes from Western cultures.

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 Human Experimental Ethics Inspection of Guangzhou Sport University. 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

WS: Validation, Writing – original draft. DZ: Conceptualization, Funding acquisition, 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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The influence of the five-factor model of personality on performance in competitive sports: a review

Ying Shuai[1,2], Shaoshen Wang[1,2], Xian Liu[1]*, Yee Cheng Kueh[2] and Garry Kuan[3]*

[1]School of Sports Management, Shandong Sport University, Shandong, China, [2]Unit of Biostatistics and Research Methodology, School of Medical Sciences, Universiti Sains Malaysia, Kota Bharu, Malaysia, [3]Exercise and Sports Science Programme, School of Health Sciences, Universiti Sains Malaysia, Kota Bharu, Malaysia

Personality is considered to be a factor affecting athletic performance. However, inconsistency in the research results regarding size and even direction of the relationship. An evaluation of the evidence of the relationship between personality and athletic performance was conducted in order to summarize the evidence available. A systematic literature search was conducted in March 2023. Sport performance and the Big Five personality model were identified in our research. We used PubMed, Web of Science, Embase, Cochrane Library, Wang Fang (Chinese), Wei Pu (Chinese), and CNKI (Chinese) databases for the systematic literature search (Prospero registration number: CRD42022364000), screened 4,300 studies, and found 23 cross-sectional studies eligible for inclusion in this review. The results of this systematic analysis show that, besides neuroticism, openness, conscientiousness, extraversion, and agreeableness are all positively correlated with sports performance. Conscientiousness and extraversion are the two main personalities in team sports. Openness and agreeableness show different results in different sports, and it is not clear to which project they are beneficial. The value of personality as a possible predictor of athletic performance is generally positive. Therefore, professionals such as applied sports psychologists, coaching personnel, athletes, and sports administrators must comprehensively grasp the significance of personality's role in achieving success in major competitions. Considering these facts, sports practitioners should promote personality screening and personality development programs.

KEYWORDS

personality, five-factor model, sport performance, systematic review, competitive sports

Introduction

The complex interplay between personality and sport has captivated the attention of researchers, coaches, and athletes for decades. Central to this discourse are two conflicting perspectives: the skeptical view, which argues that personality has a minimal effect on athletic ability, and the gullible perspective, which asserts a substantial influence of personality traits on sports performance. Recent studies, however, have introduced more nuanced theories, aiming to capture the multifaceted nature of this relationship. A comprehensive meta-analysis by Sutin et al. (2016) stands as a testament to this, offering compelling evidence regarding the association between personality and physical activity patterns. The study revealed that individuals with

higher neuroticism levels were inclined toward inactivity, while those possessing elevated levels of extraversion, openness, and conscientiousness displayed reduced inactivity. These correlations remained significant, even when considering the shared variance between these traits. Remarkably, factors like age and sex did not alter these relationships, emphasizing the significant role of inherent tendencies in determining one's engagement in physical activity. From the skeptical viewpoint, Davis, when assessing the personality traits of elite hockey players, found no correlation with their performance levels (Davis, 1991). In contrast, a large volume of literature spanning thousands of articles highlights the significance of personality within sports. Yet, it's crucial to note that many of these studies employ different personality theories and testing methods, adding complexity to the interpretation of findings. For instance, an analysis of 42 British athletic groups' mean scores on Cattell's 16-PF questionnaire shed light on how personality traits might impact athletic performance. Interestingly, while top athletes showed lower anxiety levels than their less skilled peers, their anxiety was still above the population average, challenging the common notion that sports personalities are stable extraverts (Knapp, 1974). A crucial factor that differentiates one person from another is their unique personality (Karageorghis et al., 2021).

Indeed, while personality differences between individuals might appear subtle, their implications can be profound. Personality, as defined by Burger (2011), refers to consistent patterns of behavior and internal processes stemming from the individual. Historical work by E. W. Scripture at Yale University underscores the potential for cultivating certain personality traits through sports (Franz, 1898), emphasizing that sports success is, to a considerable extent, influenced by personality (Allen et al., 2013). Notably, Hartung and Farge's assessment of middle-aged male runners revealed these athletes scored higher than the general populace in areas like intelligence, imagination, and self-sufficiency, among others (Hartung and Farge, 1977). Meanwhile, Cui Guofu's research on elite Chinese race walkers found that introverted athletes outperformed extroverted ones, particularly among male participants (Cui, 1989).

In the sports domain, a longstanding question remains: is an athlete's behavior primarily determined by the situation they find themselves in, or by their inherent personality? One intriguing study explored whether personality differences attracted individuals to sports, termed the "gravity hypothesis," or if participation in sports molded an individual's personality, the "developmental hypothesis." Early findings suggested that team sport participants consistently scored higher on extroverted sport scales compared to individual sport participants and non-participants, thereby lending credence to the gravity hypothesis (Eagleton et al., 2007). Another significant theory to consider is the "performance hypothesis" posited by García-Naveira and Ruiz-Barquín (2013) (see also García-Naveira and Ruiz-Barquín, 2016; Garcia-Naveira and Ruiz-Barquín, 2020). This hypothesis emphasizes that certain personality traits are intrinsically linked with enhanced sports performance. It posits that these traits, to a certain degree, assimilate into the high-performance sports context, implying that athletes with these traits might naturally align better with the demands and rigors of elite sports competition. Instead of adhering to fixed notions of personality types, such as the Myers–Briggs typology, theories of person–environment fit (PEFT) advocate for a dimensional approach. This perspective views personality traits

as influenced by and reflective of specific environments (Levy and Ruggieri, 2019).

Yet, the discussion extends beyond simply determining if personality affects sports participation and performance. It's essential to highlight, as pointed out by multiple authors, including García Naveira (2010), García-Naveira et al. (2011), García-Naveira and Ruiz-Barquín (2016), and Piedmont et al. (1999), that personality's influence is twofold. On one hand, it can directly affect the sporting action itself, and on the other, it can exert an indirect influence on the surrounding context and actions intimately tied to an individual's sports performance. It's crucial to discern the nature of this influence. Distinguishing between the direct and indirect effects of personality on sports behavior introduces additional complexity. A direct effect implies that personality traits linearly impact athletic performance. Conversely, an indirect effect suggests that personality traits shape other variables—like motivation or resilience—which subsequently affect sports outcomes. Allen et al. (2013) delved into this, investigating how personality shaped organized sports, its implications for athletic achievement, individual differences, and team dynamics. Their findings highlighted the interplay of both genetic and environmental factors, providing pivotal insights for applied sports psychology. Further exploring this theme, Allen and Laborde (2014) emphasized the predictive power of personality traits for both sports performance and broader physical activity. Their work uncovered connections between personality traits and various determinants, including the psychological state of athletes, harmful exercise behaviors, and even factors like strength and flexibility in older populations. Roberts and Woodman (2017) expanded the scope, focusing on the role of traits like narcissism and alexithymia in sports performance. Their call for an interactionist perspective underscores the intricate dance between personality and performance. Finally, a landmark study by Laborde et al. (2019) embarked on a sweeping overview of trait-based research in sports and exercise psychology. Analyzing a vast array of abstracts, they identified 64 unique traits clustered into 15 overarching themes, with traits like anxiety, self-efficacy, and perfectionism emerging as recurrent focal points. Their rigorous analysis linked many of these traits to the Big Five personality dimensions, although not all associations were straightforward.

Though many studies have explored the impact of personality in sports, it's important to understand the diverse developmental trajectories of personality theory. Schools of personality development, such as psychoanalysis, behaviorism, social learning, cognitive theory, and humanistic theory, aim to elucidate how personality emerges and evolves over a lifetime (Cloninger, 2009). A vast body of literature, comprising thousands of articles, has examined the sports personality domain (Ruffer, 1976), with numerous investigations underscoring the significance of personality within the realm of sports. Each researcher used a different personality theory and test method, making the results difficult to analyze.

A prominent approach within psychological research, the trait or dispositional theory, seeks to quantify enduring patterns of behavior, cognition, and emotion termed as "traits" (Kassin, 2003). Rooted in this approach, the Big Five Personality Model emerged as a pivotal framework. Historically, by analyzing personality-related terms from dictionaries in the late 1920s, psychologists discovered the inherent structure of personality traits within our language. Factor analyses distilled these traits into five core factors: extraversion, agreeableness, conscientiousness, neuroticism, and openness to new experiences

(Babcock and Wilson, 2020). The consistent appearance of these factors across studies led to the refinement of the Big Five Model (Goldberg, 1981).

According to this model, the terrain of human personality is primarily constituted by five central traits (Vealey, 2002; Allen et al., 2013; Gill et al., 2017):Neuroticism, defined by anxiety and tension vs. emotional stability. Extraversion, characterized by sociability and enthusiasm opposed to introversion. Openness, signified by adaptability and curiosity. Agreeableness, encompassing kindness and cooperativeness. Conscientiousness, marked by discipline and organization. This model posits that individual personalities are composed of varying degrees of these traits, with specific behaviors emerging as a result (McCrae and John, 1992). For instance, while conscientious individuals gravitate toward organization, neurotic individuals might be more self-conscious. The Big Five offers invaluable insights into personality differences, emphasizing the importance of individualized training approaches in sports (Rhodes et al., 2002).

Currently, sports psychologists are fervently exploring the Big Five traits (Lochbaum et al., 2010; Singley et al., 2012; Merritt and Tharp, 2013). Furthermore, they are examining additional traits like tolerance (Sheard and Golby, 2010) and their associations with athletes' mental states and behaviors. Numerous studies have unveiled significant correlations between these traits, such as neuroticism and self-consciousness, and athletic performance (Piedmont et al., 1999; Wann et al., 2004). Allen et al. (2013) deduced from an extensive review that personality traits correlate with long-term athletic success. Their findings revealed that sports participants typically display greater extraversion than non-athletes. Moreover, team athletes in high-risk sports showed increased extraversion and reduced conscientiousness compared to those in lower-risk individual sports. As evidenced by Rhodes and Smith (2006), extraversion and conscientiousness positively influence physical activity, while neuroticism can serve as a deterrent.

The interaction between personality and sports performance, while multifaceted, undeniably influences the trajectory of sports success. From questioning the centrality of personality in determining athletic performance to drawing insights from the Big Five personality model, opinions vary, but there is a consensus that individual personality traits have a critical impact on athletic outcomes. In the pursuit of a comprehensive review, the objective is to address an evident lacuna in the extant literature. While there are five preceding reviews, the most recent one dating to 2019, a systematic exploration of the subject matter remains absent. Given the burgeoning research in this domain, a current and rigorous review is both relevant and imperative. By focusing on the Big Five personality traits, this review aims to utilize a standardized methodology to systematically assess their influence on sports performance. It is hypothesized that the Big Five traits significantly impact athletic performance, and the findings of this review will amalgamate the prevailing understanding of this association. Furthermore, this investigation will offer recommendations for future research, encompassing a variety of sports disciplines for comparative evaluation.

Methods

The review was performed based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline (Page et al., 2021). Methods for conducting this review were pre-specified in a registered protocol on PROSPERO (CRD42022364000).

Search strategy

A systematic literature search was conducted on PubMed, Web of Science, Embase, Cochrane Library, Wang Fang (Chinese), Wei Pu (Chinese), and CNKI (Chinese) databases in October until December 2022. The search queries were as follows: ("Athletic Performances" OR "Performance, Athletic" OR "Sports Performance" OR "Performance, Sports" OR "Performances, Sports" OR "Sports Performances") AND ("Personalities" OR "temperament"). Two independent investigators searched databases, identified studies, screened them for eligibility, and compared them to each other. All related articles published from inception up to March 2023 were considered for inclusion.

Inclusion and exclusion criteria

Inclusion criteria

Study type: cross-sectional studies examining the impact of published personality traits on athletic performance. Subjects: Athletes are assessed solely using the Big Five Personality Type Test, which comprises the Five-Factor Personality Model (FFM), a taxonomy of personality traits including conscientiousness, extraversion, openness, agreeableness, and neuroticism (OCEAN or NEOAC). All known personality traits are contained and encompassed within these five general domains, which are thought to represent the structure of all individual differences (O'Connor, 2002). There are no restrictions on gender or age. Exposure measures: the Big Five personality assessment. Outcome indicators: sports performance or performance within specific sports disciplines. Language limitation: Only studies published in Chinese or English, without regional restrictions, will be considered.

Exclusion criteria

Unspecified study type. Inability to extract valid outcome data from the text, absence of statistical analysis for impact results, improper application of statistical methods, or incomplete original data. Duplicate literature. Unavailability of the full text. Utilization of non-Big Five personality assessments. Insufficient sample size. In addition, letters, opinion articles, editorials, reviews, and papers that were not written in English were excluded from the review process. Animal, *in vitro*, *in vivo*, and modeling studies were also excluded.

Study selection

Two researchers individually screened titles and abstracts from the databases to determine eligibility using Endnote (version 20.0, Clarivate Analytics). They recorded the number of searches and duplicates for each database. Duplicate entries were eliminated using Endnote's "check for duplicates" feature. Abstracts meeting the criteria underwent further screening to retrieve full-text articles. These articles were then evaluated against specific inclusion and exclusion standards. The researchers also conducted quality

assessments and data extraction. Any disagreements were resolved by consulting a third investigator. References of the confirmed studies were manually checked. The article selection methodology is illustrated in Figure 1.

Data extraction

Data was gathered using a standardized collection form. For every selected study, details such as the lead author's surname, year of study, participant demographics, study design, sports disciplines, tools used, and outcomes were documented in Table 1. If any data was absent, the primary authors of those studies were directly approached for clarification.

Quality assessment

We used the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) Statement to evaluate the quality of reporting in each of the 15 cross-sectional studies. The STROBE Statement includes a checklist of 22 items that should be reported in observational studies. Each study was evaluated against each of the 22 items, and each item was scored as "Yes" (if the study reported the item), "No" (if the study did not report the item), or "Not Applicable" (if the item was not relevant to the study design). The STROBE Statement assesses key aspects of cross-sectional studies, including the title, abstract, introduction, methods, results, discussion, and other relevant information, to ensure transparent and comprehensive reporting (Page et al., 2021).

FIGURE 1
Flow chart of the search and selection process of included studies.
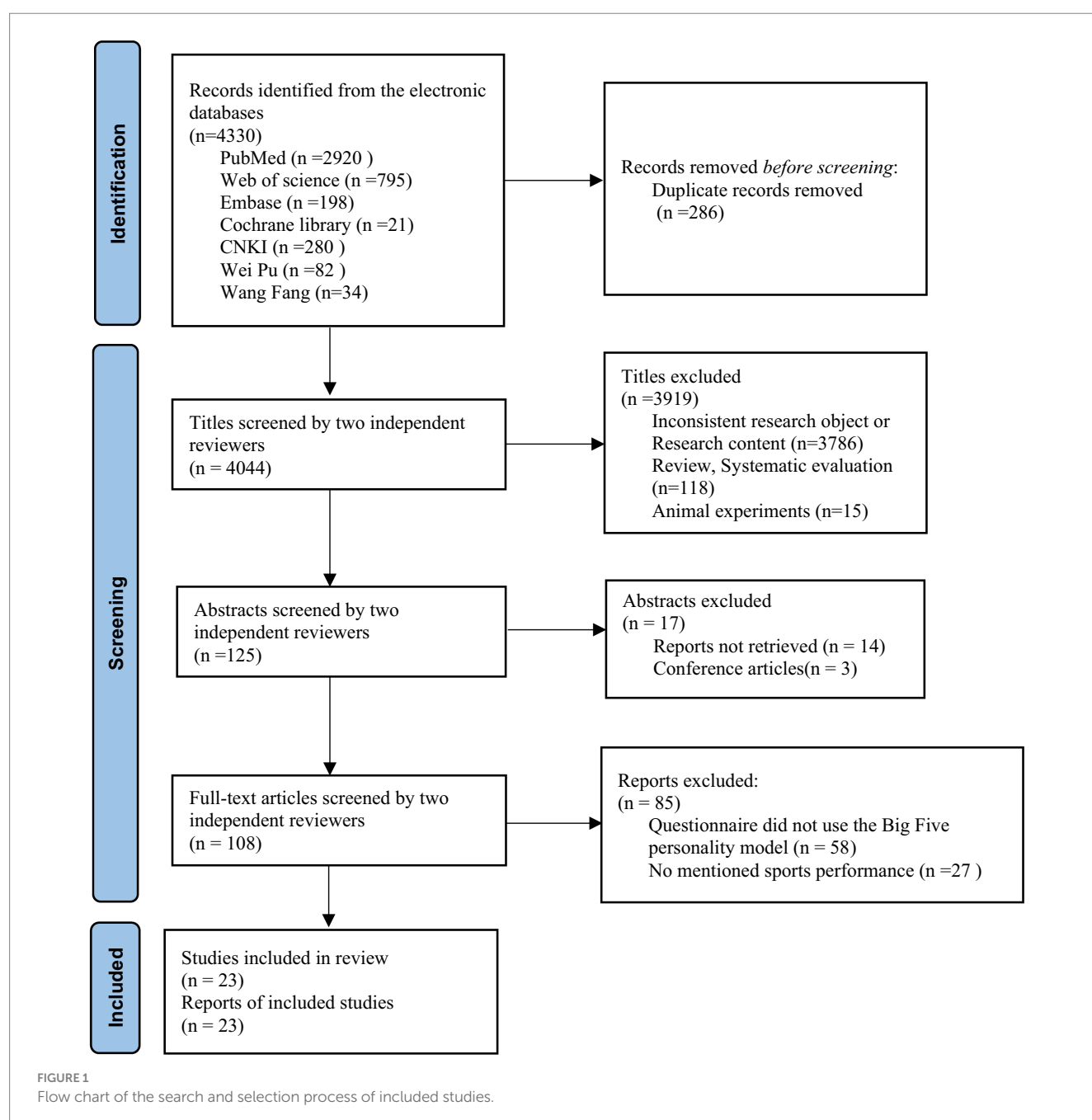
TABLE 1 Basic information of included studies.

References	N	Age	Type of sport	Personality measurement	Measurement of sports performance	Other variables
Fabbricatore et al. (2021)	161 Male: 60.82% Female: 39.18%	M = 15.42 SD = 3.20 Range = 12–30	Swimming High level	Big Five dimensions in the Italian lexical context (Barbaranelli et al., 2007; Caprara and Perugini, 1994)	(P) considers race wins and participation, combining them into an increasing value scale with five anchored options, where 5 represents the best performance	Sport performance psychological inventory (IPPS-48) (Robazza et al., 2009)
Ionel et al. (2022)	272 Male: 158 Female: 114	M = 32.10 SD = 10 Range = 16–69	Rock-climbing Other level	Big Five Inventory–2 Short Form (BFI-2-S; Soto and John, 2017)	A single rock-climbing difficulty scale (IRCRA; Draper et al., 2015)	Grit was measured by employing the 12-item inventory (Duckworth et al., 2007)
Siemon and Wessels (2022)	185 Male: N/A Female: N/A	N/A	Basketball High level	IBM Watson Personality Insights Service (Ferrucci, 2012)	www.basketball-references.com www.sport-reference.com	N/A
Piedmont et al. (1999)	79 Male: 0 Female: 79	Range = 18–21	Soccer High level	Big five adjective marker scales (Piedmont, 1995)	Game statistics for each player were obtained from the most recent soccer season	Coaches ratings (Rosenthal and Rosnow,1984, p. 163)
Lin et al. (2011)	20 Male: 10 Female: 10	N/A	Canoeing High level	Big Five Personality Test (Costa and McCrae, 1992)	Chinese National Team Canoeing Performance at the 2008 Olympic Games	N/A
Liu (2011)	133 Male: 76 Female: 57	N/A	Difficult and beautiful events Fighting athletes Other level	NEO Five Factor Inventory (Xu et al., 1996)	Athletes' competition performance: top three nationally, top three in Liaoning Province, others	Subjective well-being General Wellbeing Scale (GWB)
Allen et al. (2011)	253 Male: 187 Female: 66	M = 21.1 SD = 3.7 Range = 16–69	34 different sports High level	NEO-FFI (Costa and McCrae, 1992)	Different levels, including university, club, regional, national, and international	Coping Function Questionnaire for Sport (Kowalski and Crocker, 2001)
Zhu et al. (2013)	34 Male: N/A Female: N/A	M = 22.19 SD = 2.81 Range = 16–69	Boxing High level	Big Five Personality Inventory (Yao, 2010)	Athletes' athletic performance was evaluated by their overall performance ranking in the National Boxing Championships, Boxing Championships and National Championships in 2011	Volitional quality (Yin, 1985) Mentalt tenacity (Li, 2009)
Terracciano et al. (2013)	642 Male: 52% Female: 48%	M = 61.07 SD = 12.86 Range = 31–96	Fast walking Non-athletes	NEO Personality Inventory (NEO-PI-R) (Costa & McCrae, 1992)	Metabolic Rate and Aerobic Capacity	N/A
Balyan et al. (2016)	50 Male:50 Female:0	M = 23.5 SD = 2.11 Range = 18–25	Computer-based soccer games Other level	Five Factor Personality Inventory (Tatar, 2005)	Play a computer-simulated soccer match against an experienced player (one of the experimenters) for 10 min	Competitive State Anxiety Inventory–2 (Martens et al., 1990) Physiological Arousal, Electrodermal activity (EDA)
Klein et al. (2017)	1,399 Male: 707 Female: 692	7th (12.9 ± 0.6) 10th (15.8 ± 0.6)	Motor performance Other level	NEO Personality Inventory (NEO-PI-R) (Costa and McCrae, 1992)	German motor performance test DMT (Deutscher Motorik-Test) 6–18 (Bös et al., 2009)	Physical self-concept (self-developed short scale)

(Continued)

TABLE 1 (Continued)

References	N	Age	Type of sport	Personality measurement	Measurement of sports performance	Other variables
Stine et al. (2019)	31 Male: 0 Female: 31	M = 20.3 SD = 1.2	Rower Other level	Neo FFI (five-factor inventory, version 3) (McCrae and Costa, 2004)	2,000-m Performance Tests Stroke rate, power output, and time to complete 2,000 m were recorded	N/A
Yuan (2020)	182 Male: 114 Female: 68	N/A	Routine of Martial Arts Other level	NEO Personality Inventory (NEO-PI-R) (Costa and McCrae, 1992)	Three evaluation indexes are chosen: single entrance exam technical score, competition award-winning score (32 grades, 3.125 points each, totaling 100 points), and self-technical evaluation	N/A
Kalinowski et al. (2020)	122 Male: 122 Female: 0	Range = 16–19	Soccer High level	Polish version of NEO Personality Inventory (Zawadzki et al., 1998)	Szwarc12, This study tool makes it possible to assess the play- ers' effectiveness of performance in attack and defense by determining 15 effectiveness indicators (Szwarc, 2002)	Polish version of Coping Inventory for Competitive Sport CICS (Knittel and Guszkowska, 2016)
Matuszewski et al. (2020)	206 Male: 188 Female: 18	M = 19.99 SD = 1.88 Range = 18–27	Electronic sports High level Other level	NEO Personality Inventory (NEO-PI) (Costa and Mccrae, 1989)	League of Legends performance was operationalized here as position within the ranking ladder	N/A
Piepiora and Piepiora (2021)	1,260 Male: 1260 Female: 0	Range = 20–29	30 sporting disciplines High level	NEO-FFI Personality Inventory (Costa and Mccrae, 2007)	Champions and other athletes Sports achievements at various levels of rivalry (national, continental, and world). The best results of the respondents on the day of the study were included in the study	N/A
Zar et al. (2022)	376 Male: N/A Female: N/A	N/A	Disabled athletes team athletes High level	Big Five Personality Traits (Khormaee and Khayer, 2006)	Based on the information available in the provincial sports delegations and the Veterans and Disabled Federation, the positions obtained by each athlete were considered as a criterion for sports performance	N/A
Piepiora et al. (2021)	140 Male: N/A Female: N/A	Range = 20–29	American football Other level	NEO-FFI Personality Inventory (Costa and Mccrae, 2007)	Liga de Fútbol Americano Profesional LFA 1, LFA 2, and LFA 9	N/A
Piepiora (2021a)	300 Male: N/A Female: N/A	Range = 20–29	10 team sports High level Other level	NEO-FFI Personality Inventory (Costa and Mccrae, 2007)	Champions and other athletes sports. sports achievements at various levels of competition (national, continental, and world)	N/A

(Continued)

TABLE 1 (Continued)

References	N	Age	Type of sport	Personality measurement	Measurement of sports performance	Other variables
Klatt et al. (2021)	82 Male: 46 Female: 36	M = 26.39 SD = 4.32	Beach volleyball High level	German Big-Five-Inventory-10 (Rammstedt and John, 2007) Persönlichkeits-adjektiv-skalen (pask5) (Brandstätter, 2009)	Individual ranking points as an estimation for performance level	Affective Style Questionnaire (ASQ) (Graser et al., 2012)
Fasold et al. (2019)	84 Male: 84 Female: 0	M = 26.87 SD = 5.32	Handball High level	10-item short version of the Big Five Inventory in English and German (Rammstedt and John, 2007)	1st-3rd league vs. 4th league and lower playing in the 1st- 3rd league in Germany were considered as playing on a high performance level	N/A
Azita et al. (2019)	68 Male: N/A Female: N/A	Range = 18–22	Futsal Other level	The great five personality factors questionnaire (Costa and McCrae, 1987)	The researcher used a checklist to observe and record player performance during the game, which was then used to calculate the performance ratio for each sub-component	N/A
Ruiz-Barquín and García-Naveira (2013)	128 Male: 128 Female: 0	M = 17.5 SD = 2.5 Range = 14–24	Football High level Other level	Neo Personality Inventory NEO-FFI (Costa and McCrae, 2008)	Average athletic performance is evaluated by the coach using a 1–10 scale based on over 16 observations of each athlete's league performance	N/A

M, mean; SD, standard deviation; N/A, no answer; N, participants; The sample numbers present the absolute sample size of the studies.

Results

Search result

The database search yielded a total of 4,330 articles, whereof 23 articles were finally included in this review (Figure 1) (Page et al., 2021).

Eligibility of studies

Table 1 displays the particulars of the selected studies. Cross-sectional studies (references) adhered to the review criteria. All included studies received ethical approval from their respective institutions. According to the table, studies have examined how personality traits relate to athletic performance using the Five Factor Model (FFM). It provides information on the authors and year of publication, sample size (N) and demographics, type of sport, athlete level, personality measurement tools, sports performance metrics, and other variables assessed in each study. The studies encompass a diverse range of sports, such as swimming, rock climbing, basketball, soccer, canoeing, boxing, fast walking, computer-based soccer games, motor performance, rowing, and martial arts. Various instruments have been employed to measure the FFM, including the NEO Personality

Inventory (NEO-PI-R), the Big Five Inventory-2 Short Form (BFI-2-S), and the IBM Watson Personality Insights Service. Additionally, the studies utilize different approaches to assess sports performance, such as race wins, competition rankings, and specific performance tests. Some of the investigations also examine other psychological variables, like grit, coping strategies, and subjective well-being.

Among the 23 studies incorporated in the analysis, the earliest publication dates back to 1999 (Piedmont et al., 1999), while the remaining studies were published between 2011 and 2022, with a peak of five articles in 2021 (Fabbricatore et al., 2021; Klatt et al., 2021), three of which were authored by Piepiora (Piepiora et al., 2021; Piepiora and Piepiora, 2021; Piepiora, 2021a). The included research encompasses four studies in Chinese and the rest in English. The investigations span an array of sporting disciplines, comprising individual and team events, fundamental physical fitness assessments, and innovative e-sports. Soccer research features prominently, with four articles dedicated to the subject. The studies encompass a broad age range, from 12 to 96 years, and extend beyond professional athletes to include the general population and individuals with disabilities. In many studies, personality characteristics have a certain impact on the performance of athletes in various sports. Characteristics such as openness, agreeableness, neuroticism, extraversion, and conscientiousness affect the performance of rock climbing, football, canoeing, boxing, and other sports to varying degrees. Moreover, an

athlete's personality traits can influence their emotional and physiological state leading up to a competition, which correlates with psychological aspects like anxiety and self-confidence. The well-being of athletes is related to their personality, and personality characteristics are also different among athletes of different ages. Generally speaking, personality characteristics have a certain reference value in the selection, training, and psychological adjustment of athletes.

Table 2 summarizes the key findings from the 23 reviewed articles, highlighting the outcomes related to the five unique personality traits: openness, conscientiousness, extraversion, agreeableness, and neuroticism, as observed across these studies. Though personality traits may not have a direct impact on swimming performance, they can indirectly influence it through mental skills (Fabbricatore et al., 2021). Openness and agreeableness have been linked with climbing performance (Ionel et al., 2022), while neuroticism and conscientiousness are associated with performance in female soccer players (Piedmont et al., 1999). Furthermore, personality traits have been demonstrated to predict the performance of elite Chinese rowers (Lin et al., 2011) and the subjective well-being of Chinese athletes in esthetically demanding and combat sports, with average ages of 14 and 18 years, respectively (Liu, 2011). The five-factor model of personality can distinguish varying levels of sports involvement and pinpoint the coping techniques adopted by athletes (Allen et al., 2011). In the elderly, there's a notable link between personality traits (like neuroticism, extraversion, openness, and conscientiousness) and energy consumption. This suggests potential impacts on health aspects like weight management and lifespan (Terracciano et al., 2013). Neuroticism has been identified as crucial for comprehending athletes' emotional and physiological states before competition due to its association with anxiety, arousal, and self-confidence (Balyan et al., 2016). Furthermore, personality attributes have been linked to performance outcomes in diverse sports, rowing being one of them (Stine et al., 2019), Chang Quan, Nan Quan, Taijiquan (Yuan, 2020), and young male soccer players (Kalinowski et al., 2020). In eSports, notable variances in traits like extraversion, agreeableness, and openness were detected between players at lower ranks and those at the higher tiers of the Legendary League (LoL) (Matuszewski et al., 2020). Sports champions typically exhibit lower neuroticism and higher scores in the other five dimensions, suggesting that neuroticism is a determining factor in the level of achievement.

In summary, this comprehensive review of 23 studies emphasizes the importance of accounting for personality traits in the recruitment and training of athletes, as these traits can influence problem-solving skills in sports and result in performance disparities.

Quality assessment and analysis of publication bias

Table 3 displays an evaluation of the methodological integrity and potential bias present in the studies that were reviewed. By using the quality assessment of the 22 items in the STROBE statement, most of the analyses used technical terms in the title or abstract to describe the design of their studies (82.6%; $k = 19$). All studies presented the background of the survey, participant inclusion criteria, data sources, and evaluation methods for each study variable, and reported the results of the survey (100%, $k = 23$). Almost all surveys presented key elements of design (95.6%; $k = 22$) and outcomes that defined all

predictors and potential factors (91.3%; $k = 21$) in the outcomes. Eighty-three percent ($k = 19$) of the studies listed clear goals and made prior assumptions. Eighty-seven percent ($k = 20$) of the studies referenced pre-listed objectives and summarized key results. 78.2% ($k = 18$) of the surveys described the setting of the study, location, and date, including recruitment, contact, follow-up, and time period for data collection, and gave information on participant characteristics (e.g., demographic, clinical, and sociological) and exposure and potential confounders. In addition, subgroup and interaction analyses and sensitivity analyses were reported in 73.9% ($k = 17$) of the findings. The results of 69.5% ($k = 16$) of the studies took objectives, limitations, diversity of analyses, results of similar studies, and other relevant evidence into account. 65.2% ($k = 15$) of the study data gave an unadjusted estimate, giving a confounder-adjusted estimate and its precision (e.g., 95% confidence interval). 60.8% ($k = 14$) of the studies described the statistical methods used, the number of individuals at each stage, and discussed the limitations of the study at the end of the results, taking into account potential sources of bias or imprecision. More than half of the studies explained how quantitative variables were treated in the analysis (56.5%; $k = 13$). Only 30% of the studies discussed the generalizability of the findings ($k = 7$). How the sample size was derived was explained in only 21.7% ($k = 5$) of the results. Only four studies (17.3%) described methods to address bias in the study and received funding.

Discussion

This retrospective analysis provides the most comprehensive statistical review to date of the relationship between personality and athletic performance and confirms that the Big Five personalities are associated with athletic performance. It is clear that the Big Five personality model can provide a practical level of statistical prediction for socially important sports performance standards. Athlete personality traits can be used to predict athletic performance and provide direction for recruiting athletes and preparing for competition. Such as openness, agreeableness, and conscientiousness, which have been found to predict performance in specific sports (e.g., rock climbing, rowing), neuroticism appears to negatively affect sports performance, and lower levels of neuroticism are associated with higher performance (e.g., soccer, boxing, and martial arts). It is important to note that the personality characteristics of athletes in different sports may vary, highlighting the importance of considering the specific requirements of each sport (e.g., team sports, extreme sports). These findings may vary by sport, level of competition, and other factors such as cultural and social influences. Therefore, future researchers and scholars need further research to better understand the complex relationship between the five-factor model of personality and sports performance in different situations.

Individuals characterized by openness tend to appreciate diversity, pursue novel experiences, and exhibit curiosity and insight regarding their surroundings. These traits align with the characteristics required for rock climbing, which encompass both sport climbers and boulderers. A positive correlation has been observed between openness scores and climbing performance (Ionel et al., 2022). Risk-taking is frequently deemed a crucial subcomponent of openness, resulting in participants in high-risk sports demonstrating significantly elevated levels of extraversion and experiential openness

TABLE 2 Summary of all studies examining Five Factor Model (FFM) and sports performance.

References	Main findings
Fabbricatore et al. (2021)	While personality traits do not have a direct significant impact on performance (as evidenced by the path coefficient results), their indirect effects, mediated through mental skills, and the cumulative impact (combining direct and indirect effects) are noteworthy for evaluation
Ionel et al. (2022)	The findings revealed that both openness and agreeableness were predictors of climbing performance. Additionally, grit had a more significant influence on climbing performance than the Five Factor Model (FFM) traits. While it's a prevalent notion that grit and conscientiousness are synonymous, our results highlight that grit offers a distinctive role in explaining performance, especially in a relatively new and high-risk sport like climbing
Siemon and Wessels (2022)	The study validated a new methodology utilizing automated personality mining as a predictor of future basketball performance. This contribution advances the use of cognitive systems (automatic personality mining) and social media data for prediction. Scouts can use the results to improve their recruiting standards in the NBA enterprise
Piedmont et al. (1999)	This study highlights the significant associations between Neuroticism and Conscientiousness personality dimensions and athletic performance in female college soccer players. Results suggest that personality's contribution to performance may be selective, with professional ratings offering valuable evaluative insights. The prototypical achiever's personality profile consists of low Neuroticism and high Conscientiousness, indicating emotional stability and a drive to succeed. The findings also emphasize the potential to integrate sports research with the broader literature on motivation and performance, informing future research directions
Lin et al. (2011)	The results show that there are significant differences among the personality traits of elite canoeists in China. There are significant differences in some factors of personality traits among Chinese elite canoeists of different genders, ages, and training years. Some of the factors can predict the performance of Chinese elite canoeists
Liu (2011)	In Liaoning Province, China, active athletes tend to be emotionally sensitive and exhibit extroverted personalities, neither overly conservative nor excessively exploratory. No gender, regional, sports group, or training duration differences were observed in personality traits. Athletes in specialized improvement stages show lower agreeableness, while those in competitive maintenance stages exhibit higher agreeableness. As athletic performance improves, athletes demonstrate increased agreeableness. A correlation exists between athletes' subjective well-being and their personalities, with personality effectively predicting athletes' subjective well-being
Allen et al. (2011)	The five-factor model of personality appears to be a useful tool in distinguishing varying degrees of athletic participation and pinpointing coping mechanisms athletes might employ. Notably, there were distinct personality differences observed between elite and novice athletes, male and female competitors, as well as those engaged in individual vs. team sports
Zhu et al. (2013)	The results of a psychometric test with male boxers showed a significant correlation between the Neuroticism dimension of an athlete's personality and performance
Terracciano et al. (2013)	This study investigated the association between personality traits and energy expenditure in older adults, finding that neuroticism, extraversion, openness, and conscientiousness were significantly related to energy expenditure during peak walking pace. These findings suggest that personality differences may play a role in health outcomes, such as obesity and longevity, particularly during more challenging activities that demand cardiorespiratory fitness
Balyan et al. (2016)	This research examined the relationship among personality traits, anxiety levels, and physiological responses in athletes. The findings highlighted a significant association between neuroticism and EDA when there were incentives involved and with different forms of anxiety within the group with higher anxiety levels. Athletes who won in this high anxiety group displayed increased cognitive anxiety but decreased physiological arousal compared to those who lost. In contrast, in the group with lower anxiety, no links were found between neuroticism, CSAI-2 elements, and physiological arousal
Klein et al. (2017)	This study discusses the relationship between personality traits and physical self-concept. Neuroticism is identified as a particularly influential trait, with lower emotional stability leading to a less positive view of one's physical attractiveness and athleticism. The impact of reference groups, such as high-performance environments, is also discussed
Stine et al. (2019)	Neuroticism negatively impacts rowing performance, while agreeableness and conscientiousness trend toward better performance. Highly agreeable and conscientious rowers outperformed their less agreeable and less conscientious peers. The study suggests that personality traits may be important for athletic performance. However, limitations such as the small sample size and grouping based on personality traits call for further research
Yuan (2020)	The findings suggest that neuroticism negatively predicts performance in Changquan events, while conscientiousness positively predicts performance in Nanquan and Taichiquan events. Openness negatively predicts performance in Nanquan events. Strong willpower and anti-pressure ability are associated with better performance in Taichiquan and Changquan events, respectively. Additionally, personality traits have the greatest impact on performance in Nanquan events, followed by Changquan events, and then Taichiquan events
Kalinowski et al. (2020)	Lower neuroticism levels correlated with increased effectiveness through effort expenditure as a mediator. Higher conscientiousness levels led to greater performance effectiveness due to task-focused stress-coping strategies. Extraverted soccer players exhibited higher performance effectiveness by adopting task-focused methods for coping with stress
Matuszewski et al. (2020)	The results show notable differences in extraversion, agreeableness, and openness traits between LoL players of lower and higher ranks. Surprisingly, despite LoL being a team-oriented game, higher performance did not align with increased extraversion and agreeableness. In fact, players with lower ranks had notably higher scores in these traits than their higher-ranked counterparts

(Continued)

TABLE 2 (Continued)

References	Main findings
Piepiora and Piepiora (2021)	This study found that sports champions exhibit lower neuroticism and higher scores in the other Big Five personality dimensions compared to other athletes. Neuroticism was the key determinant for achievement levels. It is unclear whether these personality differences were shaped during athletes' careers or existed from the beginning, suggesting that personality differences may be a consequence, rather than a cause, of athletes' success
Zar et al. (2022)	The research highlighted a strong link between openness and athletes' performance at the national level for both genders. In contrast, the relationships between neuroticism, extraversion, and conscientiousness with athletic performance varied widely across competitive tiers. Additionally, a significant connection was observed between agreeableness and performance at both provincial and national stages
Piepiora et al. (2021)	The passage highlights the importance of generating personality profiles of American football players in Poland and emphasizes the relevance of similar studies conducted in the United States. It also underlines the significance of defining personality in the recruitment of players to American football and suggests the need for further research on the relationship between personality and sports experience in all sports disciplines
Piepiora (2021a)	Significant differences were found in the personality traits of team sports players across different sports disciplines, except for openness to experience. This suggests that sports activity influences personality shaping, and that personality traits impact problem-solving in sports. The specificity of each sports discipline may impose slightly different psychological requirements on competitors. Other factors, such as previous experiences and social and cultural influences, should also be taken into account
Klatt et al. (2021)	Results indicated that compared to the norm, players demonstrated a higher level of neuroticism, but lower levels of extraversion, agreeableness, and conscientiousness. However, players exhibited traits of liveliness, tension, emotional stability, reasoning, and openness to change. Moreover, beach volleyball players showed well-established emotion regulation styles that allowed them to remain focused during matches
Fasold et al. (2019)	Performance level was notably related to the personality traits of conscientiousness and openness. However, no significant associations were found between performance and traits like extraversion, agreeableness, or emotional stability. Intriguingly, handball goalkeepers tended to be less receptive to new experiences than the general populace, yet displayed higher conscientiousness and neuroticism
Azita et al. (2019)	It was observed that neuroticism personality traits had a moderating effect on the impact of the psychological preparation program on the dimensions of sport performance, while other personality traits did not have a significant effect. These results highlight the importance of considering personality traits when designing and implementing psychological preparation programs for futsal players
Ruiz-Barquín and García-Naveira (2013)	Adult players showed higher emotional stability, openness to experience, and responsibility than juvenile players. Personality traits such as responsibility, openness to experience, and emotional stability were positively related to athletic performance. Regression models showed significant predictive capacity for neuroticism and openness to experience in the overall sample, and for neuroticism and responsibility in juvenile players and neuroticism and extraversion in players over 18 years old

(Tok, 2011). A robust predictive index exists between performance in Nanquan and openness to experience (Yuan, 2020). Similarly, openness is a vital attribute in American football. Consequently, systematic personality testing among athletes is advocated during the selection process for top-tier American football competitions (Piepiora et al., 2021).

A strong correlation exists between conscientiousness and team events. In assessments of football and basketball performance, conscientiousness demonstrates a positive association with sports achievements (Kalinowski et al., 2020; Siemon and Wessels, 2022). In team sports, individual performance substantially influences competition outcomes, indicating that traits such as self-control, diligence, responsibility, and reliability contribute to enhanced performance. In contrast, specific individual exercises, including swimming and aerobic activity, exhibit no relationship with conscientiousness, aligning with earlier research. The incremental validity of researchers' incapacity to predict endurance athletes' performance via conscientiousness and motivation has been substantiated (Perry et al., 2017). Notwithstanding that descriptors like "diligence," "dependability," and "persistence" encapsulate conscientious traits, and persistence appears essential for endurance sports, the present investigation reveals no association between these elements.

Extroversion, a personality dimension, is typically associated with individuals who exhibit talkativeness, confidence, and affability. In the realm of sports, extroverted athletes are capable of engaging in effective communication with teammates, coaches, and competitors, fostering a conducive atmosphere and enhancing performance. This advantage becomes particularly salient in team sports contexts. For instance, extroverted NBA players exhibit positive correlations with various performance metrics. Basketball athletes displaying pronounced extroversion are more capable of tolerating pain due to the inherent nature of team sports (Siemon and Wessels, 2022). These individuals relish camaraderie, support, and competition while striving toward shared objectives. This notion is substantiated by the mediating effect of extraversion on performance effectiveness in relation to the task-centered approach to stress among football players (Kalinowski et al., 2020). Interestingly, a survey of individual event champions also revealed markedly high extraversion traits (Piepiora, 2021b). This observation aligns with the proclivity of active individuals to exhibit traits such as energetic demeanors, fast-paced lifestyles, confidence, and positive emotions, all of which fall within the domain of extraversion. Moreover, extroversion has been linked to increased aerobic capacity (Terracciano et al., 2013).

Agreeableness, which focuses on qualities like trust, altruism, modesty, compassion, cooperation, and honesty, is distinct from extraversion. Athletes in team sports often score higher in agreeableness compared to those in individual sports. Given its socially-oriented nature, this correlation seems logical (Nia and Besharat, 2010). But studies in beach volleyball, basketball, and American football have not confirmed this result (Klatt et al., 2021; Siemon and Wessels, 2022), in contrast to individual sports such as

TABLE 3 Quality assessment—individual evaluation of the studies examined.

References	STROBE Statement—Checklist of items that should be included in reports of cross-sectional studies																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Fabbricatore et al. (2021)	YES	YES	Partly	YES	Partly	YES	YES	YES	NO	NO	NO	Partly	YES	Partly	YES	YES	NO	YES	Partly	YES	Partly	YES
Ionel et al. (2022)	YES	YES	YES	YES	Partly	YES	YES	YES	Partly	NO	Partly	Partly	YES	YES	YES	YES	YES	YES	YES	Partly	Partly	YES
Siemon and Wessels (2022)	YES	YES	YES	YES	YES	YES	YES	YES	Partly	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	Partly	YES	NO
Piedmont et al. (1999)	YES	YES	YES	YES	YES	YES	YES	YES	Partly	NO	NO	NO	Partly	YES	YES	YES	YES	YES	YES	YES	Partly	NO
Lin et al. (2011)	Partly	YES	Partly	YES	Partly	YES	YES	YES	Partly	NO	NO	NO	NO	NO	YES	YES	YES	YES	Partly	YES	YES	NO
Liu (2011)	Partly	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO
Allen et al. (2011)	Partly	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	Partly	YES	YES	YES	YES	YES	NO
Zhu et al. (2013)	Partly	YES	Partly	YES	YES	YES	YES	YES	Partly	NO	Partly	NO	Partly	Partly	YES	YES	YES	NO	Partly	YES	YES	YES
Terracciano et al. (2013)	YES	YES	YES	YES	YES	YES	YES	YES	Partly	NO	YES	YES	Partly	YES	YES	YES	YES	YES	YES	YES	Partly	NO
Balyan et al. (2016)	YES	YES	YES	YES	YES	YES	YES	YES	Partly	NO	YES	Partly	NO	Partly	YES	YES	YES	YES	YES	YES	Partly	NO
Klein et al. (2017)	YES	YES	YES	YES	YES	YES	YES	YES	Partly	NO	YES	YES	YES	YES	YES	YES	YES	YES	NO	Partly	Partly	NO
Stine et al. (2019)	YES	YES	YES	YES	YES	YES	YES	YES	Partly	YES	YES	YES	Partly	YES	YES	YES	YES	YES	Partly	YES	Partly	YES
Yuan (2020)	YES	YES	YES	YES	YES	YES	YES	YES	Partly	NO	Partly	Partly	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO
Kalinowski et al. (2020)	YES	YES	YES	YES	YES	YES	YES	YES	Partly	NO	YES	YES	YES	YES	YES	YES	YES	Partly	YES	Partly	Partly	NO
Matuszewski et al. (2020)	YES	YES	YES	YES	YES	YES	YES	YES	Partly	Partly	NO	NO	YES	YES	YES	YES	Partly	YES	YES	YES	Partly	NO
Piepiora and Piepiora (2021)	YES	YES	YES	YES	YES	YES	YES	YES	Partly	Partly	NO	YES	YES	YES	YES	NO	Partly	Partly	YES	Partly	Partly	NO
Zar et al. (2022)	YES	YES	YES	YES	YES	YES	YES	YES	Partly	NO	YES	YES	NO	Partly	YES	NO	YES	YES	NO	Partly	NO	NO
Piepiora et al. (2021)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	Partly	Partly	YES	Partly	Partly	Partly	NO
Piepiora (2021a)	YES	YES	YES	YES	YES	YES	YES	YES	Partly	NO	YES	YES	Partly	YES	YES	NO	Partly	YES	Partly	YES	Partly	NO
Klatt et al. (2021)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	Partly	YES	YES	NO	YES	YES	YES	YES	Partly	NO
Fasold et al. (2019)	YES	YES	NO	YES	Partly	YES	Partly	YES	NO	NO	Partly	YES	YES	YES	YES	YES	Partly	YES	YES	YES	Partly	NO
Azita et al. (2019)	YES	YES	YES	YES	Partly	YES	Partly	YES	NO	NO	Partly	Partly	YES	YES	YES	Partly	YES	YES	Partly	YES	Partly	NO
Ruiz-Barquín and García-Naveira (2013)	YES	YES	YES	Partly	YES	YES	YES	YES	Partly	YES	YES	YES	YES	YES	YES	Partly	YES	YES	YES	YES	YES	NO

1 = Indicate the study's design with a commonly used term in the title or the abstract; 2 = Explain the scientific background and rationale for the investigation being reported; 3 = State specific objectives, including any prespecified hypotheses; 4 = Present key elements of study design early in the paper; 5 = Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection; 6 = Give the eligibility criteria, and the sources and methods of selection of participants; 7 = Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable; 8* = For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group; 9 = Describe any efforts to address potential sources of bias; 10 = Explain how the study size was arrived at; 11 = Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why; 12 = Describe all statistical methods, including those used to control for confounding.; 13* = Report numbers of individuals at each stage of study—e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analyzed; 14* = Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders; 15* = Report numbers of outcome events or summary measures; 16 = Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included; 17 = Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses; 18 = Summarize key results with reference to study objectives; 19 = Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias; 20 = Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence; 21 = Discuss the generalizability (external validity) of the study results; 22 = Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based. Yes = Available; Partly = Partly available; No = Not available.

canoeing. There is a significant relationship between agreeableness and sport performance in rowing, with elite athletes with high agreeableness having better performance (Liu, 2011; Stine et al., 2019).

Among the "Big Five" personality dimensions, neuroticism stands out as the sole attribute with an inherently negative implication. This trait is intrinsically linked to the autonomic nervous system's excitation levels, with neurotic individuals possessing highly unstable systems characterized by rapid agitation onset and a prolonged return to baseline (Eysenck, 1967). A plethora of research findings demonstrate that athletes exhibiting lower neuroticism levels exhibit superior sports performance, with team sports champions displaying reduced neuroticism relative to their counterparts (Piepiora, 2021a). Additionally, elite athletes exhibit lower neuroticism levels compared to non-elite athletes (Vealey, 1992), and those participating in exercise display lower neuroticism scores than non-exercise participants (McKelvie et al., 2003). Concurrently, certain studies reveal that female athletes generally possess higher neuroticism levels compared to their male counterparts (Allen et al., 2011; Lin et al., 2011), though this observation is contextually specific to Nanquan (Yuan, 2020).

The relationship between personality and performance varies across athlete levels. Studies focusing on high-level athletes, such as those aiming for the NBA, elite canoeists, or national team members, frequently highlight traits like conscientiousness, neuroticism, and agreeableness as predictive of performance outcomes (Liu, 2011; Siemon and Wessels, 2022). Notably, low neuroticism and high conscientiousness often correlate with better performance in these elite settings. This is consistent with the results of a study conducted by Steca et al. (2018), who found that more successful athletes displayed higher levels of agreeableness, conscientiousness, and emotional stability compared to those who were less successful. In non-elite athletes, the Five Factor Model of personality shows a complex relationship with sports performance. Unlike elite counterparts with distinct profiles, these athletes exhibit a wide personality range, where traits like agreeableness can predict climbing prowess (Ionel et al., 2022), while neuroticism might influence outcomes in computer-based soccer (Balyan et al., 2016) and martial arts (Yuan, 2020). It's imperative, as underscored by García Naveira (2010), Garcia-Naveira and Ruiz-Barquín (2020), and Piedmont et al. (1999), to make a clear distinction between studies. Some research focuses on disparities grounded in the athletes' competitive tiers, while others delve into the intricate relationships between personality traits and performance metrics.

Other studies have shown a correlation between personality traits and energy expenditure in elderly individuals, and found a significant correlation between neuroticism, extroversion, openness, and conscientiousness with energy expenditure during peak walking speed (Terracciano et al., 2013). But this is contrary to the latest study, Personality traits did not moderate intervention effects on physical functioning (Kekäläinen et al., 2023). It's evident that the influence of personality on performance can be multifaceted and may vary based on the sport, the competitive tier, and individual factors. When considering differences among sports, athletes in high-risk sports may be characterized by their thrill-seeking nature and openness to experiences. Meanwhile, those in team sports, like soccer, often display more extroversion but may be less emotionally stable compared to individual sport athletes. Furthermore, team sport participants tend to balance personal and group needs, whereas those in individual sports lean more toward individualism (García Naveira,

2010). In essence, the intricate interplay between personality and performance underscores the importance of considering both the individual's psychological makeup and the unique demands of their chosen sport when evaluating and predicting athletic success.

Study strengths and limitations

By compiling and analyzing an extensive array of pertinent literature, this review offers a thorough and insightful examination of the associations between the five personality traits and athletic performance. The investigation encompasses not only the overarching connections between these traits and performance but also delves into the impacts of various sport types, athletic populations, and athletes' ages on these relationships. The findings hold substantial relevance for sports psychologists, coaches, athletes, and sports administrators, furnishing valuable guidance for selection processes, training, and psychological interventions.

However, the comprehensive nature of the research domains addressed and the diverse characteristics of sports and populations could introduce heterogeneity into the study, potentially affecting the results' robustness and precision. Additionally, distinct cultural backgrounds may exert differential influences on personality traits and athletic performance, thereby constraining the applicability of the findings across diverse cultural contexts. In summary, while this review sheds light on the interplay between the five personality traits and sports performance, further meticulous and exhaustive research is necessary to surmount existing limitations and furnish more reliable evidence for practitioners.

Recommendations for future research

We suggest the following directions for future research: Utilize longitudinal study designs to establish causal relationships between the Big Five personality traits and athletic performance more effectively. Perform cross-cultural investigations to assess how the connections between personality traits and sports performance might differ in various cultural settings, thereby increasing the applicability of research findings. Examine the relationships between personality traits and athletic performance in specific sports and populations, such as team sports, individual sports, aerobic sports, and among professional, amateur, and youth athletes, offering tailored guidance for practitioners. Evaluate the impact of targeted psychological interventions focusing on personality traits in enhancing sports performance, assisting sports psychologists and coaches in designing effective approaches. Apply advanced statistical methods like structural equation modeling and multilevel analysis to deepen our understanding of the relationships between personality traits and sports performance while accounting for potential interactions and moderating variables. Investigate the interplay between personality traits and other psychological aspects, including motivation, self-efficacy, and emotion regulation, to gain a more comprehensive perspective on the psychological mechanisms driving sports performance. By addressing these suggestions, future research can contribute to a richer understanding of the links between the Big Five personality traits and athletic performance, ultimately providing valuable support for practitioners in the field.

Conclusion

This systematic analysis reveals that the relationship between personality and sports performance is influenced by various factors, including the type of sport, the athletic population, and the athletes' age. The analysis indicates that, aside from neuroticism, openness, conscientiousness, extraversion, and agreeableness display positive correlations with sports performance. Conscientiousness and extraversion emerge as predominant personality traits in team sports, contributing to team cohesion and, ultimately, improved outcomes. The influence of openness and agreeableness varies across different sports, with no definitive consensus on the specific sports they benefit. Overall, the findings offer promising insights into the potential of personality as a predictor of athletic performance. As a result, stakeholders such as applied sports psychologists, coaching staff, athletes, and sports administrators must adequately comprehend the role of personality and its pertinence to success in major competitions. Practitioners should advocate for the integration of personality assessment and development programs within the training process. To achieve this, a more profound understanding and utilization of personality concepts in physical education and sports are required, along with the development of effective, user-friendly personality tools and well-founded, easily implemented training programs.

Author contributions

YS: Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing. SW: Conceptualization, Data curation, Visualization, Writing – original draft, Writing – review & editing. XL: Conceptualization, Funding acquisition, Visualization, Writing – original draft, Writing – review & editing. YK: Conceptualization, Data curation, Formal analysis, Supervision, Writing – original draft,

Writing – review & editing. GK: Conceptualization, Data curation, Formal analysis, Supervision, 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.

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Perceived competence in ice hockey and its associations with relative age, early sport specialization, and players' position

Vincent Huard Pelletier[1,2]* and Jean Lemoyne[1,2]

[1]Laboratoire de Recherche sur le Hockey de l'UQTR, Université du Québec à Trois-Rivières, Trois-Rivières, QC, Canada, [2]Département des sciences de l'activité physique, Université du Québec à Trois-Rivières, Trois-Rivières, QC, Canada

Introduction: Ice hockey is a sport that has gained much attention in recent times, particularly concerning the development of young players. In the domain of youth sport development, one significant factor that must be considered is the perceived competence of players. This variable is closely linked to positive psychological outcomes and sustained practice. However, there is a lack of understanding about how other important developmental factors such as age, early sport specialization, players' position and relative age affect players' perceived competence. Therefore, the objective of this study is to explore the relationships between these developmental factors, perceived ice hockey competence and a global measure of perceived sport competence.

Methods: Data was drawn from 971 players (14.78 ± 1.61 mean age), who completed on-line questionnaires, from which we conducted path analyses involving all variables.

Results: Younger players tend to display higher perceived competence scores than older players. Additionally, players who opted to specialize earlier also reported higher perceived competence. Furthermore, forwards and defensemen had differing perceptions of their competence, which was in line with their respective roles on the ice. The study also showed relative age effects, in which players who were born earlier relative to the selection period tend to perceive themselves more advantageously in three components of perceived competence.

Discussion: Based on these findings, several recommendations are proposed for coaches and decision-makers to encourage the positive development of ice hockey players. The study highlights that ice hockey-specific competencies are influenced by various factors, such as early sport specialization, relative age effect, player age, and position.

KEYWORDS

sport development, self-enhancement, perceived competence, organized sports, adolescence, relative age effect, sport expertise

1 Introduction

Organized sport occupies a prominent place in society and is adolescents' practice of choice in terms of physical activity (Malm et al., 2019). In fact, nearly 60% of Canadian youth aged between 5 and 17 participate in at least one organized sport, and 74% were involved in it before the COVID-19 pandemic (Kuzik et al., 2023). One of Canada's most important organized sports is ice hockey, with over 500,000 registrations in minor ice hockey and numerous successes in international competitions (Hockey Canada, 2023). Because of its growing popularity and young players' eagerness to achieve high-performance levels, youth sports are rapidly becoming professionalized (Camiré and Santos, 2019), which can lead to external pressures from social agents such as parents and coaches (Todd and Edwards, 2021). However, studies on soccer reveal that attendance at a sports academy at a young age does not seem to have an impact on professional success, nor does performance before the age of 14 (Leyhr et al., 2018; Dugdale et al., 2021). Recently, governing bodies have focused on creating environments more conducive to the players' long-term development regarding technique, tactics, self-confidence, and sustained sports participation. However, coaches have identified many challenges regarding the complexity, applicability, and compatibility of these measures with the realities of the playing field (Beaudoin et al., 2015). Obstacles to young athletes' continued involvement in sports include time conflicts with other activities, lack of motivation, negative relationships with coaches and low perceived competence (Balish et al., 2014). The latter has been recognized for several decades as an important psychological construct in the development of young people, as it enables long-term practice and well-being (Harter, 1978).

As defined by Shavelson et al. (1976), perceived competence refers to an individual's perception of their abilities in a particular performance domain. This concept is central to various theoretical models used in sports and physical activity research, including the Self-Determination Theory (Deci and Ryan, 2008) and the Youth Physical Activity Promotion Model (Welk, 1999). A positive perception of perceived sports competence is associated with high levels of intrinsic motivation (Rodrigues et al., 2021), long-term commitment to sports (Feltz and Petlichkoff, 1983) and achievement of the highest performance standards (Feltz, 1988). Another framework that underlines the importance of perceived competence is the Personal Assets Framework (Côté et al., 2014). Tenants of this model stipulate that perceived competence is fostered by the quality of the environment in which young athletes evolve.

Throughout their formative years, individuals' self-assessment of their ability as players undergoes a transformation. In early childhood, it can be challenging for young athletes to distinguish between competence, effort, achievement, luck, ability and task difficulty when assessing oneself. Nevertheless, as they enter adolescence, their ability to evaluate their own competencies progresses significantly (Horn et al., 1993; Horn, 2004). Adolescents start using a broader range of resources to evaluate themselves (e.g., feedback from peers and teammates) and can differentiate more effectively between these resources. Moreover, they become more proficient at using self-determined performance standards, such as achieving self-set goals, and rely more on internal and psychologically based information like feelings of self-confidence or personal efficacy. While adolescents still compare themselves to their peers within the competitive sport setting, they are now capable of doing so in relation to a more

extensive, extended peer group they may not personally know (e.g., "How do I rank within the state or nation in my age group?"). The current literature indicates that young athletes' sense of competence tends to become more accurate during adolescence and diminishes as well (Tubić and Đorđić, 2015). However, no studies to date have examined perceptions of competence during adolescence in ice hockey, a sport with a significant drop-out rate in adolescence (Lemez et al., 2014).

Despite the relevance of perceived sports competence in sports development models, competence is generally measured only with items that focus on sports in general. This makes sense, of course, when measuring a general population in which a multitude of sports can be practiced (Harter, 1978; Fox and Corbin, 1989). Rottensteiner et al. (2015) however, argues that an athlete's perceived competence in a particular discipline is associated with increased participation in that discipline, underlining the importance of a sport-specific measure under study. Lemoyne et al., 2015 also offered a good example of such associations with a cohort of college students. As a result, efforts have been made in recent years to measure perceptual competence for a specific sport, such as swimming (Marsh and Perry, 2005), gymnastics (Kipp and Weiss, 2013), or soccer (Forsman et al., 2016). More recently, the Self-Perceived Ice Hockey Competence Scale was developed and validated with adolescent hockey players (Huard Pelletier and Lemoyne, 2023). This study showed that ice hockey perceived competence is characterized by six dimensions: skating, strength and power, tactics, offensive abilities, coachability and resilience. Skating is the ability to move with ease on the ice rink and is increasingly important in modern ice hockey. The "strength and power" dimension refers to the ability to produce strength, whether in shots, in one-on-one battles or by other types of physical involvement on the ice (e.g., body checks). Tactics involve making the right decisions with and without the puck and applying the coach's play system. Offensive abilities include goal-scoring skills such as puck handling and shooting accuracy. Coachability refers to leadership skills and gestures that promote positive interactions with teammates and coaches, while resilience reflects the ability to cope with adversity and difficult situations.

In sports, there is great interest in having young athletes compete at the highest level before reaching adulthood, whether at the amateur or professional levels (Malina, 2010). This seemingly innocuous phenomenon is not without consequences for youths and their behavior. Recent years have witnessed a more significant investment of free family time in organized sporting activities and the professionalization of sports (Feeley et al., 2016) to improve children's performance and enable them to out-perform others (Sturm, 2005). This may have been exacerbated by success stories like those of Andre Agassi and Tiger Woods, who were involved intensively in sport specialization behaviors at a very young age and quickly entered the world's elite (Farrey, 2008; Agassi, 2011). Indeed, this trend toward early sport specialization has become increasingly pronounced in recent decades (Smith, 2015). The construct of sport specialization was originally developed by Wiersma (2000) and is defined as participation in a single sport at a high intensity of training and competition. Early sport specialization (ESS) definition was refined more than a decade later by Jayanthi et al. (2013) who proposes ESS as an "intense training in a single sport to the exclusion of all other sports." Laprade et al. (2016) went a step further, defining ESS as "the decision to focus on a specific sport for at least 8 months a year before

the age of 12 and to participate in specific training and competitions throughout the year, often to the detriment of exploring other sports." Recently, Kliethermes et al. (2021) underscored the lack of consistency in the definition and measurement of the ESS concept. In view of the multiple determinants and complexity of ESS, each of its characteristics' merits attention. Furthermore, this approach is often motivated by the desire to progress rapidly and maximize the chances of success in a given discipline (Normand et al., 2017); the result is increasing reports of negative effects such as a greater number of overuse injuries (Bell et al., 2018) and psychological issues leading players to quit the sport (Keegan et al., 2010). In Canadian youth hockey, early sport specialization is prevalent across all age groups and playing levels, regardless of gender (Huard Pelletier and Lemoyne, 2022). It's important to determine whether specialization impacts players' perceived competence. However, different studies have produced conflicting results. One study suggests a connection between specialization and perceived physical self-concept (Huard Pelletier and Lemoyne, 2020), while another shows opposite results for perceived competence, specifically in ice hockey (Huard Pelletier and Lemoyne, 2022). According to a review by Mosher et al. (2022), we must now attempt to better understand the mechanisms behind the potentially harmful effects of early sport specialization. For example, do the negative psychological effects of ESS stem from the demands of early rigorous physical conditioning, participation in specialized off-season camps, or the fact that playing ice hockey precludes participation in other sports? Furthermore, the development of the perceived Ice Hockey Competence scale has now made it possible to measure the links between ESS and ice hockey competence, which was not formally done in the past. Could specialized players feel competent in their chosen sport, where they invest most of their time, but feel much less so in sports overall?

Another construct that may influence ice hockey players' perception of competence but has rarely been measured in the scientific literature to date is the position the player evolves in. Indeed, forwards and defensemen have significantly different tasks on the ice; the primary mandate of forwards is to score goals, while that of defensemen (and goaltenders) is to defend, or prevent the opponents from the same outcome. In the past, defenders were shown to be generally taller, heavier and more powerful in terms of upper-body muscles, while forwards were smaller, faster and more agile (Geithner et al., 2006; Kutáč and Sigmund, 2015). However, a recent study of non-professional ice hockey players aged 17 to 23 reported no significant anthropometric differences between forwards and defenders (Czont et al., 2023). Technically, there are important differences in the way forwards and defenders move around the rink; forwards make more quick turns, accelerate and move more often at high speed, while defenders spend more of their time skating backwards and must often change direction (Montgomery et al., 2004). Furthermore, the birth distribution seems to differ according to the players' position, as demonstrated in ice hockey (Grondin and Trudeau, 1991) and junior soccer (Romann and Fuchslocher, 2013). Additionally, there are trends toward early position-specific specialization in sports such as baseball (Ogden and Warneke, 2010), volleyball and basketball (Horn, 2015), all technically demanding sports where the athlete's size is essential. The aforementioned paper may also provide insights into birth distribution and players' positions. In this regard, it seems probable that forwards and defensemen might be different

in terms of their tasks and physical condition. This begs the question of whether a player's position impacts their self-perception as an athlete and, if so, how.

When it comes to organized sports, access to the highest competitive levels is affected by the relative age effect (RAE). According to Cobley et al. (2009), RAE refers to the observation that, for a particular age category, children born earlier in the selection period tend to be over-represented in elite sports teams compared to those born later in the year (Cobley et al., 2009). The reason is that categories are divided based on birth dates in organized sports and schools. The biased selection of athletes is well-documented and can affect players' development opportunities. Musch and Grondin (2001) proposed four mechanisms contributing to Relative Age Effects (RAEs) in organized sports. They include (1) depth of competition, where RAEs are more significant when many athletes compete for fewer roster positions; (2) physical development differences, where RAEs are more prominent in sports that prioritize players who experience earlier physical growth; (3) cognitive differences, where RAEs result from psychological advantages among relatively older athletes; and (4) experience, where relatively older children have more sports practice than younger ones. Those advantaged by the relative age effect have access to better coaches and higher levels of competition (Baker et al., 2010). This phenomenon can be described as the *Mathew Effect*, where the rich get richer, and the poor stay poorer (Hancock et al., 2013). Secondly, relatively older players have increased expectations from coaches, which helps them develop and is known as the *Pygmalion effect*. Finally, athletes with a relative age advantage can develop better self-perceptions (Lemoyne et al., 2021), leading to better performances. This phenomenon is known as the *Galatea effect*. It's unclear, however, whether these young athletes also perceive themselves as better in specific aspects of ice hockey competence.

Exploring the connections between perceived competence, early sport specialization, position played, and relative age effect in youth hockey is paramount. However, the current literature lacks a conclusive understanding of these links, largely due to the absence of validated questionnaires on perceived ice hockey competence. Additionally, the specific aspects of early sport specialization that impact perceived competence among young ice hockey players remain unclear. For instance, it is unknown whether playing ice hockey for more than 8 months annually at a young age or participating in off-season development camps significantly affects a player's perceived competence. Furthermore, a lack of empirical data allows us to affirm if forwards feel more competent than defensemen, and vice versa. By properly understanding the intricate relationships between these variables, we can evaluate the potential effects of early specialization and age-based selection on the development of young ice hockey players. More specifically, this study aims to model the impact of age categories, early sport specialization, player position and birth quartiles on ice hockey-specific perceived competence and perceived sport competence. Based on the existing literature, four hypotheses can be put forward:

1) Younger players should display higher levels of ice hockey competence;
2) Specialized players should have more negative self-perceptions. Inversely, less specialized players should have similar or even stronger self-evaluation of their global perceived sport competence;

3) There should be differences in perceived competence according to players' position;
4) There should be relative age effect on players' perceived competence.

2 Materials and methods

2.1 Sample and data collection

Participants were recruited with the collaboration of the Quebec Ice Hockey Federation and approved by the board of ethics of the researchers' institution (CER-21-27507.04). Invitations were sent directly to ice hockey program directors across the province. The directors of 29 organizations accepted; they were subsequently contacted for an information session and invited to complete an online questionnaire (using the Qualtrics platform). In the participating organizations, each program director sent invitations to the players of 54 teams across the 29 organizations. To be eligible, participants had to be between 12 and 17 years old and registered with the provincial ice hockey federation. This age bracket made it possible to include most players at the U13, U15 and U18 levels, corresponding to the age of students in Quebec high schools. We informed the players of the project and obtained their written consent or that of their parents (for players under 14). It should be noted that data collection was carried out exclusively in French, the official language of the population under study.

2.2 Measurement

2.2.1 Perceived competence

We measured perceived ice hockey competence with the Self-Perceived Ice Hockey Competence Scale (Huard Pelletier and Lemoyne, 2023). This questionnaire was previously validated in French and using 5-point Likert scales (from 1 = does not represent me at all, to 5 = represents me perfectly). The questionnaire comprises 6 subscales: skating (4 items; I am a fast skater), strength and power (4 items; I am physically strong), tactics (4 items; I can apply the game systems without problem), offensive abilities (4 items; I am efficient in the offensive zone), coachability (3 items; I have a good work ethic that helps me to perform) and resilience (3 items; I remain confident even if my playing time decreases). This questionnaire provides a good conceptualization of the perceived competence specific to ice hockey. It also displays good reliability (McDonald's Omega ω varying from 0.74 to 0.84) and good temporal stability (intraclass correlation coefficient all >0.87). The items of this instrument can be seen in Supplementary File 1. We also measured perceived sports competence (PSC) using three 5-point Likert-type items taken from the French short version of Corbin's Physical Self-Perception Profile (Maïano et al., 2008) (e.g., *Inventaire du Soi Physique*) with the following wording: (a) *I find that all sports are easy for me*, (b) *I find that I'm good in all sports*, and (c) *I do well in sports*. The subscale showed good internal reliability (ω = 0.94).

2.2.2 Player's age and position

Players' age was categorized in three different age-groups in which they play: (e.g., U13: 12–13 years = 1, U15: 14–15 years = 2 and U18: 16, 17, 18 years = 3). Players' position was dichotomized: forwards (1) and defensemen (2). Both variables were then treated as categorical variables.

2.2.3 Early sport specialization

Early sport specialization indicators were measured retrospectively with three questions inspired by LaPrade et al. (2016) definition and previous ice hockey studies (Huard Pelletier and Lemoyne, 2020, 2022) using a Likert scale with three response options. It's worth noting that since the ice hockey season spans at least 8 months, athletes were not required to specify this in the questionnaire. The first question was "I feel that playing ice hockey prevented me from playing another sport" (1 = Definitely, 2 = Very little, 3 = Not at all). The second and third questions were "At what age did you start summer strength and conditioning specifically for ice hockey on a regular basis" and "At what age did you start participating in summer development hockey-specific activities on a regular basis" (1 = From 4 to 8 years old, 2 = From 9 to 11 years old, 3 = From 12 to 16 years old, 4 = Never/not yet). Internal consistency for the ESS measures suggests acceptable reliability (ω = 0.71). We then calculated a composite score (mean) by regrouping each ESS indicators for the following analyses.

2.2.4 Relative age

The athlete's month and year of birth were requested in the questionnaire. Months were then categorized according to birth quartile (1 = January–March, 2 = April–June, 3 = July–September, 4 = October–December), which was treated as a categorical variable. Birth quartiles were congruent with the Canadian Ice Hockey Federation guidelines for defining age group categories. To prevent the potential bias distribution of birth quartiles (e.g., make sure that the actual sample is similar to population), we followed Delorme and Champely (2015) recommendations by analyzing 2024's province of Quebec birth rates, because it corresponds to the median age of our sample (Statistique Canada, 2018). We found no significant differences in birth quartile distributions.

2.3 Statistical analysis

The following analyses were carried out with Mplus (version 8). Descriptive statistics and data distribution (kurtosis, skewness) were measured to determine whether the sample's assumption of normality was violated. After analysis, it was concluded that the sample was not normally distributed, so the maximum likelihood Robust (MLR) modeling procedure was used to evaluate the path analysis (Yuan and Bentler, 2007). To address the four research objectives, a path analysis was conducted to model the possible influences of ESS, age category, player position and birth quartile on the six dimensions of perceived ice hockey competence and perceived sport competence. Since there was not a specific model to test involving the constructs under study, the path analysis approach allows more flexibility for testing associations between all independent variables in a same model, and their links with

each component of perceived competence (global or specific to ice hockey). Each construct, except for ESS, was treated as an observed variable in the model. Consequently, this means that path coefficients that involve ESS construct with component of perceived competence were treated as continuous (e.g., higher coefficient means strong associations). For the categorical variables (e.g., Age, RAE, players' position), paths coefficients were determined form each factor's corresponding reference category. Model interpretation was based on the most common fit indices. The chi-square statistic (χ^2) indicates the level of model fit. To estimate the quality of the indices, we used the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI). Estimation errors were estimated using the Rooted Mean Square Error of Approximation (RMSEA) and the Standardized rooted mean square residual (SRMR). To interpret the indices, we followed the suggestions of Hu and Bentler (1999): 1- a non-significant value of $\chi 2$ (goodness-of-fit); CFI and TLI > 0.950; RMSEA and SRMR <0.07. The LaGrange Multiplier (LM) test was also considered, but only for modifications supported by theoretical assumptions. To verify if the new model was significantly better than the previous one, Satorra and Bentler (2001) scaled chi-square difference (SB$\Delta\chi^2$) test was used.

3 Results

3.1 Sample

Table 1 describes the study's sample with regard to all variables. Of the 1,058 players contacted, 971 (92%) agreed to answer the questionnaire. Once goaltenders were excluded, the sample size decreased to 864 (76%). All participants were males between 12 and 18 years old, with a mean age of 14.78 ± 1.61; they were selected from all development networks in the area of the study. The sample comprised 24.9% U13 players, 41.6% U15 players, and 33.6% U18 players. Most in the sample (59%) played as forwards, while 36% played as defensemen. This was expected because all teams align more forwards than defensemen. Only 5% of participants (n = 43) neglected to mention their playing position. Regarding birth quartiles, 33.3% (n = 285) were born in the 1st, 24.3% in the 2nd (n = 207), 20% in the 3rd (n = 172), and 20.4% in the 4th (n = 173). In this regard, a significant relative age effect was observed with the current sample ($\chi^2_{(df)} = 40.76_{(3)}$; $p < 0.001$).

3.2 Model estimation

Despite acceptable fit indices ($\chi^2_{(df)} = 47.72_{(23)}$, $p = 0.002$: CFI = 0.990, TLI = 0.966; RMSEA = 0.037), the results of the LM test suggest the addition of two covariances (age categories with Birth Quartile; age categories with engagement in hockey specific activities). Both additions produced a final model that displayed a better fit ($\chi^2_{(df)} = 26.24_{(22)}$, $p = 0.241$: CFI = 0.998, TLI = 0.994; RMSEA = 0.015). In fact, these additions resulted in significant improvement of the proposed model ($\Delta SB\chi^2 = 21.48_{(1)}$, $p < 0.001$). All model standardized estimates are presented in Table 2 at the end of the Results section.

3.2.1 Objective 1 − age and perceived competence

As Table 2 demonstrates, older players (U18 = 3) displayed lower scores in two components of ice hockey perceived competence: perceived skating abilities ($\beta = -0.090$, $p = 0.016$) and resilience ($\beta = -0.079$, $p = 0.021$). The negative loading suggests that older age groups tend to display lower scores for these two sub-dimensions. Interestingly, this tendency was also observed with regard to perceived offensive abilities ($\beta = -0.057$, $p = 0.092$). No other age-related differences were noted.

3.2.2 Objective 2 − ESS and perceived competence

Table 2 shows that ESS tends to have significant, favorable associations with all components of perceived competence. Significant regression coefficients were observed for perceived skating abilities ($\beta = 0.144$, $p = 0.001$), perceived strength and power ($\beta = 0.272$, $p < 0.001$), perceived tactical abilities ($\beta = 0.192$, $p < 0.001$), perceived offensive abilities ($\beta = 0.209$, $p < 0.001$), coachability ($\beta = 0.226$, $p < 0.001$), resilience ($\beta = 0.086$, $p = 0.018$) and PSC ($\beta = 0.226$, $p < 0.001$). In summary, results suggest that players who tend to be more specialized in their sport (e.g., high ESS scores) tend to have stronger perceptions of their competencies.

3.2.3 Objective 3 − player position and perceived competence

Results in terms of players' position reveal some differences. In general, they suggest that player position is significantly associated with three components of perceived competence in ice hockey. Some loadings, however, showed specific position-related differences. Defensemen (higher category) reported higher scores

TABLE 1 Means, standard deviation, and inter-items correlation.

Variables (n = 774)	M ± SD	1	2	3	4	5	6	7
1. Skating	4.00 ± 0.75	1						
2. Strength	3.93 ± 0.72	0.436**	1					
3. Tactical	4.18 ± 0.60	0.540**	0.517**	1				
4. Offensive	3.87 ± 0.65	0.491**	0.408**	0.469**	1			
5. Coach	4.15 ± 0.68	0.500**	0.438**	0.623**	0.430**	1		
6. Resilience	4.06. ±0.68	0.436**	0.386**	0.518**	0.331**	0.521*	1	
7. PSC	2.08 ± 0.76	0.627**	0.491**	0.586**	0.528**	0.558**	0.418**	1

TABLE 2 Age, ESS, player's position, birth quartile, and perceived competence.

Exogenous variable →	Endogenous variable	Estimate	Standard error	*p*-value
Age category[1]	Perceived skating	−0.090*	0.037	0.016
ESS		0.144**	0.042	0.001
Position[2]		0.001	0.055	0.991
Birth quartile[3]		0.018	0.024	0.436
Age category	Perceived strength and power	0.003	0.035	0.924
ESS		0.272**	0.037	0.000
Position		0.111*	0.051	0.030
Birth quartile		−0.063**	0.023	0.007
Age category	Perceived tactical abilities	0.049	0.032	0.121
ESS		0.192**	0.035	0.000
Position		0.138**	0.045	0.002
Birth quartile		−0.047*	0.020	0.018
Age category	Perceived offensive abilities	−0.057	0.034	0.092
ESS		0.209**	0.035	0.000
Position		−0.328**	0.046	0.000
Birth quartile		−0.017	0.020	0.404
Age category	Perceived Coachability	0.011	0.034	0.743
ESS		0.226**	0.042	0.000
Position		0.005	0.053	0.925
Birth quartile		−0.048*	0.023	0.037
Age category	Perceived Resilience	−0.079*	0.034	0.021
ESS		0.086*	0.036	0.018
Position		0.019	0.053	0.721
Birth quartile		−0.016	0.022	0.483
Age category	Global PSC	−0.017	0.035	0.624
ESS		0.226**	0.040	0.000
Position		0.002	0.050	0.967
Birth quartile		−0.029	0.022	0.186

*$p < 0.05$; **$p < 0.01$. ESS: Early sport specialization.
[1]Age; U13 = 1, U15 = 2, U18 = 3. Negative coefficients mean lower scores for older group.
[2]Position; Forwards = 1, Defensemen 2. Negative coefficients mean stronger scores for forwards.
[3]Birth Quartiles; 1 = Q1, 2 = Q2, 3 = Q3, 4 = Q4. Negative coefficients mean lower scores for Q4.

in perceived strength and power (β = 0.111, *p* = 0.030) and perceived tactical skill abilities (β = 0.138, *p* = 0.002), while forwards, conversely, tend to display higher scores for offensive skills (β = −0.328, *p* = 0.037).

3.2.4 Objective 4 – relative age effect on perceived competence

Table 2 suggests the presence of a relative age effect on three of the six ice hockey competencies. In fact, being born in a later quartile (e.g., Q4 versus Q1) suggests significant, negative associations for three dimensions of perceived competence: strength and power (β = −0.063, *p* = 0.007), tactical skills (β = −0.047, *p* = 0.018) and coachability (β = −0.048, *p* = 0.037). There was no significant difference for the other perceived competence dimensions.

4 Discussion

This study's objective was to analyze the associations between relative age effect, early specialization in sports, player position choice and perceived competence in Canadian men's minor ice hockey. To our knowledge, this is the first study to link aspects of sports development (age, ESS, player position, REA) with perceived sport-specific competencies in young people. Following a thorough review of the relevant literature, four objectives and hypotheses were formulated and examined. The first objective was to measure perceived competence as a function of players' age. According to our results, players who evolve in older age group categories tend to have lower perceptions of their offensive and skating abilities and their perceived resilience, confirming hypothesis 1. Such a tendency was expected because, in late adolescence, players have access to

more resources for self-comparison and can better identify their weaknesses (Horn, 2004). By the same token, players in older categories may have a more accurate or informed assessment of their skills. Similar tendencies were observed for Perceived strength-power and PSC, although not statistically significant. Tactical skills and coachability, on the other hand, tend to increase slightly, but not significantly, in the current sample. The reason may be that players deepen their tactical understanding of the game during adolescence and feel more at ease after a few years of learning. In addition, they begin to understand the importance of a work ethic and what their coaches expect of them.

The second objective was to measure the potential influence of early specialization on perceived competence, either in a specific context (e.g., ice hockey) or from a general perspective (perceived sports competence). Our results show that early sport specialization appears to be positively related to both perceived ice hockey competence and global perceived sport competence, refuting hypothesis 2. Although such results may come as a surprise given the potentially negative impact of ESS on perceived competence (Gould, 2010), it's reasonable to believe that time invested in a preferred sport may have a positive impact on self-perceptions of one's athletic skills, suggesting a specific relationship between perceived competence and the physical activity corresponding to the targeted competence. This relationship, moreover, is supported by Lemoyne et al. (2015) using samples of college students.

One of the reasons why ESS is associated with a more positive perception of skating abilities as well as strength and power might be athletes' investment of time and effort during the off-season. Indeed, improvements and efforts in strength and conditioning during the off-season are associated with more positive perceptions of the physical self in university athletes (Jones et al., 2010). Additionally, improvements in ice hockey players' physical fitness have a direct impact on skating performance (Delisle-Houde et al., 2019) and ice time (Delisle-Houde et al., 2018). Professionally supervised strength and conditioning training for young people is beneficial and recommended for enhancing motor skill development, reducing injury risks and improving self-esteem; thus, the results of this study are consistent with this approach (Faigenbaum et al., 2009). The adoption of a sport practice similar to ESS also seems to be associated with more positive perceptions of tactical and offensive skills. We can presume that young athletes who take part in several ice hockey-specific development camps often rub shoulders with quality coaches who help them better understand the tactical aspect of the sport, even though no studies have examined the content of these camps to date. However, it's possible that athletes who choose to spend more time with qualified coaches during the summer to improve their shooting, passing and puck-handling skills likely feel more competent regarding the offensive dimension as well (Aalto and Räihä, 2012). This study also highlights positive associations between ESS and the two psychosocial dimensions of ice hockey competence: coachability and resilience. The reason may be that young people who opt for specialization behaviors undergo high volumes of on-ice and strength-conditioning (Bell et al., 2018) and must therefore develop a higher-than-average work ethic (coachability) and perseverance (resilience) to sustain this practice over time. It is generally accepted that ESS brings players into contact with many high-level athletes, which may be conducive to more negative self-perceptions (Gould, 2010).

However, based on the results of this study, we believe that exposure to role models who perform and invest a great deal of time in their chosen sport may also benefit young ice hockey players by enabling them to learn various life skills (communication, cooperation, goal setting, leadership) that increase their feeling of competence (de Subijana et al., 2022). By definition, specialized young people opt for the intensive practice of one sport to the detriment of others (Bell et al., 2021). Therefore, they may be expected to feel competent in their chosen sport, but much less so regarding other sports in general. However, the results of this study do not support this view. This may be partly because ice hockey is a difficult sport requiring many different skills (speed, power, agility, decision-making) that can be transferred to other sports (Vigh-Larsen and Mohr, 2022).

The third objective, to measure potential differences in perceived competence based on players' positions, gave rise to some interesting conclusions and confirmed the third hypothesis. Results indicate that defensemen perceived themselves to be more powerful and more competent in playing team systems (e.g., tactical skills). Forwards, on the other hand, showed higher perceived competence in terms of offensive skills. These findings are consistent with those of antecedent research suggesting that defensemen tend to be larger and possess greater upper-body strength than forwards, which reinforces the former's perception of strength and power. However, the tactical dimension of ice hockey competence produced an unexpected outcome insofar as it revealed that defensemen feel more competent than forwards when it comes to tactical abilities. A closer examination of the items forming the tactical dimension shows they include ease in the defensive zone, precise passes to teammates and the marking of opposing players. While these items can also be applied to forwards, they tend to be more directly related to defensemen. Thus, the role of defensemen is to prevent the opposing team from scoring and to initiate the attack by passing the puck to their forwards. In line with this hypothesis, the forwards' primary objective is to score goals (or create situations that will lead to this). This explains their positive response to offensive abilities items such as puck handling, shooting accuracy and creativity in the offensive zone.

The fourth objective was to determine if there were differences in perceived competence among players based on their birth quartile. Our results show that early-born players tend to feel stronger, perceive themselves to have better tactical abilities and feel more coachable than those born later, partially confirming hypothesis 4. These results align with those of Lemoyne et al. (2021), who measured physical self-concept in a comparable sample. Young players born earlier in the selection year tend to have a physical advantage and therefore feel more competent than those born later. Players born earlier in the year also report higher levels of tactical ability and coachability. This may be partly because players born early in the selection year generally play more games and have more ice time, which offers them more opportunities to shine (Lemoyne et al., 2023). Moreover, coaches may trust these players more and feel they can implement game plans, thus positively affecting their perceived competencies.

4.1 Limitations and future directions

Although this study makes significant progress in evaluating how perceived competence is impacted by different variables of influence

in ice hockey, some limitations prevail. First, the sample size consisted solely of adolescent male players, meaning results cannot be generalized to female ice hockey players. Since previous research also highlights potential gender differences in the way perceived competence is fostered during adolescence (Cairney et al., 2012), the inclusion of female hockey players in future studies may be an aspect to consider. Another limitation concerns the players' position. In this regard, goaltenders were not included in the study as there is no reliable questionnaire that addresses their perception of competence. Since goaltenders play a crucial and equally important role in the hockey ecosystem, however, it would be interesting to examine their perceptions of their hockey competencies in future studies. Furthermore, information regarding indicators of early sport specialization was collected retrospectively, which increases the risk of recall bias (Raphael, 1987). A longitudinal study could be conducted to track groups of specialized and non-specialized athletes and measure the evolution of their perceived competence during their development and, potentially, into early adulthood when other consequences of specialization may arise. Possible selection bias must also be mentioned. Indeed, most of the best performing players in the U18 age category may play in the U18AAA league or the Canadian Hockey League and were not included in the recruitment process. Because the aforementioned leagues reunite Canada's best prospects, these athletes may have reported higher perceived competence scores. Such a bias might eliminate some of the gap we observed between younger and older players. At the other of the spectrum, the present study covers players who were active at the time of data gathering. Thus, players who had given up ice hockey and had a potentially lower perceived competence were also excluded. Finally, the results presented here are specific to athletes in the Quebec development model, which hinders the generalizability of the results. In this regard, cross validation studies with other populations (age group, nationality, gender), could confirm whether the concept of perceived competence in ice hockey can be conceptualized similarly elsewhere.

4.2 Practical applications

The decline in perceived competence during adolescence could be mitigated by better coaching and support from coaches and other sports stakeholders. Toward the end of adolescence, athletes should, crucially, be made aware of their strengths and given opportunities to experience sports allowing them to leverage these strengths (Curran et al., 2016). This nurtures the sense of competence and provides a chance to develop in another sport should they decide to leave ice hockey. Results of the present study suggest that ESS measures are positively associated with perceived ice hockey competence. At first glance, it appears that players who are highly involved in their sport of choice develop a strong sense of perceived competence in it. Their choice may be an ill-advised one, however, as it could entail the risk of overuse injuries (Bell et al., 2018) and other potential psychosocial consequences (Gould, 2010). A sport specialization environment that enhances players' positive development is therefore important (Holt et al., 2020). Thus, an option worth considering is participation in summer development camps ideally supervised by professionals who create a healthy motivational climate (Allen and Hodge, 2006) and allow players to develop their gross motor skills (Jaakkola et al., 2017). Results regarding the third objective suggest that later-born players

may be disadvantaged by the impacts this has on perceived hockey competence. To counter these negative impacts, coaches – especially those responsible for most competitive teams/programs – should be advised to take the situation into account during team selection. Additionally, the governing bodies of sports federations should also consider the idea of incorporating teams composed of players born in the latter part of the year in tournaments or exhibitions held at the end of the season. As well, they should acknowledge the performances of later-born athletes in public publications. Regarding the fourth objective, perceived competence appears to differ based on the players' position. Since the positions of forwards and defensemen correspond to different components of perceived competence, young players may do well to vary their position during the season and develop abilities that fit the requirements of each position. Indeed, Hockey Canada recommends this course of action for players under the age of twelve, as it allows them to expand their repertoire of skills and improve their knowledge and understanding of their sport (Hockey Canada, 2023). Furthermore, coaches should emphasize the importance of tactical skills and physical involvement in forwards, while encouraging defenders to contribute more positively to the attack to improve players' perception of competence.

5 Conclusion

This study explores the impact of relative age, early specialization and position selection on perceived competence in Canadian minor ice hockey. This research highlights the fact that players in their late teens tend to have lower perceived competence in ice hockey than those in their early teens. Next, early sport specialization behaviors in ice hockey are positively associated with perceived competence in ice hockey as well as PSC. The study also shows that defensemen perceive themselves as more competent in tactical and physical aspects, while forwards feel more competent in their offensive abilities, demonstrating differences in relation to player position. Finally, a relative age effect is present in the sample studied, as players born earlier in the selection period feel more competent in terms of power, tactical abilities and coachability. The findings shed light on the complex interplay between individual factors and perceived competence in the context of Canadian minor ice hockey.

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 human/animal participants was reviewed and approved by the ethics committee of the Université du Québec à Trois-Rivières. 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

VH: Data curation, Funding acquisition, Investigation, Methodology, Visualization, Writing – original draft. JL: Formal analysis, 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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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2024.1336529/full#supplementary-material

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The influence of athletes' gratitude on burnout: the sequential mediating roles of the coach–athlete relationship and hope

Liangshan Dong[1], Shisi Zou[1], Rong Fan[1]*, Bin Wang[2] and Lv Ye[3]

[1]School of Physical Education, China University of Geoscience, Wuhan, China, [2]School of Physical Education, Central China Normal University, Wuhan, China, [3]School of Physical Education, Yangzhou University, Yangzhou, China

Background: Athlete burnout is a widespread psychological syndrome in competitive sports, negatively impacts athletes' competitive state and hampers the healthy development of sports organizations. With the rise of positive psychology, exploring the mechanisms of athlete psychological fatigue through the lens of psychological capital has become a focal point of recent research. This study introduces gratitude, a key element of psychological capital in positive psychology, to examine its effect on athlete burnout and its mechanism of action, with a particular focus on the sequential mediating roles of the coach–athlete relationship (CAR) and hope.

Method: A cross-sectional study design was utilized, involving 483 active Chinese athletes from national training teams and professional sports teams. The sample comprised both male (n=251) and female (n=232) athletes, with an average age of 19.24 ± 3.99 years. Participants were asked to complete self-administered questionnaires, including the Gratitude Questionnaire, CAR Questionnaire, Hope Questionnaire, and Athlete Burnout Questionnaire. Structural equation modeling in AMOS 24.0 and descriptive statistics and correlation analyses in SPSS 20.0 were employed for data analysis.

Results: The study revealed significant associations between athlete gratitude, CAR, hope, and athlete burnout. Notably, gratitude was found to both directly and indirectly (via CAR and hope) influence burnout levels among athletes, suggesting a sequential mediation effect.

Conclusion: The findings highlight the importance of positive psychological constructs in buffering against athlete burnout. Specifically, gratitude, alongside a supportive CAR and elevated levels of hope, may play crucial roles in mitigating burnout symptoms. These insights offer promising directions for the development of targeted intervention strategies aimed at fostering athlete well-being and performance, advocating for the integration of positive psychology principles in the management and prevention of athlete burnout.

KEYWORDS

athlete burnout, gratitude, coach–athlete relationship, hope, positive psychology

TABLE 1 A synopsis of typical symptoms of burnout.

Dimension	Typical symptoms
Emotional/Physical Exhaustion	"I've lost most of my enthusiasm. I just go through the motions during training to satisfy my own expectations." "My body feels stiff all over, with aching waist and back." "I feel completely drained, as if nothing matters anymore."
Reduced sense of accomplishment	"There was a time when I simply did not want to train anymore, perhaps because the plan was inappropriate. I felt I could not improve, and mentally I felt defeated." "As I get older and reach my potential limits, I start to think that maybe this is the best I can achieve." "Day after day, year after year, I have no idea when it will all end." "Sometimes my coach puts me down, and I begin to doubt whether I am cut out for swimming."
Negative sport evaluation	"Sometimes, not winning a championship seems irrelevant; I just feel that finishing is enough." "Swimming is exhausting and monotonous, while playing badminton or basketball is much more enjoyable." "My body is constantly injured, which affects my training and prevents me from improving my performance. I'm at a loss; I feel I can neither quit nor continue, especially with so many people watching."

The above symptoms were identified through interviews with elite swimmers.

1 Introduction

In the dynamic environment of competitive sports, athletes are subject to an array of pressures, including stringent performance expectations, rigorous selection processes, and elevated risks of injury. These challenges contribute significantly to the prevalence of psychological burnout among athletes, a state characterized by emotional exhaustion, a diminished sense of achievement, and devaluation of sports participation (Raedeke and Smith, 2001; Gustafsson et al., 2017). Furthermore, psychological burnout adversely impacts an athlete's well-being and performance, as well as team dynamics and cohesion (Isoard-Gautheur et al., 2016).

The advent of positive psychology has shifted focus toward the exploration of how positive mental states and emotions, notably gratitude, can serve as a buffer against athlete burnout. Gratitude, identified as a fundamental virtue within positive psychology, is posited to promote well-being and mitigate symptoms of burnout (Wood et al., 2009). Despite the broad positive outcomes associated with gratitude, such as enhanced positive emotions, well-being, prosocial behavior, and spirituality/religiosity (McCullough et al., 2002), the specific mechanisms through which gratitude impacts burnout among professional athletes remain underexplored, indicating a critical gap in research.

This study aims to address this gap by examining the influence of athletes' gratitude on burnout within the professional sports context, with a particular emphasis on the sequential mediating roles of the coach-athlete relationship (CAR) and hope. This approach not only seeks to extend the theoretical framework pertaining to gratitude in sports psychology but also endeavors to reveal practical interventions for alleviating athlete burnout. Hence, the significance of this research lies in its potential to deepen our understanding of the role of positive psychology in sports, especially through the lens of gratitude and its mediating effects on preventing and managing athlete burnout.

In summary, this investigation into the effects of gratitude on athlete burnout among professional athletes fills an essential gap in the literature, offering a nuanced understanding of how gratitude, in conjunction with supportive relationships and hope, can form a vital component in the psychological toolkit against burnout, ultimately fostering athletes' well-being and success in competitive sports.

2 Theoretical background and research hypotheses

Within the competitive sports domain, athlete burnout is characterized as a decrement in psychological functioning, precipitated by the continuous depletion of mental and physiological resources due to internal and external pressures, absent sufficient recovery. Manifestations of this condition include three primary dimensions: emotional/physical exhaustion, reduced sense of personal accomplishment, and a devaluation of sports participation (Zhang et al., 2006). Table 1 presents the archetypal symptoms associated with each dimension. Previous research has demonstrated that burnout can have detrimental effects on athletes' physical and mental health, potentially impairing performance, undermining social relationships, and leading to a discontinuation of sports participation (Raedeke and Smith, 2001; Zhang, 2010; Zhang et al., 2014).

Research into athlete burnout has historically employed Smith's (1986), viewing burnout as a culmination of chronic stress. Moreover, investigators have deployed various theoretical frameworks to explore this phenomenon, including the Negative Training Stress Response Model, the Identity Development and External Control Model, and the Athletic Commitment Model. The advent of positive psychology has introduced a novel perspective, incorporating constructs of psychological capital to examine the underlying mechanisms of athlete burnout, indicating a critical shift in contemporary research trajectories (Zhang et al., 2014; Ye et al., 2016b).

Theoretical research suggests that gratitude may help alleviate athlete burnout. Fredrickson (2004) posited that gratitude, a positive emotion, has the potential to broaden individuals' thought processes

and foster creative thinking, as proposed by the Broaden-and-Build Theory. This cognitive broadening can lead to novel approaches in expressing gratitude, reciprocating to others, developing loving and thankful skills, and building friendships and social networks. These resources, in turn, become enduring personal assets that enhance resilience to stress and adversity. Consequently, they are less likely to resort to negative coping strategies such as avoidance, self-blame, substance abuse, or denial, which could mitigate the adverse effects of athlete burnout. Empirical research substantiates the adaptive benefits of gratitude in reducing psychopathological symptoms, such as depression and post-traumatic stress disorder, significantly improving subjective well-being and self-efficacy, and boosting physical health (Tennen et al., 2009; Wood et al., 2009). Furthermore, studies have found that gratitude improves sleep quality, which, in turn, boosts physical health (Wood et al., 2009). It is also a significant predictor of a decrease in symptoms like dizziness and headaches (Froh et al., 2009).

Considering the established research, our study seeks not merely to reaffirm the negative correlation between gratitude and athlete burnout but to delve deeper into this relationship. Specifically, we aim to explore how gratitude interacts with other psychological constructs within the athletic context and its impact on the multifaceted nature of burnout. Therefore, this paper advances the hypothesis:

> *H1*: Gratitude is a significant negative predictor of athlete burnout, with our study providing further insight into its role and interactions within the context of competitive sports.

Previous studies have shown that the onset and progression of athlete burnout are associated with a spectrum of physiological, psychological, and sociological factors. The coach-athlete relationship (CAR) and hope are recognized as pivotal mediators in how gratitude might affect athlete burnout. CAR involves a dynamic interaction of emotional, cognitive, and behavioral elements between coaches and athletes. Meanwhile, hope refers to the experiential success resulting from the synergistic operation of pathway and agency thought processes during the pursuit of goals, representing cognitive and behavioral inclinations.

The moral affect theory of gratitude highlights the importance of moral motivation, suggesting that feelings of gratitude can lead to increased prosocial behaviors and motivations, such as altruism, care, sharing, and forgiveness. It also prompts a proactive search for opportunities to reciprocate to benefactors (McCullough et al., 2001). Individuals with high levels of gratitude tend to experience fewer interpersonal conflicts and societal obstacles (Gan, 2012). Algoe et al. (2008) examined the impact of gratitude among sorority members and found that greater gratitude in recipients led to better quality in establishing and maintaining interpersonal relationships. Further, Algoe et al. (2012) discovered that expressions of gratitude in one romantic partner significantly enhanced the perceived responsiveness of the other partner, which was predictive of relationship improvements over a six-month trajectory.

In the field of athletics, athletes with high levels of gratitude seek to understand their coaches' perspectives during crises within the CAR. They appreciate the coach's dedication and efforts and seek to mend the relationship (Wang et al., 2014). Qualitative studies on athlete burnout have identified that a harmonious CAR, characterized by effective communication, active listening, and empathetic concern from the coach, can provide athletes with greater social support, thereby mitigating the negative impact of burnout attributed to sports

activity (Cresswell and Eklund, 2005). Moreover, positive social interactions, such as valuable advice, timely encouragement, and assistance, have been found to correlate negatively with sports-related athlete burnout (DeFreese and Smith, 2014). In summary, gratitude not only promotes harmonious interpersonal relationships but also fosters the development of the CAR, which is closely associated with athlete burnout. Consequently, this paper proposes the hypothesis:

> *H2*: The CAR mediates the effect of athletes' gratitude on their burnout.

The broaden-and-build theory of positive emotions posits that gratitude can lead individuals to positively assess their present and future, fostering prosocial behaviors that foster social cohesion and strengthen interpersonal resources (Fredrickson and Branigan, 2005). These interpersonal resources, in turn, expand individuals' coping strategies when faced with stress, aligning with the pathways thinking aspect of hope theory. Additionally, gratitude reinforces motivation; individuals with high levels of gratitude report greater recognition of social support from others, including parental upbringing, coaching, and friendship. This increased recognition is manifested as sustained passion and motivation during training and competitions, in harmony with the agency thinking aspect of hope theory. Individuals with high hope levels, who exhibit strong agency and pathways thinking, tend to view stressors as challenges and are more likely to engage in positive actions (Snyder, 2000). Furthermore, research indicates that hope alleviates burnout among college athletes, enhances achievement motivation, and stimulates learning interest (Xie et al., 2016). In sports, hope is inversely related to the three dimensions of burnout; athletes with higher hope levels report significantly lower burnout scores. Moreover, hope not only directly reduces sports-related burnout but also serves as an indirect influence through the mediating effects of positive emotions and perceived stress (Gustafsson, 2010; Gustafsson et al., 2011). Therefore, this paper proposes the hypothesis:

> *H3*: Hope mediates the relationship between athletes' gratitude and their burnout.

Hope emerges from stable and secure attachment relationships and is closely connected to social connectedness (Snyder, 2002). As social groups develop, they commonly establish ideologies and norms. To align with the group's collective standards, individuals engage in cooperation within the group and intra-group competition, which simultaneously enhances their agency thinking. Additionally, within social groups, members offer mutual support and actionable advice, aiding in the identification of concrete methods to achieve collective goals, thus enhancing individuals' pathways thinking. A harmonious and effective CAR promotes more positive and effective communication (Jowett, 2012). Such a relationship significantly increases an athlete's hope level and, through hope, increases satisfaction with athletic performance while reducing the negative effects of external pressures (Ye, 2016b). There is a clear link between athletes' gratitude and the CAR, which affects the athletes' hope level, and consequently, hope predicts athlete burnout. Consequently, this study proposes the following hypothesis:

> *H4*: The CAR and hope act as serial mediators between athletes' gratitude and athlete burnout.

3 Methods

3.1 Research design and sampling method

This study adopted a convenience sampling strategy to select athletes from national training teams and professional sports teams across varied provinces and cities, including Beijing, Hubei, Zhejiang, Heilongjiang, Guangdong, and Yunnan. In total, 502 questionnaires were distributed, and 483 valid responses were received, resulting in an effective response rate of 96.2%. The participant demographic was composed of 251 males (52.0%) and 228 females (47.2%), with gender information missing for 4 participants. Additionally, 11 participants (2.3%) did not specify their competition level. The average age of the athletes was 19.24 years (SD = 3.99), and the average training duration was 6.86 years (SD = 3.55). Athletes' competition levels varied, including secondary level (40 participants), first level (218 participants), national master level (180 participants), and international master level (34 participants), with 11 participants not specifying their level.

The survey included a broad range of sports disciplines, such as marathon, martial arts, gymnastics, shooting, archery, clay pigeon shooting, cycling, triathlon, modern pentathlon, swimming, canoeing, middle and long-distance running, weightlifting, basketball, volleyball, boxing, judo, taekwondo, wrestling, high jump, tennis, and equestrian. The convenience sampling method facilitated rapid and efficient access to a diverse group of professional athletes, offering a practical solution amidst constraints of resources and time, despite the potential limitations in statistical representation inherent to this sampling method. Our direct engagement with athletes at their training bases and schools enhanced the depth and authenticity of the collected data.

3.2 Data collection procedure

The data collection process was rigorously designed to adhere to ethical guidelines, safeguarding the privacy and confidentiality of participant data. This study received ethical clearance from the Institutional Review Board (IRB) of Central China Normal University, emphasizing our commitment to conducting research with the utmost integrity and respect for participant welfare. Data collection was executed on a team basis using a group testing method, allowing for an extensive reach across a diverse range of athletes. Prior to data collection, explicit consent was obtained from both team leaders and athletes, ensuring their informed participation. Furthermore, participants were compensated for their valuable contribution to the research.

The task of collecting data was entrusted to graduate students specializing in sports psychology, all of whom had received rigorous training to perform this role efficiently. This team's expertise guaranteed the precision and effectiveness of the data collection process. To protect participant privacy, all questionnaires were completed anonymously. Participants were assured of the strict confidentiality of their responses, which would be used solely for scientific analysis. Detailed instructions were provided to encourage thorough and independent responses, thus ensuring the data's authenticity and reliability. Each participant was given approximately 20 min to complete the questionnaire, which was then immediately collected on-site to maintain data integrity.

Employing an on-site data collection strategy not only improved the response rate but also the accuracy and reliability of the collected data, thereby significantly enhancing the research's quality and integrity. Our systematic approach in recruiting participants actively engaged in structured training environments, coupled with a rigorous review of returned questionnaires, further solidified the validity of our findings. This meticulous attention to ethical standards and data collection methodology underscores our dedication to producing credible and ethically sound research outcomes.

3.3 Measures

3.3.1 Gratitude questionnaire

The study employed the Gratitude Questionnaire (GQ) as adapted by Chen and Kee (2008), which was originally developed by McCullough et al. (2002). This scale employs a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), where higher scores reflect higher levels of gratitude. The questionnaire is composed of 5 items, including "Listing everyone I feel grateful to during my sporting career would be a lengthy process," with the third item being reverse-scored. Confirmatory factor analysis indicated the following results: $\chi^2/df = 12.34$, indicating good structural validity for this version of the questionnaire. The original English version of the GQ had a reliability coefficient of 0.87 (McCullough et al., 2002). In the present study, the overall reliability of the Gratitude Scale was found to be 0.80, indicating good reliability. The GQ total score showed a moderate correlation with several theoretical constructs relevant to the scale (namely happiness, optimism, agreeableness, and extraversion), which suggests good criterion-related validity (Chen et al., 2009).

3.3.2 Athlete burnout questionnaire

The study utilized the Athlete Burnout Questionnaire (ABQ) in its form revised by Zhang et al. (2010), which was originally developed by Raedeke and Smith (2001). The scale employs a Likert 5-point scale (1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = always), where higher scores denote higher levels of psychological burnout, and lower scores reflect lower levels. It comprises 15 items, such as "Training tires me out so much that I do not have the energy to do other things," and "I am unable to concentrate during competitions as I used to," and includes three subscales: emotional/physical exhaustion, reduced sense of accomplishment, and devaluation in sport. These subscales account for 61.66% of the variance. Confirmatory factor analysis utilizing the maximum likelihood estimation on a first-order three-factor model of the Athlete Burnout Questionnaire yielded: $\chi^2/df = 4.29$, RMSEA = 0.08, SRMR = 0.05, GFI = 0.91, NFI = 0.87, CFI = 0.90, IFI = 0.90, suggesting good construct validity for this iteration. The subscales' reliabilities for emotional/physical exhaustion, reduced sense of accomplishment, and sport devaluation, as translated into Chinese by Lu et al. (2006), were 0.88, 0.87, and 0.70, respectively. The scale's overall reliability was measured at 0.78 in this study, with the subscales for emotional/physical exhaustion, reduced sense of accomplishment, and sport devaluation recording reliabilities of 0.78, 0.78, and 0.62 respectively, confirming good reliability. The scale demonstrated a significant positive relationship against the Chinese version of the ABQ translated by Lu et al. (2006), supporting good criterion-related validity.

3.3.3 CAR questionnaire

The study employed the CAR Questionnaire (CART-Q) following the revisions of Zhong and Wang (2007), adapted from the Greek version of the CART-Q developed by Jowett and Ntoumanis (2004). This questionnaire utilizes a Likert 5-point scale (1 = strongly disagree; 2 = disagree; 3 = somewhat agree; 4 = mainly agree; 5 = strongly agree) for scoring, with higher scores signifying more positive coach-athlete relationships (CARs) and lower scores denoting less satisfactory relationships. It features 15 items, such as "I am loyal to my coach and am willing to maintain a long-term cooperation with him," and "I am open to my coach's advice and suggestions," covering three dimensions: closeness, commitment, and complementarity, which account for 64.525% of the variance. Confirmatory factor analysis revealed: $\chi^2/df = 4.98$, RMSEA = 0.081, SRMR = 0.049, GFI = 0.90, NFI = 0.89, CFI = 0.91, IFI = 0.91. The original CAR Questionnaire demonstrated reliabilities for closeness, commitment, complementarity, and compliance of 0.87, 0.82, 0.88, and 0.93, respectively. In this study, the dimensions' reliabilities were measured at 0.85, 0.86, 0.81, and 0.84, respectively, confirming the questionnaire's good reliability. The overall scale score demonstrated significant correlations with two criterion items from the Greek version of the CART-Q (0.689 and 0.696), suggesting good criterion-related validity of the translated version of the questionnaire.

3.3.4 Trait hope scale

The Trait Hope Scale (THS), following the revisions by Chen et al. (2009) based on the original scale by Snyder et al. (1991), was employed in the study. The scale comprises 12 items, such as "I can think of many ways to get out of a bind" and "I have been successful in my athletic career," and is comprised of two dimensions: agency thinking and pathways thinking. It employs a Likert 5-point scale (1 = strongly disagree; 2 = disagree; 3 = somewhat agree; 4 = agree; 5 = strongly agree), with higher scores reflecting greater levels of hope. The confirmatory factor analysis yielded: $\chi^2/df = 3.81$, RMSEA = 0.076, SRMR = 0.042, GFI = 0.96, NFI = 0.94, CFI = 0.96, IFI = 0.96. The English version of the THS demonstrated reliabilities across agency and pathways thinking domains of 0.74 and 0.84, respectively. In the current study, the questionnaire exhibited an overall reliability of 0.82, with reliabilities for agency and pathways thinking at 0.69 and 0.78, respectively, and exhibited a test–retest correlation coefficient of 0.80, indicating consistency with the reliability of the English version of the Hope Scale. Validity testing revealed that agency and pathways thinking dimensions of the Hope Scale were significantly positively correlated with a proactive coping approach and significantly negatively correlated with a passive coping style, consistent with international research findings (Woodward et al., 2006), indicating good criterion-related validity of the scale.

3.4 Data analysis

Data were organized, processed, and analyzed using SPSS 20.0 and AMOS 24.0 software. Beyond descriptive statistics and bivariate correlations, the study primarily employed Structural Equation Modeling (SEM) as the method of data processing, with the significance level established at $\alpha = 0.05$. While these components—emotional/physical exhaustion, reduced sense of achievement, and negative sports appraisal—are facets of burnout, their distinct contributions must be considered and not aggregated. The utilization of Zhang et al.'s (2010) weighted total score formula for burnout (Burnout Weighted Total Score = Z-score for Reduced Sense of Achievement × 0.47 + Z-score for Emotional/Physical Exhaustion × 0.21 + Z-score for Negative Sports Appraisal × 0.32) facilitated the derivation of the composite burnout score. These scores were additionally subjected to individual analyses for each dimension. The research not only examined the mediating roles of the CAR and hope between gratitude and the composite burnout score but also their intermediary functions between gratitude and the three discrete dimensions of burnout. These analyses elucidated the complex interplay among these variables, contributing to a deeper understanding of athlete burnout.

4 Results

4.1 Control and test for common method bias

Data were collected through self-report measures in this study, which raises the potential for common method bias. To mitigate this, the administration of the measures included imposing strict procedural controls regarding the data's confidentiality, anonymity, and exclusive use for scientific research. Furthermore, Harman's single-factor test was applied for analytic examination (Podsakoff et al., 2003; Zhou and Long, 2004). This method involved loading all measurement items of the study variables into a single factor to create a one-factor model and contrasting it with the fit indices of an 11-factor model that aligned with the theoretical dimensions. The results indicated that the fit indices for the 11-factor model ($\chi^2 = 1959.39$, df = 979, $\chi^2/df = 2.00$, RMSEA = 0.05, CFI = 0.90, IFI = 0.90, TLI = 0.88) were significantly better than those for the single-factor model ($\chi^2 = 6208.24$, df = 1,034, $\chi^2/df = 6.00$, RMSEA = 0.10, CFI = 0.44, IFI = 0.44, TLI = 0.41), which suggests that a serious common method bias is unlikely in the current study.

4.2 Correlation analysis of gratitude, CAR, hope, and burnout

As presented in Table 2, upon controlling for demographic variables (gender, age, years of athletic participation, and level of competition), gratitude, CAR, and hope showed a significant negative correlation with burnout. Moreover, gratitude and CAR demonstrated a significant positive correlation with hope, and gratitude was significantly positively correlated with the CAR. The absolute values of the correlation coefficients among the study variables ranged between 0.32 to 0.50, indicating their appropriateness for further analysis. The mean scores for gratitude and the CAR were notably high, potentially reflecting the influence of social desirability effects, while the limited variability could be attributed to a ceiling effect.

TABLE 2 Correlation coefficients among gratitude, CAR, hope, and burnout (N = 483).

	M	SD	1	2	3	4
1. Gratitude	4.12	0.75	1.00			
2. CAR	4.01	0.72	0.50***	1.00		
3. Hope	3.46	0.62	0.41***	0.33***	1.00	
4. Burnout	2.47	0.63	−0.41***	−0.39***	−0.32***	1.00

*p < 0.05, **p < 0.01, ***p < 0.001; the same below.

TABLE 3 Regression analysis overview for testing the mediation effects of CAR and hope between gratitude and burnout.

Regression equation		Overall model fit			Regression coefficient significance	
Outcome variable	Predictor variable	*R*	R^2	*F*	*β*	*t*
CAR	Gratitude	0.52	0.28	28.10***	0.52	11.70***
Hope	Gratitude	0.51	0.26	28.89***	0.27	5.29***
	CAR				0.19	3.58***
Burnout	Gratitude	0.50	0.25	18.54***	−0.23	−4.33***
	CAR				−0.21	−3.42***
	Hope				−0.19	−3.56***

All variables were standardized before being entered into the regression equation.

TABLE 4 Overview of bootstrap analysis for the mediating effects of CAR and hope between gratitude and burnout.

Path	Standardized effect	Proportion of total effect	Boot standard error	95% Confidence interval		Significance
				Lower limit	Upper limit	
Total effect	−0.41	—	0.04	−0.49	−0.33	Significant
Total indirect effect	−0.18	43.90%	0.03	−0.24	−0.12	Significant
Gratitude → CAR → Burnout	−0.11	26.83%	0.03	−0.17	−0.05	Significant
Gratitude → Hope → Burnout	−0.05	12.20%	0.02	−0.09	−0.02	Significant
Gratitude → CAR → Hope →Burnout	−0.02	4.88%	0.01	−0.04	−0.01	Significant

4.3 Examination of the mediating effect of CAR and hope between gratitude and burnout
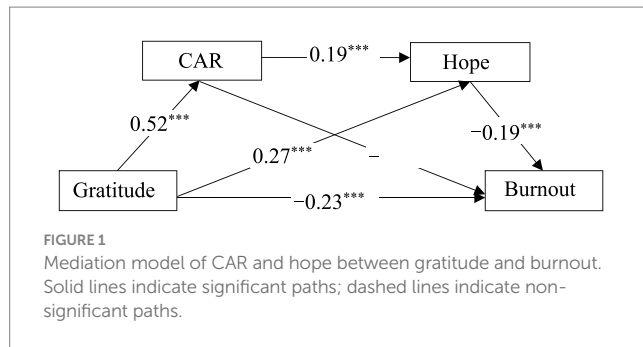
Following the recommendation of Fang et al. (2012), the percentile Bootstrap method with bias correction offers superior statistical power compared to the traditional Sobel test. Consequently, this study employed the SPSS macro program PROCESS, developed by Hayes (2013),[1] and controlled for demographic variables including gender, age, duration of sports participation, and level of athletic competition. Mediation effects were evaluated through a structural equation model, based on 5,000 bootstrap samples to establish 95% confidence intervals.

Preliminary results, as shown in Table 3, indicated that gratitude maintained a significant positive influence on CAR ($β = 0.52$,

$p < 0.001$). When gratitude and CAR were predictors of hope, gratitude maintained a significant positive influence ($β = 0.27$, $p < 0.001$), and CAR also displayed a significant positive impact ($β = 0.19$, $p < 0.001$). When gratitude, CAR, and hope were introduced into the regression equation concurrently, each variable exhibited a significant negative predictive influence on burnout ($β = −0.23$, $p < 0.001$; $β = −0.21$, $p < 0.001$; $β = −0.19$, $p < 0.001$), indicating a significant mediating role of CAR and hope in the relationship between gratitude and burnout.

Furthermore, detailed scrutiny of the mediation effects, as presented in Table 4, showed that the total indirect effects produced by CAR and hope did not include zero within the 95% Bootstrap confidence interval, indicative of a significant mediating effect by the two variables between gratitude and burnout. The mediation effect comprises three indirect effects: (1) The first, generated by the path "Gratitude → CAR → Burnout," with the confidence interval excluding zero, indicates a significant CAR mediation between gratitude and burnout (−0.11, contributing to 26.83% of the total effect); (2) the second, generated by the path "Gratitude → Hope → Burnout," with the confidence interval excluding zero, indicates a significant hope mediation between gratitude

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1 http://www.afhayes.com

FIGURE 1
Mediation model of CAR and hope between gratitude and burnout.
Solid lines indicate significant paths; dashed lines indicate non-
significant paths.

and burnout (−0.05, contributing to 12.20% of the total effect); and (3) the third, generated by the path "Gratitude → CAR → Hope → Burnout," with the confidence interval excluding zero, indicates partial mediation by CAR and hope between gratitude and burnout (−0.02, contributing to 4.88% of the total effect). Based on these results, a serial mediation model as depicted in Figure 1 can be constructed, accounting for 25% of the variance in burnout.

5 Discussion

This study investigated the association between athlete gratitude and burnout, considering the perspectives of CARs and hope, and the mechanisms underlying this relationship. The findings indicate a significant negative correlation between athlete gratitude and burnout, with additional regression analysis demonstrating that athlete gratitude significantly predicts lower levels of burnout, thereby supporting Hypothesis H1. Athlete gratitude was also identified as being significantly positively correlated with the CAR; subsequently, a strong CAR was observed to significantly predict lower burnout, thus confirming Hypothesis H2. The mediation analysis revealed that the CAR and hope mediate the influence of athlete gratitude on burnout. This mediation effect unfolded via two pathways: the independent mediating role of hope and the sequential mediating effect of the CAR to hope, thereby validating Hypotheses H3 and H4. In summary, all four hypotheses proposed in this study have been corroborated by empirical evidence.

5.1 The direct effects of gratitude on burnout

Gratitude, recognized as a positive and affirming emotion, can broaden an individual's scope of thought and action. Individuals who habitually practice gratitude tend to focus on the positive and pleasant aspects of life, enhancing their ability to recover from the negative effects of adverse events (Fredrickson, 2004). According to gratitude coping theory, those with a strong propensity for gratitude are more likely to engage in positive coping strategies when faced with challenging or risky situations (Fredrickson and Cohn, 2008). These individuals view everything they have, including life itself, as a gift, meeting life's challenges with heightened positivity and optimism, which facilitates better social adaptation and well-being (Wood et al., 2007, 2008, 2009).

In the context of sports, gratitude can broaden athletes' cognitive and behavioral patterns, bolster personal resources, and provide the essential material and psychological support necessary to strengthen resilience against setbacks and diminish the negative impact of distressing emotions. This enhancement of psychological well-being contributes to the prevention of burnout. Empirical evidence suggests that athletes' gratitude leads to greater investment in their sport and adherence to ethical behavior, thereby fostering improved engagement in training and competition, superior performance, and recognition from coaches and peers (Wang et al., 2014; Ye, 2016). Additionally, athletes with a pronounced sense of gratitude are more apt to attribute their successes to the collective efforts of their support networks, including their country, family, coaches, and teammates. Confronted with competitive stress or the adversities of life, such athletes typically embrace an optimistic and proactive approach, successfully circumventing negative appraisals in sports.

5.2 The mediating effects of the CAR and hope on the relationship between gratitude and burnout

In the nexus of interpersonal dynamics, the Coach-Athlete Relationship (CAR) acts as a critical bridge. Gratitude fosters the development of a harmonious CAR, which is instrumental in building and sustaining social bonds. The expansive cognitive and behavioral effects of gratitude facilitate the creation and preservation of positive social connections, thereby attracting enhanced social support (Fredrickson, 2004; Fredrickson and Branigan, 2005; Wood et al., 2009). In the domain of sports, athletes who possess a strong propensity for gratitude can adopt their coaches' perspectives during crises within the CAR, acknowledging the coaches' sincere efforts and dedicating themselves to repairing any rifts (Gan, 2012). This propensity toward gratitude also influences coaches, who respond with proactive prosocial behaviors, nurturing the growth of a harmonious rapport. Additionally, the CAR has been shown to inversely predict burnout, with harmonious interactions enabling athletes to maintain robust relationships and emotional connections with coaches, thus mitigating undue interpersonal stress and curbing the onset of burnout symptoms (Jowett, 2009; Adie and Jowett, 2010; Tabei et al., 2012).

Hope, as elucidated by the broaden-and-build theory, serves as a mediator in the gratitude-burnout relationship. Individuals with a strong disposition toward gratitude are likely to perceive the world more positively and proactively expand their cognitive horizons with an inclusive mindset, thereby effectively managing stress (Fredrickson, 2004; Fredrickson and Branigan, 2005). Research by Chen and Chi (2012, 2015) corroborates that hope and self-confidence are significantly tied to enhanced athletic performance, suggesting that elevated levels of these attributes in college athletes correlate with superior performance outcomes. An augmentation in hope allows individuals to sustain agency and pathways thinking, essential when confronting challenges or stress, safeguarding against negative affectivity and thus

forestalling or lessening burnout (Gustafsson et al., 2010). Consequently, psychological interventions targeting burnout could potentially be optimized by concentrating on elevating hope levels, which may improve athletic performance while simultaneously mitigating burnout risks.

5.3 The sequential mediating effects of CAR and hope on the relationship between gratitude and burnout

McCullough et al. (2002) contend that gratitude, conceptualized as a moral emotion, serves as a vital cohesive force within social collectives. Within the context of coach-athlete dyads, a harmonious CAR promotes positive and efficacious interactions that alleviate interpersonal tensions, thereby fortifying athletes' sense of self-identity, clarifying their motivational direction, and amplifying their satisfaction derived from athletic endeavors. This environment is conducive to fostering a hopeful disposition, an optimistic state that buffers against adverse feelings and behaviors (Tennen et al., 2009; Jowett and Nezlek, 2012; Ye et al., 2016a,b). Gustafsson et al. (2010) further reveal that hope robustly negates the propensity for athlete burnout. The present study indicates that athletes endowed with elevated hope are adept at navigating adversities, utilizing optimal strategies to surmount challenges, and maintaining heightened motivation. Hope is instrumental not only in facilitating success when free from impediments but also in proactively addressing and ameliorating psychological distress in response to stressors and adversities, thereby diminishing manifestations of athlete burnout. In summation, both CAR and hope constitute integral components of a 'mediatory chain' that links gratitude to athlete burnout, delineating a complex interplay of psychological constructs that underlie the well-being of athletes.

5.4 Limitations and future research

This study adopts a cross-sectional design, constraining the extent to which causal relationships can be inferred among the examined variables. Recognizing that athlete burnout fluctuates over time, as suggested by Gustafsson et al. (2010), longitudinal research could offer a more nuanced understanding of its progression. The analysis of the CAR in this study is limited to athletes' self-reports, omitting coaches' perspectives, which may provide a more comprehensive overview of the CAR dynamic. Consequently, future studies should consider incorporating matched reports from both coaches and athletes to enrich the understanding of CAR. Methodologically, while the current study constructs a mediation model exploring the interp r mediating roles in the gratitude-burnout nexus, future studies may delve deeper into how gender and sports performance influence these relationships. Our preliminary analyses indicate that these factors might significantly affect the psychological state of athletes. In particular, further research could explore the relationship between technical level and athlete burnout and consider how this relationship may evolve over time.

6 Conclusion

The research findings indicate that gratitude, CAR, and hope are integral in attenuating athlete burnout, serving as potent negative predictors. The sequential mediation model elucidated herein demonstrates that gratitude impacts athlete burnout indirectly through CAR and hope, both individually and in combination. These insights provide a theoretical foundation and practical framework for creating interventions aimed at diminishing athlete burnout. To optimize future intervention strategies, enhancing athletes' gratitude levels, nurturing harmonious CAR, and fostering hope are pivotal. Such measures could not only mitigate the incidence of burnout but also enrich the overall psychological resilience of athletes, thereby contributing to their well-being and performance longevity.

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 China University of Geosciences. 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

LD: Writing – original draft, Writing – review & editing. RF: Formal analysis, Methodology, Project administration, Supervision, Writing – review & editing. SZ: Supervision, Writing – review & editing. BW: Project administration, Writing – review & editing. LY: Project administration, 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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Factors influencing perseverance in teaching Chinese martial arts abroad: a self-determination theory perspective among international instructors

Xueying Cao[1] and Hui Lyu[2]*

[1]Faculty of Sports Science, Ningbo University, Ningbo, China, [2]Ningbo Innovation Center, Zhejiang University, Ningbo, China

Background: The global dissemination of Chinese martial arts (CMAs), transcends mere physical activity; it represents a cultural and philosophical journey that contributes to enhanced psychological well-being. Capturing international attention, CMAs have engendered a network of global instructors committed to their cross-cultural teaching. However, the narrative of CMAs across the globe is incomplete without understanding the psychological factors that fuel the perseverance of these international instructors. Their relentless commitment, motivated by factors beyond the cultural and geographical barriers, poses a unique question: What motivates these instructors to persist in teaching CMAs in the face of such challenges? The study aims to uncover the key motivational mechanisms that influence the perseverance of international CMAs instructors in their teaching endeavors.

Methods: Employing Self-Determination Theory, 147 international CMAs instructors completed the Motivation for Teaching CMAs Scale, Perceived Belonging Scale, and Perseverance in Teaching CMAs Scale. SPSS 20.0 was utilized for conducting descriptive statistics, common method bias tests, and correlation analyses. Structural equation modeling was performed using AMOS 26.0.

Results: Autonomous Motivation positively affected perseverance in teaching CMAs ($\beta = 0.369$, $b = 0.465$, $t = 4.232$, $p < 0.001$). In contrast, Amotivation negatively affected perseverance ($\beta = -0.323$, $b = -0.382$, $t = -3.561$, $p < 0.001$). Neither Controlled Motivation nor Sense of Belonging significantly affected perseverance. The model explained 27.9% of the variance in perseverance, offering insights into the motivational mechanisms influencing international CMAs instructors.

Conclusion: This study concludes that the perseverance of international instructors in teaching CMAs is primarily driven by overcoming amotivation and fostering autonomous motivation, rather than short-term internal or external incentives, which appear ineffective. Additionally, sense of belonging to their CMA school does not significantly influence their perseverance, potentially due to the diverse cultural backgrounds of the instructors surveyed. The findings suggest that by enhancing the recognition and acceptance of CMAs' core philosophies and values, aligning teaching practices with personal and cultural values, and fostering a profound passion for CMAs, international instructors could boost their autonomous motivation, which is crucial for their sustained commitment in promoting CMAs globally.

1 Introduction

The global dissemination of Chinese martial arts (CMAs), known as Wushu, transcends the mere transmission of physical skills, embodying a rich tapestry of cultural heritage, philosophy, and psychological well-being (Jennings et al., 2010; Guo et al., 2014; Kee, 2019). CMAs, a term that encapsulates a variety of styles and practices originating from China, has not only been a cornerstone of Chinese cultural identity but has also captivated the interest of enthusiasts and practitioners worldwide (Farrer and Whalen-Bridge, 2011; Lau, 2022). This international appeal has led to the emergence of a dedicated cadre of instructors who play a pivotal role in the cross-cultural exchange and teaching of CMAs outside its homeland.

Teaching CMAs abroad encompasses more than mere cultural dissemination; it represents a practice that underscores the harmony between mind and body, fostering psychological resilience, discipline, and well-being (Jennings, 2014). As CMAs continue to weave their narrative across the globe, grasping the psychological drivers that underpin the perseverance of international instructors becomes paramount. These individuals serve not only as ambassadors of CMAs but also as custodians of its cultural and psychological significance. Their dedication to teaching in environments markedly different from the art's origins magnifies the critical role of motivation behind their commitment. This commitment raises a compelling inquiry into the motivations or forces that sustain their teaching endeavors despite the challenges posed by cultural and geographical dislocation.

While existing literature has extensively explored the technical training aspects and cultural values of CMAs, there appears to be a significant gap in understanding the motivational dynamics of international CMAs instructors. Research highlighting the biomechanical and physiological benefits of CMAs practice, especially its positive effects on physical health and skill development (Lip et al., 2015; Wang et al., 2024). Concurrently, the work of Guo et al. (2014) has elucidated the cultural and historical significance of CMAs, underscoring its role in promoting Chinese heritage globally. However, these inquiries have predominantly concentrated on the art form itself, with limited attention given to the instructors who are pivotal in its cross-cultural transmission.

Specifically, the psychological resilience and motivation required for instructors to persist in teaching CMAs, especially in environments vastly different from their origins, remain poorly understood. Although some studies have noted the pedagogical challenges CMAs instructors face in non-native settings (Sun and Wang, 2011; Yuan, 2017; Lu and Li, 2019), the detailed investigation into the motivational factors that empower these instructors to overcome such challenges has yet to be conducted. This oversight highlights a critical research gap: the lack of comprehensive understanding of what drives international CMAs instructors to continue their teaching endeavors despite the obstacles they face.

This study aims to fill this gap by applying Self-Determination Theory (SDT) to explore the intrinsic and extrinsic motivational factors influencing the perseverance of international CMAs instructors. By shifting the focus from the art form to the educators behind its global dissemination, this research contributes to a more nuanced understanding of the psychological factors that support the sustained teaching of CMAs abroad.

Self-Determination Theory (SDT), is a widely recognized framework for understanding human motivation and psychological well-being. Developed by Deci and Ryan (1985), SDT distinguishes between different types of motivation based on the degree to which they are self-determined or autonomous. Based on the nature of motivation, SDT categorizes motivation into three major types: autonomous motivation, controlled motivation, and amotivation. Autonomous motivation further encompasses three specific forms of motivation: intrinsic motivation integrated regulation, and identified regulation; controlled motivation includes two specific forms: introjected regulation and external regulation (Vansteenkiste and Sheldon, 2006; Ratelle et al., 2007). Intrinsic motivation represents the highest degree of autonomy in motivation, referring to behaviors that are driven entirely by internal interest and pleasure, unrelated to any external rewards. Integrated regulation is a form of motivation with a high degree of autonomy, where external objectives are accepted as personally important goals, and these goals are integrated into one's core values and beliefs. Identified regulation refers to a more autonomous form of motivation, where individuals recognize and accept the intrinsic value of a behavior, incorporating it into their sense of self. Introjected regulation refers to behavior taken to avoid feelings of guilt or self-reproach, with actions controlled by internal factors. External regulation is the form of motivation with the highest level of control, where people's performance and behavior are aimed at obtaining rewards or avoiding punishments, controlled by external factors. Amotivation describes a state in which an individual is either not motivated to act or acts without intentionality (Deci and Ryan, 2000; Ryan and Deci, 2000).

In the domain of sports psychology, SDT has been applied to understand the motivation behind sports participation, coaching behaviors, and athletes' performance and persistence (Ratelle et al., 2007; Reynders et al., 2019). Despite this, the application of SDT in the context of international CMAs teaching remains scantily explored. In light of this, the current study aims to fill this gap by exploring the motivational factors affecting the persistence of international CMAs instructors in overseas teaching, thereby further deepening the understanding of psychological dynamics in the context of cultural and educational exchanges.

Research indicates that autonomous motivation, which includes intrinsic motivation, integrated regulation, and identified regulation, plays a crucial role in the persistence of behaviors (Ryan et al., 1997; Deci and Ryan, 2008; Keshtidar and Behzadnia, 2017). Identified regulation, a subcomponent of autonomous motivation, has been

FIGURE 1
Research Model. Note: PiTCMA – Perseverance in Teaching Chinese Martial Arts.
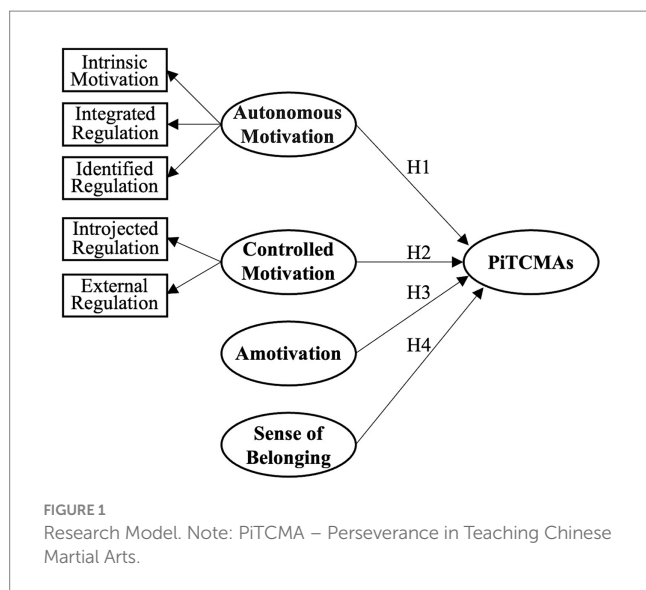
shown to be particularly highly related to persistence (Howard et al., 2021). The more an individual's behavior regulation aligns with autonomous motivation, the higher their willingness to engage, the level of initiative and involvement, and the duration of persistence (Oman and McAuley, 1993; Levesque et al., 2007; Dong and Mao, 2020). Based on these findings, this study proposes the following hypotheses (see Figure 1):

H1: Autonomous motivation, encompassing intrinsic motivation, integrated regulation, and identified regulation, will positively influence perseverance in teaching CMAs.

Controlled motivation, which encompasses introjected regulation and external regulation, refers to the type of motivation that is subject to external forces. Introjected regulation is a form of controlled motivation where behavior is regulated by internal pressures like self-esteem and pride, or by the desire to avoid guilt and self-reproach, which is considered to have lower voluntariness than autonomous motivation (Pelletier et al., 2001). External regulation, another component of controlled motivation, is influenced by external rewards or punishments and lacks interaction with intrinsic motivation (Vlachopoulos and Karageorghis, 2005). Howard et al. (2021) found that external regulation was not associated with persistence. Further, Keshtidar and Behzadnia (2017) found that controlled motivation does not significantly predict the intention to continue sport in the future. Given these insights, this study hypothesizes that:

H2: Controlled motivation, encompassing both introjected and external regulation, will not significantly affect the perseverance of instructors in teaching CMAs.

Furthermore, individuals lacking motivation or being completely amotivated are more likely to give up halfway (Vallerand et al., 1997). Higher levels of amotivation have been linked to increased sport dropout (Calvo et al., 2010). Consequently, it is hypothesized:

H3: Amotivation will negatively impact instructors' perseverance in teaching CMAs.

Incorporating the Self-Determination Theory (SDT), belongingness is identified as a fundamental psychological need, alongside autonomy and competence, that underpins human motivation and well-being (Deci and Ryan, 2000). The sense of belonging, or relatedness, is crucial for motivating self-determined behaviors, driving individuals to seek connections and nurture relationships, thereby fostering a sense of unity and mutual care within groups (Deci and Ryan, 1991). This theoretical perspective underscores the relational need for individuals to feel connected and valued within their social contexts. Carron et al. (1988) support this by demonstrating that team cohesion, which encompasses a strong sense of belonging, significantly correlates with sustained exercise behavior and adherence. Therefore, acknowledging the pivotal role of belonging within SDT's framework,

H4: A sense of belonging will significantly enhance the perseverance of instructors in teaching CMAs.

Although Self-Determination Theory (SDT) has been widely applied to understand motivation in sports participation, coaching behaviors, and athletes' performance and persistence (Ratelle et al., 2007; Reynders et al., 2019), its application in the context of international teaching of CMAs remains scantily explored. The current study aims to fill this gap by exploring the motivational factors affecting the persistence of international CMA instructors in their overseas teaching, thereby deepening our understanding of psychological dynamics within the context of cultural and educational exchanges. Specifically, this research focuses on the effects of autonomous motivation, controlled motivation, amotivation, and a sense of belonging on instructors' perseverance in teaching, aspects not thoroughly discussed in existing literature. By applying the theoretical framework of SDT to the practice of international CMAs teaching, this study not only unveils key psychological mechanisms driving instructors' sustained teaching commitment but also provides theoretical and practical guidance for promoting the global dissemination of CMAs. Therefore, this research contributes new perspectives to the field of cultural sports psychology, highlighting the significance of psychological well-being in the international protection and promotion of intangible cultural heritage.

2 Materials and methods

2.1 Participants

This study initially employed Apify's Google Maps Scraper service to harvest information on 16,382 Chinese Martial Arts (CMAs) dojos. Of these, 11,894 entries included website information. After removing duplicates—accounting for the fact that some dojos shared the same website, which led to repetitive website entries—the data set was refined to 8,929 unique website URLs. Subsequently, the study utilized the Octoparse Web Scraping Tool to methodically extract email addresses from the homepage of each of these 8,929 websites, ultimately gathering 2,374 email addresses.

Following data collection, a survey questionnaire, created using Google Forms, was distributed to the 2,374 acquired email addresses through a targeted "BCC" (blind carbon copy) email campaign. To further maximize information collection, the survey was also

disseminated within several Facebook groups centered on Chinese martial arts, such as Chinese Martial Art & Kung-Fu Club, Traditional Chinese Martial Arts Community, Chinese Martial Arts, Wing Chun Forum, Hakka Kung Fu, Wushu Stars, and Monkey Steals Peach. These groups were approached with prior consent from their administrators to post the survey invitation. This approach resulted in 156 international CMAs instructors completing the questionnaire.

The collected questionnaires underwent a rigorous screening process based on predetermined criteria, which included checking for patterned responses, inconsistencies in answers, and duplicate submissions. Following this scrutiny, a total of 147 questionnaires were deemed valid, achieving a valid response rate of 94.2%.

2.1.1 Demographic characteristics

Table 1 shows the basic information of the survey participants. Ages were primarily above 35 years, with 26.5% between 35 and 44, 32.0% between 45 and 54, and 28.6% over 55. The sample was predominantly male (91.5%), likely due to the masculine nature of CMAs, resulting in higher male participation and making data from female instructors abroad more difficult to obtain. Additionally, the CMAs instructors surveyed had a high duration of practice, with 94.5% practicing CMAs for more than 10 years, and 66.7% teaching CMAs for over a decade. A total of 59.9% had a bachelor's degree or higher, possibly influenced by the educational level during the collection of non-English speaking countries' questionnaires, but consequently, most data came from English-speaking countries. The data showed that 12.2% of participants were ethnic Chinese. This indicates that the international CMAs instructors studied were predominantly non-Chinese, potentially providing strong evidence for the reasons non-Chinese individuals persist in teaching CMAs.

2.1.2 CMAs content selection

The surveyed CMAs instructors taught a variety of styles, with Yang Style Tai Chi (34.7%) and Wing Chun (26.5%) being the most

popular. Moreover, these instructors mainly disseminated the following contents:

First, combat techniques are considered the most important aspect of teaching CMAs by respondents (97.3%), reflecting the essence of combat in CMAs. Among them, 69.4% of instructors teach according to a systematic curriculum (grading), while some do not follow a grading system, believing that teaching authentic fighting techniques is most crucial;

Second, 91.2% of the respondents believe it is essential for students to understand the historical background and lineage of the CMAs they learn. This not only enhances the students' or disciples' understanding of CMAs but also fosters a sense of pride, belonging, and cohesion;

Third, 90.5% of respondents share the cultural and philosophical foundations of CMAs, such as Yin and Yang, Ba Gua, Buddhism, and Taoism, during their teaching. Some instructors view CMAs as a lifestyle, integrating its culture and philosophy into daily practice. As these instructors themselves benefit from the culture and philosophy of CMAs, they particularly emphasize these aspects in their teaching;

Fourth, 83.7% of respondents believe that Wu De (martial virtue) is an important teaching content. They argue that a clear set of values, such as respect, self-discipline, perseverance, and integrity, should be established in the dissemination of CMAs. This way, one can "share benevolence, the heart of Kung Fu." Additionally, 76.2% of respondents emphasized the importance of Wu Li (martial etiquette), showcasing the relationship between Wu De and Wu Li and reflecting the combination of moral cognition and moral practice in CMAs (Lin and Cao, 2020). Lastly, some respondents mentioned teaching some martial arts terms in Chinese, such as titles within the martial family and names of movements, during the dissemination process.

2.2 Instruments

This study incorporated three scales: Motivation for Teaching CMAs Scale, Perceived Belonging Scale and Perseverance in Teaching

TABLE 1 Demographic characteristics of the study group ($N = 147$).

Variables	Distribution	Percent (%)	Variables	Distribution	Percent (%)
Gender	Male	91.5	Age	18–24	2.0
	Female	8.5		25–34	10.9
Ethnic Chinese	Yes	12.2		35–44	26.5
	No	87.8		45–54	32.0
Education level	Bachelor's Degree	21.8		55–64	21.8
	Graduate Degree	30.6		65–74	6.8
	High School	15.6	Years of CMA Practice	≤10 years	5.5
	Professional Degree	7.5		11–20 years	27.2
	Other	24.5		21–30 years	29.9
Nationality	Brazil	15.1		31–40 years	22.4
	United Kingdom	15.1		>40 years	15.0
	United States	14.4	Years of CMA Teaching	≤5 years	17.0
	Germany	7.5		6–10 years	16.3
	Italy	6.2		11–20 years	34.0
	Canada	4.8		21–30 years	17.7
	Other	36.9		>30 years	15.0

CMAs Scale. To ensure the reliability and validity of the measurement tools, this research primarily utilized scales that have been previously employed in studies, which were then modified according to the research objectives to serve as empirical tools.

- Motivation for Teaching CMAs Scale. The Motivation for Teaching CMAs Scale, inspired by Self-Determination Theory (Deci and Ryan, 1980), incorporates elements from several established scales: the Work Tasks Motivation Scale for Teachers (WTMST) (Fernet et al., 2008), Work Extrinsic and Intrinsic Motivation Scale (WEIMS) (Tremblay et al., 2009), Motivation at Work Scale (MAWS) (Gagné et al., 2010), and the Multidimensional Work Motivation Scale (MWMS) (Gagné et al., 2015). This comprehensive scale categorizes motivation for teaching CMAs into six dimensions: Intrinsic Motivation, Integrated Regulation, Identified Regulation, Introjected Regulation, External Regulation, and Amotivation, with each dimension comprising three items for a total of 18 items. It has demonstrated high reliability with Cronbach's alpha coefficients above 0.80 for all dimensions and its structural validity has been validated through Structural Equation Modeling, reflecting a high fit (Gagné et al., 2015). Items on this scale are rated using a 7-point Likert scale that ranges from 1 (Not at all) to 7 (Exactly), allowing for a nuanced assessment of instructors' motivations for teaching CMAs.
- Perceived Belonging Scale. Belongingness refers to the instructors' sense of subordination to, identification with, and maintenance of their affiliation with their mentorship or group. Referencing the Perceived Belonging Scale (PBS), this scale is constructed based on Self-Determination Theory and utilizes 11 items to measure the communicators' perceived belonging. The scale's Cronbach's alpha coefficients is above 0.70, and its construct validity has been verified through Structural Equation Modeling, showing a high level of fit (Allen, 2006). Items are measured using a Likert 7-point scale, ranging from 1 (Disagree strongly) to 7 (Agree strongly).
- Perseverance in Teaching CMAs Scale. This scale measures the extent to which instructors persist in their efforts to spread CMAs amidst challenges and obstacles. The perseverance scale developed by Liu et al. (2011) has an alpha coefficient of 0.85, indicating good fit. After revising this scale to suit Perseverance in Teaching CMAs, it was translated into English through a back-translation method by two bilingual translators (Brislin, 1980). Items are measured using a Likert 5-point scale, with options ranging from 1 (Strongly disagree) to 5 (Strongly agree).

2.3 Analysis

The study utilized SPSS 20.0 and the Structural Equation Modeling (SEM) software AMOS 26.0 to conduct empirical analysis following these steps: First, employing a single-factor method for common method bias test; Second, using confirmatory factor analysis to test reliability and validity as well as the fit of the measurement model; Third, exploring the relationships between variables through correlation analysis; Fourth, assessing the overall fit of the structural model; Fifth, revising and interpreting the results of the model fit.

Additionally, the data underwent the following processes:

(1) Scale conversion. As the majority of scales used in this study were 7-point scales, the 5-point scale, was uniformly converted to 7-point scales for data analysis. The conversion formula is: $Y = (B - A) \times \dfrac{x - a}{b - a} + A$, where Y is the function of the converted scale, X is the function of the scale used in the original questionnaire, a and b are the minimum and maximum values of the original scale, and A and B are the minimum and maximum values of the converted scale, respectively.

(2) Removal of outliers. This study excluded 3 outliers that exceeded the Mahalanobis distance, leaving 144 data entries.

(3) Item parceling. SEM analysis typically requires a sample to observed variable ratio of at least 10:1 (Thompson, 2000). Given the challenge of obtaining overseas sample data, the small sample size, and the complexity of the model, this study, based on the reliability and validity tests of the scales' latent variables, parceled single-dimensional, homogeneous latent variables. For instance, under the second-order model of autonomous motivation, three first-order indicators were separately parceled, such as Q30a = (Q30a_1 + Q30a_2 + Q30a_3)/3. To further address these challenges, the high-medium loading method was employed for item parceling (Wu and Wen, 2011). This method involves arranging items based on their factor loadings from highest to lowest and then creating groups that each contain a high-loading, a medium-loading, and a low-loading item, thereby ensuring a balanced representation of item loadings within each parcel. This balanced approach helps in maintaining the integrity and variability of the underlying construct across the parcels. Applying this method, the Perceived Belonging Scale's 8 items were parceled into 3 groups, with the first group including items Q29_11, Q29_5, Q29_10; the second group containing items Q29_6, Q29_7, Q29_8; and the third group including items Q29_4, Q29_2. Similarly, the Perseverance in Teaching CMAs Scale's 5 items were parceled into 3 groups, with the first group containing items Q8_1, Q8_6; the second group containing items Q8_2, Q8_5; and the third group containing item Q8_3. Through this method, we ensured that each parcel accurately represents the construct's range of factor loadings, thereby facilitating a more reliable analysis within the constraints of our study's sample size and structural complexity.

3 Results

3.1 Test for common method bias

Given that all data were self-reported by CMAs instructors, the study first employed Harman's single-factor test to examine common method bias. The exploratory factor analysis with rotation identified six factors with eigenvalues greater than 1, where the largest factor accounted for 32.765% of the variance. These results are in line with the criteria proposed by Podsakoff et al. (2003), where more than one factor with eigenvalues greater than 1 and the largest factor's variance explanation being less than 40% indicate that severe common method bias is not present in this study.

TABLE 2 Summary of confirmatory factor analysis for each factor in the research model (N = 144).

Factor	Item	Model parameter estimates				Convergent validity				Goodness-of-fit indexes					
		UFL	S.E.	t	P	SFL	SMC	C.R.	AVE	χ^2	df	χ^2/df	GFI	AGFI	RMSEA
Intrinsic motivation ($\alpha = 0.910$)	Q30a_1	1.000				0.925	0.856	0.916	0.785	0.000	0	–	–	–	–
	Q30a_2	0.906	0.068	13.388	***	0.857	0.734								
	Q30a_3	0.894	0.075	11.987	***	0.875	0.766								
Integrated regulation ($\alpha = 0.942$)	Q30b_1	1.000				0.930	0.865	0.939	0.838	0.000	0	–	–	–	–
	Q30b_2	1.073	0.053	20.063	***	0.946	0.895								
	Q30b_3	1.069	0.065	16.469	***	0.868	0.753								
Identified regulation ($\alpha = 0.733$)	Q30c_1	1.000				0.575	0.331	0.825	0.618	0.000	0	–	–	–	–
	Q30c_2	1.098	0.157	6.995	***	0.844	0.712								
	Q30c_3	0.888	0.131	6.797	***	0.901	0.812								
Introjected regulation ($\alpha = 0.835$)	Q30d_1	1.000				0.803	0.645	0.855	0.670	0.000	0	–	–	–	–
	Q30d_2	1.071	0.108	9.942	***	0.990	0.980								
	Q30d_3	0.707	0.087	8.171	***	0.621	0.386								
External regulation ($\alpha = 0.923$)	Q30e_1	1.000				0.882	0.778	0.922	0.798	0.000	0	–	–	–	–
	Q30e_2	0.999	0.067	14.984	***	0.897	0.805								
	Q30e_3	0.986	0.066	15.036	***	0.900	0.810								
Amotivation ($\alpha = 0.843$)	Q30f_1	1.000				0.646	0.417	0.860	0.677	0.000	0	–	–	–	–
	Q30f_2	1.233	0.148	8.344	***	0.942	0.887								
	Q30f_3	1.057	0.124	8.548	***	0.853	0.728								
Sense of belonging ($\alpha = 0.932$)	Q29_2	1.000				0.759	0.576	0.937	0.654	29.185	20	1.459	0.955	0.919	0.056
	Q29_4	1.131	0.105	10.798	***	0.831	0.691								
	Q29_5	1.145	0.110	10.422	***	0.807	0.651								
	Q29_6	1.103	0.102	10.811	***	0.832	0.692								
	Q29_7	1.140	0.109	10.509	***	0.813	0.661								
	Q29_8	1.011	0.113	8.956	***	0.709	0.503								
	Q29_10	1.052	0.110	9.592	***	0.753	0.567								
	Q29_11	1.154	0.092	12.559	***	0.942	0.887								
PiTCMA ($\alpha = 0.826$)	Q8_1	1.000				0.879	0.773	0.837	0.517	11.013	5	2.203	0.970	0.910	0.092
	Q8_2	1.052	0.087	12.025	***	0.868	0.753								
	Q8_3	0.852	0.100	8.482	***	0.654	0.428								
	Q8_5	0.714	0.117	6.090	***	0.499	0.249								
	Q8_6	0.739	0.094	7.864	***	0.617	0.381								

UFL, unstandardized factor loadings; S.E., standard error; SFL, standardized factor loadings; SMC, squared multiple correlations; C.R., composite reliability; AVE, average variance extracted; df, degrees of freedom; GFI, goodness of fit index; AGFI, adjusted goodness of fit index; RMSEA, root mean square error of approximation; PiTCMA, persistence in teaching Chinese martial arts; ***$p < 0.001$.

3.2 Reliability and validity test and analysis of the fit of the measurement model

This study analyzes the correspondence between measurement factors and items through Confirmatory Factor Analysis (CFA) (see Table 2).

(1) Measurement Model Fit. Items within each latent variable with standardized factor loadings below 0.4 were deleted (Hair et al., 2014); model fit indices were checked, and items causing excessively high chi-square values due to residual correlations, indicating item similarity, were removed (Landis et al., 2009). Ultimately, items 1, 3, and 9 from the Perceived Belonging Scale (Q29) and item 4 from the Perseverance in Teaching CMAs Scale (Q8) were deleted, achieving a satisfactory model fit for each latent variable, with fit indices meeting the criteria of χ^2/df < 3.0, AGFI >0.90, CFI > 0.90, RMSEA <0.08 (Hair et al., 2014). Latent variables not annotated with fit indices in the table are due to having only three items, constituting a just-identified model, where the number of data points matches the number of parameters to be estimated in the model, resulting in zero degrees of freedom, also known as a saturated model.

(2) Internal Consistency Coefficient (α). This value is a commonly used index for testing reliability, with the formula: $\alpha = \frac{K}{K-1}\left(1 - \frac{\sum S_i^2}{S^2}\right)$, where K is the number of items in the scale,
- S_i^2 is the total variance of the scale items, and S^2 is the variance of the total score of the scale items. The α coefficient ranges from 0 to 1, with DeVellis (2017) suggesting that values between 0.65 and 0.70 are the minimum acceptable; values between 0.70 and 0.80 are quite good; values between 0.80 and 0.90 are very good. All latent variables in this study had α coefficient values above 0.70, indicating quite good internal consistency.

(3) Convergent Validity is represented by the Average Variance Extracted (AVE), which can be calculated using the formula: $AVE = \frac{\left(\sum \lambda^2\right)}{\left(\left(\sum \lambda^2\right) + \sum \theta\right)}$, where λ represents the standardized factor loadings of the observed variables on the latent variable, and θ represents the error variance of the indicator variables. AVE reflects the extent to which a latent variable construct can explain the variance of its indicator variables. Higher AVE values indicate higher reliability and convergent validity of the construct. Fornell and Larcker (1981b) consider values between 0.36 and 0.5 as the minimum acceptable, and values above 0.5 as ideal. All latent variables in this study had AVE values above 0.5, indicating good convergent validity.

(4) Composite Reliability (CR). This value can be calculated using the formula: $CR = \frac{\left(\sum \lambda\right)^2}{\left(\left(\sum \lambda\right)^2 + \sum \theta\right)}$, where λ represents the standardized factor loadings of the observed variables on the latent variable, and θ represents the error variance of the indicator variables. CR indicates whether all items within each latent variable consistently explain that latent variable. Fornell and Larcker (1981a) suggest that a CR value above 0.6 indicates good composite reliability. All latent variables in this study had CR values above 0.6, indicating good composite reliability.

3.3 Correlation analysis of motivation for teaching CMAs, sense of belonging, and perseverance in teaching CMAs

Table 3 presents the descriptive statistics and correlation coefficients for Motivation for Teaching CMAs, Sense of Belonging and Perseverance in Teaching CMAs. Correlation coefficients with statistical significance related to Perseverance in Teaching CMAs are highlighted in bold, with M ± SD denoting mean ± standard deviation. The bold italic numbers on the diagonal are the square roots of the Average Variance Extracted (AVE) for each variable. The results indicate a positive correlation between Perseverance in Teaching CMAs and Sense of Belonging ($r = 0.213$, $p < 0.05$), a positive correlation with Intrinsic Motivation ($r = 0.377$, $p < 0.01$), a positive correlation with Integrated Regulation ($r = 0.427$, $p < 0.01$), a positive correlation with Identified Regulation ($r = 0.292$, $p < 0.01$), a positive correlation with Introjected Regulation ($r = 0.230$, $p < 0.01$), and a negative correlation with Amotivation ($r = -0.283$, $p < 0.01$). There was no significant correlation with External Regulation. Additionally, comparing the square root of each variable's AVE with its correlation coefficients with other variables, the square root of the AVE for each variable was greater than its correlations with other variables, indicating discriminant validity among the variables in this study.

3.4 Structural model test of the perseverance behavior formation mechanism in teaching CMAs

3.4.1 Testing the second-order model of motivation

3.4.1.1 Autonomous motivation

Validation of the second-order model of autonomous motivation was conducted in three steps. First, the model's ability to explain the first-order constructs was assessed. According to Marsh and Hocevar (1985), a target coefficient (related chi-square value of the first-order factor/chi-square value of the second-order model) close to 1 suggests a precise model. The target coefficient for autonomous motivation was found to be 1, indicating excellent adaptability of the second-order CFA indices. Second, the fit of the second-order model was assessed, revealing $\chi^2/df = 1.184$, GFI = 0.937, CFI = 0.983, and RMSEA = 0.075, indicative of a good fit (see Table 4). Third, convergent validity and composite reliability were evaluated, with AVE = 0.830 and CR = 0.936, meeting the requirements. Hence, the second-order model of autonomous motivation is deemed acceptable, adequately explaining the first-order factor constructs (see Figure 2, Table 5).

TABLE 3 Descriptive statistics and correlation coefficients for factors ($N = 144$).

|	$M \pm SD$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) PiTCMA	5.777 ± 1.257	**_0.719_**	–	–	–	–	–	–	–
(2) Sense of belonging	6.442 ± 0.753	**0.213***	**_0.809_**	–	–	–	–	–	–
(3) Intrinsic motivation	6.095 ± 1.119	**0.377***	0.466**	**_0.886_**	–	–	–	–	–
(4) Integrated regulation	6.428 ± 0.924	**0.427***	0.407**	0.770**	**_0.915_**	–	–	–	–
(5) Identified regulation	6.137 ± 0.993	**0.292***	0.443**	0.686**	0.779**	**_0.786_**	–	–	–
(6) Introjected regulation	4.736 ± 1.787	**0.230***	0.258**	0.350**	0.332**	0.372**	**_0.819_**	–	–
(7) External regulation	2.889 ± 1.803	0.076	0.101	0.155	0.097	0.129	0.396**	**_0.893_**	–
(8) Amotivation	1.676 ± 1.160	**−0.283***	−0.120	−0.181*	−0.252**	−0.247**	0.123	0.210*	**_0.823_**

The bold italic numbers on the diagonal are the square roots of the AVE for that variable; PiTCMA, perseverance in teaching Chinese martial arts. *$p < 0.05$, **$p < 0.01$.

TABLE 4 Goodness-of-fit indexes for alternative models of the second-order autonomous motivation ($N = 144$).

	χ^2	df	χ^2/df	GFI	AGFI	CFI	RMSEA
0. Null model	1185.613	36	32.934	0.000	0.000	0.000	0.473
1. 1 First-order factor	158.647	27	5.876	0.787	0.646	0.885	0.185
2. 3 First-order factors (uncorrelated)	313.863	27	11.625	0.701	0.502	0.750	0.273
3. 3 First-order factors (correlated)	43.530	24	1.814	0.937	0.882	0.983	0.075
4. 1 Second-order factor	43.530	24	1.814	0.937	0.882	0.983	0.075
Reference value	Smaller is better	Larger is better	<3	>0.9	>0.9	>0.9	<0.08

df, degrees of freedom; GFI, goodness of fit index; AGFI, adjusted goodness of fit index; CFI, comparative fit index; RMSEA, root mean square error of approximation.

FIGURE 2
Second-order Model of Autonomous Motivation. ***$p < 0.001$.
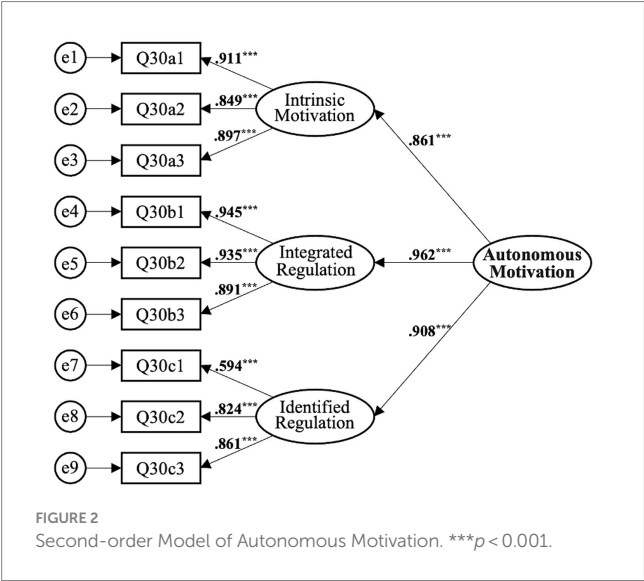
3.4.1.2 Controlled motivation

Similarly, the validation of the second-order model of controlled motivation proceeded through three main steps. Initially, the model's explanatory power for first-order constructs was tested, yielding a target coefficient of 0.89 as per Marsh and Hocevar (1985), signifying the model's satisfactory precision. The model fit indices were exemplary, with χ^2/df = 0.850, GFI = 0.983, AGFI = 0.960, CFI = 1, and RMSEA = 0.000, denoting an excellent fit (see Table 6). Convergent validity and composite reliability assessments showed AVE = 0.451 and CR = 0.617, both of which are within acceptable ranges as per Fornell and Larcker (1981a,b) criteria, thus validating the second-order model of controlled motivation (see Figure 3 and Table 7).

3.4.2 Testing the formation mechanism model of perseverance in teaching CMAs

Sense of Belonging, Autonomous Motivation, Controlled Motivation, and Amotivation are treated as exogenous variables, and Perseverance in Teaching CMAs is treated as an endogenous variable. The model fitting is conducted using the Maximum Likelihood (ML) estimation method.

(1) Overall Model Fit Test. Initially, the model's conformity to a normal distribution is tested. The skewness and kurtosis coefficients for each observed variable in this study meet the requirements of a normal distribution (Kline, 1998). Subsequently, the overall model fit is tested. The model's overall fit is assessed based on absolute fit measures, incremental fit measures, and parsimonious fit measures.

The overall fit indices for the structural model of the perseverance behavior formation mechanism in international CMAs instructors, as shown in Table 8, are as follows:

- Absolute Fit Measures: these indices evaluate how well the proposed model reproduces the observed data. The chi-square (χ^2) value was noted at 140.280, where a lower value indicates a better fit. Although chi-square is sensitive to sample size, it provides a fundamental measure of model discrepancy. The Goodness-of-Fit Index (GFI) was recorded at 0.884, slightly below the recommended threshold of 0.90, suggesting a marginally acceptable fit. The Root Mean Square Error of Approximation (RMSEA) stood at 0.080, aligning with the threshold of 0.08, indicating a reasonable error of approximation by the model.
- Incremental Fit Measures: these measures compare the proposed model against a baseline model, usually a null model with no relationships among variables. The Normed Fit Index (NFI) was 0.880, and while it was just below the preferred benchmark of 0.90, it signals a moderate improvement over the baseline model. The Incremental Fit Index (IFI), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI) exhibited values of 0.938, 0.922, and 0.937, respectively, all surpassing the 0.90 mark, which indicates a substantial improvement from the baseline model and suggests a good fit.
- Parsimonious Fit Measures: aimed at evaluating the model's fit while considering its complexity, the parsimony ratio of chi-square to degrees of freedom (χ^2/df) was found to be 1.922, well below the maximum acceptable ratio of 3, denoting a good balance between model fit and parsimony.

In summary, despite certain indices slightly missing their respective recommended thresholds, the overall fit indices collectively indicate an acceptable level of model fit to the data, thereby supporting the structural model of perseverance behavior formation in international CMAs instructors as a viable representation of the underlying psychological processes.

(2) Model Path Analysis and Hypothesis Testing. Figure 4 displays the structural model of the perseverance behavior formation mechanism in international CMAs instructors. The results indicate that Autonomous Motivation has a significant positive impact on Perseverance in Teaching CMAs ($\beta = 0.369$, $b = 0.465$, $t = 4.232$, $p < 0.001$), supporting H1; Amotivation has a significant negative impact on Perseverance in Teaching CMAs ($\beta = -0.323$, $b = -0.382$, $t = -3.561$, $p < 0.001$), supporting H3; Controlled Motivation has no significant impact on Perseverance in Teaching CMAs, consistent with

TABLE 5 Confirmatory factor analysis for the second-order model of autonomous motivation.

Second-order factor	First-order factors	Model parameter estimates				Convergent validity			
		UFL	S.E.	t	P	SFL	SMC	C.R.	AVE
Autonomous motivation ($\alpha = 0.893$)	Intrinsic motivation	1.000				0.861	0.741	0.936	0.830
	Integrated regulation	0.928	0.081	11.480	***	0.962	0.925		
	Identified regulation	0.955	0.140	6.830	***	0.908	0.824		

UFL, unstandardized factor loadings; S.E., standard error; SFL, standardized factor loadings; SMC, squared multiple correlations; C.R., composite reliability; AVE, average variance extracted; ***$p < 0.001$.

TABLE 6 Goodness-of-fit indexes for alternative models of the second-order controlled motivation ($N = 144$).

	χ^2	DF	χ^2/df	GFI	AGFI	CFI	RMSEA
0. Null Model	570.625	15	38.042	0.421	0.189	0.000	0.509
1. 1 First-order factor	183.776	9	20.420	0.718	0.343	0.685	0.369
2. 2 First-order factors (uncorrelated)	32.567	9	3.619	0.935	0.849	0.958	0.135
3. 2 First-order factors (correlated)	6.793	8	0.849	0.985	0.960	1.000	0.000
4. 1 Second-order factor	7.651	9	0.850	0.983	0.960	1.000	0.000
Recommended values	Smaller is better	Larger is better	<3	>0.9	>0.9	>0.9	<0.08

df, degrees of freedom; GFI, goodness of fit index; AGFI, adjusted goodness of fit index; CFI, comparative fit index; RMSEA, root mean square error of approximation.

the original hypothesis H2; Sense of Belonging has no significant impact on Perseverance in Teaching CMAs, not supporting H4; the model explains 27.9% of the variance in Perseverance in Teaching CMAs (see Table 9).

4 Discussion

This study, grounded in Self-Determination Theory, conducts an empirical exploration into the mechanisms behind the development of perseverance behaviors in the international promotion of CMAs. Our findings reveal that: (1) Autonomous motivation significantly enhances perseverance behavior; (2) Amotivation notably undermines perseverance behavior; (3) Controlled motivation does not significantly affect perseverance behavior; (4) Belongingness does not significantly influence perseverance behavior.

4.1 Conceptual explanation of perseverance in teaching CMAs

Perseverance in the context of teaching CMAs is characterized by the sustained efforts of international instructors to continue their educational endeavors despite encountering challenges. Our study operationalizes perseverance as a construct to evaluate the steadfastness in teaching CMAs. Through an examination of standardized factor loadings from our measurement items, we have identified the most salient indicators of perseverance, as detailed in Table 2. Primarily, these are the habitual nature of teaching CMAs (0.879) and the resolve to continue teaching against the constraints of time (0.868). These findings intimate that for those engaged in the propagation of CMAs, perseverance transcends mere volitional act, embedding itself into their daily practices and value systems. A moderate factor loading of 0.654 emphasizes the importance of emotional investment in maintaining efforts to disseminate CMAs.

This attachment may arise from a profound affinity for CMAs, gratification derived from teaching, or a sense of duty toward preserving culture. Moreover, the factor loading of 0.617 associated with the anticipation of future CMA engagements serves as a significant motivational force. This prospective enthusiasm can fortify an individual's resolve in the face of adversity.

Additionally, a willingness to confront and navigate impediments, despite its relatively lower factor loading of 0.499, underscores the necessity for resilience and adept problem-solving in promotional endeavors. This suggests that instructors retain their zeal and determination to spread CMAs knowledge, even when confronted with challenges.

The synthesis of these measurement items and their respective factor loadings paints a multifaceted picture of perseverance in the teaching of CMAs. It encapsulates habit formation, emotional engagement, forward-looking motivation, and resilience against obstacles. Instructors who exhibit elevated levels of perseverance demonstrate a propensity for persistence-related behaviors, marked by patience, dedication to teaching CMAs, and a proactive stance in surmounting difficulties. Perseverance here is not solely about the commitment to teach; it signifies an allegiance to the conservation and proliferation of a cultural legacy. The insights gleaned from these findings are pivotal for bolstering the international propagation of CMAs, suggesting that reinforcing these key dimensions can considerably aid in their global promotion.

4.2 Explanation of the formation mechanism of perseverance in teaching CMAs

4.2.1 The impact of autonomous motivation on perseverance in teaching CMAs

Our research findings reveal a positive correlation between autonomous motivation and perseverance in teaching CMAs,

evidenced by a significant regression coefficient ($\beta = 0.369$, $p < 0.001$). This indicates that instructors who are autonomously motivated are more inclined to sustain and continue their teaching endeavors. This correlation is in line with the findings of Grolnick and Ryan (1987), who argued that autonomous motivation is more conducive to the endurance of behavior than other forms of motivation, including introjected regulation, external regulation, and amotivation. Deci and Ryan (2008) posit that autonomous motivation correlates with more positive behaviors, attitudes, and emotional responses, potentially accounting for its significant link to the perseverance of teaching behaviors. Empirical studies by Vallerand et al. (1997) and Black and Deci (2000) further corroborate the critical role of autonomous motivation in promoting sustained engagement in activities such as teaching CMAs.

Within the construct of autonomous motivation - comprising intrinsic motivation, integrated regulation, and identified regulation - integrated regulation emerged as the most substantial factor (standardized factor loading = 0.944), followed by identified regulation (0.825) and intrinsic motivation (0.820) (see Figure 4). Integrated regulation, characterized by a profound understanding and internalization of the behavior's value, likely contributes most significantly to teaching perseverance. Identified regulation pertains to the recognition of a behavior's relevance to personal goals and values. Intrinsic motivation involves participation in an activity for inherent satisfaction. Consistent with Núñez et al. (2010), our study adopts a non-discriminatory approach to these autonomous motivation types due to their continuum nature.

Instructors with high autonomous motivation not only derive enjoyment and satisfaction from teaching CMAs but also acknowledge

FIGURE 3
Second-order model of Controlled Motivation. ***$p < 0.001$.

and incorporate the value of teaching into their core beliefs and lifestyle. This integration reflects a psychological mechanism that aligns personal significance and objectives with one's profession, as noted by Littman-Ovadia and Lavy (2016).

Our survey results revealed that respondents were autonomously motivated in their dedication to teaching CMAs. Master D.C., with over 30 years of experience teaching Tai Chi in the United States, expressed, "Tai Chi is a way of life. My life's goal is to elevate my own Tai Chi practice while improving the health and well-being of others." Echoing this sentiment, another master stated, "Chinese martial arts are my life. The longer I teach Tai Chi, the more I understand its significance in today's world, which is plagued by violence and illness. If everyone could grasp the essence of Tai Chi, the world would be a more peaceful place." Moreover, our study found that 15.0% of the CMA schools operate on a non-profit basis, with one master emphasizing, "I teach CMAs out of respect for tradition, not for profit." This highlights how the perseverance of international instructors is often fueled by a deep alignment with personal and cultural values.

Instructors also cited the values embedded in CMAs, such as humility, respect, and justice, as key to their persistence. One instructor noted, "Learning CMAs teaches you to cultivate humility and respect, which are necessary for peace and harmony with the world. CMAs guide you to live in harmony with yourself, others, and nature, to seek peace and to defend it when necessary. They foster a sense of brotherhood and inspire one to be a person of moral integrity, standing up for justice and protecting the weak. The important values I've gained through CMAs – respect, perseverance, and justice – I strive to embody and share through my teaching. I believe CMAs are superior to other martial arts because their philosophy imparts a timeless essence and value. Without its virtues and historical richness, the teaching of CMAs would not fulfill its true purpose." This reflection aligns with Howard et al. (2021), who found identified regulation to be closely linked with persistence.

In conclusion, autonomous motivation significantly influences international instructors' perseverance in teaching CMAs. This motivation is manifested through the alignment of CMAs with personal ambitions and the embodiment of its intrinsic values. The degree to which instructors internalize and resonate with the cultural essence of CMAs correlates with their teaching tenacity. Our findings underscore the need to nurture instructors' autonomous motivation to facilitate CMAs' global propagation. This has implications for developing strategies aimed at bolstering teaching perseverance, suggesting that fostering autonomous motivation could be instrumental in promoting sustained instruction of CMAs.
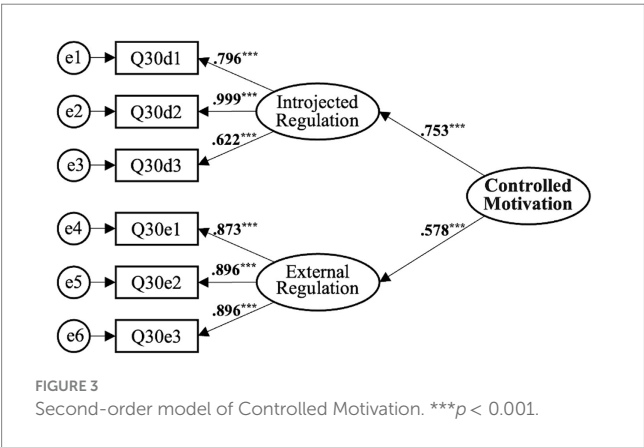
TABLE 7 Confirmatory factor analysis for the second-order model of controlled motivation.

Second-order factor	First-order factors	Model parameter estimates				Convergent validity			
		UFL	S.E.	t value	P	SFL	SMC	C.R.	AVE
Controlled motivation ($\alpha = 0.893$)	Introjected regulation	1.000				0.753	0.567	0.617	0.451
	External regulation	0.716	0.087	8.255	***	0.578	0.334		

UFL, unstandardized factor loadings; S.E., standard error; SFL, standardized factor loadings; SMC, squared multiple correlations; C.R., composite reliability; AVE, average variance extracted;
***$p < 0.001$.

4.2.2 The impact of controlled motivation and amotivation on perseverance in teaching CMAs

Our study reveals that controlled motivation, encompassing introjected and external regulation, does not significantly influence the perseverance of instructors in teaching CMAs. Introjected regulation, driven by self-sanctioning emotions such as guilt or shame, showed no

meaningful correlation with long-term commitment, aligning with Deci and Ryan (1995) assertion that the sense of worth derived from such regulation may lead to an inconsistent motivational basis for persistence. Similarly, external regulation, motivated by external rewards or the avoidance of penalties, demonstrated a minimal correlation ($r = 0.076$) with perseverance in teaching CMAs. This supports existing literature

TABLE 8 Goodness-of-fit indexes for the research model.

Fit index	Index value	Reference value	Test result
(1) Absolute fit indexes			
χ^2	140.280	Smaller is better	✓
GFI	0.884	>0.90	Nearly meets
RMSEA	0.080	<0.08	Nearly meets
(2) Incremental fit indexes			
NFI	0.880	>0.90	Nearly meets
IFI	0.938	>0.90	✓
TLI	0.922	>0.90	✓
CFI	0.937	>0.90	✓
(3) Parsimony fit index			
χ^2/df	1.922	<3	✓

GFI, goodness of fit index; RMSEA, root mean square error of approximation; NFI, normed fit index; IFI, incremental fit index; TLI, Tacker-Lewis index; NNFI, non-normed fit index; CFI, comparative fit index.
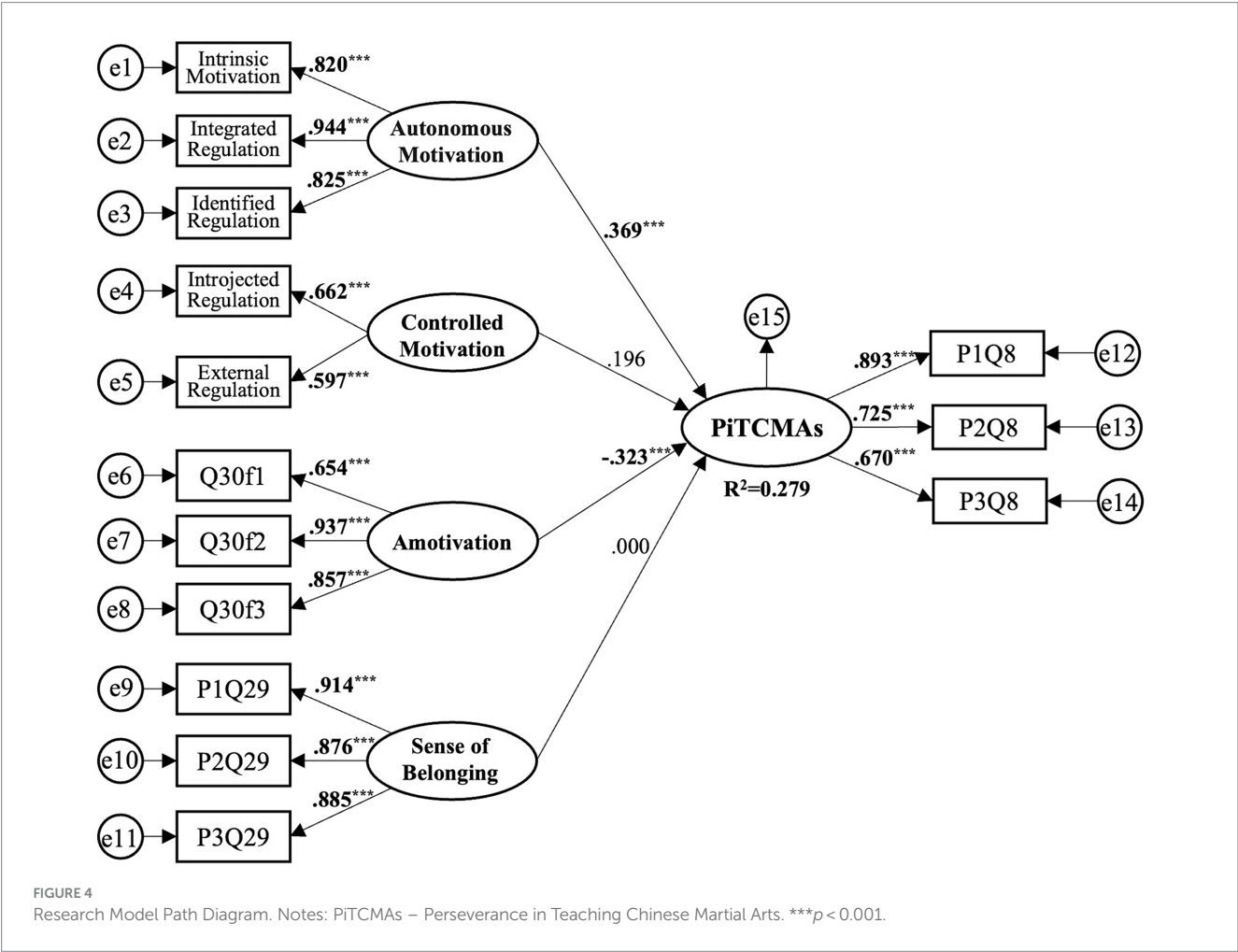

FIGURE 4

Research Model Path Diagram. Notes: PiTCMAs — Perseverance in Teaching Chinese Martial Arts. ***$p < 0.001$.

TABLE 9 Path analysis of the research model.

Paths between latent variables	b	S.E.	t	β	P	Corresponding hypothesis	Test result
PiTCMA ← Autonomous motivation	0.465	0.110	4.232	0.369	***	H1	✓
PiTCMA ← Controlled motivation	0.192	0.134	1.432	0.196	0.152	H2	✓
PiTCMA ← Amotivation	−0.382	0.107	−3.561	−0.323	***	H3	✓
PiTCMA ← Sense of belonging	0.000	0.130	0.003	0.000	0.998	H4	✗

b, unstandardized path coefficients, represents the direct effect of one variable on another, measured in the original units of the variables; S.E., standard error; β, standardized path coefficients, indicates the strength and direction of the relationship between variables, measured in standard deviation units, facilitating comparison across different paths in the model; PiTCMAs, perseverance in teaching Chinese martial arts; ***$p < 0.001$.

suggesting that external motivators are less effective in sustaining long-term behaviors crucial for the enduring commitment required in CMA instruction (Vlachopoulos and Karageorghis, 2005). These findings underscore the need for strategies that foster more intrinsic forms of motivation among CMA instructors, potentially leading to more sustainable teaching commitments.

Conversely, amotivation presented a substantial negative association with instructional persistence ($β = −0.282$, $p < 0.01$), consistent with the findings of Vallerand et al. (1997). Amotivation, defined as the absence of motivation, reflects a state where individuals perceive activities as meaningless or feel incompetent to perform them. This condition is detrimental in the context of CMAs dissemination, as it undermines the instructor's likelihood of maintaining effort and engagement.

These findings suggest that the key to promoting enduring teaching of CMAs may lie in nurturing autonomous motivation, which involves personal endorsement and a sense of volition. To foster perseverance among instructors, it is imperative to address amotivation by bolstering their autonomous motivation. This involves facilitating an environment where instructors recognize the intrinsic value of their work and perceive their role in the propagation of CMAs as significant and empowering.

In conclusion, our research underscores the importance of focusing on the quality of motivation among CMAs instructors to ensure their sustained engagement. It is imperative for dissemination strategies to prioritize the enhancement of autonomous motivation and to address any elements of amotivation, rather than relying on introjected or external regulatory factors which appear to have limited impact on long-term persistence.

4.2.3 The impact of sense of belonging on perseverance in teaching CMAs

Our findings revealed a notable yet complex relationship between instructors' sense of belonging and their perseverance in teaching CMAs. Initially, a positive correlation was observed, with a correlation coefficient of 0.213 ($p < 0.01$), suggesting a significant independent relationship. However, the introduction of this variable into a Structural Equation Model (SEM) alongside other predictors resulted in a negligible factor loading of 0.005, rendering the impact of sense of belonging on perseverance statistically insignificant. This outcome deviates from our research hypothesis, prompting a deeper examination.

The diminished significance of sense of belonging in the SEM context may be attributed to two primary factors. Firstly, the presence of variables with stronger effects within the model might overshadow those with weaker effects, such as sense of belonging, particularly when these weaker variables do not substantially enhance the model's overall explanatory power. Secondly, the instructors' cultural background likely

plays a crucial role. Sense of belonging, in this context, encompasses feelings of allegiance to and identification with the instructors' respective CMAs schools, reflecting a tradition of master-disciple transmission and the aspiration to honor one's lineage, a concept deeply rooted in the cultural heritage of CMAs (Chen and Wang, 2020).

Notably, a significant portion (87.8%) of the international instructors in our study are not ethnically Chinese, potentially indicating a less profound connection to the cultural heritage and sense of belonging to CMAs compared to instructors of Chinese descent. This conjecture aligns with previous research indicating the positive effects of sense of belonging and cohesion on behavioral persistence within more confined or homogeneous groups (Carron et al., 1988). However, the unique dissemination context of our study subjects—who primarily return to their home countries to promote CMAs—might further explain the observed insignificance of sense of belonging on their perseverance.

In conclusion, the influence of sense of belonging on the perseverance of international CMAs instructors emerges as a multifaceted issue. It is shaped by the interplay of model variables, cultural backgrounds, and the distinct environments of CMAs dissemination. This complexity underscores the need for further investigation into how sense of belonging affects instructors' commitment to teaching CMAs, with a particular focus on the nuances of cultural and environmental contexts.

4.3 Practical implications

Our research findings offer valuable insights for the global community of CMAs schools, program designers, and policymakers. These insights can be instrumental in developing strategies to enhance the motivation and perseverance of CMAs instructors, which is crucial for the sustainable dissemination and teaching of CMAs worldwide.

Initially, for organizations and schools teaching CMAs globally, it's critical to recognize and foster autonomous motivation among instructors. Institutions should prioritize selecting and developing instructors who not only possess deep expertise in CMAs but also embody the philosophical and cultural values integral to these arts. Enhancing instructor commitment and teaching quality necessitates providing continuous professional development opportunities that resonate with their intrinsic interests and values. Conducting workshops on integrating CMAs philosophy with teaching methods, enhancing pedagogical skills, and effective student engagement strategies can improve instructors' motivation and effectiveness.

Furthermore, to counteract amotivation among CMAs instructors, schools and organizations should implement targeted interventions. This could involve offering feedback that acknowledges

instructors' efforts and achievements, providing counseling services to assist instructors in overcoming challenges, and fostering an inclusive environment that respects and values diversity. Tailored support mechanisms that cater to the unique needs and concerns of individual instructors can aid in preventing feelings of incompetence or disconnection from their teaching roles.

In summary, enhancing autonomous motivation and addressing amotivation are pivotal for the perseverance of CMAs instructors. By prioritizing professional development aligned with instructors' values and providing tailored support, CMAs institutions can ensure a passionate and committed teaching faculty, thereby contributing to the art's global propagation and sustainability.

4.4 Limitations and directions for future research

While this study provides new insights and theoretical contributions to understanding persistence in teaching CMAs, it also presents limitations that direct future research. Firstly, the sample selection may limit the generalizability of our findings, as the study focuses on non-ethnically Chinese CMAs instructors from Western countries. This suggests our results might mainly reflect this group's experiences, potentially overlooking the influences of different cultural backgrounds on teaching persistence. Future research should include a wider range of instructors to broaden the findings' applicability and explore how cultural variations affect commitment to teaching CMAs, thereby enhancing understanding of CMAs' global dissemination. Secondly, the scales and survey methods used, while providing important initial insights, may have limitations in capturing the complex psychological dynamics related to culture. Particularly in measuring sense of belonging, existing tools might not fully reflect the profound impact of CMAs' traditional master-disciple relationships and cultural heritage. Future research should consider employing more in-depth qualitative research methods, such as in-depth interviews or case studies, to more comprehensively understand the impact of traditional cultural factors on sense of belonging and perseverance. Lastly, while Structural Equation Modeling (SEM) serves as a powerful tool for deciphering the complex relationships among variables, its explanatory capacity is limited by the chosen variables and theoretical framework. Unconsidered variables, such as personal experiences and social support, may significantly influence the perseverance in teaching CMAs. Future research should aim to incorporate additional psychological and social variables to gain a more comprehensive understanding of the factors affecting the perseverance in teaching CMAs. In summary, although this study contributes to understanding the role of perseverance in teaching CMAs, future research must overcome these limitations to deeply explore the complex interactions among cultural, psychological, and educational dynamics to more comprehensively understand and promote the transmission and development of CMAs.

5 Conclusion

This study delves into the key factors influencing the sustained motivation of international instructors teaching CMAs, highlighting the pivotal role of overcoming amotivation and fostering autonomous motivation in promoting enduring teaching engagement. Compared to short-term internal or external incentives, autonomous motivation emerges as fundamentally more effective. Additionally, the study finds that a sense of belonging does not significantly impact instructors' perseverance, potentially reflecting the diverse cultural backgrounds of the participants. The findings highlight the importance of cultivating instructors' passion for CMAs, increasing their recognition of the cultural essence and values of CMA, and guiding instructors to integrate the dissemination of CMAs with their personal values and life goals, thereby enhancing their long-term commitment to disseminating these arts. This study not only offers practical strategies for CMAs' global propagation but also sets the stage for future research to explore the effects of cultural backgrounds and additional psychological factors on teaching persistence. Ultimately, enhancing our understanding of these dynamics can further support the global spread and sustainable development of CMAs.

Data availability statement

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

Ethics statement

Ethical approval was not required for the studies involving humans because this study involved non-sensitive, anonymous data collection through public domain research methods, with no potential risk to participants. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements because implied consent was obtained through completion of the survey, in line with the consent statement provided at the beginning of the survey.

Author contributions

XC: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Writing – original draft, Writing – review & editing. HL: Investigation, Methodology, 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.2024.1391207/full#supplementary-material

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Assessing ethical behavior and self-control in elite ultimate championships: a cross-sectional study using the spirit of the game scoring system

José Pedro Amoroso[1,2]*, Luís Coelho[1,2,3], Rebecca A. Boulton[4],
Christie M. González-Toro[5], Felipe Costa[6],
Efstathios Christodoulides[7], Wouter Cools[8,9], Dean Dudley[10],
James E. Moore Jr[11], Guilherme Eustáquio Furtado[12,13]*,
Ming-Yang Cheng[14] and Luís Calmeiro[15,16]

[1]ESECS—Polytechnic of Leiria, Leiria, Portugal, [2]CIEQV—Life Quality Research Center, Polytechnic of
Leiria, Leiria, Portugal, [3]Research Center in Sport, Health, and Human Development (CIDESD), Vila Real,
Portugal, [4]Biological and Environmental Sciences, University of Stirling, Stirling, United Kingdom,
[5]Department of Kinesiology, Manhattan College, Bronx, NY, United States, [6]Faculty of Physical
Education, Brasília University, Brasília, Brasil, [7]School of Sciences, Sport and Exercise Sciences,
University of Central Lancashire Cyprus, Larnaka, Cyprus, [8]BrusselMultidisciplinair Instituut
Lerarenopleiding, Brussels Institute for Teacher Education & Movement and Nutrition for Health and
Performance (MOVE) Research Group, Vrije Universiteit, Brussels, Belgium, [9]Artevelde University of
Applied Sciences, Ghent, Belgium, [10]Macquarie School of Education, Macquarie University, Sydney,
NSW, Australia, [11]Department of Bioengineering, Imperial College London, London, United Kingdom,
[12]Polytechnic Institute of Coimbra, Applied Research Institute, Coimbra, Portugal, [13]Research Centre for
Natural Resources Environment and Society (CERNAS), Polytechnic Institute of Coimbra, Coimbra,
Portugal, [14]School of Psychology, Beijing Sport University, Beijing, China, [15]National Institute of
Education, Nanyang Technological University, Singapore, Singapore, [16]Faculty of Medicine, Institute of
Environmental Health, University of Lisbon, Lisbon, Portugal

Introduction: Implementing a self-refereeing system presents a unique
challenge in sports education, particularly in academic and training settings
where officiated sports prevail. However, Ultimate Frisbee stands out by
entrusting players with both athlete and referee roles, introducing distinctive
ethical complexities. This manuscript is intended to evaluate ethical behavior
and self-control within the Spirit of the Game (SOTG) scoring system in Elite
Ultimate. To address these, Ultimate employs the (SOTG) scoring system,
integral since the sport's inception in the late 1980s. SOTG aims to enhance
and evaluate athletes' ethical conduct. This study evaluates SOTG's
effectiveness in elite-level Ultimate, analyzing variations across divisions and
age groups in three high-level tournaments.

Methods: Using a cross-sectional design, data were collected from five
international Ultimate tournaments in 2022. Teams spanned diverse age
groups (under 17 to over 50) and divisions (women's, mixed, open). Post-
match, teams assessed opponents' SOTG in five domains: Rules knowledge,
fouls, fairness, attitude/self-control, and communication. Ratings used a
5-point Likert scale ("poor" to "excellent"). An overall SOTG score was
calculated by aggregating domain scores.

Results: Our study consistently revealed high SOTG scores, reflecting strong
sportsmanship. "Positive attitude and self-control" consistently ranked highest,
while "Knowledge and use of the rules" scored lowest. Divisional differences in
SOTG were statistically insignificant. Notably, WMUCC2022 (participants aged
30+) had significantly higher SOTG scores, possibly indicating age-related

self-control improvement or evolving sport culture. Lower rules knowledge scores may stem from linguistic translation challenges.

Conclusion: Self-refereeing promotes ethical behavior across divisions and age groups. SOTG underscores sportsmanship's importance and aligns with International Olympic Committee (IOC) and with Sustainable Development Goals (SDGs), particularly SDG 3, 4, 5 and 16 fostering a fairer, healthier, and more peaceful world.

1 Introduction

This manuscript is intended ethical behavior and self-control within the Spirit of the Game (SOTG) Scoring System in Elite Ultimate Frisbee. The popular belief that sport builds character is almost as old as the origins of sport itself. The ultimate reflection of this philosophy, which has far-reaching implications for the development of morality, involves the concept of fair play. Fair play manifests itself in respect for the rules of the game, consideration for the opponent, honest competition, and the pursuit of enjoyment of the game itself (1, 2). Education is important in relation to a discussion regarding SOTG teaching in physical education and sports pedagogy, and important in relation to the question of who or what should be transformed in order for transformative learning and teaching to occur (3). In recent years, It has been argued that the educational value of sport has declined (4, 5). Violence and aggressive behaviour continue to be a part of sports culture that is relatively tolerated and to which does not seem to attach punishment (6). Sporting excellence should be gratifying for spectators as well as for athletes, not only because of outstanding athletic performance, but also due to their ethical qualities encompassing courage, self-control, generosity, and fairmindedness (7). These attributes have the potential to make sport more attractive from a spectator's perspective and increase its educational value for different target groups.

As the leader of the Olympic Movement, the IOC will continue to work to provide access to sport for people around the world. Over the past decade, many partnerships have been established with UN agencies to develop global campaigns, but also with local organisations through NOCs and NFs to increase sports participation at all levels of society. In 2015, the United Nations recognised sport as an important enabler for achieving the SDGs. This was welcomed by the Olympic Movement and the Sport for Development and Peace community with great interest and a commitment to further develop society through sport (8).

Self-regulation is the ability to purposefully regulate dominant impulses, needs and desires to allow individuals to attain desired long-term outcomes (9). Self-regulation is an important skill in sport participation and a multifaceted phenomenon operating through a number of subsidiary cognitive processes, including self-monitoring, standard setting, evaluative judgment, self-appraisal,

and affective self-reaction (10). In most sports the presence of a referee or other official takes the forces the player to engage in self-control. An exception to this is Ultimate, non-contact team sport played with a flying disc. It is unique among team sports because it is self-refereed, even at the world championship level. The self-refereeing system used in Ultimate involves each team assessing their opponents and themselves after each match on various aspects of the "Spirit of the Game" (SOTG) such as Knowledge and use of the rules, Fouls and body contact, Fair-mindedness, Positive attitude and self-control, and Communication (11).

Good communication, sportspersonship, and respect are important reasons why people stay involved in sports (12). Within the physical activity and sport literature, communication has also been shown to contribute to team cohesiveness (13). Teams which demonstrate high SOTG behaviour will communicate better within the team, sharing knowledge and strategies effectively to achieve the best competitive outcomes (14). However, it has been argued that teams with poor SOTG are often seen as competitively superior, an assertion that remains to be formally tested. Communication is mandatory in Ultimate. It is through it that players communicate whenever a foul is called. Differentiating factor directly associated with the self-control that it is necessary to have/acquire in order to be able to expose our point of view.

Fairness is an important characteristic of ethical behaviour and moral reasoning. Beller and Stoll (15) argue that morality "involves a consideration of and concern for others, as well as being able to distinguish between what is honest and dishonest, fair, and unfair, respectful and disrespectful (p. 353). Haan (16) argued the importance of context in moral reasoning. Each sport is characterized by a particular complexity of relationships and roles that may have differing impact on the participants. Shields and Bredemeier (17) questioned athletes and non-athletes about moral dilemmas concerning everyday life and sport situations. Their research led to the development of the concept of bracketed morality. In sport situations, individuals condone behaviours that are not consistent with good character if demonstrated outside sport (18). For example, in "game reasoning", players react with a lower moral reasoning stage during participation in sport, but, when they understand that issues are related to everyday life, they shift to more mature reasoning (19, 20).

Moreover, evidence exists that non-athletes present more mature moral reasoning than athletes (15) and that individual

sport athletes, in turn, score higher than team sport athletes (21). Therefore, the contention that sport automatically builds character has been contested as competitive sport places athletes in conflict situations where sportsmanship and fair play is secondary to winning (15). In introducing SOTG system, Ultimate creates changes the nature of those complex relationships and is thought to provide a fairer, more honest sport experience.

In the current research, we seek to identify patterns of the athletes' assessments of the SOTG a self-refereed sport such as Ultimate. Specifically, we compare SOTG scoring across levels of competition and divisions. In this study, the five international events encompass different age groups while the Divisions represent different gender composition, therefore acting as proxies for those variables. It has been argued that differences in moral reasoning exist depending on the stage of life (i.e., young adults, middle-aged adults) and gender, although longitudinal studies of moral dilemmas failed to identify differences between males and females. For example, contrarily to Gilligan's (1) conceptualisation, which holds that males have a normative and fairness orientation due to their focus on rights, duties and justice and females have a utilitarianism and perfectionism orientation due to their focus on welfare, relationships, caring and harmony, no gender differences were found in moral orientation (22) or stage (23). Therefore, the main research question we will address in this study is whether SOTG scores differ across competitions and divisions elite level Ultimate events, taking into consideration the overall SOTG scores and its different dimensions.

2 Methods

2.1 Study design

This study adopted a cross-sectional research design to evaluate the usefulness of the SOTG scoring system in elite-level Ultimate across various divisions and age groups. The study's cross-sectional approach allowed for the collection of data from multiple sources simultaneously, enabling an analysis of SOTG variations in diverse competitive settings.

2.2 Participants and settings

The participants in this study were drawn from a five competitions of Ultimate Frisbee tournaments, providing a rich dataset for our analysis. These tournaments included the World Games (TWG) held in Birmingham, Alabama, USA, from July 7th to July 17th, 2022, which brought together 118 athletes representing four continents: Asia (15), Europe (43), North America (30), and Oceania (14). The (24) World Ultimate Club Championships (WUCC), a major event in Ohio, USA, from July 23rd to July 30th, 2022, featured a substantial gathering of 3,100 athletes and 128 teams from 30 nations. Moreover, the (24) World Master's Ultimate Club Championships (WMUCC)

convened at the University of Limerick, Ireland, from June 25th to July 2nd, 2022, attracting over 2,800 athletes and clubs hailing from 23 different nations. Lastly, the World and European Youth Championship (U20 & U17) jointly took place in Wroclaw, Poland, in 2022, where a total of 49 teams representing 29 national teams participated. All athletes are chosen by the national coaches of their teams. The culmination of these diverse tournaments resulted in a dataset comprising 2,832 self-refereed games, featuring 7,025 players (Figure 1). The players competed across nine divisions, each with specific age and gender criteria, including Open, Mixed, Women's, Master Open, Master Mixed, Master Women's, Grand Master Open, Grand Master Mixed, and Great Grand Master Open.

These divisions ensured a wide representation of participants across various age groups and genders, contributing to the richness of the dataset and enabling a comprehensive analysis of SOTG scores.

2.3 Data collection

Immediately after each game SOTG score sheets were collected by the Spirit Director of the event after: (a) the Spirit Captain (SC) facilitated a Spirit Circles (Sci) event with the opposing team. If for some reason there was no time to set up a Sci, the SCs at least checked in with the opposing team's SC to share any quick thoughts and to decide if further discussion was needed; (b) the teams evaluated their opponent teams promptly on the five principles of SOTG. The whole of each team was required to engage in scoring SOTG, to reflect on the game and their own team's spirit; (c) scores were entered or returned promptly to tournament organizers or scorekeepers; and (d) all SOTG scores were saved into a digital spreadsheet. During the tournaments, the spirit team, led by the spirit directors of the WUCC, WMUCC, TWG, U17 and U20 constantly monitored the scores and followed up with any teams that had displayed signs of poor spirit. All scores were locked and saved online where they could be viewed by all teams. The online versions make up the raw data analysed in the current study. Data from 2,832 self-refereed games were collected.

2.4 Instrumentation

The "Spirit of the Game" (SOTG) was used for the first time in 1980 and since then it has been part of all national and international championships, at a time when lifelong friendships created such strong personal ties that basic mutual respect was given. It is considered the number 1 rule of disc sports. SOTG was measured based on a scoring system in which athletes within a team score the opposition team after each game (12). SOTG was measured by the sum of the scores obtained in five questions addressing the following domains: Knowledge and use of the rules; Fouls and body contact; Fair-mindedness; Positive attitude and self-control, and Communication. Answers were given on a 5-point Likert scale (0 = Poor; 1 = Not Good; 2 = Good; 3 = Very Good;
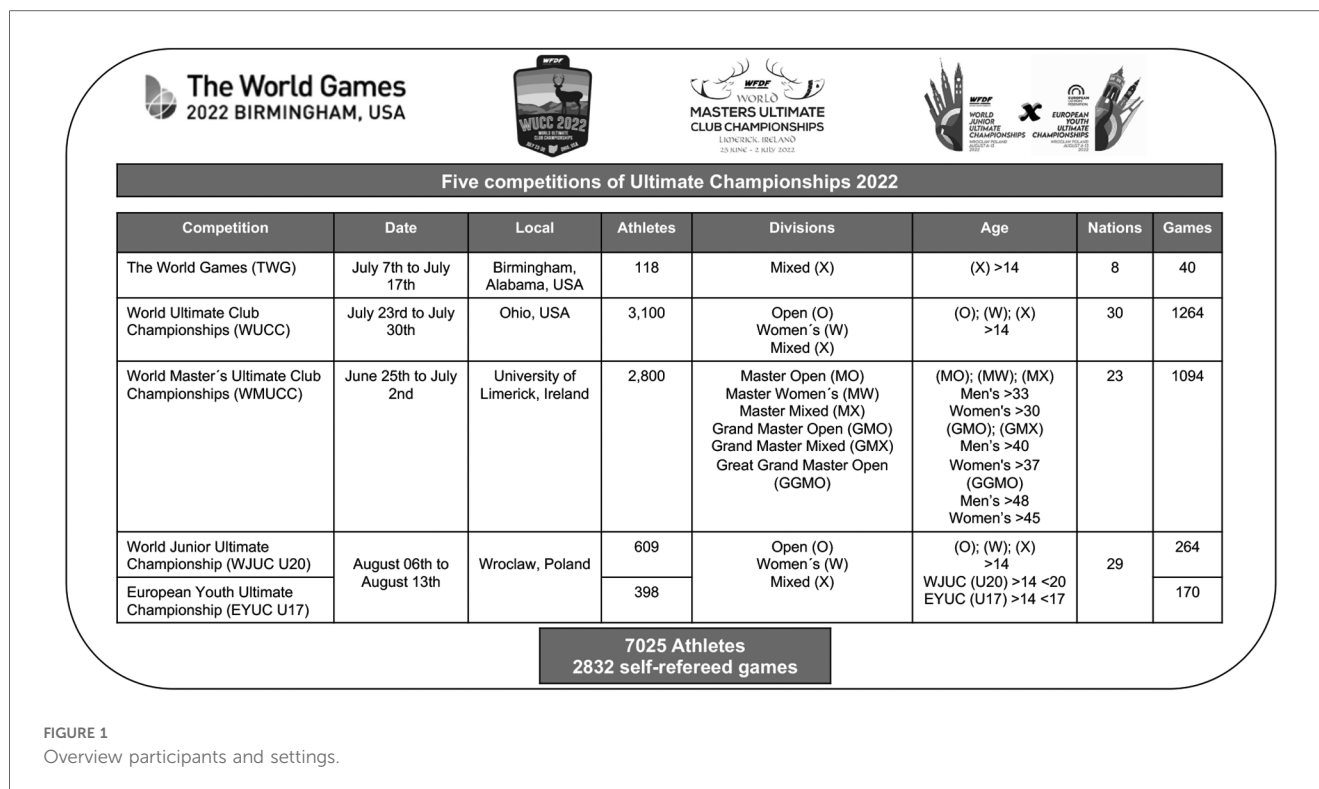
FIGURE 1
Overview participants and settings.

4 = Excellent). After each game, players rated whether the other team was "better than," "worse than," or "the same as" a rival in a regular game, using the anchor "Good" as a baseline for comparison. The final SOTG score is the sum scoring/marking and may vary between 0 and 20, where a score of 10 is considered normal, good SOTG (24).

2.5 Ethical issues

Permission for data collection was sought from the World Flying Disc Federation and approved by the Chair of Ethics Committee of WFDF (8 February 2022). The procedures followed the Declaration of Helsinki and produced by the Association (25) for research with humans. In this study, just teams scores were analyzed, we did not use personal data, and only general anonymized data were analysed.

2.6 Analysis

Data analysis was conducted with the Statistical Package for Social Sciences (SPSS 28.0). No missing data was observed. SOTG Scores were summarized using descriptive statistics (mean and standard deviation). Our data, for all cases, was confirmed to be not normally distributed, after using Kolmogorov–Smirnov normality test. Differences on SOTG scores between championships and divisions were examined by performing a Kruskal-Wallis H test, followed by Bonferroni post-hoc test. The level of statistical significance was set at 0.05.

3 Results

Mean overall SOTG scores for each event and for all divisions were above 10 points (Table 1), which corresponds to an assessment of "good" or better (10.8 ± 1.9). Nonetheless, some 0's and 20's scores were given at WUCC2022 and WMUCC2022, respectively, but not representative for all scores and championships, in sum, self-referring maintains a good level of ethical conduct in high level ultimate. The master's competition WMUCC2022 had significantly higher overall SOTG scores than all others with 11.31 ± 1.8 points ($p < 0.001$), followed by WUCC2022 (10.47 ± 1.9 points), U20 (10.50 ± 1.9 points), U17 (10.31 ± 1.7 points) and TWG2022 (10.28 ± 1.3 points). WMUCC2022 also showed higher mean individual results across all SOTG dimensions, but statistically significant differences were observed for "Knowledge and use of the rules" (2.01 ± 0.5), "Fouls and body contact" (2.06 ± 0.6), and "Fair-mindedness" (2.43 ± 0.6; $p < 0.001$) except for TWG2022, for which differences were statistically non-significant (1.93 ± 0.3 points, 1.83 ± 0.4 points, 2.08 ± 0.5 points, respectively).

For "Positive attitude and self-control", WMUCC2022 had, once again the highest scores (2.49 ± 0.6 points), but it was only statistically different between WUCC2022 (2.3 ± 0.6 points) and U20 (2.36 ± 0.6 points). "Communication" was also scored most highly at WMUCC2022 (2.33 ± 0.6 points), but it was only statistically different between WUCC2022 (2.2 ± 0.6 points) and U17 (2.08 ± 0.5 points) ($p < 0.001$).

When SOTG scores are analysed within tournaments and compared across divisions for WUCC2022 (Table 2), there were small but statistically significant differences in overall mean

TABLE 1 SOTG scores, overall and for each dimension, for WUCC2022, WMUCC2022, TWG2022, U17 & U20.

		N	Mean	Std	Min.	Máx.	P
SOTG	WUCC2022	1,264	10.47	1.9	0	17	<0,001
	WMUCC2022	1,094	11.31	1.8	3	20	
	TWG2022	40	10.28	1.3	6	13	
	U17	170	10.31	1.7	3	14	
	U20	264	10.50	1.9	3	16	
	Total	2,832	10.78	1.9	0	20	–
Knowledge and use of the rules	WUCC2022	1,264	1.89	0.4	0	4	<0,001
	WMUCC2022	1,094	2.01	0.5	0	4	
	TWG2022	40	1.93	0.3	1	2	
	U17	170	1.79	0.5	0	3	
	U20	264	1.84	0.4	0	3	
	Total	2,832	1.93	0.5	0	4	–
Fouls and body contact	WUCC2022	1,264	1.92	0.5	0	4	<0,001
	WMUCC2022	1,094	2.06	0.6	0	4	
	TWG2022	40	1.83	0.4	1	2	
	U17	170	1.86	0.5	1	3	
	U20	264	1.9	0.6	0	3	
	Total	2,832	1.97	0.6	0	4	–
Fair-mindedness	WUCC2022	1,264	2.16	0.7	0	4	<0,001
	WMUCC2022	1,094	2.43	0.6	0	4	
	TWG2022	40	2.08	0.5	1	3	
	U17	170	2.14	0.6	0	3	
	U20	264	2.15	0.7	0	4	
	Total	2,832	2.26	0.7	0	4	–
Positive attitude and self-control	WUCC2022	1,264	2.3	0.6	0	4	<0,001
	WMUCC2022	1,094	2.49	0.6	0	4	
	TWG2022	40	2.23	0.6	1	3	
	U17	170	2.44	0.7	1	4	
	U20	264	2.36	0.6	1	4	
	Total	2,832	2.38	0.6	0	4	–
Communication	WUCC2022	1,264	2.2	0.6	0	4	<0,001
	WMUCC2022	1,094	2.33	0.6	1	4	
	TWG2022	40	2.23	0.6	1	3	
	U17	170	2.08	0.5	1	3	
	U20	264	2.25	0.6	0	4	
	Total	2,832	2.25	0.6	0	4	–

SOTG scores. The Open division had the highest score (10.79 ± 1.9 points) and this was significantly higher than scores for the Mixed division (10.43 ± 2.2 points; $p < 0.05$) and the Women's division (10.21 ± 1.3 points; $p < 0.001$).

In the "Knowledge and use of the rules", "Fouls and body contact" and "Positive attitude and self-control" dimensions, all three divisions obtained statistically similar results (total: 1.89 ± 0.4 points, 1.92 ± 0.5 points, and 2.30 ± 0.6 points, respectively; $p > 0.05$). On the other hand, "Fair-mindedness" and "Communication" were scored higher in the Open division. The Open scores for both dimensions were significantly higher than those given in the women's division. For mixed vs. open only fair-mindedness differed significantly (see Table 2 for a full breakdown).

Similar results were observed for WMUCC2022, but these can be further broken down into six age-gender categories (Table 3). Open divisions scored consistently the highest and were overall highest in the "Great Grand Master Open" division (12.44 ± 2.5 points; $p < 0.001$) followed by "Grand Master Open" (11.53 ± 1.7 points), "Master Open" (11.41 ± 1.7 points), "Grand Master Mixed" (11.28 ± 1.8 points), "Master Mixed" (11.22 ± 1.7 points)

and "Master Women's" (10.52 ± 1.4 points). It is worth noting the fact that "Master Women's" division lower mean results are also statistically different from all other divisions ($p < 0.001$).

In the "Knowledge and use of the rules" dimension, "Great Grand Master Open" division had the highest score when compared with all the others, with a mean score of 2.34 ± 0.7 points ($p < 0.001$). "Master Women's" achieved, once again, the lowest mean score for this dimension (1.89 ± 0.4 points), nevertheless, it was only statistically different from "Grand Master Open" ($p < 0.05$) and "Great Grand Master Open" divisions ($p < 0.001$).

For "Fouls and body contact" "Great Grand Master Open" division again had the highest score when compared with all the others with a mean score of 2.23 ± 0.7 points ($p < 0.001$) and this was statistically different from "Master Women's" (1.84 ± 0.5 points, $p < 0.001$) and "Master Mixed" divisions (2.02 ± 0.6 points $p < 0.05$).

In the Fair-mindedness dimension, "Great Grand Master Open" division again had the highest score when compared with all the others, with a mean score of 2.68 ± 0.6 points, this results only showed to be statistically like "Grand Master Open" and

TABLE 2 Overall and detailed SOTG scores for WUCC2022, according to divisions.

Championship WUCC2022		N	Mean	Std	Min.	Máx.	P
SOTG	Open	398	10.79	1.9	0	17	<0.001
	Women's	394	10.21	1.3	5	14	
	Mixed	472	10.43	2.2	0	16	
	Total	1,264	10.47	1.9	0	17	–
Knowledge and use of the rules	Open	398	1.94	0.4	0	4	0.15
	Women's	394	1.89	0.4	0	3	
	Mixed	472	1.86	0.5	0	4	
	Total	1,264	1.89	0.4	0	4	–
Fouls and body contact	Open	398	1.97	0.6	0	3	0.116
	Women's	394	1.89	0.4	0	4	
	Mixed	472	1.91	0.6	0	4	
	Total	1,264	1.92	0.5	0	4	–
Fair-mindedness	Open	398	2.22	0.7	0	4	<0.001
	Women's	394	2.05	0.6	0	3	
	Mixed	472	2.20	0.7	0	4	
	Total	1,264	2.16	0.7	0	4	–
Positive attitude and self-control	Open	398	2.32	0.7	0	4	0.164
	Women's	394	2.25	0.5	0	4	
	Mixed	472	2.32	0.7	0	4	
	Total	1,264	2.30	0.6	0	4	–
Communication	Open	398	2.33	0.6	0	4	<0.001
	Women's	394	2.13	0.5	0	3	
	Mixed	472	2.14	0.6	0	4	
	Total	1,264	2.20	0.6	0	4	–

"Grand Master Mixed" ($p > 0.05$). "Master Women's" gathered, once again, the lowest mean score for this dimension (2.18 ± 0.6 points) and it was statistically different from all others ($p < 0.001$).

"Positive attitude and self-control" and "Communication" dimensions had "Great Grand Master Open" division scores, once again, on top of all other divisions with mean results of 2.59 ± 0.7 and 2.61 ± 0.7 points, respectively. Nonetheless, for the first, statistical differences were only confirmed between "Master Women's" (2.33 ± 0.6 points, $p < 0.001$), while on the second one was confirmed between all divisions ($p < 0.001$).

"Master Women's" received the lowest mean score for these two dimensions (2.33 ± 0.6 and 2.18 ± 0.4 points, respectively) but it was only statistically different from "Master open" (2.50 ± 0.6 points, $p < 0.05$), "Master mixed" and "Great Grand Master Open" ($p < 0.001$) for "Positive attitude and self-control" and statistically different from "Master open" (2.36 ± 0.7 points, $p < 0.01$), "Grand master open" (2.41 ± 0.5 points, $p < 0.01$) and "Great Grand Master Open" ($p < 0.001$) for "Communication" dimension.

4 Discussion

The aim of the study was to compare athletes' SOTG scoring across levels of competition and divisions in high level Ultimate. Our results suggest this system may help in the construction of an ethical and sportspersonlike conduct across all levels and divisions, as overall average scores were all above 10 (good) and individual domain specific scores above or close to 2 (good). Importantly, these results suggest that self-refereeing is possible across different levels of play, at elite level competitions.

The International Olympics Committee (IOC) implicitly values SOTG through its core values of peace and development through sport. Yet, there still appears to be an underlying ambiguity about the "spirit" of Ultimate that remains intangible (26). Also in these competitions, the SOTG is valued positively in all divisions (open, womeńs and mixed) at the Joint Junior Ultimate championship (11). A self-refereed sport like Ultimate has the potential to develop pedagogies which teach self-regulation, moral reasoning and communication whilst improving wellbeing through the physical benefits of activity. Therefore, Ultimate has the potential to promote teamwork, task cohesion, leadership, and increase friendship (27). As such, self-refereeing and SOTG scoring may be employed as a tool for developmental and social education of young people and further contribute to the use of sport experiences to develop athletes' life skills (28, 29). Establishing local knowledge is essential before attempting to engage new participants in the sport, particularly working with disadvantaged young people (30, 31).

The results of our study also highlight some potentially interesting patterns within divisions. Our finding that SOTG scores were always above average ("good") across all divisions, even when scores from under 17 and under 20 competitions were included, is encouraging and suggests that self-refereeing and SOTG scoring has potential as a teaching tool in sports education from a young age (U17). Although we found that all overall mean scores were "good" or better regardless of age group or gender split, we did observe scores to increase in older age categories, particularly for male dominated "Open" divisions. We also saw that scores were generally higher in Open divisions than Women's or Mixed (gender) divisions. We can only

TABLE 3 Overall and detailed SOTG scores for WMUCC2022, according to divisions.

		N	Mean	Std	Min.	Máx.	P
SOTG	Master open	264	11.41	1.7	8	17	<0.001
	Master women's	190	10.52	1.4	5	13	
	Master mixed	288	11.22	1.7	3	18	
	Grand master open	146	11.53	1.7	6	15	
	Grand master mixed	102	11.28	1.8	5	15	
	Great grand master open	104	12.44	2.5	7	20	
	Total	1,094	11.31	1.8	3	20	–
Knowledge and use of the rules	Master open	264	2.02	0.5	0	4	<0.001
	Master women's	190	1.89	0.4	1	3	
	Master mixed	288	1.95	0.5	0	3	
	Grand master open	146	2.06	0.4	1	3	
	Grand master mixed	102	1.99	0.5	1	3	
	Great grand master open	104	2.34	0.7	1	4	
	Total	1,094	2.01	0.5	0	4	–
Fouls and body contact	Master open	264	2.08	0.6	1	3	<0.001
	Master women's	190	1.94	0.5	0	3	
	Master mixed	288	2.02	0.6	0	4	
	Grand master open	146	2.16	0.6	1	3	
	Grand master mixed	102	2.01	0.6	0	3	
	Great grand master open	104	2.23	0.7	1	4	
	Total	1,094	2.06	0.6	0	4	–
Fair-mindedness	Master open	264	2.46	0.6	1	4	<0.001
	Master women's	190	2.18	0.6	1	4	
	Master mixed	288	2.42	0.7	0	4	
	Grand master open	146	2.45	0.6	1	4	
	Grand master mixed	102	2.51	0.7	1	4	
	Great grand master open	104	2.68	0.6	1	4	
	Total	1,094	2.43	0.6	0	4	–
Positive attitude and self-control	Master open	264	2.50	0.6	1	4	<0.001
	Master women's	190	2.33	0.6	1	4	
	Master mixed	288	2.58	0.6	0	4	
	Grand master open	146	2.45	0.6	0	3	
	Grand master mixed	102	2.46	0.6	0	3	
	Great grand master open	104	2.59	0.7	1	4	
	Total	1,094	2.49	0.6	0	4	–
Communication	Master open	264	2.36	0.6	1	4	<0.001
	Master women's	190	2.18	0.4	1	3	
	Master mixed	288	2.26	0.5	1	4	
	Grand master open	146	2.41	0.5	1	4	
	Grand master mixed	102	2.31	0.6	1	4	
	Great grand master open	104	2.61	0.7	1	4	
	Total	1,094	2.33	0.6	1	4	–

speculate as why this might be. One possibility is that gendered stereotypes about morally appropriate behaviour differ for male vs. female-identifying players. Women may be perceived as being less spirited than men when behaving the same.

This phenomenon has been highlighted in some studies in which assertive behaviour is evaluated more negatively when displayed by women compared to when identical behaviour is displayed by men (32, 33). During coeducational physical education, girls are more frequently confronted with a contradiction between further developing their female gender identity, and on the other hand the male gender role expectations such as competition, achievement orientation and self-reliance (34). It is also possible that women rate SOTG offences more harshly than men. It will be important in the future to carry out

randomised control trials that ask participants of different gender identities to rate the SOTG of hypothetical players of different gender identities, in order to better understand how gender stereotypes influence the attribution of SOTG. Such studies could also evaluate the role of other biases, such as country or age, in SOTG scoring which will help when developing instructional materials to raise awareness about unconscious biases in SOTG scoring so that the process itself can be fairer.

Higher SOTG scores (and greater variability of scores) in the upper master's division suggests that a new generation of players, particularly those with more international competition experience, know that a good game is a 10 (normal game), and they must justify giving anything well outside that range (high or low). At The World Games data players had shown how to use

the scoring system. Teams that lack experience with SOTG scoring often have to be told not to give high or low scores, unless there is some clear justification.

4.1 Strengths and limitations

The study's strengths lie in its comprehensive dataset from five international Ultimate tournaments, enabling a thorough examination of the SOTG scoring system's effectiveness. The cross-sectional design facilitated a diverse age and division analysis, highlighting the impact of self-refereeing and SOTG on ethical behavior in elite Ultimate. Noteworthy limitations include linguistic barriers affecting SOTG scores, necessitating caution in non-English-speaking regions. While gender biases in SOTG scoring were explored, other studies should delve into biases linked to factors like country and age. Complexity within the SOTG scoring system warrants further investigation.

4.2 Perspectives for future studies

Future research should focus on gender stereotypes' influence on SOTG scoring and explore how varying behaviors are perceived based on gender. Raising awareness of unconscious biases in SOTG scoring and developing equitable assessment tools are essential. Comparative sports analysis, examining SOTG's applicability in other sports, is a promising avenue. Longitudinal studies tracking young athletes' ethical development, emphasizing self-regulation and moral reasoning, are worth pursuing (35). Firstly, control trials of a more qualitative nature to better understand why scoring differences occur, especially checking for potential biases regarding gender, age, and nationality; sencondly, examining the applicability of SOTG and self-refereeing in other sports; and thirdly longitudinal studies tracking athletes' development.

4.3 Practical implications

Integrating the SOTG system into sports education programs teaches crucial skills like self-regulation and ethical decision-making. This approach enhances young athletes' well-being and fosters teamwork, leadership, and lasting friendships. On the other hand, the SOTG system's relevance extends to elite-level athletic development, maintaining ethical standards and promoting fair play. In international competitions, it serves as a universal ethical benchmark, ensuring ethical behavior in diverse cultural contexts.

Furthermore, recognizing SOTG's alignment emphasising its potential impact on broader societal objectives like peace, social inclusion, and sustainable development. Promoting ethical behavior in sports and sustainable development, aligns with COI and SDGs incorporating SOTG principles into sports education, fostering individuals who value fairness, cooperation, and respect, central to the SDG´s vision, particularly SDG 3 (Good Health and Well-being), SDG 4 (Quality Education) and SDG 5 (Gender Equality) and SDG 16 (Peace, Justice, and Sustainable Institutions) (11, 36). Ethical sports behavior contributes to peace, social inclusion, and sustainable development.

5 Conclusions

This study examined SOTG results in five different competitions. Score distributions aligned with expectations, assuming that most teams consistently exhibited good sportsmanship. "Positive attitude and self-control" consistently received the highest scores across all divisions, confirming positive SOTG outcomes in all competitions. In contrast, rules knowledge consistently scored the lowest in all divisions, emphasizing the need to enhance rule comprehension. Further data analysis may reveal the extent of linguistic barriers posing a problem in this regard. Utilizing the SOTG system through self-arbitration has proven to be an effective means of implementing self-refereeing and maintaining ethical conduct in a sporting context.

Furthermore, this study underscores the crucial role of sportsmanship and ethics through promoting ethical behaviour in sports and nurturing skills in self-regulation and moral decision-making, this study emphasizes sports' contribution to creating a fairer, healthier, and more peaceful world.

Data availability statement

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

Ethics statement

The studies involving humans were approved by Chair of Ethics Committee of World Flying Disc Federation. 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

JA: Conceptualization, Funding acquisition, Investigation, Methodology, Writing – original draft. LC: Methodology, Writing – original draft, Formal Analysis, Software. RB: Writing – review & editing, Investigation, Visualization. CG-T: Writing – review & editing, Supervision, Conceptualization, Validation. FC: Conceptualization, Investigation, Methodology, Validation, Writing – review & editing. EC: Investigation, Methodology, Validation, Writing – review & editing. WC: Conceptualization, Methodology, Supervision, Validation, Writing – original draft. DD: Conceptualization, Supervision, Validation, Writing – original draft. JM: Conceptualization, Supervision, Validation,

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