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Psychological factors in physical education and sport, volume II

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

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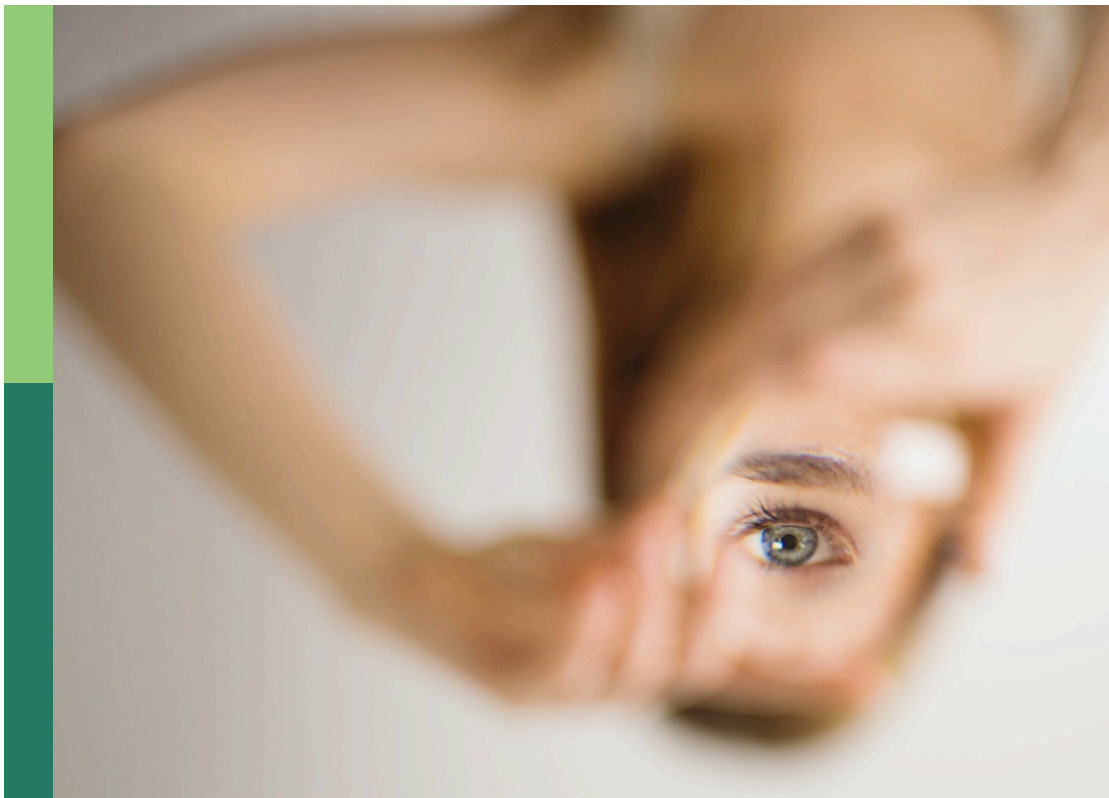

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Psychological factors in physical education and sport, volume II

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

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EDITED BY
Pedro Forte,
Higher Institute of Educational Sciences of the Douro, Portugal

REVIEWED BY
Soukaina Hattabi,
University of Jendouba, Tunisia
Álvaro Fortunato,
Polytechnic Institute of Bragança (IPB), Portugal

*CORRESPONDENCE
Manuel Gómez-López
✉ mgomezlop@um.es

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

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

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

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motivation, education, sport, physical education, psychological wellbeing

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

This Research Topic compiles the most recent research on some of the factors that influence the physical and psychological wellbeing of those who practice physical-sports activities and how to promote adherence in both the educational and sports contexts.

In recent years, studies on athlete leadership have increased. Today it is recognized as a vital component of team performance and as a determining factor that facilitates a more positive and sustainable sporting environment. The results of the study developed by Kim and Cruz showed that effective leadership in sport depends on the interaction between the leadership behaviors of the coach, the personal characteristics of the players and situational factors. Furthermore, the importance of transformational leadership was also demonstrated as an important requirement for creating a more positive and sustainable sport environment. In this group, we find studies that highlight the importance of the coach, and more specifically of leadership styles and their relationship with resilience or cohesion in athletes. In this group, we find studies that highlight the importance of the coach, and more specifically of leadership styles and their relationship with resilience or cohesion in athletes. The study by Liu et al. recommends that elite youth soccer schools pay attention to leadership styles and apply them to sports practice. On the other hand, Flemington et al., suggest that a cohesive team shares leadership responsibilities with many peer bonds. In addition to this, there is also the need to develop and validate a scale that can measure the leadership of the coaching service (Takamatsu).

On the other hand, we have perceptions and their importance as determinants of people's behavior. In this field, not much is known about athletes' perceptions of their sport and the links of these perceptions with the physical and psychological benefits perceived by athletes, such as sport commitment or quality of life. In general, it has been shown that athletes' perceptions seem to be relevant for experiencing training satisfaction and general wellbeing. As an example, we have the results provided by Limpo et al.. This study revealed that karateka's perceived benefits of karate predicted engagement directly and quality of life indirectly through vigor. In general, it was shown that karateka's perceptions appeared to be relevant to experiencing training satisfaction and general wellbeing. Another perception that influences sport performance is the motivational climate generated by the coach during

training and competitions. Specifically, it has been shown that a mastery motivational climate reinforces in the athlete the perception of performance as the result of task mastery and personal effort, as opposed to a competitive climate that reinforces competition and rivalry among team members. The study developed by Appleton et al. suggested that the EDMCQ-C scale can be used to provide meaningful latent mean comparisons of the empowering and disempowering climates created by coaches among athletes.

Other key factors in sport performance, are emotional intelligence, confidence, attention, and cognitive reappraisal, since sport is an emotional experience. Mercader-Rubio et al. demonstrated that emotional intelligence is a predictor of identified regulation, introjected regulation and external regulation. In addition, Wang D. et al. concluded that the development of sport confidence and mindfulness in archery athletes should be strengthened. Athletes who use cognitive reappraisal in archery competition should be aware of their potential appropriation of cognitive resources and should be directed to enhance sport confidence or develop a positive orientation to arouse emotion.

On the other hand, we also find research, such as the one carried out by Bisagno et al., that has focused on finding out which psychological abilities are the most relevant to train, depending on whether it is a sport modality in which open or closed skills predominate or the relationship that exists between the mental abilities of the athlete and the gender and specific position of the game. Thus, the results found by Jakšić et al. demonstrated that Bull's Mental Abilities Questionnaire in the Serbian sample of handball players reflected satisfactory although different psychometric characteristics with the original one. Finally, the study carried out by Török et al. analyzes the perfectionist drive of elite athletes vs. worries as opposite predictors of self-elimination with the mediating role of attributional style. A first step within a broader program aiming to reduce self-enhancement in high-level athletes through attributional retraining intervention.

In the field of health and quality of life of athletes, Wang Y. et al., demonstrated the importance of favoring intrinsic motivation to increase the intention to use mobile technology, such as sports bracelets, which facilitate the acquisition of a healthy lifestyle, Vieira et al. described the profile of fitness professionals and the importance of improving their working conditions and quality of life and Zhang et al. how a meta-analysis shows that although more research is still needed, the results of the studies confirm that physical exercise has moderate positive effects on depression in adolescents. It should be remembered that in the COVID-19 confinement stage there were profound changes in relation to the practice of physical activity that affected the motivation and satisfaction of the basic psychological needs of the athletes, also affecting their social identity, this was demonstrated by Parker et al.. Moreover, LaForge-MacKenzie et al. showed a positive association has been demonstrated between sports practices during the pandemic and low levels of depressive symptoms, i.e., better mental health outcomes in children and young people.

Finally, in the educational context we find two problems that continue to be investigated, on the one hand, to know which are the ideal teaching methods to apply in Physical Education classes to promote intrinsic motivation of students and increase their learning (Ezeddine et al.) and on the other hand, to find the multidisciplinary factors that influence the identification of sports talents at school (Xiang et al.). In the first study, Ezeddine et al. found that the problem-solving method is an effective strategy to improve motor skills and performance, as well as to develop motivation during physical education courses. And in the second, Xiang et al. showed that the main factors affecting sports talent identification in physical education curriculum are personal physical quality, psychological quality, coach's knowledge, and schools' sports talent identification policies.

Author contributions

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

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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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BRIEF RESEARCH REPORT
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Examining the Relationship Between Basic Psychological Needs and Athlete Identity During the COVID-19 Pandemic

Patti C. Parker, Adam M. Beeby and Lia M. Daniels*

Alberta Consortium for Motivation and Emotion, College of Social Sciences and Humanities, University of Alberta, Edmonton, AB, Canada

Objectives: During COVID-19 athletes have had games canceled, seasons postponed, and social supports lost. These changes negatively impact their motivation, and potentially identity, as athletes. We draw on self-determination theory to examine motivation in sport and its relationship with athlete identity during COVID-19.

Design: A cross-sectional study design was employed consisting of online quantitative surveys.

Method: We gathered background engagement and motivation data from 115 athletes involved in organized sport. They responded to questions on basic psychological needs satisfaction (competence, relatedness, autonomy) and athlete identity.

Results: When reflecting on their basic psychological needs during the pandemic, most athletes considered them important. Athletes' competence and relatedness in sport were associated with social-related athlete identity, but not autonomy. Only relatedness in sport was associated with exclusivity-related social identity.

Conclusions: Using a self-determination theoretical lens, our findings contribute to understanding athlete motivation and identities when sport is interrupted.

Keywords: athletes, COVID-19, basic psychological needs, athlete identity, motivation

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Reviewed by:
Aurelio Olmedilla, University of Murcia, Spain
Manuel Gómez-López, University of Murcia, Spain
Rodrigo Sudatti Delevatti, Federal University of Santa Catarina, Brazil

****Correspondence:***
Patti C. Parker
pparker@ualberta.ca

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INTRODUCTION

As a consequence of the COVID-19 pandemic, sporting events and competitions were put on hold for many individuals. This recent stoppage of sport is already negatively impacting athletes' mental health—including grief, stress, anxiety, depression, as well as their motivation in sport (Ruffault et al., 2020; Schinke et al., 2020). With the social isolation measures mandated by the pandemic, many athletes lost social supports, regular training regimens, and the ability to participate in their activities which are critical to their identities as athletes (Graupensperger et al., 2020). Athlete identity refers to the degree to which a person identifies with, and relates to, their role as an athlete (Brewer et al., 1993a) and is instrumental to commitment and investment in sport. How athletes' identities are threatened by the type of sport setbacks and interruptions brought about by COVID-19 is an important area for sport research. Our study investigates how the pandemic has affected athlete motivation and its relationship with athlete identity. We draw from self-determination theory (SDT) for a motivational lens to understand the athlete perspective during the pandemic.

SDT is defined as the internal development and inborn psychological needs that serve as foundational development toward a person's self-motivation, integration, and growth of the self (Ryan and Deci, 2002; Deci and Ryan, 2011). This type of motivation focuses on the self and is important for optimal functioning across various achievement domains, including school, sports, and career. Three basic psychological needs are identified in SDT: (a) *competence*, a person's sense of accomplishment or effectiveness within their environment; (b) *relatedness*, a person's connection with the people around them and in their community; and (c) *autonomy*, a person's feeling in control of their own behaviors (Ryan and Deci, 2002).

Competence, relatedness, and autonomy all matter because when they are met or experienced by a person they lead to internal growth resulting in greater self-motivation and mental health (Deci and Ryan, 2000). Whereas, when basic psychological needs are not met, they can result in less self-motivation and decreased wellbeing. It is not surprising that during the public health restrictions for COVID-19, across various countries athletes indicated having lower motivation (e.g., autonomous) (Martínez-González et al., 2021)—particularly expert athletes, those competing at a lower level, and those without training programs in place. Further, Leyton-Román et al. (2021) showed supporting athletes' need for competence (in Spain) and autonomous motivation helped bolster self-efficacy and commitment to practice. Additionally, athletes who reported more connectedness with teammates and greater social support during COVID-19 were better able to maintain their athlete identities (Graupensperger et al., 2020). Thus, we recognize the significance of self-motivation and athlete identities and focused on these relationships during the setbacks and interruptions associated with the COVID-19 pandemic.

Athlete identities can have many positive implications for athletes. For example, athlete identity is linked to enhanced athletic performance, commitment, and social connections (Brewer et al., 1993b; Horton and Mack, 2000). Notably, research on athlete identity reveals three dimensions that reflect social, exclusivity, and negative affectivity aspects of athlete identity (Brewer and Cornelius, 2001). Social-related athlete identity pertains to how much athletes view themselves as fitting the athlete role (e.g., "I consider myself an athlete") and is associated with positive forms of personal competence such as social acceptance and behavioral conduct (Ryska, 2002), and athlete satisfaction (Burns et al., 2012). Exclusivity-related athlete identity reflects how much athletes have a narrow focus on sport and view themselves exclusively as an athlete (e.g., "I spend more time thinking about sport than anything else"). This dimension of athlete identity appears to benefit and harm aspects of motivation and wellbeing in that it is positively linked to scholastic and vocational types of competence (Ryska, 2002), but also burnout (Gustafsson et al., 2008) and is negatively related to athlete satisfaction (Burns et al., 2012). Finally, negative affectivity has to do with how athletes feel when they perform poorly or cannot fulfill their role as an athlete (e.g., "I feel bad about myself when I do poorly in sport") and is related to athlete satisfaction (Burns et al., 2012) and anxiety (Masten et al., 2006).

For many, the athlete role can require a lot of commitment and investment, and lead athletes to feel a strong sense of who they are (Brewer et al., 1993b). However, when athletes' involvement in sport is threatened such as by injuries or early termination, they tend to reduce their identification, or dissociate from it, to avoid the costs of having to adjust (Lavallee et al., 1997; Brewer et al., 1999, 2010; Manuel et al., 2002). This dissociation can unfortunately lead to feeling a sense of loss and lower mental health (Sanders and Stevinson, 2017). These findings support the idea that the athlete identity is dynamic and can change, especially when threatened, and arguably, COVID-19 represents a global and ongoing threat to athlete identity. Schinke et al. (2020) further add that high-performance athletes place a lot of importance on their athlete identities and those at the highest levels who have made long-term commitments can have very focused and singular identities that may be incompatible with a socially isolating pandemic.

Since March 2020, competing athletes' engagement in their sport has been substantially, sometimes permanently, interrupted—this type of setback provides a unique situation in which to study athletes' self-determined motivation and how it relates to athlete identity. Thus, our study considers athletes' basic psychological needs during the COVID-19 pandemic and how needs satisfaction relates to two dimensions of athletic identity (social and exclusivity). Since we wanted to examine how their self-determined motivation impacts athletes' current views of their identity, for this study we were not interested in the third dimensions—negative affectivity—because it focuses on athletes' feelings of anticipated outcomes in sport which were largely paused.

Our study sought to understand athlete identity in the context of the COVID-19 pandemic. In doing so, as a first objective, we described athletes' reported frequencies of sport-related participation during the pandemic (e.g., how often they played their sport in the last 3 months). As a second objective, we examined the effect of autonomy, competence, and relatedness on social and exclusivity-related athlete identity while controlling for competitive sport status. We hypothesized that autonomy, competence, and relatedness would be positively associated with social-related athlete identity. This hypothesis is based on the idea that athletes who feel free to make choices, feel competent, and supported in their sport are likely to identify more with their social role as an athlete. Considering the conflicting evidence for exclusivity-related identity on motivation and wellbeing (Burns et al., 2012), we explored whether basic psychological needs would impact this type of identity but did not make specific hypotheses.

METHODS

We used a cross-sectional correlational design to collect self-report data on basic psychological needs and identity from adult athletes (18 years or older).

Study Procedure

The study procedure received ethics approval from the researchers' institutional research ethics board (Pro00103711)

and all participants provided informed consent. Data collection began at the beginning of December 2020 and finished at the end of January 2021. Participants were recruited using a snowballing method in which online advertisements (i.e., Twitter), listservs (i.e., Student Digest for a midwestern Canadian university), and emails were used to circulate the survey link and request that it be forwarded. A research assistant was responsible for regularly posting the recruitment materials (email, social media, university digests) and asking recipients to further share the opportunity for participation. The online survey link (SurveyMonkey) was included directly in the recruitment materials. Upon clicking the link, participants responded to a number of questions about sport participation (e.g., level of sport, sport type), demographic information (e.g., gender), and the target motivation and identity variables. There was no remuneration for participating. The survey took on average 11 min to complete.

Participants

A total of 143 athletes clicked the survey link. Of these, the sample was reduced to 115 participants who met the study inclusion criteria of being athletes aged 18–25 who play at least one organized sport. We also excluded participants who had more than 30% missing data, indicating lack of full engagement with the survey. The sample consisted of 60% women, 37% men, and 3% were non-binary. The participants indicated playing the following sports: soccer (22), competitive dancing (12), volleyball (11), hockey (11), competitive cheerleading (9), weightlifting (7), basketball (5), team handball (5), multi-sport (4), distance running (4), rugby (4), ringette (3), swimming (3), alpine/cross-country skiing (2), football (2), golf (2), curling (1), track and field (2), ultimate frisbee (2) figure skating (1), gymnastics (1), paddling (1), and Jiu Jitsu (1). Of the sample, 41.7% comprised athletes playing organized sport at the competitive level, 31.2% at the recreational level, and 27.0% at both levels (see **Table 1** for more sport-related descriptive information).

Materials

The online survey consisted of a total of 46 items designed to measure participants' background information, basic psychological needs, and athlete identity.

Background Information

In order to get a sense of participants' previous and current sport engagement during the COVID-19 pandemic we asked seven general background questions such as their level of sport and if they had been able to return to their sport as COVID-19 regulations eased. This information was primarily collected to describe the sample. Descriptive information for each item including scales and frequencies are available in **Table 1**.

Basic Psychological Needs

We measured Basic Psychological Needs in two ways. First, we created three single-item measures asking participants to rate how important they felt satisfaction of competence, relatedness, and autonomy for sport is during COVID-19 (1 = *strongly disagree*, 10 = *strongly agree*). Second, we used Ng et al.'s (2011). Basic Needs Satisfaction in Sports Scale to measure participants'

TABLE 1 | Frequencies for background, sport engagement variables, and basic psychological needs.

	Frequency	%
1. Gender		
1 = Man	43	37.4
2 = Woman	69	60.0
3 = Non-binary	3	2.6
4 = Prefer not to share	0	–
2. Level organized sport is played		
1 = Recreational	36	31.3
2 = Competitive	48	41.7
3 = Both	31	27.0
3. Sport type		
1 = Team	14	12.2
2 = Individual	73	63.5
3 = Both	28	24.3
4. Competitive sport status (played competitively at some point)		
1 = No	13	11.3
2 = Yes	102	88.7
5. Amount sport was played pre-pandemic		
1 = More than once a week	84	73.0
2 = Weekly	29	25.2
3 = Every two weeks	2	1.7
6. Amount sport was played in last three months		
1 = More than once a week	33	28.7
2 = Weekly	17	14.8
3 = Every two weeks	3	2.6
4 = Once a month	9	7.8
5 = I didn't play this sport in the last three months	53	46.1
7. How long sport has been played		
1 = Age 2-5	29	25.2
2 = Age 6-12	36	31.3
3 = Age 13-18	28	24.3
4 = Started after high school	22	19.1
8. Able to return to sport as some regulations lifted during pandemic lockdown		
1 = No	52	45.2
2 = Yes	63	54.8
9. Autonomy: It is important for me to maintain my personal investment and commitment to training for my organized sport		
1 = Strongly disagree	2	1.8
2	0	–
3	7	6.3
4	6	5.4
5	12	10.8
6	14	12.6
7	6	5.4
8	12	10.8
9	11	9.9
10 = Strongly agree	41	36.9
10. Competence: It is important to me to have the ability to perform well in my organized sport once play is allowed to resume		
1 = Strongly disagree	2	1.8

(Continued)

TABLE 1 | Continued

	Frequency	%
2	0	–
3	3	2.7
4	1	0.9
5	6	5.4
6	9	8.1
7	12	10.8
8	12	10.8
9	12	10.8
10 = Strongly agree	54	48.6
11. Relatedness: It is important for me to maintain relationships with the people that are close to me within my organized sport (i.e., coaches, team)		
1 = Strongly disagree	0	–
2	1	0.9
3	3	2.7
4	4	3.6
5	8	7.2
6	6	5.4
7	17	15.3
8	20	18.0
9	15	13.5
10 = Strongly agree	37	33.3

Frequencies shown for the demographic and sport engagement variables, and importance of basic psychological needs in sport during the COVID-19 pandemic.

autonomy, competence, and relatedness as predictor variables. Participants were asked to answer these items while keeping in mind how they felt during the COVID-19 pandemic. All items were rated on a Likert scale (1 = *not true at all*, 7 = *very true*) and were slightly adapted to refer to sport as "organized sport". Participants completed 4-items to measure their autonomy (e.g., "In my organized sport, I get opportunities to make choices"; Cronbach's $\alpha = 0.89$), 5-items to measure their competence (e.g., "I get opportunities to feel that I am good at my organized sport"; Cronbach's $\alpha = 0.85$), and 5-items to measure relatedness (e.g., "I have close relationships with people in my organized sport"; Cronbach's $\alpha = 0.81$).

Athlete Identity

Athlete identity was examined as an outcome variable using Brewer and Cornelius' (2001) Athletic Identity Measurement Scale (AIMS; 1 = *strongly disagree*, 7 = *strongly agree*). The AIMS can be broken into three subscales reflecting social, exclusivity, and negative affectivity subscales (Brewer and Cornelius, 2001; Visek et al., 2008). The items were adapted to refer to sport as "organized sport". Three items formed the social subscale measuring athlete's perceptions of how much they see themselves as an athlete and can maintain sport goals and relationships (e.g., "I consider myself an athlete"; Cronbach's $\alpha = 0.69$). Two items formed the exclusivity subscale measuring athletes' perceptions on how focused and important their sport is in their lives (e.g., "I spend more time thinking about my organized sport than anything else"; Cronbach's $\alpha = 0.90$). We chose not to analyze the third subscale measuring negative affectivity since, as previously mentioned, it reflected feelings on anticipated outcomes and not a current view of the athlete role.

TABLE 2 | Zero-order correlation matrix and descriptive statistics for main variables.

	1	2	3	4	5	6
1. Competitive sport status	–					
2. Autonomy	−0.13	–				
3. Competence	0.31*	0.40*	–			
4. Relatedness	−0.09	0.50*	0.54*	–		
5. Athlete Identity (social)	0.29*	0.16	0.55*	0.52*	–	
6. Athlete Identity (exclusivity)	0.11	0.09	0.35*	0.35*	0.72*	–
M	1.89	21.84	29.97	30.07	16.05	7.30
SD/%	88.7%	5.22	4.48	4.72	3.92	3.74

*Zero-order correlations were calculated using pairwise deletion (n range = 105–115). *p < 0.01 (two-tailed tests). Competitive sport status was dummy-coded (1 = no, 2 = yes).*

Analysis Plan

As a preliminary analytic plan, we employed descriptive analysis to assess frequencies of athletes' sport engagement in terms of sport level, sport type, competitive status, amount sport played pre-pandemic, amount sport played last 3 months, how long sport has been played, and whether athletes have been able to return to sport, as well as gender. In addition, we assessed frequencies of athletes' ratings of the importance of the three basic psychological needs during COVID-19 (see **Table 1**). Appropriate for a cross-sectional correlational design, we conducted zero-order correlations for the main study variables including athletes' competitive sport status, and basic psychological needs and athlete identity variables (see **Table 2**) before using OLS regressions to test if autonomy, competence, and relatedness explained a meaningful amount of variance in athlete identity in terms of social and exclusivity aspects (at $p < 0.05$). These regression tests covaried for competitive sport status. The results are reported using standardized regression coefficients (see **Table 3**).

RESULTS

Preliminary Analyses

All frequencies are presented in **Table 1** and we highlight a few interesting patterns here. More than 80% of participants had been playing their sport since before they were in high school, with a quarter of respondents beginning in early childhood (age 2–5). A notable proportion of the sample played their organized sport competitively at some point (89%) and many played a team sport (64%). Before COVID-19, 73% of athletes indicated playing their sport more than once a week, a number that dropped to 29% over the course of the last 3 months of the COVID-19 pandemic. Moreover, 45% of participants said they had not played their sport at all since COVID-19 began in approximately March 2020. Between these two extremes, about 15% of participants had

TABLE 3 | Regression analyses: basic psychological needs and competitive sport status relationships with athlete identity.

	Outcome variables					
	Athlete identity					
	Social-related			Exclusivity-related		
Predictor variable	**β (*b*)**	***t***	**95% CI of β**	**β (*b*)**	***t***	**95% CI of β**
Competitive sport status	0.26* (3.11)	3.15	1.15, 5.08	0.08 (0.87)	0.73	−1.51, 3.25
Autonomy	−0.15 (−0.11)	−1.70	−0.24, 0.02	−0.12 (−0.09)	−1.08	−0.24, 0.07
Competence	0.29* (0.25)	2.88	0.08, 0.41	0.20 (0.16)	1.60	−0.04, 0.37
Relatedness	0.46* (0.38)	4.80	0.22, 0.53	0.31* (0.25)	2.61	0.06, 0.44
Adjusted R^2	0.44			0.14		

*Standardized regression coefficients reported (unstandardized coefficients in brackets). Competitive sport status was dummy-coded (1 = no, 2 = yes). *$p < 0.05$.*

returned to play weekly, 3% were playing every 2 weeks, and 8% about once a month.

Regarding participants' perceptions of the importance of each basic psychological need, 89% agreed to strongly agreed competence is important in that they have the ability to perform well in their organized sport once play is allowed to resume. For relatedness, over 85% agreed it is important for them to maintain relationships with people close to them within their organized sport (i.e., coaches, team), whereas ∼4% disagreed. For autonomy, 76% agreed to strongly agreed it is important to maintain their personal investment and commitment to training for their organized sport and <8% disagreed to some extent.

Main Analyses

Zero-order correlations revealed positive associations between athletes' basic psychological needs of autonomy, competence, and relatedness in their organized sport during COVID-19 ($rs = 0.40$–0.54; see **Table 2**). Athletes' competitive sport status positively related to their reported competence and social-related athlete identity. Both their competence and relatedness positively correlated with social- and exclusivity-related athlete identities. Finally, social- and exclusivity-related athlete identities shared a strong correlation.

Our first OLS regression model comprised of autonomy, competence, and relatedness as predictor variables, and competitive sport status as a covariate, explained 44% of the variance in social-related athlete identity [$F_{(4, 99)} = 21.50$; $R^2 = 0.44$, $p < 0.001$]. As expected, the analyses revealed both competence ($\beta = 0.29$, $p < 0.001$) and relatedness ($\beta = 0.46$, $p < 0.001$) were associated with social-related athlete identity. Autonomy was not significantly related ($\beta = -0.15$, $p = 0.092$). The model also revealed competitive sport status was positively associated with social-related athlete identity ($\beta = 0.26$, $p < 0.001$).

The second regression model was also significant which tested how much autonomy, competence, relatedness, and competitive sport status, explained exclusivity-related athlete identity [$F_{(4, 99)} = 5.29$; adjusted $R^2 = 0.14$, $p < 0.001$]. In this model, we found only relatedness was positively associated with exclusivity-related social identity ($\beta = 0.31$, $p < 0.001$). Autonomy, competence, and competitive sport status were unrelated. The full model explained 14% of the variance in the outcome.

DISCUSSION

Our study focused on the relationships amongst the basic psychological needs of autonomy, competence, and relatedness and athlete identity during the COVID-19 pandemic. To address our study's first objective, we highlight a few important findings related to athletes' sport participation in the pandemic. To address our second objective, we discuss basic psychological need satisfaction and athlete identity in terms of social and exclusivity aspects. We conclude with implications, limitations, and directions for future research.

Athletes in a COVID-19 Context

Before COVID-19, 73% of participants indicated they were playing their organized sport more than once a week prior to the pandemic, providing some confidence that this sample indeed reflected committed adult athletes. Remarkably only 29% reported having been able to return to that frequency of participation during the pandemic. Notably, just under half of the athletes had not been able to return to their sport in any form during the previous three months even as regulations began to lift. It is important to note that many of these athletes had been playing their sport since childhood, so lack of participation likely created a meaningful void in their lives. This finding reflects a loss of opportunity to engage in sport for athletes during the COVID-19 restrictions. Although this loss of opportunity can simply be assumed by the nature of public health restrictions, it shows that even as restrictions began to ease, not all athletes had been able to return to play—perhaps suggesting COVID-19 represents a setback or interruption that is less easily overcome than more traditional barriers such as a minor injury.

Athletes were much more likely to agree than disagree that satisfaction of basic psychological needs was important to their return to sport. Nearly 90% of participants reported competence as important, reinforcing the competitive and performance elements of sport. Likewise, relatedness with teams and coaches were viewed as important perhaps in response to the isolating and lonely reality many young people are

experiencing in COVID-19 (Bu et al., 2020). Despite strong agreement for all needs, it is interesting that 25% of participants were neutral or disagreed about the importance of autonomy in terms of aspects such as personal investment and training. Again, it is possible that as COVID-19 progressed, athletes had to re-evaluate their personal commitments making it more important to examine how basic psychological needs relate to athlete identity.

Athlete Identity

When considering social-related athlete identity—as in, how much athletes view themselves as athletes—our findings indicate both competence and relatedness positively relate to their athlete identity supporting our hypotheses. These results are both intuitive and align with research that suggests competence is linked to athlete identity reflections (Coatsworth and Conroy, 2009) and to behaviors—such as commitment to sport—that convey their athlete identities (Martínez-González et al., 2021). Feeling connected to others in sport is also strongly tied to social-related athlete identity (Graupensperger et al., 2020). Thus, it makes sense that the more competence athletes felt in their sport and the more connected, the stronger they viewed themselves as athletes, even during a pandemic. Furthermore, playing competitive sport was positively related to social-related athlete identity, which is consistent with Costa et al.'s (2020) study that found elite athletes, competing at higher levels, revealed higher athletic identities during lockdown.

Contrary to our hypothesis, our findings did not show autonomy was positively linked to social-related athlete identity. Although we cannot be sure, this may in part be explained by athletes' limited opportunities to make decision and choices in their organized sport as a result of the pandemic. This uncertainty about one's own volition in the sport experience may be one reason why athletes' autonomy is not related to their social-related athlete identity. Supporting this idea, recent evidence suggests university athletes experienced a significant decline in autonomous goal striving, as measured by identified and intrinsic motives, during their COVID-19 lockdown (Deci and Ryan, 2000). This study also highlighted that an athlete's resilience was a possible factor in helping to predict changes in autonomy over the lockdown period.

Athletes' levels of relatedness were positively associated with exclusivity-related athlete identities that reflected how focused they are on their organized sport. Autonomy, competence, and competitive sport status, however, did not predict this dimension of athlete identity. Of note, the bivariate correlation for competence and exclusivity-related athlete identity was significant but its influence on the identity outcome was suppressed when sharing variance with the other basic psychological needs. Evidently, during the pandemic, feeling a sense of belonging and support from others involved in sport (e.g., athletes and coaches) appears to promote a narrower focus on sport as conveyed by the exclusivity-related athlete identity measure. Athlete's perceptions of volition and how competent they felt in their organized sport did not seem to influence their focus on it. One speculation, is that since many athletes indicated engaging less frequently in their sport than before the pandemic, a sense of connection and support from important others (i.e., coaches and teammates) during the pandemic may have prompted them to acknowledge and re-focus on their sport role.

Our study also revealed findings concerning the role of competitive sport status for athletes' competence during the pandemic. Bivariate correlations between competitive sport status and competence and social-related athlete identity were significant. These findings imply that during COVID-19, playing at a more competitive level was associated with greater competence and social-related identity. Although seemingly intuitive, these associations reveal that the expected relationships still emerge during a global pandemic.

Limitations and Implications

The results presented herein need to be considered in light of three limitations. First, athletes aged 18–25 years old were allowed to participate in the study but specific age and ethnicity information was not collected. Second, the sample is unbalanced in terms of gender with more women responding than men. Although these sample characteristics are less than desirable, there is little theoretical rationale for these demographic variables to influence basic psychological needs which have been shown to be universal principles (Ryan and Deci, 2008) and thus are unlikely to have substantially influenced our results. Nonetheless, more intentional recruitment strategies may produce more precise samples in future research. Third, this correlational study is only a snapshot of young adult athletes' participation in organized sports, basic psychological needs, and identity during COVID-19. More research is warranted to consider these findings using longitudinal study designs and addressing the context of the athlete population being examined.

Notwithstanding these limitations, the study findings are a timely and theory-based contribution to the literature on athletes' basic psychological needs and athlete identity during a global pandemic. In this circumstance, athletes may have fewer opportunities for autonomy not just in sport but in life in general, so it may be that competence and relatedness matter more concerning their social-related athlete identities. At the same time, athletes' relatedness, as in their social connectedness and support in sport during the pandemic, was related to a more myopic focus on their role as an athlete in sport.

Given that the majority of the athletes in our sample considered autonomy, competence, and relatedness important in their sport during COVID-19, this finding has implications for supporting athletes' basic psychological needs during critical setbacks and sport interruptions. A qualitative study by Bejar et al. (2019) found athletes enduring an injury were overall motivated in their sport injury rehabilitation when they perceived their athletic therapists to be fulfilling these needs. Another study found that depending on athletes' needs being satisfied or frustrated had an impact on their wellbeing during the COVID-19 outbreak (Šakan et al., 2020). Additionally, Leguizamo et al. (2021) studied the confinement of athletes during the pandemic and found that employing coping strategies, such as "emotional calming" and "cognitive restructuring" were negatively associated

with negative emotional states such as anxiety, depression and stress. These studies point to the importance of equipping athletes with trained personnel, resources, and cognitive coping strategies, in order to support their basic psychological needs during sport setbacks.

Specifically, our findings suggest sport professionals (sport psychologists, coaches, etc.) may be able to help foster social-related athlete identities during COVID-19 and other sport interruptions by focusing on strategies to enhance competence (e.g., giving athletes goals and skills to work on) and relatedness (e.g., creating spaces to strengthen relationships with teammates and staff via digital platforms). To combat possible negative outcomes that can result from strong exclusivity-related athlete identities (Gustafsson et al., 2008), athletes can be encouraged to seek out valued support in other places, such as family, career or school, particularly to help them adjust in times when opportunities for sport engagement is limited. Furthermore, our findings have implications for education programs. Physical education programs in schools and communities can benefit from understanding how athletes' basic psychological needs can impact their athlete identities so that individuals working with athletes can learn ways to satisfy these needs during unprecedented times.

CONCLUSION

Our study showed that the majority of young adult athletes valued basic psychological needs of autonomy, competence, and relatedness during the COVID-19 pandemic. With athletes having fewer opportunities for autonomy in sport during the pandemic, competence and relatedness appeared to matter more in terms of their social-related athlete identity—while relatedness during the pandemic was related to a greater focus on exclusivity-related athlete identity. Our findings point to helping athletes foster adaptive sport identities during COVID-19 by encouraging strategies to build competence and relatedness; while reminding athletes of other places to seek connectedness when sport engagement opportunities are limited.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Alberta Research Ethics Board 2. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

PP, LD, and AB contributed sufficiently to the manuscript to justify authorship. AB and LD conceptualized the project, defined the methodology, and were involved in the data collection. PP and AB conducted the analysis and drafted the original manuscript. All authors were involved in the interpretation and write-up of the results, contributed to the final version and approval of the manuscript, and agreed to be accountable for the content of the work.

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Assessing the Intention to Use Sports Bracelets Among Chinese University Students: An Extension of Technology Acceptance Model With Sports Motivation

Yi Wang[1], *Xiaotian Zhang*[1] *and Li Wang*[2]*

[1] Faculty of Education, University of Macau, Taipa, Macao SAR, China, [2] School of Psychology, Beijing Sport University, Beijing, China

The use of mobile technology, such as sports bracelets, is gaining popularity as it modifies the ways and processes of learning and teaching in college physical education (PE). However, little empirical evidence can be seen in literature to demonstrate crucial factors that influence university students' acceptance of sports bracelets. Guided by the technology acceptance model (TAM), this study hence aimed at explaining university students' intention to use sports bracelets. In total, 445 university students in China responded to a 19-item survey package. Results indicated that users' attitudes toward technology and perceived usefulness were significant predictors of intention to use sports bracelets. Meanwhile, users' intrinsic sports motivation significantly promoted users' positive attitudes toward this technology and was significantly influenced by perceived ease of use and perceived usefulness. Overall, our findings highlighted the importance of stimulating young adults' intrinsic sports motivation that facilitates their intention to use sports bracelets such that to develop a healthy lifestyle that benefits their physical health.

Keywords: technology acceptance model, intention to use technology, sports bracelet, sports motivation, university students

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***Correspondence:**
Li Wang
wangli@bsu.edu.cn

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INTRODUCTION

Mobile technology has been permeating most aspects of university students' lives over the past decade. Alongside the integration of mobile technology with educational purposes into higher education, advances in such technology, and the availability of associated cyber sources avail the opportunities for ubiquitous and flexible learning to users (Pimmer et al., 2016). Empirical evidence signaled that notwithstanding the direct impact of mobile technology on effective learning ways and processes, university students' intention to use certain mobile technological products can be influenced by technology infrastructure (Kim et al., 2017), users' satisfaction (Du, 2015), instructional support for mobile learning (Safford and Stinton, 2016), and users' technology literacy (George and DeCristofaro, 2016). Insofar as the reliance on mobile technology grows for preparing students for the twenty-first century workplace, identifying motivators and hinders related to learners' acceptance of mobile technology have been at the foci of vibrant and proliferating streams of research across cultures and disciplines (e.g., Chang et al., 2017; Hanafi et al., 2018; Saroia and Gao, 2019; Hoi, 2020). As Teo and Zhou (2014) pointed out, it remains an important issue to understand how learners accept and use a technological product.

Alongside the globally recognized importance to promote the health of young adults who have been spending a considerable amount of time in sedentary behavior (Peterson et al., 2018), mobile technology improves physical health-related quality of life mushrooms in the marketplace. Sports bracelet is one of such products known for their wearability along with powerful data collection and analysis capabilities (Khare, 2017). Huang and Wang (2018) have given accolades to sports bracelet for its feasibility to be applied in college physical education (PE) with its five key functions: function of fitness, the function of activity record, function of social networking analysis, function of exercise promotion, and function of 24-h and 7-day monitoring. Given its personalized nature stressing individual characteristics, such as body mass index, sports habits, and preferences, they further observed the increasing popularity yet still peripheral use of sports bracelets among university students in physical activities inside and outside PE classes. Researchers have endeavored to investigate the effectiveness of sports bracelets in monitoring different types of physical activity and denoted their power in stimulating interests in sports, strengthening subjective consciousness, and promoting sports abilities (e.g., Weghorn, 2016; Hao et al., 2019). Limited empirical evidence, however, can be found in literature deciphering individuals' perceptions of and intention to use this technology for fitness improvement. This warranted the investigation of university students' acceptance of sports bracelets, which has great potential to make their learning, sports, rest, and diet to achieve a more scientific balance. The present study, therefore, made an early attempt to identify essential factors that affected university students' intention to use sports bracelets.

Literature Review

Technology Acceptance Model

User acceptance is a crucial factor for successful technology implementation. Originated from the theory of reasoned action (TRA) and the theory of planned behavior (TPB), the technology acceptance model (TAM) has been widely acknowledged and used to understand technology users' potential acceptance or rejection of a technology (Davis, 1989; Marangunić and Granić, 2015). Two determinants are identified in predicting users' technology acceptance: perceived ease of use and perceived usefulness. Perceived ease of use refers to "the degree to which a person believes that using a particular system would be free of effort" and perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 428). The two factors together with attitudes, an individual's positive or negative feelings about performing the action, can impact individuals' intention to use technology (Davis, 1989; Marangunić and Granić, 2015).

Although it has been widely accepted and used, TAM still has some limitations, among which lacking of motivational constructs is a major concern (e.g., Davis et al., 1992; Venkatesh et al., 2003; Pedrotti and Nistor, 2016). In view of this, several researchers have attempted to enrich TAM by emphasizing and adding motivational factors across disciplines (Fagan et al., 2008; Sánchez and Hueros, 2010; Zhou, 2016; Huang, 2017; Nikou and Economides, 2017). However, the main concepts and constructs in motivational models usually overlapped with those in TAM by regarding perceived enjoyment as intrinsic motivation and taking perceived usefulness as extrinsic motivation (EM). To this end, an expansion of incorporating motivational factors in TAM was advocated for better interpretation of how other factors can be added to the core TAM variables "to achieve greater explanatory powers and validity" (Teo and Zhou, 2014, p. 127).

Intrinsic and Extrinsic Sports Motivation

Motivation is a hot topic in the PE or sports domain, which elicited researchers' efforts to investigate its functions and effects on individuals' behaviors, persistence, learning, and performance (e.g., Pelletier et al., 1995, 2013; Lee et al., 2017). To extend the measurement of sports motivation into a broader context, Pelletier et al. (2013) validated the Sport Motivation Scale (SMS-II) that presented a tripartite intrinsic-extrinsic motivation taxonomy based on the self-determination theory (Ryan and Deci, 2000). Intrinsic sports motivation refers to individuals' engagement in a physical activity purely for the pleasure and satisfaction derived from doing the activity *per se*, which consists of three subcategories: intrinsic motivation to know, intrinsic motivation to accomplish things, and intrinsic motivation to experience stimulation. Extrinsic sports motivation pertains to multiple engaging physical actions and behaviors as means to goal achievement (Deci, 1975; Pelletier et al., 2013). It has been classified into three categories: external regulation, introjection, and identification. They lie along the self-determination continuum from lower to higher levels (Pelletier et al., 2013). In the sports domain, the more self-determined types of motivation contributed more to sports participation intensity, sports persistence, affective feelings of sports, interests in sports, and satisfaction toward sports, or sports dropout possibility (e.g., Martens and Webber, 2002; Standage et al., 2003; Lee et al., 2017). Sports motivations were also significant predictors of activity intentions. Standage et al. (2003) explored secondary school students' intention to partake in leisure-time physical activities, results revealed a positive relationship between self-determined motivation and activity intention.

Sports bracelet is an emerging activity-tracking product that is able to initiate necessary inner drives for physical activities (Mercola, 2016; Donnachie et al., 2017). As a technology with the potential to stimulate users' different types of motivations for physical actions, however, it has received limited attention on its associations with sports motivations. To this end, we drew on the TAM and the intrinsic-extrinsic-tripartite sports motivational frameworks to investigate essential factors that influence students' intention to use sports bracelets in their physical activities.

The purpose of this study was to establish an extended TAM model and evaluate its exploratory potential among a group of Chinese students in tertiary institutions. We extended TAM with both intrinsic and extrinsic sports motivation to investigate influential factors for students' intention to use sports bracelets in physical activities. We selected two sub-constructs of sports

motivation: intrinsic motivation to know and identification of extrinsic motivation based on the following considerations that given the benefits of sports bracelets in promoting physical activities, the two constructs are at a higher self-determined level, which could enhance psychological functioning and elicit adaptive motivational responses and in turn stimulate more actions (Standage et al., 2003). Taken together, we developed five hypotheses to uncover the relations between students' sports motivations and their intention to adopt sports bracelets.

Hypothesis Development

Attitudes

Studies have strengthened the vital role of attitudes in predicting learner's intention to use technology (Davis, 1989; Hoi, 2020). Previous studies have repeatedly shown that there was a significant relationship between attitudes and intention to use wearable devices, such as smartwatches (Choi and Kim, 2016; Lunney et al., 2016). Accordingly, in the current study, we also assumed that positive attitudes can drive individuals to use sports bracelets and vice versa. Thus, the first hypothesis was proposed:

H1 Students' attitudes toward sports bracelets will have a significant influence on their intention to use the device.

Perceived Usefulness

Perceived usefulness was found to have a direct influence on the attitudes toward technology and had a positive impact on behavioral intention to use technology by the mediation effect of attitudes toward technology (Davis et al., 1992; Venkatesh et al., 2003; Choi and Kim, 2016; Lunney et al., 2016). In a TAM study, which explored taekwondo competitors' acceptance of electronic body protectors and scoring systems, perceived usefulness was significantly related to attitudes and further influenced their purchasing intention (Ko et al., 2011). Perceived usefulness, as a key driver concerning utility values for technology usage, was also found to significantly correlate with intrinsic motivations to use technology (Lee et al., 2005; Yoo et al., 2012). Theoretically, perceived usefulness relates to the attitudes and intention to use technology (i.e., sports bracelets). The usage of sports bracelets, in turn, had the potential to facilitate students' autonomy, competence, and relatedness to be intrinsically motivated to adopt sports bracelets (Murcia et al., 2009). Such inclination for technology adoption can deepen students understanding of sports bracelets and facilitate their ultimate goals in using sports bracelets for physical development. Therefore, the increase of autonomy, competence, and relatedness of sports bracelets may also be able to cultivate students' intrinsic motivation to sports bracelets and their intrinsic sports motivation, which can further influence their attitudes toward sports bracelets and their intentions to use them (Ntoumanis, 2005; Murcia et al., 2009). To wit, if users perceived that sports bracelet is useful and beneficial, they would not only be more intrinsically motivated to learn, accept, and utilize it, but also more likely to hold positive attitudes toward sports. To this end, we hypothesized that:

H2 Students' perceived usefulness of sports bracelets will have a positive significant influence on their (a) intrinsic sports motivation, (b) attitudes toward sports bracelets, and (c) intention to use sports bracelets.

Perceived Ease of Use

According to TAM, perceived ease of use has a significant influence on perceived usefulness (Davis et al., 1992; Venkatesh et al., 2003; Choi and Kim, 2016). If users perceive that using the technology is free of effort, they tend to recognize the usefulness of the technology. Further, informed by the positive association between perceived ease of use and attitudes toward the intention to use devices or systems (e.g., Wu et al., 2016; Nikou and Economides, 2017), perceived ease of use can also influence students' intention to use devices as mediated by their attitudes. The impact of perceived ease of use on acceptance of technology, theoretically underpinned by TAM and self-determination theory can also be extended to sports motivation in PE (Davis et al., 1992; Ntoumanis, 2005; Murcia et al., 2009). According to Ryan and Deci (2000), perceived ease of use can be associated with intrinsic sports motivation. If students perceive that using sports bracelets is free of effort, they will have a tendency to accept and use sports bracelets in their sports practices, through which they can gain accumulated experience and competence of it, understand the benefits of sports bracelets in sports practices, and be more motivated to participate in the sports practices on their own for the sake of personal development. Taken together, we proposed the third hypothesis:

H3 Students' perceived ease of use will have a positive significant influence on their (a) perceived usefulness, (b) attitudes toward technology, (c) intrinsic sports motivation, (d) extrinsic sports motivation, and (e) intention to use sports bracelets.

Intrinsic and Extrinsic Sports Motivation

Intrinsic sports motivation refers to students' practicing sports for the pleasure and the satisfaction that they experience while learning, exploring, or trying to understand it (Pelletier et al., 2013). Intrinsic motivation in sports domain is crucial for individuals' persistence, positive emotions, greater interest, and sports satisfaction (Pelletier et al., 1995, 2013; Standage et al., 2003). In other words, such motivations are able to induce more positive consequences and lead to more enjoyable feelings (Murcia et al., 2009). Given this relationship, we assumed that students who are more intrinsically motivated to wear sports bracelets in their sports practices for sheer pleasure will have more positive attitudes toward sports bracelets. We hence proposed the fourth hypothesis:

H4 Students' intrinsic sports motivation will have a significant influence on their attitudes toward sports bracelets.

As a contributing factor to behavioral persistence, extrinsic sports motivation, identified with a higher autonomous level on the controlled-to-autonomous motivation continuum, has the potential to predict intention to use technology (e.g., Ryan and Deci, 2000). That is, students who are more extrinsically motivated to wear sports bracelets in sports practices due to their improved knowledge and recognition of the technology

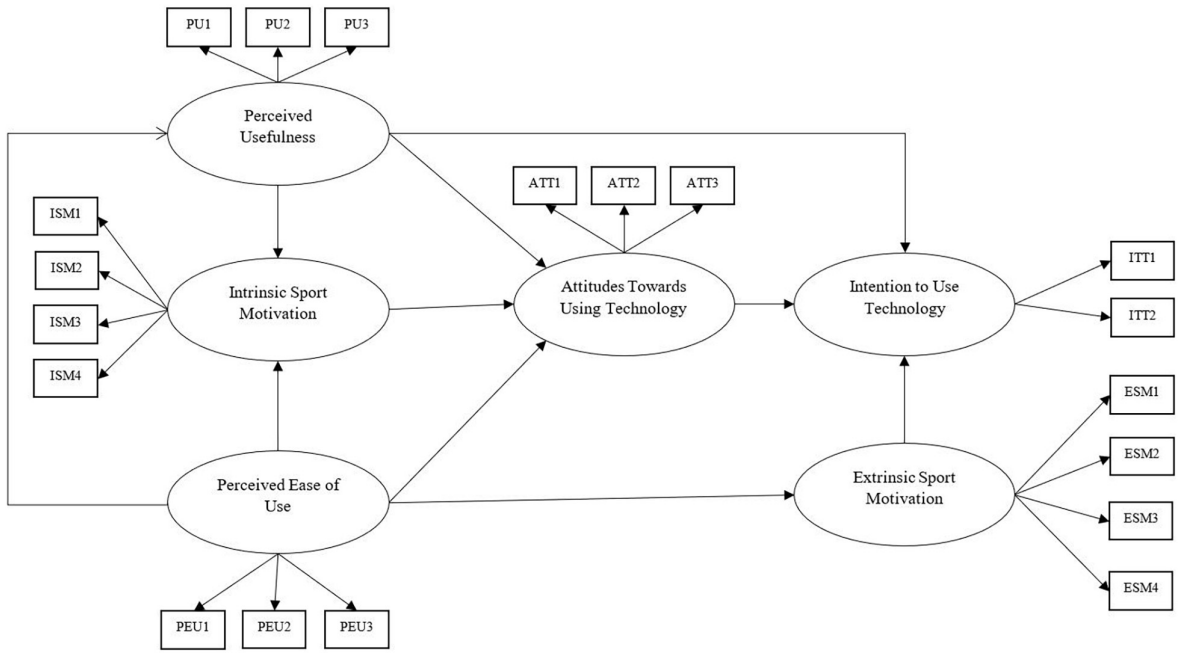

FIGURE 1 | Hypothesized model (permission for using TAM in the current research has been obtained from the authors).

will better appreciate the benefits of this technology, and will be more internally self-regulated and self-determined to use this technology in their practices (Pelletier et al., 2013). Meanwhile, as indicated by self-determination theory (Ryan and Deci, 2000), extrinsic sports motivation can also be influenced by perceived ease of use. If students perceive it is difficult to accept or utilize sports bracelets in their sports practices, they may weaken the importance of the technology and its usefulness in attaining their personal goals. Consequently, they can be less extrinsically motivated to accept sports bracelets in sports practices. Accordingly, the fifth hypothesis was developed as follows:

H5 Students' extrinsic sports motivation will be significantly influenced by perceived ease of use, and students' extrinsic sports motivation will significantly influence intention to use technology.

The hypothesized model is presented in **Figure 1**.

METHOD

Participants

In total, 445 participants were invited to complete the online survey on a voluntary basis (50.6% were women). The average age was 19.05 [standard deviation (SD) = 1.59]. Of the 445 students, 84.5% majored in Social Science and Humanities and 15.5% majored in Science and Technology. Invitations to participate in this study with an online survey link or quick response (QR) code were sent out to 503 WeChat (a popular online social networking platform in China) users who were currently college students. In total, 58 cases that reported they have never used any type of sports bracelets were removed, leading to a final sample of 445.

Measures

The survey items were adapted from previous studies that were found to be statistically reliable (Davis, 1989; Pelletier et al., 2013). The six constructs presented in the research model were measured by 19 items: intrinsic sports motivation (4 items); extrinsic sports motivation (4 items); perceived usefulness (3 items); perceived ease of use (3 items); attitudes toward using technology (3 items); and intention to use technology (2 items). Each item was rated on an 11-point Likert scale, ranging from 0 (strongly disagree) to 10 (strongly agree). Participants' demographic information (e.g., gender, age, and majors) was also collected. A full list of survey items was presented in the "**Appendix A**."

Data Analysis

As reminded by Anderson and Gerbing (1988), when assessing model fit, comparison between the target model and other models should be ensured. Therefore, a standard two-step approach to structural equation modeling (SEM) was used in the present study. The first step was to conduct a confirmatory factor analysis (CFA) to examine the validity of constructs within the measurement model. The measurement model provides a baseline comparison for the structural model and an upper limit on the fit of the saturated variable model (Baumgartner and Weijters, 2010). In the second step, SEM was performed to test the proposed model using the maximum likelihood estimation (MLE) method in Amos 23.0.

RESULTS

Evaluation of the Measurement Model

The mean values of all 19 items were above the mid-point of 5.0, ranging from 5.98 to 7.18. The SDs ranged from 1.49 to 1.86, revealing an overall positive response to all items that were used to measure the constructs within the model, and a fairly narrow spread of scores around the mean (see **Table 1**). Positive correlations among the six constructs were identified. The values of skewness (ranged from − 0.02 to 0.08) and kurtosis (ranged from −0.90 to −0.74) were between the recommended cutoffs from the six constructs were identified. univariate normality of data (Kline, 2010). Hoelter's (1983) critical N was valued by researchers to ensure reliable results in SEM (Callum et al., 2014; Hoque and Sorwar, 2017). The sample size of this study is 445, and Hoelter's (1983) critical N for the model is 264, indicating the hypothesis that the proposed model is correct would be accepted at a 0.01 level of significance. Therefore, SEM was considered as an appropriate technique for data analysis.

The MLE procedure that assumes multivariate normality of the observed variables was employed to assess the measurement model of the present study. According to Mardia's (1970) and Raykov and Marcoulides (2008) normalized multivariate kurtosis value should be lower than p (p+2), where p means the number of observed variables in the model. The Mardia's coefficient in this study was 194.22, lower than 399 [19 × (19 + 2)]. Therefore, multivariate normality of the data was assumed.

Average variances extracted (AVE) and composite reliability (CR) were employed to evaluate the validity and reliability of internal constructs. Compared to Cronbach's α, AVE and CR are considered to better comply with the key assumptions in the multidimensional scale (Teo and Fan, 2013). Factor loadings of all the items in the measuring range from 0.65 to 0.98 meeting the threshold suggested by Hair et al. (2010) that an item is significant if its factor loading is above 0.50. The AVE, a more conservative indicator of validity, was above 0.4. The CR was above 0.6. Both values of AVE and CR were hence considered to be statistically acceptable for being above 0.4 (Fornell and Larcker, 1981; Hair et al., 2010). As shown in **Table 2**, the standardized factor loading, AVE, and CR of all constructs met the aforementioned guidelines, which jointly indicated that the measures were reliable.

TABLE 1 | Means, standard deviations, and correlations of the constructs.

	Constructs	1	2	3	4	5	6
1	Perceived usefulness (PU)	1					
2	Perceived ease of use (PEU)	0.49**	1				
3	Attitudes toward using technology (ATT)	0.63**	0.64**	1			
4	Intention to use technology (ITT)	0.44**	0.44**	0.53**	1		
5	Intrinsic sport motivation (ISM)	0.34**	0.32**	0.38**	0.25**	1	
6	Extrinsic sport motivation (ESM)	0.31**	0.29**	0.30**	0.23**	0.70**	1
	Mean	6.98	6.79	6.91	6.48	6.87	6.31
	SD	1.6	1.49	1.39	1.53	1.39	1.34

$^{**}p < 0.01$.

The following indices were adopted to test the model fit within SEM: goodness-of-fit index (GFI), comparative fit index (CFI), and Tucker-Lewis index (TLI). As recommended by researchers (Hair et al., 2010), a value of 0.9 and higher of these indices can be considered adequate. In addition to the root-mean-square error of approximation (RMSEA), the standardized root mean square residual (SRMR), with a value of <0.08, indicate that an acceptable fit was used (Hu and Bentler, 1999). Results of SEM analysis suggested a good fit between the measurement model and the whole dataset: χ^2 = 286.61, χ^2/df = 2.09, GFI = 0.94, CFI = 0.97, TLI = 0.97, RMSEA = 0.050, and SRMR = 0.036.

Evaluation of the Structural Model and Hypothesis Testing

Results of the hypothesis testing, structural model, and path coefficients are summarized in **Table 3** and **Figure 2**. The results reflected the relationship among the constructs regarding their magnitudes and significance, from which, each of the hypotheses can be decided to be either supported or rejected. The structural model had a good fit: χ^2 = 308.270, χ^2/df = 2.19, GFI = 0.93, CFI = 0.97, TLI = 0.96, RMSEA = 0.052, and SRMR = 0.052. All but one hypothesis (H5) was supported by the results. Hypotheses 1–3 were significant, supporting the TAM as a valid framework in explaining students' intention to use sports bracelets. Of the external constructs, intrinsic sports motivation was significantly affected by perceived usefulness and perceived ease of use. Intrinsic sports motivation, on the other hand, exerted significant influence only on the attitudes toward technology, by which H4 was supported. In addition, the extrinsic sports motivation was significantly influenced by perceived ease of use but could not predict the intention to use sports bracelets, partially supporting H5.

From the final model (see **Figure 2**), five endogenous constructs were tested. Of the variance in intention to use technology, 30.1% was explained by attitudes toward technology, perceived usefulness, and extrinsic sports motivation. The attitude toward using technology was significantly predicted by perceived usefulness, perceived ease of use, and intrinsic sports motivation with an R^2 of 0.544, demonstrating the three constructs could explain 54.4% of the variance in attitudes toward technology. Of the variance in intrinsic sports motivation, 14.7% was significantly explained by perceived ease of use and perceived usefulness. The variances in the other two endogenous constructs, perceived usefulness and extrinsic sports motivation, were explained by the determinant constructs in amounts of 24.2 and 8.6%, respectively.

DISCUSSION

The aim of this study was to enrich the TAM by introducing refined motivational factors (i.e., intrinsic motivation to know and identification in extrinsic motivation) into technology acceptance and assess the predictors of college students' intention to use sports bracelets. Results indicated that perceived usefulness, perceived ease of use, and sports motivation significantly predicted students' attitudes toward sports bracelet

TABLE 2 | Results of the measurement model, composite reliability (CR), and average variance extracted (AVE).

Construct	Item	Standardized factor loading	*t*-value	CR[a]	AVE[b]
Intention to use (ITT)	ITT1	0.699	–	0.836	0.724
	ITT2	0.979	12.361***		
Attitudes toward using technology (ATT)	ATT1	0.884	–	0.907	0.765
	ATT2	0.893	25.998***		
	ATT3	0.847	23.692***		
Perceived usefulness (PU)	PU1	0.909	–	0.929	0.813
	PU2	0.898	28.720***		
	PU3	0.898	28.717***		
Perceived ease of use (PEU)	PEU1	0.796	–	0.907	0.766
	PEU2	0.915	22.157***		
	PEU3	0.910	22.061***		
Intrinsic sport motivation (ISM)	ISM1	0.740	16.803***	0.863	0.612
	ISM2	0.810	18.822***		
	ISM3	0.755	17.221***		
	ISM4	0.821	–		
Extrinsic sport motivation (ESM)	ESM1	0.697	–	0.783	0.491
	ESM2	0.686	12.627***		
	ESM3	0.719	13.148***		
	ESM4	0.650	12.043***		

$^{***}p < 0.001$. $a\frac{(\sum\lambda)^2}{(\sum\lambda)^2+(\sum 1-\lambda^2)}$. $b\frac{\sum\lambda^2}{\sum\lambda^2+(\sum 1-\lambda^2)}$.

use, wherein 61.9% of the variance was explained. Students' intention to use sports bracelets was influenced by their perceived usefulness and attitudes toward sports bracelet use, supporting H1–H3. The findings echoed previous TAM research, which suggested that perceived usefulness and attitudes were important factors that influenced students' intention to use a technology (Schepers and Wetzels, 2007; Zhang et al., 2012; Teo and Zhou, 2014).

In this study, intrinsic sports motivation and extrinsic sports motivation, as the external constructs of the TAM, were additionally examined. Rooted in self-determination theory, this study identified predictive factors of individuals' behavioral intention to use sports bracelets. The hypotheses (H4) related to sports motivation were supported, but the hypothesis (H5) involving extrinsic sports motivation was not supported as the path from extrinsic sports motivation to intention to use the technology was not significant. The results were out of line with Fagan et al.'s (2008) study in which EM was found to positively predict first-line managers' intention to use computers. In the setting of higher education, EM was also reported to significantly predict students' intention to use the Internet-based learning medium (Lee et al., 2005). However, our results were consistent with Yoo et al.'s (2012) findings, which denoted that the extrinsic motivators did not directly promote e-learning at the workplace in South Korea.

Several plausible explanations need to be noted for the inconformity between the findings. First, although scholars have widely recognized the important role of motivation in TAM (Atkinson, 1997; Venkatesh and Davis, 2000), it is possible that the inconsistency between findings of this study and others was caused by the differences in motivational constructs and sports technologies of investigation (Pedrotti and Nistor, 2016; Zhou, 2016; Nikou and Economides, 2017). Second, the effect size of intrinsic and extrinsic sports motivation might be different in terms of individuals' behavioral intention to use technology. As Huang (2017) has suggested that the influence of intrinsic motivation on intention to use sports bracelets was larger than that was exerted by extrinsic motivation. Compared with extrinsic sports motivation, intrinsic sports motivation was proved to more closely relate to individuals' perceptions of competence, autonomy, and levels of self-determination (Ryan and Deci, 2000; Murcia et al., 2009). Third, extrinsic sports motivation can be determined by external sources that impact an individual's behavior involved in sports, such as motivational climate (Standage et al., 2003), supports from friends, parents, and material rewards (Gordon et al., 1995). Given that extrinsic sports motivation can be influenced by other contextual factors (e.g., external rewards), Ruskin et al. (2007) found that individuals who performed sports to improve themselves were more likely to remain motivated than those who practiced merely for gaining rewards. In other words, students who perform sports for external rewards may have a low level of desire for adopting sports equipment, such as wearing bracelets, in a bid to improve their fitness. In the current study, sports performed by the students were not associated with any rewards, the extrinsic sports motivation can therefore be reduced in non-voluntary environments (Wu and Lederer, 2009), that is, the power of extrinsic sports motivation in predicting students' intention to use bracelet could have been reduced. Fourth, the missing relationship between extrinsic sports motivation and intention to use sports bracelets may imply that individuals who were inclined to use this technology were driven by their beliefs, attitudes, and intrinsic motivation, but barely directly guided by extrinsic sports motivation. The influence of extrinsic motivation on intention to use technology, as noted by Yoo et al. (2012), can be mediated by intrinsic motivation.

Despite the variety of research findings, the results of this study have a unique contribution to explaining students' intention to use wearable technology from the perspective of sports motivation in higher education. TAM has been widely opined as a solid base theory for examining users' intention to use wearable devices. Nonetheless, some researchers critiqued TAM for insufficiently explaining users' technology adoption behaviors (Lin et al., 2007). Our study hereby responded to the call made by scholars (Conner and Armitage, 1998; Perugini and Bagozzi, 2001) and extended TAM by supplementing additional constructs in the context of PE. This is believed to proffer empirical evidence in promoting the probing of psychological processes involved in individuals' perceptions of the value of a technology.

Following the significant influence that perceived usefulness has on intrinsic sports motivation, attitudes toward technology,

TABLE 3 | Hypothesis testing.

Hypothesis	Path	Path coefficient	*t*-value	Results
H1	Attitudes toward technology → Intention to use technology	0.471	6.428***	Support
H2	Perceived usefulness → Intrinsic sport motivation	0.118	2.637**	Support
	Perceived usefulness → Attitudes toward technology	0.331	9.337***	Support
	Perceived usefulness → Intention to use technology	0.121	2.860**	Support
H3	Perceived ease of use → Intrinsic sport motivation	0.308	5.228***	Support
	Perceived ease of use → Attitudes toward technology	0.449	9.051***	Support
	Perceived ease of use → Perceived usefulness	0.522	10.538***	Support
H4	Intrinsic sport motivation → Attitudes toward technology	0.104	2.582*	Support
H5	Extrinsic sport motivation → Intention to use technology	0.054	1.213	Not support
	Perceived ease of use → Extrinsic sport motivation	0.334	6.190***	Support

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

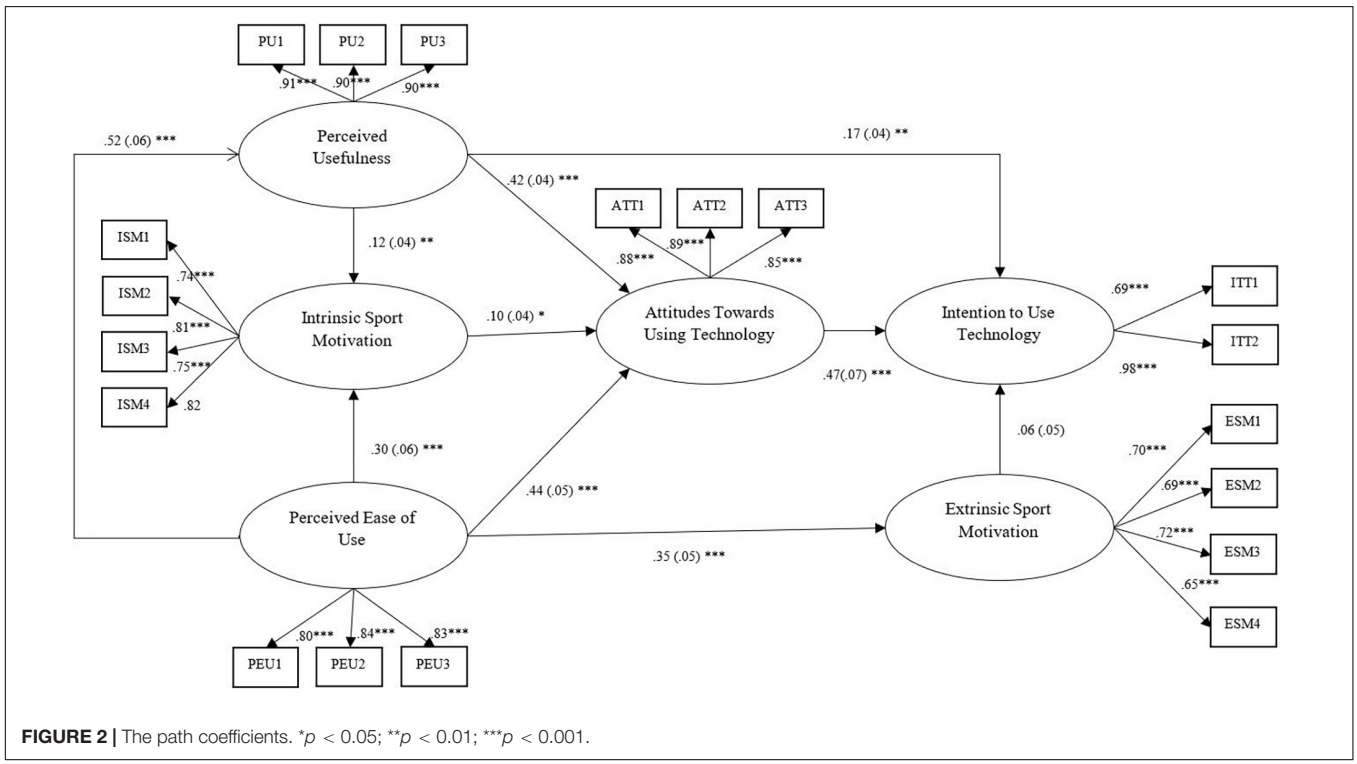

FIGURE 2 | The path coefficients. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

and intention to use technology, educators would be suggested to focus on aspects of their course design in ways that promote utilitarian activities by highlighting the effective features and powerful capabilities of sports bracelet. From the results, attitudes toward technology and perceived usefulness significantly and directly influenced students' intention to use sports bracelets. This requires a coherent strategy to stress the role of mobile technology in different procedures of teaching and learning during PE classes (i.e., lecture giving, interactions, administration, assessment, and feedback), as well as off-campus physical activities wherein students can personally experience effective learning process, and witness productive outcomes after harnessing the power of this mobile technology. Specific examples include efficiency in completing learning tasks, quick and convenient access to information for assessing physical ability and quality, and timely and personalized plans for improvement based on monitoring data. Meanwhile, to cultivate learners' positive attitudes toward using sports bracelets, it is crucial to proffer them with adequate support and instruction for proceeding with mobile learning with this technology. Moreover, the use of sports bracelets could be a possible solution to a sedentary lifestyle among young adults. The findings of this study suggest that designers of sports bracelets can provide users with some practical functions that may strengthen their perceived usefulness and positive attitudes toward the technology, as it would in turn increase their intention to use sports bracelets. For example, the combination of heart rate monitoring and positioning can be used to detect whether the user is in a

sedentary state. If so, reminding the user to stand up and stretch the muscles after sitting for a while and presenting example body movements on the app interface for the users to follow are believed as helpful to promote individuals' healthy lifestyle. It is also a possible direction for future studies to explore whether the usage of sports bracelets directly develops individuals' physical condition and active lifestyle.

Some limitations should be noted. First, this study has concentrated on collecting data only from university students that are familiar with the use of mobile technology and innovations in technology. Interpretation of the results hence needs to be careful in wider user market who are potential sports bracelet users. As compared with the younger generation, older adults often have weaker intentions to adopt new technology (Czaja et al., 2006; Wu et al., 2015). Future studies hence are encouraged to involve participants from more various age groups to further investigate the role that sports motivation plays in the acceptance and use of wearable devices. Second, the participants of this study share the same cultural background. To further validate the findings, students with different cultural backgrounds may be included in the sample. Third, the results of this study are based on the analysis of self-reported data. Future studies may include observational data to triangulate the findings and overcome the shortcomings of self-reported data.

CONCLUSION

To conclude, the findings enriched the existing literature on critical factors that influence mobile technology use in PE by confirming with a Chinese sample that the intention to use sports bracelets can be determined particularly by users' attitudes toward technology and perceived usefulness. Additionally, users' intrinsic sports motivation plays a facilitating role in developing users' positive attitudes toward sports bracelets, which in turn, can be significantly affected by perceived ease of use and perceived usefulness.

The current study made an early attempt and contributed empirical evidence to explain university students' intention to use sports bracelets in college PE. The finite operationalization of perceived usefulness invites future studies to focus not only on primary fitness-related functions (e.g., pedometer function combined with body mass index through analysis of walking step spacing and energy consumption) but also on other relatively secondary functions, such as entertainment and social networking. As it has been repeatedly reported by previous studies (e.g., Venkatesh, 2014; Salimon et al., 2017) that users' hedonic motivation could significantly determine the continued use of technology. Methodologically, future research into sports bracelet intention is suggested to include qualitative techniques such that outstanding features, desired, and undesired features perceived by users can be identified to enlighten technology developers who aim at tailoring products appealing to different potential users. Intervention studies that examine the effectiveness of sports bracelets in improving users' physical quality will also be valuable. With such evidence that underscores the most effective functions of sports bracelets in fitness enhancement, educators will be able to make the best use of such features in their pedagogical practices to optimize the use of this technology in PE.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Board of the School of Psychology, Beijing Sport University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

YW, XZ, and LW contributed to the conception and structure of the manuscript and wrote the manuscript. XZ carried out the data collection. YW conducted the data analysis. All authors contributed to the article and approved the submitted version.

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APPENDIX A

TABLE 1 | Survey items.

Construct	Item	
Intention to use (ITT)[a]	ITT1	I intend to use bracelet for activities.
	ITT2	I will reuse bracelet for relevant activities.
Attitudes toward using technology (ATT)[a]	ATT1	Using bracelet is a good idea.
	ATT2	Using bracelet is a wise idea.
	ATT3	I like the idea of using bracelet.
Perceived usefulness (PU)[a]	PU1	Using bracelet in my sport engagement would enable me to accomplish tasks more quickly.
	PU2	Using bracelet would improve my sport performance.
	PU3	Using bracelet sport would increase my productivity.
Perceived ease of use (PEU)[a]	PEU1	My interaction with bracelet would be clear and understandable.
	PEU2	It would be easy for me to become skillful at using bracelet.
	PEU3	I would find bracelet easy to use.
Intrinsic sport motivation (ISM)[b]	ISM1	For the pleasure it gives me to know more about the sport that I practice.
	ISM2	For the pleasure of discovering new training techniques.
	ISM3	For the pleasure that I feel while learning training techniques that I have never tried before.
	ISM4	For the pleasure of discovering new performance strategies.
Extrinsic sport motivation (ESM)[b]	ESM1	Because, in my opinion, it is one of the best ways to meet people.
	ESM2	Because it is one of the best ways I have chosen to develop other aspects of myself.
	ESM3	Because it is a good way to learn lots of things which could be useful to me in other areas of my life.
	ESM4	Because it is one of the best ways to maintain good relationships with my friends.

[a]*Items were adapted from Davis (1989) and Davis et al. (1992).*
[b]*Items referred to Briére et al. (1995).*

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Effect of Cognitive Reappraisal on Archery Performance of Elite Athletes: The Mediating Effects of Sport-Confidence and Attention

Dongling Wang[1], Ti Hu[1], Rui Luo[1,2], Qiqi Shen[1], Yuan Wang[3], Xiujuan Li[4], Jiang Qiao[5], Lina Zhu[6], Lei Cui[1] and Hengchan Yin[1]**

[1]College of P.E. and Sports, Beijing Normal University, Beijing, China, [2]Mental Health Education and Counseling Center, China University of Labor Relations, Beijing, China, [3]State-Owned Assets Management Office, Beijing Normal University, Beijing, China, [4]P.E. Department, Renmin University of China, Beijing, China, [5]BaoLong Foreign Language School, Shenzhen, China, [6]College of Physical Education, Yangzhou University, Yangzhou, China

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Edited by:
Manuel Gómez-López,
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Rabiu Muazu Musa,
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Francesco Sessa,
University of Foggia, Italy

***Correspondence:**
Lei Cui
cuilei@bnu.edu.cn
Hengchan Yin
yinhengchan@bnu.edu.cn

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Through empirical studies or laboratory tests, previous studies have shown that sport-confidence, attention, and emotion regulation are key factors in archery performance. The present study aims to further identify the effects and pathways of sport-confidence, attention, and cognitive reappraisal (a specific emotion regulation strategy) on real-world archery performance by constructing a hypothesized model to provide a basis for scientific training of athletes to improve sport performance. A survey design was utilized on a sample of 61 athletes (12 international-level athletes, 30 national-level athletes, and 19 first-class athletes) from the Chinese National Archery Team to test the model. The measurement and hypothesized models were tested using partial least squares structural equation modeling (PLS-SEM). The results indicate that the model fit well and explained 33.6% of the variance in archery performance. Sport-confidence (total effects = 0.574, $p < 0.001$) and attention (total effects = 0.344, $p = 0.009$) were important predictive indicators of archery performance, while the relationship between cognitive reappraisal and archery performance showed considerable complexity (direct effects = –0.268, $p = 0.020$; total effects = –0.007, $p = 0.964$). We conclude that the development of sport-confidence and attention of archery athletes should be strengthened, but athletes who use cognitive reappraisal in archery competition should be mindful of its potential appropriation of cognitive resources and should be directed to improve sport-confidence or develop a positive orientation to arouse excitement.

Keywords: archery, performance, sport-confidence, attention, cognitive reappraisal, PLS-SEM

INTRODUCTION

Archery performance is affected by athletes' skills (mental, fitness, etc.), among which skills and mental abilities are key factors. The "two-point-one-line" aiming method of archery requires athletes to pursue the "stability" or "consistency" of movement skills (Stuart and Atha, 1990; Soylu et al., 2006; Sarro et al., 2021). The repeatability and consistency of skills are strongly correlated with mental ability. In addition, the current Olympic archery rules, such as the

single elimination with two out of three games in three arrows per set and a single arrow shoot-off when there is a tie, greatly increase the uncertainty of the competition, make the competition extremely uncertain, and have placed higher demands on the mental ability of the athletes (Wang and Liu, 2013).

Studies have shown that archers with extensive sports experience or competition experience perform better in terms of lack of worries, confidence, and concentration (Bebetsos, 2015), or attention networks (Lu et al., 2021), and higher archery shooting scores or smaller arrow dispersion are predicted by mental abilities, such as anxiety (Zhao et al., 2013; Taha et al., 2018), confidence (Zhao et al., 2013; Taha et al., 2018; Salleh et al., 2020), concentration (Taha et al., 2018), and emotion regulation (Zhao et al., 2013; Kim and Oh, 2015). By comparing 13 mental factors, Yang et al. (2008) found that the indicators of elite archery athlete selection include the distribution of attention, kinesthetic perception, and anxiety/confidence. Similarly, by comparing 10 mental factors, Kim et al. (2015) combined the Delphi survey and hierarchical analysis to verify that confidence, concentration, and emotion control are the three most important factors affecting archery performance.

However, most previous studies describe archery performance in the form of subjective evaluations or based on tests under laboratory conditions, lacking validation with real-world archery performance; moreover, the studies (Carson and Collins, 2016; Stanger et al., 2018) have implied that there might be interactions among confidence, attention, and emotion regulation strategy, suggesting that we could investigate the relationship between them in an integrated and linked perspective. Thus, this study aims to construct a theoretical model that investigates the relationship between sport-confidence, attention, emotion regulation, and sports performance.

Based on the above statements, this study will make research contributions in the following aspects: (1) verifying the effects of sport-confidence, attention, and cognitive reappraisal on actual archery performance; and (2) exploring the path of the interaction between the above psychological factors.

LITERATURE REVIEW

Sport-Confidence and Archery Performance

The multidimensional theory of anxiety proposes that cognitive anxiety shares a negative linear relationship with performance, and confidence shares a positive linear relationship with performance (Martens et al., 1990). Research on competitive state anxiety is based on the premise that cognitive anxiety has a negative linear relationship with performance and that confidence has a linear positive relationship with performance and is considered to be a protective factor against cognitive anxiety (Weinberg and Gould, 2014). When facing stress, athletes with higher confidence are better able to interpret anxiety as a positive emotion and promote sport performance (Martens et al., 1990; Woodman and Hardy, 2003; Hays et al., 2009). Similarly, confidence has a significant effect on sport performance in archery (Zhao et al., 2013; Bebetsos, 2015), even though it affects performance to the greatest extent on different factors among skills and mental and physical fitness (Yang et al., 2008; Kim et al., 2015). In addition, several studies have examined the effects of trait anxiety (Kaur and Shenoy, 2019) and state anxiety (Lim, 2016; Kaur and Shenoy, 2019) on archery performance, but it is not clear whether there is a difference in the effect of trait sport-confidence and state sport-confidence [concepts belonging to a sport-specific model of self-confidence (Vealey, 1986)] on archery performance. In summary, we propose the following hypothesis:

> *H1*: *Sport-confidence, including trait sport-confidence and state sport-confidence, positively predicts archery performance.*

Attention and Archery Performance

Attention is described as the sustained focus of cognitive resources on information while filtering or ignoring extraneous information. It is a vital prerequisite of successful performance in sports (Abernethy et al., 2007; Moran, 2012). Athletes with a higher attention ability are better able to achieve desirable performance in competition (Moran, 1996; Love et al., 2018). Likewise, researchers have concurred that attention, especially concentration, is critical for archery athletes (Lee, 2009; Zhao et al., 2013; Bebetsos, 2015; Taha et al., 2018). Gonzalez et al. (2017) pointed out that longer quiet eye durations (QED) are required for archers to aim accurately at the bullseye, and they noted that attention control plays an important role in determining QED performance. A study focusing on athlete selection indicated that attention allocation is an important indicator for selecting elite archers (Yang et al., 2008). Lu et al. (2021) also found that national team archers performed better than provincial team archers in terms of attentional network efficiency. During the aiming process, archers need to rely on their own proprioception and environmental information (e.g., wind direction) to adjust their posture or aiming skills (Lu et al., 2021), which requires strong attention allocation and a certain breadth of attention to cope with and process this information. At the same time, athletes seem to invoke conflict control to shift attention from distracting factors (e.g., focusing on the performance of other athletes or caring about ranking) to valid information (e.g., paying attention to coordinated body movements). Thus, following the facts above, the different aspects of attention, that is, shifting, breadth, and allocation, may all influence the archery performance. In summary, hypothesis 2 is proposed:

> *H2*: *Shifting, breadth, stability, and allocation of attention positively predicts archery performance.*

Emotion Regulation and Archery Performance

In sports (e.g., archery) that require movement of fine control (Eysenck and Calvo, 1992; Mellalieu et al., 2004, 2009) or a high level of concentration (Kubiak et al., 2019), anxiety could

provoke a decline in sport performance. Emotion regulation is often used by individuals as a means of reducing anxiety (Cisler et al., 2010). Admittedly, emotional control or emotion regulation is an essential mental skill for archery athletes (Yang et al., 2008; Zhao et al., 2013; Kim et al., 2015). However, previous research has progressed mostly to emphasize the importance of emotion regulation, and there has been less exploration of specific means of emotion regulation applicable to archery athletes. Although there are a considerable number of ways to regulate emotions, one prominent and adaptive approach to control emotions is through cognitive reappraisal (Gross and John, 2003; Gross, 2010; Uphill et al., 2012). Studies have found that positive cognitive reappraisal is positively associated with motor performance in table tennis, whereas expression suppression is not (Kubiak et al., 2019), and it enhances archery athletes' feelings of positive emotions and improves performance on experimental tasks (Kim and Oh, 2015). In addition, similar to cognitive reappraisal, arousal reappraisal prevents golfers from "choking" and to some extent ensures performance in putting tasks (Balk et al., 2013). In conclusion, we chose cognitive reappraisal as a specific strategy for emotion regulation and proposed the following hypothesis:

H3: *Cognitive reappraisal positively predicts archery performance.*

Sport-Confidence and Attention

According to attentional control theory, anxiety impairs the goal-directed attention system and reduces individuals' performance on attention control by inhibiting attentional transfer processes (Eysenck et al., 2007; Eysenck and Derakshan, 2011). Among archery athletes, it has also been shown that concentration increases when competitive anxiety decreases (Indahwati and Ristanto, 2016). Multidimensional anxiety theory states that sport-confidence is an important mental quality for individuals to avoid cognitive anxiety (Martens et al., 1990). Athletes with high levels of confidence improve their attentional control and motor performance by investing more mental effort, even when they are anxious (Eysenck and Calvo, 1992). As evidence, a recent questionnaire-based study showed that high levels of attentional control are related to lower levels of competitive state anxiety and higher levels of self-confidence, and competitive state anxiety and self-confidence are significant predictors of attentional control (Tomé-Lourido et al., 2019). As a result, sport-confidence may ensure attention control by resisting anxiety and maintaining confidence. Studies on shooting athletes found that confidence had a relatively greater effect on concentration among the mental skills of target setting, representational and anxiety control (Mun, 2011), suggesting to us that confidence contributes to shifting, breadth, and allocation of attention. In summary, it is proposed the following hypotheses:

H4: *Sport-confidence positively predicts attention in archers.*

H4a: *Attention mediates the relationship between sport-confidence and archery performance.*

Sport-Confidence and Cognitive Reappraisal

Research on the relationship between confidence and cognitive reappraisal in sports is relatively scarce. We only know that cognitive reappraisal can enhance subjects' confidence in memory tasks (Richards and Gross, 2000). Studies on arousal reappraisal have shown that the reappraisal group displayed higher self-confidence than the control group when completing a pressurized dart-throwing task (Sammy et al., 2017). Along these lines, cognitive reappraisal affects emotion-related outcomes by modulating the intensity of emotional responses (Gross, 2010) and stress responses (Jamieson et al., 2013), such as reducing anxiety (Hofmann et al., 2009; Uphill et al., 2012; Efinger et al., 2019) and depression (Uphill et al., 2012) and shifting negative stress states (Jamieson et al., 2013). A study of a sport-specific model of self-confidence also states that these negative emotions are related to sport-confidence (Vealey, 1986). In addition, archery athletes' sport-confidence is significantly and negatively correlated with competition anxiety and negative emotions (Zhao et al., 2013; Lim, 2016). Furthermore, according to the theory of self-efficacy, emotions are one of the sources of self-efficacy, and successful regulation of emotional experiences can enhance individuals' perceptions of personal competence (Bandura, 1977a,b). As a result, cognitive reappraisal may promote sport-confidence by improving emotional experience and consequently affect sports performance. Therefore, we propose the following hypotheses:

H5: *Cognitive reappraisal positively predicts archers' sport-confidence.*
H5a: *Sport-confidence mediates the relationship between cognitive reappraisal and archery performance.*
H5b: *Sport-confidence and attention have a chain mediating effect of cognitive reappraisal and attention.*

Attention and Cognitive Reappraisal

Both attention and cognitive reappraisal are related to cognitive control (Ochsner and Gross, 2005; Buschman and Miller, 2010). Although cognitive reappraisal may be associated with lower cognitive costs (Gross and Thompson, 2007), recent research suggests that cognitive reappraisal depletes cognitive resources (Sheppes and Meiran, 2008; Keng et al., 2013). The use of cognitive reappraisal requires the invocation of cognitive processes, including working memory, task switching, and antagonistic dominance responses (Ortner et al., 2016; Gan et al., 2017), which may conflict with attentional control and attentional orientation. Under the condition of stress, cognitive reappraisal not only takes away self-control resources but also reduces the control of negative emotions (Sheppes and Meiran, 2007; McRae et al., 2012; Ortner et al., 2016).

When athletes deliberately seek to be "more in control" to gain control over emotions and movement skills, it often comes at the cost of depleting more cognitive resources, as evidenced by decreased performance on reaction time tasks and increased rates of missed and false manipulation tasks (Sun et al., 2013; Ortner et al., 2016). Thus, we propose the following hypotheses:

H6: *Cognitive reappraisal negatively predicts attention in archers.*
H6a: *Cognitive reappraisal mediates the relationship between sport-confidence and attention.*

Combining the hypotheses above, a theoretical model of archery athletes' sport-confidence, attention, and cognitive reappraisal influencing sport performance was obtained, as shown in **Figure 1**.

MATERIALS AND METHODS

Participants

Sixty-one athletes from the Chinese National Archery Team participated in the study. Among them, 26 were males and 35 were females, 12 were international-level athletes, 30 were national-level athletes, and 19 were first-class athletes. These technical hierarchies were officially determined by the General Administration of Sport of China. International-level athletes are those who have won certain competition placement in international competitions, national-level athletes are those who have achieved corresponding competition results international, continental, or national competitions, and first-class athletes are those who have won certain competition results in national competitions (General Administration of Sport of China, 2019). Informed consent was obtained from all athletes and coaches before testing. The detailed demographic distribution is presented in **Table 1**.

Measurements

Archery Performance

To avoid the bias arising from the description of sports performance by a single indicator and take into account the description of athletes' sports performance in both long-term and short-term dimensions, we constructed an archery performance indicator that includes competition performance score (the total ranking score in the qualification and the total set score in the matchplay) and technical hierarchy score.

According to Olympic archery competition rules, athletes are required to participate in the qualification phase and the matchplay phase successively. The performance in the qualification phase is usually reflected by the total ranking score (total score of shooting 72 arrows), which could reflect the stability of the athletes' performance; the performance in the matchplay phase is reflected by the total set score (cumulative score of each match), which can reflect the confrontational ability of the athletes. In addition, referring to the scoring method of Arribas-Galarraga et al. (2017) for the competition places achieved by athletes in different levels of competition, we devised a method for converting technical level into technical level score, that is, the second-class level, the first-class level, the national level, and the international level were assigned 1, 2, 3, and 4, respectively. Thus, the technical level score of the second-class athletes was 1 (1), that of the first-class athletes was 3 (1 + 2), that of the national-level athletes was 6 (1 + 2 + 3), and that of the international-level athletes was 10 (1 + 2 + 3 + 4).

Attention

The paper–pencil version of the Elite Athlete Attention Test (EAAT; Yin et al., 2006) was selected to measure the attentional

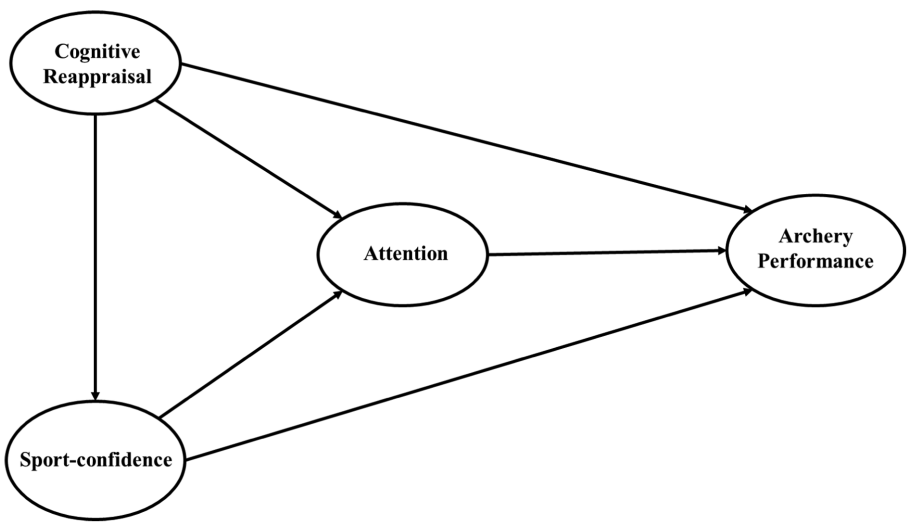

FIGURE 1 | Structural model.

TABLE 1 | Participants' demographics.

Gender	Technical level	*N*	Age (*M* ± SD)	Training years (*M* ± SD)
Male	International	6	23.50 ± 1.23	10.67 ± 1.86
	National	17	22.12 ± 2.83	8.88 ± 3.02
	First-class	4	16.50 ± 1.29	5.75 ± 2.06
Female	International	6	27.17 ± 2.86	13.33 ± 0.52
	National	13	20.15 ± 2.97	8.54 ± 2.47
	First-class	15	19.80 ± 2.34	7.73 ± 2.34
Total		61	21.39 ± 3.51	8.93 ± 2.94

M, Mean; SD, standard deviation.

allocation, breadth, and shifting of athletes. The EAAT, based on theory related to trials of attention, consists of the Graphic Discrimination Test (subjects were asked to find 2 target shapes among 16 similar shapes and mark them, the total number of shapes being $15 \times 20 = 300$), the Pick 4 Circles Test (subjects were asked to mark the squares with four small circles among the squares with different numbers of small circles, the total number of squares being $26 \times 25 = 650$), and the Addition and Subtraction Test (subjects were asked to alternate between "addition" and "subtraction" and to write the results in the middle of the two numbers, the total number of results being $22 \times 12 = 264$), which measure attentional allocation, breadth, and shifting, respectively. The validity of the EAAT has been proven in national team athlete populations in tennis, diving, short track speed skating, basketball, free-skiing aerials, and sailing, by comparing the attention ability with those of the self-assessment and the coaches' assessment (Yin et al., 2006).

Sport-Confidence

The State Sport-Confidence Inventory (Chinese Version; SSCI-CV; Fung et al., 2001) was chosen to measure the state sport-confidence in this study. The SSCI-CV revised from the State Sport-Confidence Inventory (SSCI; Vealey, 1986), which has been a widely used measure of state sport-confidence and has shown good reliability and validity. It consists of 13 items (e.g., "compare your confidence in your ability to perform under pressure to the most confident athlete you know") and each scored on a 9-point Likert scale from 1 (low confidence) to 9 (high confidence). The internal consistency of the SSCI-CV was 0.94 in this study.

The Athlete Sport-Confidence Inventory (ASCI; Shen, 2004) was chosen to measure the trait sport-confidence in this study. The ASCI is an instrument for measuring trait sport-confidence based on self-efficacy theory (Shen, 2004), sport-specific model of self-confidence (Vealey, 1986), and the Chinese elite athlete self-confidence model (Anmin et al., 1999). Compared to the Trait Sport-Confidence Inventory (TSCI; Vealey, 1986), the ASCI incorporates competition orientation, which can be a valid predictor of trait sport-confidence (Martin and Gill, 1991; Shen, 2004) and would more comprehensively measure and reflect athletes' trait sport-confidence. The ASCI consists of 16 items and each scored on a 6-point Likert scale ranging from 1 (not at all) to 6 (very much so). It is designed to measure the trait task sport-confidence (six items, e.g., "Even with a lot of pressure, I was able to play well as I should") and trait coping sport-confidence (10 items, e.g., "Whether I win or lose, I believe I can reach the goal I have in mind"). The test–retest reliability and the coefficient of were 0.78 and 0.84 for task dimension and were 0.73 and 0.90 for coping. In this study, the internal consistency of the ASCI was 0.94.

Cognitive Reappraisal

The Emotion Regulation Questionnaire-Chinese Revised Version (ERQ-CRV; Wang et al., 2007), a revised version of the Emotion Regulation Questionnaire (ERQ; Gross and John, 2003), was selected to measure the use of cognitive reappraisal strategies. The ERQ has been a widely used measure of emotion regulation strategies and has shown good reliability and validity. The ERQ-CRV comprises two subscales and assesses the habitual use of two emotion regulation strategies: cognitive reappraisal and expressive suppression. This study applied the Cognitive Reappraisal Scale, which consists of six items (e.g., "When I'm faced with a stressful situation, I make myself think about it in a way that helps me stay calm"), and each scored on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The test–retest reliability and the coefficient of ERQ-CRV were 0.82 and 0.85 for cognitive reappraisal dimension. The internal consistency coefficient was 0.80 in this study.

Procedure

All of the athletes took the psychological test as a group at the same time and participated in an archery competition 1 week after the test. The psychological tests were conducted 2 h after the end of training in a warm, well-ventilated, and quiet room. Before implementing the attention tests, the chief examiner explained each subtask of the EAAT one by one and confirmed that the athletes understood the content of the EAAT, and then counted down the time to start the attention tests on the athletes. All three subtasks of the EAAT were limited to 3 min (Yin et al., 2006). After completing the attention tests, the athletes filled out the ERQ-CRV, the SSCI-CV, and the ASCI. The archery competition was conducted in accordance with Olympic archery competition rules. During the competition, we collected the total ranking score in qualification phase and the total set score in the matchplay phase. In addition, the technical level data are collected from the "Athlete Technical Hierarchy Integrated Management System" before the competition.

Statistical Analysis

In this cross-sectional study, structural equation modeling (SEM) was chosen to analyze the measurement and structural models. SEM was divided into two categories: covariance-based SEM (CB-SEM) and partial least squares-SEM (PLS-SEM; Chin, 1998). Compared to CB-SEM, PLS-SEM (1) is more suitable for addressing small sample data and does not require normally distributed data (Chin, 1998; Urbach and Ahlemann, 2010); (2) focused on predictions and theory building, rather than model verification, by maximizing the explained variance of

endogenous latent variables because its power is relatively higher (Hair et al., 2011); and (3) The model constructed in this study is permeated with various theories or hypotheses and is a development of theory rather than a validation of the theory, which determines the applicability of PLS-SEM for this study. The data were analyzed in SmartPLS V.3.3.3 (Ringle et al., 2015).

We assessed the model using a two-stage analytical procedure for PLS-SEM as delineated by Hair et al. (2020): (1) We tested the measurement model to refine our measures and establish validity and reliability; and (2) We examined the structural model and tested the significance of path coefficients. The PLS algorithm was utilized to calculate the weights/loading, path coefficients, predictive accuracy (R^2), effect size (f^2), reliability, and validity of the model; bootstrapping (resamples = 5,000, confidence intervals method is bootstrap with corrected bias-corrected and accelerated bootstrap) was utilized to calculate the statistical significance of path coefficients; and blindfolding (omission distance = 7) was utilized to calculate Stone-Geisser's Q^2, which indicates predictive relevance (Hair et al., 2017). The remaining calculation parameters were the software's default values. To comply with the rule of the "minimum sample size should be equal to the larger 10 times the largest number of formative indicators used to measure one construct sample" in the PLS-SEM algorithm (Marcoulides and Saunders, 2006), we packaged the SC-state and SC-trait in the form of summation of each item's score.

RESULTS

Measurement Model

Items for which the indicator loading is less than 0.6 should not be included in the subsequent analysis (Sarstedt et al., 2017). The preliminary PLS-SEM algorithms showed that the outer loading of the first and second items of the latent variable cognitive reappraisal ranged from 0.475 and 0.586. Based on the results of both PLS algorithms and empirical analyses (the two items are correlated in connotation with other items, and removing them does not affect the content validity), we deleted the two items above. Meanwhile, the relationship between cognitive reappraisal and attention (H6) was removed from the original hypothesized model due to a non-significant path coefficient [$\beta = 0.200$, 95% CI $\in (-0.069, 0.449)$]. The following section will develop the analysis with the revised model (**Figure 2**).

To measure reliability, indicator loadings higher than 0.7, composite reliability (*CR*) ranging from 0.8 to 0.95, and Cronbach's alpha (*CA*) higher than 0.7 have been used as common criteria to assess indicator reliability and internal consistency reliability (Sarstedt et al., 2017). However, some researchers criticized *CA* as an indicator to assess the reliability of the measurement model in PLS-SEM, in that the calculation of *CA* is based on the assumption that "all items have tau-equivalence reliability," which may underestimate the true reliability (Hair et al., 2012; Peterson and Kim, 2013). As shown in **Table 2**, indicator loadings (0.708–0.912) of each item, *CR* values (0.826–0.897) of each latent variable, and *CA* values (0.771–0.807) of the latent variables above cognitive reappraisal, sport-confidence, and attention comply with the requirements of the test standard. Although the *CA* value for the latent variable archery performance was 0.696, we considered the *CA* for archery performance to be acceptable due to the inherent large uncertainty in archery performance and the general tendency of *CA* to underestimate the reliability. In all, the measurement model was considered to have acceptable reliability in this study.

The validity tests of measurement models focus on convergent validity and discriminant validity tests (Hair et al., 2020). Convergent validity, which reflects the extent to which different measures of the same construct converge or strongly correlate with one another (Taherdoost, 2016), was assessed through

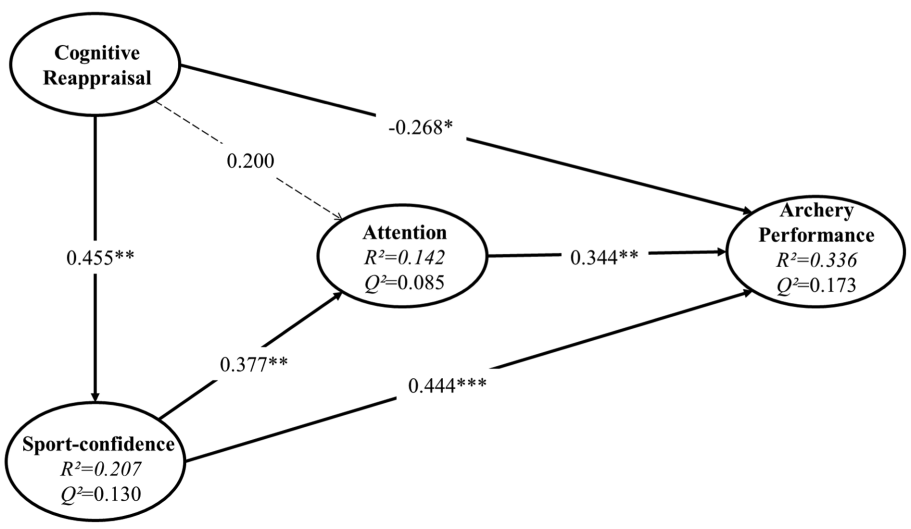

FIGURE 2 | Structural model and PLS-SEM results. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

TABLE 2 | Reliability tests and validity tests of the measurement model.

Constructs	Loadings range	*CA*	*CR*	*AVE*
Archery Performance	0.756–0.835***	0.696	0.826	0.614
Sport-confidence	0.893–0.912***	0.772	0.897	0.814
Attention	0.793–0.874***	0.771	0.866	0.684
Cognitive Reappraisal	0.708–0.851***	0.807	0.872	0.631

*CA, Cronbach's alpha; CR, composite reliability; AVE, average variance extracted. ***p < 0.001.*

the average variance extracted (*AVE*). All *AVEs* (**Table 2**) in this study exceeded the recommended threshold of 0.5 (Hair et al., 2020), indicating that the measurement variables can effectively explain the latent variables and that the measurement models were both good in convergent validity. The discriminant validity assessment ensures that a reflective construct has the strongest relationships with its own indicators (Hair et al., 2020). Traditionally, the Fornell–Larcker criterion (Fornell and Larcker, 1981) discriminated whether $\sqrt{AVE_i} > \max\left|r_{ij}\right|\left(\forall i \neq j\right)$ was used, but Henseler et al. (2015) pointed out that the PLS algorithm would overestimate indicator loadings and underestimate correlation coefficients among the constructs, and they suggested that a heterotrait–monotrait ratio of correlations (HTMT) lower than 0.85 should be used as a criterion of discriminant validity assessment. **Tables 3** and **4** present the results of these criteria. Both the Fornell–Larcker criterion and HTMT test were approved. Therefore, we demonstrated satisfactory validity of our measurement model.

TABLE 3 | Fornell–Larcker criterion analyses.

Constructs	1	2	3	4
1. Archery Performance	**0.784**			
2. Attention	0.426	**0.827**		
3. Cognitive Reappraisal	0.044	0.320	**0.794**	
4. Sport-confidence	0.452	0.377	0.455	**0.902**

The numbers in bold on the diagonal in the matrix of correlation are the square roots of the AVE.

TABLE 4 | Heterotrait–monotrait (HTMT) analysis.

Constructs	1	2	3	4
1. Archery Performance				
2. Attention	0.545			
3. Cognitive Reappraisal	0.165	0.374		
4. Sport-confidence	0.583	0.476	0.545	

Structural Model

Assessing the structural model, we checked for multicollinearity issues by examining the variance inflation factor (VIF) values first. No multicollinearity issues were found, as all VIF values, ranging from 1.272 to 2.370, were below the threshold value of three (Hair et al., 2020). As shown in **Figure 2**, the endogenous variables' R^2 value (range from 0.142 to 0.336) and Q^2 value (range from 0.085 to 0.173) also indicated good predictive accuracy and predictive relevance, where R^2 equals 0.67, 0.33, and 0.19 for large, medium, and small predictive power, respectively, and Q^2 values greater than zero are meaningful, whereas values below zero indicate a lack of predictive relevance.

Direct Path Analysis

To assess the direct effect of the path, path coefficients' significance (p) and effect size (f^2) were used, in which f^2 values above 0.02 and up to 0.15 are considered small effects, values of 0.15 and up to 0.35 are considered medium effects, and values 0.35 and above are considered large effects (Cohen, 1988). The relationships between sport-confidence and archery performance (H1; $\beta = 0.444$, $p < 0.001$), sport-confidence and attention (H4; $\beta = 0.377$, $p < 0.001$), and cognitive reappraisal and sport-confidence (H5; $\beta = 0.455$, $p < 0.001$) were found to have a medium effect size. Small effects were observed for the relationships between attention and archery performance (H2; $\beta = 0.344$, $p < 0.001$) and between cognitive reappraisal and archery performance (H3; $\beta = -0.268$, $p < 0.001$; see **Table 5**). Overall, these results support H1, H2, H4, and H5. Beyond our anticipation, the results do not support H3, but a significant negative relationship between cognitive reappraisal and archery performance was found. In addition, no significant relationships were found between cognitive reappraisal and attention (H6), which had been clarified in the model revision process.

Mediation Analysis

The mediation analysis procedure recommended by Hair et al. (2017) was used, in which, if the coefficient of the path including the mediator variable is significant, then we need to determine the significance of the direct effect. Partial mediation is found when the direct effect is significant, whereas support for full mediation is demonstrated when the direct effect is not significant. Among the results of the mediating effects test (**Table 5**), we found that attention acted as a partial mediator of the relationships between sport-confidence and archery performance (H4a, $\beta = 0.130$, $p < 0.05$). Sport-confidence acted as a suppressing mediator between cognitive reappraisal and archery performance (H5a, $\beta = 0.202$, $p < 0.05$) due to the opposite sign of the coefficient of the indirect effect and the coefficient of the direct effect ($\beta = -0.268$, $p < 0.05$). Moreover, a mediating effect of sport-confidence was found in the path between cognitive reappraisal and attention (H6a, $\beta = 0.172$, $p < 0.05$). Certainly, sport-confidence and attention have no chain mediating effect between cognitive reappraisal and attention (H5b, $\beta = 0.059$, $p > 0.05$). Overall, the results of the indirect relationships provided support for H4a, H5a, and H6a, and did not support H5b.

TABLE 5 | Path coefficients of the structural model and significance testing results.

Path of the research model	*Beta*	*95% CI*		f^2	Hypothesis decision
		2.5%	97.5%		
1. Sport-confidence → Archery Performance	0.444***	0.207	0.684	0.218	H1 is supported
2. Attention → Archery Performance	0.344**	0.068	0.581	0.148	H2 is supported
3. Cognitive Reappraisal → Archery Performance	−0.268*	−0.486	−0.036	0.083	H3 is not supported
4. Sport-confidence →Attention	0.377**	0.148	0.588	0.166	H4 is supported
5. Cognitive Reappraisal → Sport-confidence	0.455**	0.044	0.684	0.261	H5 is supported
6. Cognitive Reappraisal → Attention	0.200	−0.069	0.449	–	H6 is not supported
7. Sport-confidence → Attention → Archery Performance	0.130*	0.021	0.257	–	H4a is supported
8. Cognitive Reappraisal → Sport-confidence → Archery Performance	0.202*	0.011	0.419	–	H5a is supported
9. Cognitive Reappraisal → Sport-confidence → Attention → Archery Performance	0.059	−0.004	0.145	–	H5b is not supported
10. Cognitive Reappraisal → Sport-confidence → Attention	0.172*	0.009	0.354	–	H6a is supported

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

Total Effect Analysis

To compare the magnitude of different independent constructs affecting the dependent constructs, we collated the total effects of sport-confidence, attention, and cognitive reappraisal to influence archery performance by summing the direct and indirect effects. As shown in **Table 6**, the ranking of the total effects of the different constructs on archery performance was, in descending order, sport-confidence [0.574, 95% CI ∈ (0.342, 0.796)], attention [0.344, 95% CI ∈ (0.068, 0.581)], and cognitive reappraisal [−0.007, 95% CI ∈ (−0.354, 0.271)].

DISCUSSION

The main purpose of this study was to explore the pathways and effects of sport-confidence, attention, and cognitive reappraisal on real-world archery performance from a connected perspective. Before proving the hypothesized relationships, we verified that the measurement models had acceptable internal consistency reliability, convergent validity, and discriminant validity. In addition to demonstrating again that sport-confidence and attention are important predictive indicators of archery performance (Yang et al., 2008; Kim et al., 2015; Taha et al., 2018), we also found complexity when cognitive reappraisal affects archery performance. Furthermore, the fact that the model explained a total of 33.6% of the variance in archery performance is in line with our expectations and the conclusions of a previous study (Kim et al., 2015), considering that the factors influencing archery performance also include skill-based factors, physical fitness-based factors, and other mental factors.

Echoing the hypothesis of a positive linear relationship between sport-confidence and archery performance proposed by Martens et al. (1990) in multidimensional anxiety theory, this study demonstrated that sport-confidence has a positive effect on archery performance. Stable technical performance comes from stable mental dominance, which depends heavily on confidence (Yang et al., 2008; Kim et al., 2015). Consistent with the findings of Kim et al. (2015), we reconfirm that confidence has the greatest effect on archery performance compared to attention and emotion regulation and state the primacy of developing sport-confidence in archers. Moreover, the results support the assumption that both state and trait sport-confidence are equally important, which gives us reason to speculate that an athlete's past success is an important prerequisite for optimal performance at high levels of competition (Rosenqvist and Skans, 2015) and suggests that the development of sport-confidence in archers can be carried out in terms of improving the degree of belief in using their abilities to accomplish their sporting tasks and the degree of belief in facing pressure and overcoming difficulties. Therefore, paying attention to improving the sport-confidence of athletes in diversified ways is a necessary part of daily training and pre- and post-competition training.

The present study found that archery performance was affected by multiple attentional abilities, including shifting, breadth, stability, and allocation of attention. Yang et al. (2008) focused on attentional stability and attentional assignment, and Lu et al. (2021) based on attention network theory, found that the ability to alert, orient, and conflict control was related to archery performance. These studies of different attentional elements all point to the importance of abilities in maintaining focus, identifying targets and distractors, and rapidly shifting the object of attention. In other words, to ensure consistent technical performance during the competition, archery athletes need to keep their focus stabilized on the target and bow sight, along with controlling their body movements, which demands attentional breadth and attentional allocation at the same time (Pei and Song-ping, 2007). In turn, there are a large number of distractions in the competition diverting the athlete's attention, requiring the athletes to shift the direction of their attention and keep the focus on valid information or the task at hand.

In addition, attention plays a partially mediating role in the path of sport-confidence to archery performance. The findings support the hypothesis of processing efficacy theory (Eysenck and Calvo, 1992) and attentional control theory (Eysenck and Derakshan, 2011) regarding the relationship between anxiety and attention. The lack of confidence in athletes is often manifested by the inability to focus well on the process of the game but more on the opponent's performance or the outcome of the game, which negatively affects their normal performance on a technical level (Yang et al., 2008). If the

TABLE 6 | Direct effects and indirect effects of independent constructs among Archery performance.

Constructs	Sport-confidence	Attention		Archery Performance		
	Direct	Direct	Indirect	Direct	Indirect	Total
1. Sport-confidence	–	0.377**	–	0.444***	0.130*	0.574***
2. Attention	–	–	–	0.344**		0.344**
3. Cognitive Reappraisal	0.455**		0.172*	−0.268*	0.261*	−0.007

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

inverse relationship between confidence and anxiety holds true, it may also suggest that anxiety has a more negative effect on performance when the task is more demanding on the central executive system (Eysenck and Derakshan, 2011). In short, we can infer that individuals with higher levels of sport-confidence are more likely to maintain and control their attention on valid information and operational tasks, thus ensuring performance.

Previous studies have indicated emotion regulation (Kim and Oh, 2015) or emotion control (Yang et al., 2008; Zhao et al., 2013; Kim et al., 2015) as an important factor in archery performance. However, we found that the relationship between cognitive reappraisal and archery performance is considerably complex. The direct effect of cognitive reappraisal on archery performance was significantly less than zero, while the total effect was approximately equal to zero and non-significant. Differences in the measurement of emotion regulation and differences in contexts when using cognitive reappraisal strategies may have contributed to the different results of the studies.

We chose emotion regulation strategies as an entry point to measure athletes' emotion regulation ability from the "method" perspective and investigated athletes' cognitive reappraisal, which is a relatively efficient emotion regulation strategy. Most previous studies have investigated the importance of control emotions based on "outcome" orientation, e.g., "The importance of emotional control on archery performance is …" (Yang et al., 2008; Kim et al., 2015), or "I lose control of my emotions under stress," "My emotions prevent me from performing at my best in competition" (Zhao et al., 2013). From this, we can realize that although emotion regulation is crucial for athletes to achieve good performance, the specific methods used in regulating emotions still need to be treated differently.

Context is an important factor to consider in determining the usefulness of a particular emotion regulation strategy (Gross and John, 2003; Kucharski et al., 2018). The presence of contextual differences between the two may also account for the differential effects of cognitive reappraisal. Some scholars (Sheppes and Meiran, 2007; Ortner et al., 2016) have pointed out that the effectiveness of using cognitive reappraisal to improve negative emotional experiences in emotionally stressed conditions is lower than that of using it in non-stressed conditions. In the present study, sport performance was collected under real-world competition, while other similar studies (Wagstaff, 2014; Kim and Oh, 2015; Lane et al., 2016) measured performance under laboratory settings. In competitive situations where individuals are constantly faced with new stimuli of emotional arousal, the use of cognitive reappraisal strategies not only fails to effectively regulate emotions but also eventually leads to enhanced emotional instability and adversely affects performance as the frequency of use increases and the effectiveness of use decreases (Sheppes and Meiran, 2007; Ortner et al., 2016). Athletes tended to use more complex strategies (e.g., cognitive reappraisal) following a disappointing game or personal performance (Kucharski et al., 2018). However, increased cognitive costs are associated with the use of cognitive reappraisal strategies in a higher intensity stimuli context (Sheppes and Meiran, 2008; Ortner et al., 2016), or the cognitive reappraisal and attention spent on the task would compete for limited cognitive resources. From this, it can be inferred that archery performance is negatively influenced by cognitive reappraisal due to deviations from conventional behavioral patterns or the occurrence of additional expenditure of cognitive resources by athletes. This is in line with the ego-depletion theory (Baumeister et al., 1998).

In addition, the suppressing effect of sport-confidence between cognitive reappraisal and archery performance suggests that if athletes direct their cognitive reappraisal toward boosting sport-confidence, the use of the strategy might facilitate archery performance. This is in line with the importance to archers of positive thinking (Kim et al., 2015). This might be interpreted as individuals reappraising their anxious arousal as excitement and consequently increasing their confidence and improving their performance (Stanger et al., 2018). Through self-statements, such as "I am excited" rather than "trying to relax or stay calm," cognitive reappraisal promotes a more positive way of thinking and elicits a stronger feeling of excitement, which in turn indirectly affects sports performance (Brooks, 2014). In summary, athletes, at least archers, should understand that using cognitive reappraisal in the field tends to reduce competitive performance by taking up cognitive resources and distracting attention, but when it is applied in a way that enhances confidence (e.g., "the current situation is a challenge for me, and I believe I can handle it"), it may promote competitive performance.

Limitations and Future Research

The primary limitations found in this study concerned the cross-sectional nature of data collection. Cross-sectional designs limit the causality in the hypothesized relationships by examining only the relations among the variables; hence, we cannot assert that the antecedents are causally related to desired outcomes. In addition, given the difficulty of reaching 61 national archery

athletes at the same time and place, we could not guarantee collecting data periodically or conducting a complete experimental study. As a result, future research could further test the model using a longitudinal design or quasi-experiment to make the findings more convincing.

The model constructed in this study involved three psychological predictive constructs and explained 33.6% of the variance in archery performance. However, cognitive reappraisal may not be a one-size-fits-all approach to regulate emotion in archery competition. We not only encourage additional investigations to further verify the psychometric properties of the measures used in this study, but also suggest the inclusion of other constructs of emotion regulation in the model, such as acceptance. Acceptance encourages individuals to become aware of and accept their feelings, rather than trying to actively change them, and it not only reduces negative perceptions of unpleasant emotional and physiological states and maintains or increases physiological arousal (Desbordes et al., 2015; Feldman et al., 2016), but more importantly, it occupies lower cognitive costs and is easier to operate than cognitive reappraisal (Troy et al., 2017).

Furthermore, psychometric measures alone cannot possibly capture a thorough and detailed explanation of the factors influencing performance in archery. Thus, the present results can be complemented by integrating skill constructs, fitness constructs and to shed light on the relative importance of archery performance factors and guide the training practice process. Besides, recent studies have also suggested that genetic polymorphisms are associated with athletes' emotional control (Altamura et al., 2019) and sport performance (Ahmetov et al., 2016), and therefore, the inclusion of genetic polymorphism structure in the model could be considered and guide the athlete selection.

Finally, the differences in the experience levels and level of participation among the athletes could affect their psychological capability which may affect the result. This study only focused on an elite archery athlete population, and therefore, the applicability of the model is currently limited to this group. Future research could further explore the applicability of the model to archers with different levels of experience or participation, even to athletes in other sports that require movement of fine control and a high level of concentration, such as shooting and golf. Comparisons between athletes of different experience levels and between different sports will bring their own contribution to the field in practice and in the literature.

CONCLUSION

The model constructed in this study has good reliability and validity, with three psychological constructs (sport-confidence, attention, and cognitive reappraisal) explaining 33.6% of the variance in archery performance. The total effects of the three mental constructs on archery performance were, in descending order, sport-confidence, attention, and cognitive reappraisal. Sport-confidence and attention are the priority components of archery mental training, in which sport-confidence development should include the development of state sport-confidence and trait sport-confidence, and attention training should also aim at attentional allocation, breadth, and shifting. In terms of emotion regulation, archery athletes should be guided to use cognitive reappraisal strategies when facing differentiated contexts, that is, cognitive reappraisal could regulate emotions and enhance sport-confidence, but its use in competition may potentially negatively affect performance by taking up cognitive resources and should directly improve sport-confidence or a develop a positive orientation to arouse excitement.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

DW contributed to the experimental design, data collection and analysis, and drafting of the manuscript. TH contributed to the experimental design and revision of the manuscript. RL, QS, YW, XL, JQ, and LZ contributed to the data collection and examined the study. HY conceived of and examined the study and revised the manuscript. LC contributed to the experimental design and data collection and revised the manuscript. All authors contributed to the article and approved the submitted version.

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Elite Athletes' Perfectionistic Striving vs. Concerns as Opposing Predictors of Self-Handicapping With the Mediating Role of Attributional Style

Lilla Török[1,2†], Zsolt Péter Szabó[3†] and Gábor Orosz[1†]*

[1]Unité de Recherche Pluridisciplinaire Sport Santé Société, Université d'Artois, Liévin, France, [2]Department of Psychology and Sport Psychology, University of Physical Education, Budapest, Hungary, [3]Department of Ergonomics and Psychology, Budapest University of Technology and Economics, Budapest, Hungary

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***Correspondence:**
Gábor Orosz
gabor.orosz@univ-artois.fr

†ORCID:
Lilla Török
orcid.org/0000-0001-7566-1047
Zsolt Péter Szabó
orcid.org/0000-0001-8124-2869
Gábor Orosz
orcid.org/0000-0001-5883-6861

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Self-handicapping is not only present among amateurs, but also even among the most elite athletes. The vast majority of the research investigates self-handicapping in academic context among students with mediocre performance. However, scientific examinations of predictors among top performers in the field of sports is terra incognita. Among the predictors of self-handicapping, perfectionistic strivings, and concerns as well as attributional style, were demonstrated as relevant ones among samples in prior studies. However, these links have never been examined among elite athletes who can be characterized by various aspects of perfectionism. In this study, the link between self-handicapping and perfectionistic striving and concerns was examined both directly and indirectly through the potential mediating effect of attributional style among elite athletes ($N = 111$) where more than half of the participants was competing at international level such as European and World Championships or Olympic Games. As it was expected, a positive relationship was found between perfectionistic concerns and self-handicapping, whereas the findings suggested a negative relationship between perfectionistic striving and self-handicapping. These connections were partially mediated by attributions for negative sport-related events. It appears that explanations for negative events are crucial in connection with protecting oneself through self-handicapping even among top athletes. The present work is a first step of a broader program in which the goal is reducing self-handicapping of top athletes through attributional retraining intervention.

Keywords: elite athlete, perfectionistic striving, perfectionistic concerns, self-handicapping, sport-related attributional style

INTRODUCTION

Professionals working with elite athletes often face the issue of setting excessively high standards and finding ways to prevent inherent failure. This challenge is demonstrated by the behavior of prominent and perfectionist soccer player David James (Daily Mail, 2008). In a memorable report from 1997, he revealed that instead of sleeping he had been playing video games all

night the day before a critically important match against Newcastle (ESPN, 2011). Besides these anecdotes very little is known about elite athletes' self-handicapping. In the present study, we intended to thoroughly explore a relationship pattern among multiple dimensions of perfectionism and self-handicapping, while focusing on the potential mediating effect of attributional style regarding sport-related events.

Self-Handicapping

An athlete constantly arriving at the track minutes before competitions or complaining about injuries are both examples of self-handicapping in sport. According to Berglas and Jones (1978, p. 406) self-handicapping "involves any action or choice of performance setting that enhances the opportunity to externalize (or excuse) failure and to internalize (reasonably accept credit for) success." In their seminar paper, the authors argued that many professional athletes might resort to self-handicapping. Self-handicappers control their attributions by providing themselves an opportunity to externalize a poor performance and protect their self-esteem. By contrast, self-handicapping has also been found to positively relate to failure avoidance (Elliot and Church, 2003).

Surprisingly, little empirical evidence is available on self-handicapping among elite athletes. Considering its negative impact on performance (Elliot et al., 2006; Schwinger et al., 2014) and specifically sport performance (Coudevylle et al., 2008), it is important to thoroughly understand the process of self-handicapping.

Perfectionism

Perfectionism is a trait characteristic of a person striving for flawlessness and setting excessively high performance standards, accompanied by overly critical self-evaluations. It is also characterized by their concerns over how others may evaluate them (Frost et al., 1990). Adaptive (i.e., perfectionistic striving) and maladaptive (i.e., perfectionistic concerns) aspects of perfectionism are often distinguished (see Gotwals et al., 2012 for review; Frost et al., 1993; Rice and Ashby, 2007; Stoeber and Gaudreau, 2017). Perfectionistic striving is characterized by realistic and reasonable self-expectations, with attempts to strive for flawlessness accompanied by a sense of satisfaction and enhanced self-esteem. However, perfectionistic concerns involve setting unrealistically high standards and are driven by a fear of failure, while being connected to conditional approval (Terry-Short et al., 1995).

There is increasing interest in perfectionism in the realm of sport (Hill et al., 2020). As Rees et al. (2016, p. 1049) stated, "super-elite athletes are conscientious, optimistic, hopeful, and perfectionist." While a high level of perfectionistic striving is beneficial in order to succeed (Gould et al., 2002; Gotwals et al., 2012), high levels of perfectionistic concerns relate to viewing sporting experiences negatively (Sellars et al., 2016). Gould et al. (2002) found that Olympic champions scored highly on the adaptive aspect of perfectionism but had low scores on the maladaptive form. Also, Sellars et al. (2016) reported negative impact (e.g., dissatisfaction, over-thinking, aggression, concerns over mistakes, and fear of failure) of perfectionistic concerns on sporting experiences. Despite it appears that top athletes benefit from perfectionistic striving and suffer from perfectionistic concerns, it is not well studied how these are related to their self-handicapping tendencies.

Attributional Style

To organize, simplify and explain their experiences, people formulate causal attributions. Attributional style is a moderately stable characteristic influencing how the outcome of an event may be explained habitually by the given person (Peterson and Steen, 2002). Explanations could be classified along several attributional dimensions (e.g., locus of causality, stability, controllability, globality, and intentionality; Hanrahan et al., 1989).

It has been found that the explanatory style is associated with athletic performance. Gordon (2008) found that soccer players scoring high on optimism (with internal, stable, and global attributions to positive events) demonstrated better performance during a loss than pessimists (with external, unstable, and specific attributions to positive events). Prior studies showed that attributional style serves to preserve one's self-esteem in case of failure (e.g., Rees et al., 2005). Despite scientific examination of attributional styles has an in-depth scientific tradition, very little is known about top sports performers' attributions in the light of their perfectionism and self-handicapping.

The Relationship Between Self-Handicapping, Perfectionism, and Attributional Style

Self-handicapping and the attributional theory are interconnected on several levels. According to Rhodewalt (2008), self-handicapping occurs for the purpose of controlling one's attributions about the self. Pioneering review of Rhodewalt (1990) considered attributional style to be a key factor in understanding the dynamics of self-handicapping; however, very few and inconsistent results are available. It proposed that in comparison to low self-handicappers, high self-handicappers attribute positive daily life events to less stable and less internal factors, whereas they attribute negative events to more stable factors. The two groups did not differ in their external attributions for negative events. The study also reported no difference between the two groups in terms of the globality (and specificity) of the attributions. Another study found that self-handicapping was significantly associated with an internal, stable, and global attributional style for negative events (Rhodewalt and Hill, 1995). Regarding locus of control, Stewart and de George-Walker (2014) reported positive association between external locus of control and self-handicapping.

According to Kearns et al. (2008), perfectionism and self-handicapping go hand in hand. More specifically, Stewart and de George-Walker (2014) reported that self-handicapping and perfectionistic concerns are positively related. In the same vein, Pulford et al. (2005) reported a negative association between the adaptive aspects of perfectionism and self-handicapping. The authors argue that highly self-oriented perfectionists

(predominantly adaptive in nature) in comparison to low self-oriented perfectionists care more about how they achieve their success, thus are less prone to self-handicapping.

The relationship between perfectionism and sport-related attributions has not been researched in detail. According to Anshel and Mansouri (2005), high perfectionistic concerns (i.e., concerns over mistakes) are related to internal causal attributions at the event of failure. However, they did not investigate attributions in relation to events of success, thus the methodology used remains one-sided or partial. Stoeber and Becker (2008) found that the adaptive aspects of perfectionism (i.e., striving for perfection) are positively related to self-serving attributions, whereas perfectionistic concerns (i.e., negative reactions to imperfection) were positively related to self-depreciating attributions among female soccer players. Periasamy and Ashby (2002) reported that both types of perfectionists scored higher on internal locus of control than non-perfectionists. As Stewart and de George-Walker (2014) proposed, the interaction between maladaptive social cognitive constructs and self-handicapping needs further investigation.

In the present study, we propose that perfectionism and self-handicapping are connected to each other, and that this relationship is partially mediated by the attributional style that top athletes adopt. More specifically, we propose that perfectionistic concerns positively correlate with self-handicapping, whereas perfectionistic striving negatively correlates with self-handicapping. We also expect that perfectionistic concerns positively associate with the level of internal, stable, controllable, intentional and global attributions for negative sport-related outcomes, and this partially explains their tendencies for self-handicapping.

MATERIALS AND METHODS

Participants and Procedure

A sample of 111 elite (based on Rankinen et al., 2000; Swann et al., 2015) athletes (66 men, 45 women) participated in our study. More than half of the sample (54.9%) were medalists or participants of international competitions, such as European and World Championships or Olympic Games and 36.9% were national level competitors such as medalists (51.2% of them gold medalists) at national level (8.1% missing). Using a snowball sampling method, they were recruited to participate in an online survey *via* email from the personal contacts of the first author. The age of the participants ranged from 13 to 36 ($M = 20.76$, $SD = 4.75$). Fifty-nine participants took part in individual sports, 32 in team sports, and 20 in both individual and team sports. The time participants spent playing sports competitively was an average of 9.91 years ($SD = 4.79$). Elite athletes were targeted for our sample as based on prior literature (Gould et al., 2002; Rees et al., 2016), we supposed that they will have high scores on perfectionism. Among the participants, there were one two-time Olympic gold medalist and several World and European Champions.

This research was approved by the Institutional Review Board of the local university. Participants first provided informed consent (and passive parental consent when necessary). They were informed that participation was voluntary and anonymous, without compensation. They then received the demographic and sports-related questions, which were followed by the Frost Multidimensional Perfectionism Scale (Frost et al., 1990), then the Sport Attributional Style Scale (SASS; Hanrahan et al., 1989), and finally the Short Self-Handicapping Scale (SHS; Rhodewalt, 1990).

Measures

The Frost Multidimensional Perfectionism Scale (FMPS, Terry-Short et al., 1995) was used to measure perfectionistic concerns and striving. The FMPS is a 35-item self-report questionnaire originally designed to measure the multidimensional construct of perfectionism through six subscales (Personal Standards, Concern over Mistakes, Doubts about Actions, Parental Criticism, Parental Expectations, and Organization). It utilizes a five-point Likert-type scale ranging from "strongly disagree" (1) to "strongly agree" (5). Participants were asked to consider situations in sport indicating how strongly they agree with each statement (e.g., "Other people seem to accept lower standards from themselves than I do"). Following past research (Frost et al., 1993; Moser et al., 2012), we defined perfectionistic concerns to be composed of four subdimensions: Concern over Mistakes, Doubts about Actions, Parental Expectations, and Parental Criticism. Perfectionistic striving comprises two subdimensions: Personal Standards and Organization. In the present study, we found Cronbach's coefficient alphas (α) of 0.90 for perfectionistic concerns and 0.82 for adaptive perfectionism.

The short 10-item SASS (Hanrahan et al., 1989; Hanrahan and Grove, 1990) was used to measure sport-related attributions. This scale presented 10 hypothetical situations (five positive and five negative). The positive and negative situations corresponded to each other and were matched for content ("The coach compliments/criticizes your performance"). Participants were asked to vividly imagine themselves in each situation and state what they believe would have been the single most likely cause of the given event. Then, participants were asked to rate their answer on a seven-point scale with five attributional dimensions: internality (internal vs. external), stability (stable vs. unstable), globality (global vs. specific), controllability (controllable vs. uncontrollable), and intentionality (intentional vs. unintentional).[1] Based on previous research (e.g., Seligman et al., 1990; Martin-Krumm et al., 2003; Gordon, 2008), we totaled these scores separately for the negative and positive outcome situations providing separate composite scores for explanations of negative events ($\alpha = 0.72$) and positive events ($\alpha = 0.71$). Higher scores indicated internal, stable, global, controllable, and intentional attributions.

Self-reported self-handicapping tendencies, such as lack of effort, procrastination, and illness were assessed with the 14-item Self-Handicapping Scale (e.g., "I would do a lot better if I tried harder"; Rhodewalt, 1990). All items were assessed on a six-point scale ranging from "strongly disagree" (1) to "strongly agree"

[1]The participants were also requested to indicate on seven-point scales the importance and the vividness of the event. These are not attributional dimensions; therefore, we did not include these measures in the present analytic model.

(6). The SHS score ($\alpha = 0.74$) was formed by averaging the items; higher scores represented greater self-reported self-handicapping. Participants were asked to consider sport situations in connection with each item, indicating how strongly they agree with each statement.

Analytic Strategy

In this study, SPSS 22.0 was used to analyze the data. We first examined correlations between the main variables and then conducted hierarchical regression analysis. In Step 1, we entered the scores for perfectionistic striving and concerns into SPSS. In Step 2, sport-related attributions (i.e., separate composite scores for explanations of negative events and of positive events) were entered to identify unique variance beyond the two forms of perfectionism. Finally, to test the hypothesis that attributions mediate the relationship between perfectionism and self-handicapping, we used the bootstrapping method recommended by Hayes (2017) to obtain bias-corrected 95% bootstrap CI for the indirect effects (Model 4).

RESULTS

Zero-Order Correlations

Table 1 provides the descriptive statistics and correlations for each research variable. Self-handicapping showed a significant, positive correlation with perfectionistic concerns. On the other hand, the zero-order correlation was non-significant between self-handicapping and perfectionistic striving. In addition, self-handicapping displays a significant, positive correlation with the composite score for explanations of negative events, thus indicating that self-handicapping was associated with internal, stable, global, controllable, and intentional attributions for the negative events. Furthermore, perfectionistic concerns show a significant, positive correlation with both composite scores (i.e., explanations of negative and positive events). Participants characterized by high level of perfectionistic concerns tend to make internal, stable, global, controllable, and intentional attributions regardless of the valence of the event outcome (i.e., positive or negative situation). There was a nonsignificant association between the two types of perfectionism. Additionally, there was a significant correlation between the explanations of negative and positive events.

Regression Analysis

Multicollinearity (indicated by VIF > 10 and/or tolerance < 0.10) was not detected in the regression analysis (Myers, 1990). Perfectionistic concerns were a significant, positive predictor of self-handicapping, whereas perfectionistic striving was a significant, negative predictor of self-handicapping in both Step 1 and Step 2, which supports our hypotheses. After the sport-related attributions were added to the model in Step 2, the standardized betas of perfectionistic concerns and striving weakened but remained significant. In Step 2, the composite score of the explanations for negative events was a significant predictor of self-handicapping: those participants who adopted internal, stable, global, controllable, and intentional attributions for the negative events were more likely to show self-handicapping tendencies. Similarly, the explanations for positive events was a significant negative predictor of self-handicapping: those participants who adopted internal, stable, global, controllable, and intentional attributions for the positive events were less likely to show self-handicapping tendencies (see **Table 2**).

Multiple Mediation Analysis

Bootstrapping (Hayes, 2017) was used in order to test the hypotheses that sport-related attributions mediate the relationship between the two forms of perfectionism and self-handicapping. To assess the independent indirect effects of these relationships, we used bootstrapping to obtain the bias-corrected 95% CI for the total indirect effects of both forms of perfectionism and the specific indirect effects of each mediator.

The total indirect effect of perfectionistic concerns *via* sport-related attributions on self-handicapping was non-significant, $b = 0.06$, $SE = 0.05$, 95% CI [−0.04, 0.16]. However, the scores for explanations of positive events and scores for explanations of negative events cancel each other out, leading to this non-significant total indirect effect (see Demming et al., 2017). In fact, both the composite score for explanations of negative events, $b = 0.16$, $SE = 0.07$, 95% CI [0.04, 0.30] and the composite score for explanations of positive events, $b = -0.10$, $SE = 0.06$, 95% CI [−0.23, −0.01] were significant mediators between perfectionistic concerns and self-handicapping. The total direct (unmediated) effect of perfectionistic concerns on self-handicapping, $b = 0.50$, $SE = 0.11$, 95% CI [0.28, 0.71], as well as the total effect, $b = 0.55$, $SE = 0.10$, 95% CI [0.35, 0.75] were

TABLE 1 | *Means*, *SDs*, and zero-order correlations ($N = 111$).

Measure	1. Self-handicapping scale	2. Perfectionistic concerns	3. Perfectionistic striving	4. Explanations of negative events	5. Explanations of positive events
1. Self-handicapping scale	–				
2. Perfectionistic concerns	0.34**	–			
3. Perfectionistic striving	−0.04	0.12	–		
4. Explanations of negative events	0.37**	0.35**	−0.06	–	
5. Explanations of positive events	0.12	0.39**	0.12	0.62**	–
Mean	41.62	2.44	3.86	107.83	108.26
SD	9.94	0.71	0.60	14.69	13.46

Explanations of negative events = composite score for explanations of negative events, Explanations of positive events = composite score for explanations of positive events.
***p < 0.01, two-tailed tests.*

TABLE 2 | Hierarchical regression analysis predicting self-handicapping.

	DV: Self-handicapping							
	Step 1				Step 2			
	β	*SE*	*β* 95% CI	*p*	*β*	*SE*	*β* 95% CI	*p*
Perfectionistic concerns	0.52	1.40	[4.94, 10.47]	<0.001	0.46	1.48	[3.95, 9.83]	<0.001
Perfectionistic striving	−0.27	1.75	[−8.56, −1.61]	0.01	−0.20	1.74	[−7.21, −0.29]	0.03
Explanations of negative events					0.34	0.07	[0.08, 0.38]	0.002
Explanations of positive events					−0.24	0.08	[−0.34, −0.02]	0.03
	Model summary				Model summary			
	$R^2 = 0.231$, $F(2, 106) = 15.62$, $p < 0.001$				$R^2 = 0.300$, $F(4, 106) = 10.91$, $p < 0.001$			

Explanations of negative events = composite score for explanations of negative events, Explanations of positive events = composite score for explanations of positive events. β, standardized coefficients.

significant (Sobel tests: $z = 2.24$, $p = 0.03$ for the negative events; $z = -0.42$, $p = 0.67$ for the positive events). The model is depicted in **Figure 1**.

The total indirect effect of adaptive perfectionism *via* sport-related attributions on self-handicapping was negative and significant, $b = -0.08$, $SE = 0.04$, 95% CI [−0.17, −0.01]. Examination of the bias-corrected 95% CI from 5,000 bootstrap samples revealed that the composite score for explanations of positive events was not a significant mediator, $b = 0.01$, $SE = 0.03$, 95% CI [−0.05, 0.07]. However, the composite score for explanations of negative events was, $b = -0.09$, $SE = 0.05$, 95% CI [−0.19, −0.01], which supports our hypothesis (see **Figure 1**). Both the total direct (unmediated) effect of adaptive perfectionism on self-handicapping, $b = -0.23$, $SE = 0.11$, 95% CI [−0.43, −0.02], and the total effect, $b = -0.31$, $SE = 0.11$, 95% CI [−0.52, −0.10] were significant (Sobel tests: $z = -0.63$, $p = 0.53$ for the negative events; $z = 0.92$, $p = 0.36$ for the positive events).

DISCUSSION

Athletes differ in their extents of self-handicapping across the dimensions of perfectionism, and their beliefs regarding negative sports events play a significant role in determining this. The purpose of this study was to examine a model linking self-handicapping with perfectionism through the mediation of attributional styles among elite athletes. The results showed significant relationships between the variables in the directions hypothesized. As it was expected, a positive relationship was found between perfectionistic concerns and self-handicapping, whereas there was a negative relationship between perfectionistic striving and self-handicapping. Preoccupation with avoiding mistakes (in contrast to approaching success) is a common base of both perfectionistic concerns and self-handicapping. By contrast, adaptive perfectionism is characterized by a desire to strive for excellence deriving from an approach motivational basis (Elliot and Church, 2003; Gucciardi et al., 2012; Burnam et al., 2014). Individuals that display characteristics of perfectionistic concerns may resort to self-handicapping due to the need to protect themselves against the threat of failure as a result of setting unattainable goals.

Our results showed that perfectionistic concerns were positively related to interpreting positive events as internal, stable global, controllable, and intentional. Similarly to previous studies (e.g., Harper et al., 2020), we found that perfectionistic concerns were positively associated with self-depreciating attributional style (internal, stable, global, controllable, and intentional) for negative events. This result can be a consequence of elevated self-blame that people with high level of maladaptive perfectionism experience (Stoeber and Janssen, 2011). Therefore—with using a composite score of attributions—we might see a strong sensitivity to both positive and negative feedback that can explain the self-depreciating attributions after negative feedback as well as the self-enhancing reactions to positive feedback. These results indicate that elite athletes with high perfectionistic concern could be particularly reliant on feedback and take them especially seriously irrespective of their direction. Perfectionistic striving and self-depreciating attributional style regarding negative events show an inverse relationship. This means that participants who scored higher on the adaptive aspects of perfectionism made less internal, stable, global, controllable, and intentional attributions for the negative events. This result supports previous findings showing that people with high perfectionistic striving tend to attribute failures in a self-favoring way (e.g., Levine et al., 2017). This kind of attributional style may lead to adaptive functioning in performance settings that is a characteristic of healthy perfectionistic individuals (Gould et al., 2002). Our results also support the theory of optimal illusions (Baumeister, 1989; see also Brown, 2014) showing that distorting the reality toward the positive end may lead to elevated well-being and more adaptive functioning.

According to our results, the relationship between both perfectionistic aspects and self-handicapping is partially mediated by the attributional style in connection with negative events. More specifically, those displaying internal, stable, global, controllable, and intentional attributions when presented with negative events were more likely to show self-handicapping tendencies; this kind of attributional style is particularly related to perfectionistic concerns. The same attributional style regarding positive events has been associated with perfectionistic concerns, but this was not found to be related to self-handicapping. This is partly in line with previous research (Rhodewalt, 1990; Anshel and Mansouri, 2005); however, it also broadens our theoretical and empirical understanding of the mediating role

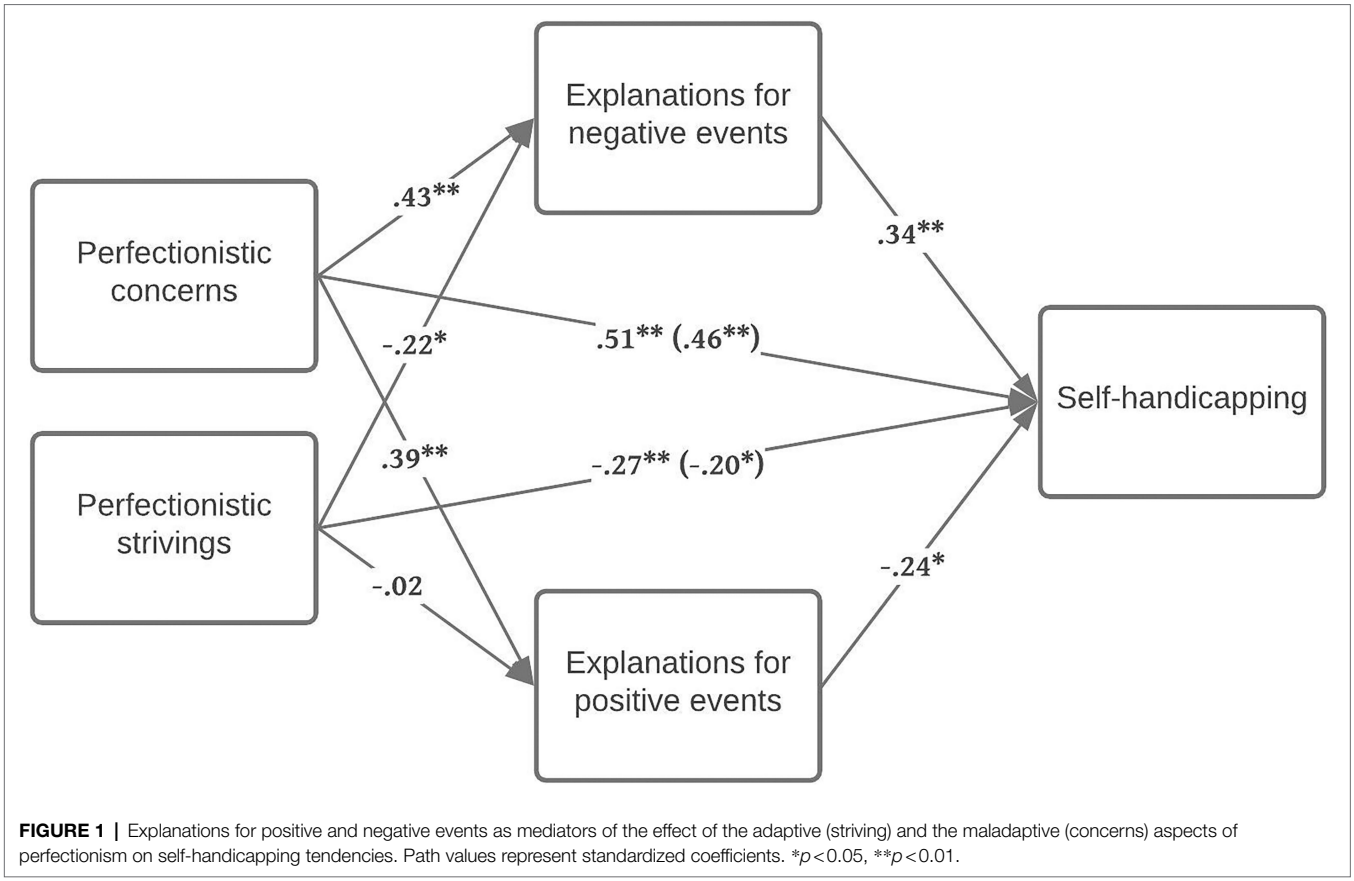

FIGURE 1 | Explanations for positive and negative events as mediators of the effect of the adaptive (striving) and the maladaptive (concerns) aspects of perfectionism on self-handicapping tendencies. Path values represent standardized coefficients. *$p < 0.05$, **$p < 0.01$.

of attributions between perfectionism and self-handicapping. Our results showed that explanations for negative events are crucial in connection with protecting oneself *via* self-handicapping among top athletes. Experiencing self-blame and rumination on failures deriving from excessively high standards may lead to punctual maladaptive attributions and chronic maladaptive attributional style in the long run regarding performance-events (Flett et al., 2002; Stoeber and Janssen, 2011; Harper et al., 2020). Since this kind of thinking poses a threat to one's self-esteem (e.g., fixed implicit theory of ability; Chen et al., 2008), it could result in more intense self-protection such as self-handicapping, leading to a vicious circle.

However, these findings may have some limitations. First, the constructs investigated in this study are self-reported in nature, thus it is not clear what role self-deception plays in these processes (Török et al., 2018). In the future, more objective methods (such as behavioral measures) could be employed. Second, the measure used for attributional styles is sport-specific, while the measures we implemented to assess perfectionism and self-handicapping were not specific to sports situations—although we asked participants to take into account sport-relevant situations while answering the questions. Future research should consider this factor since both constructs could differ across domains (Stoeber and Becker, 2008; Schwinger, 2013; Sellars et al., 2016). Third, although the sample size was special in terms of the level of the performers, it was numerously small. Therefore, further larger studies are required to confirm these results. It should also be noted that the results obtained in this study are based on correlational relationships, so further investigations are needed to clarify causal interpretations.

Nonetheless, the present findings have important implications in order to understand the processes involved with perfectionism and self-handicapping in sports. This study provides further support for the multidimensional nature of perfectionism by identifying adaptive and maladaptive correlates of the construct (Frost et al., 1993; Rice and Ashby, 2007; Hill et al., 2020). As a coach, it is crucial to maintain a comprehensive stance on perfectionism that considers its positive and negative aspects for individual athletes. Our results provide further support to prior studies demonstrating that attributional retraining techniques could be beneficial in achievement settings (Perry et al., 2010) such as sport (Rascle et al., 2008; Parkes and Mallett, 2011). Furthermore, the obtained results are based on a sample of top performing elite athletes, which is very sparse in the literature within this field (but see Gould et al., 2002; Kuczka and Treasure, 2005). The majority of the sample were top-level athletes including Olympic medalists and a world record holder. Interestingly, self-handicapping was clearly present even in this sample. It appears that the level of self-handicapping in our sample was relatively similar

to other samples (e.g., Ryska, 2002; Prapavessis et al., 2003; Allen, 2018, Unpublished manuscript[2]). Although, the most successful athletes from our sample, such as Olympic and World or European Championships medalists ($N = 30$) showed significantly lower self-handicapping ($M = 37.69$, $SD = 9.29$) compared to the rest of the sample ($M = 43.18$, $SD = 10.10$). Future research should consider perfectionism according to the 2×2 model of Gaudreau and Thompson (2010) and extend the current model with non-perfectionism (low in both adaptive and maladaptive aspects) and mixed perfectionism (high in both adaptive and maladaptive aspects) in order to gain a better understanding of these processes.

DATA AVAILABILITY STATEMENT

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

[2]Allen, J. (2018). Burnout, Motivation, and Self-Handicapping in Collegiate Club Athletes. Unpublished manuscript. Bowling Green State University, Bowling Green, USA.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Eotvos Lorand University, Faculty of Education and Psychology Institutional Review Board, 2018/413. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

LT and ZS contributed to the study design, literature review, and data gathering. LT, ZS, and GO contributed to the manuscript writing, data analysis, and interpretation. All authors contributed to the article and approved the submitted version.

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Coaching Servant Leadership: Scale Development and Validation

*Shohei Takamatsu**

Faculty of Education, Kobe Shinwa Women's University, Kobe, Japan

This study aimed to develop a valid and reliable scale for measuring coaching servant leadership in different contexts (Japan and the United States). First, potential items were collected in Japan using both deductive (i.e., literature review) and inductive (i.e., surveys among 103 coaches and 34 university students) approaches and narrowed down via content validity assessment by 10 experts. Next, quantitative studies were conducted to validate the scale's construct validity, among 936 high school athletes from Japan. Finally, the scale's applicability to the US context was demonstrated, among 278 university athletes in the US. The analyses resulted in a six-factor model with 17 items to assess coaching servant leadership behaviors: (1) acceptance; (2) shared vision; (3) empowerment; (4) dedication; (5) humility; and (6) winning second. In conclusion, this study developed a coaching servant leadership scale by applying both deductive and inductive approaches and deemed it applicable not only in Japan but also in the US. It is anticipated that future studies will examine the impact of coaching servant leadership on athletes in detail, with findings applied in practice for the development of coaches.

Keywords: servant leader, leadership, coach, scale development, athlete first, sport, high school, university

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***Correspondence:**
Shohei Takamatsu
takamatsu@kobe-shinwa.ac.jp

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INTRODUCTION

Fifty years have passed since Greenleaf (1970) introduced the servant leadership concept. Servant leadership is a leadership approach that promotes authenticity, focuses on supporting followers, and prioritizes maximization of followers' potential (Liden et al., 2015). According to Rieke et al. (2008), the leader is traditionally at the top of the "pyramid," with followers are expected to follow their directions; however, a servant leader inverts the pyramid and places themselves at the bottom of the hierarchy. In a servant leadership environment, followers are given clear roles, and the leader's job is to help them perform these roles (Rieke et al., 2008). Several researchers have developed scales to measure servant leadership: Eva et al. (2019), for example, reviewed 16 such measurement scales and clarified the antecedents, moderators, mediators, and outcomes of servant leadership by reviewing empirical studies on servant leadership. Many studies have focused on the business management field.

The sport domain has witnessed increasing interest in servant leadership. Sullivan (2019) highlighted several reasons for this, including the fact that many schools belonging to the National Collegiate Athletic Association (NCAA) have been punished for violations. Moreover, values have changed with the growth in the number of working millennials (i.e., those born between 1983 and 1994), and positive psychology, including the concept of wellbeing, has increased in popularity. Since the NCAA's core values include integrity and sportspersonship, respect, and inclusive cultures (Robinson et al., 2018), servant leadership—an other-centered approach that prioritizes followers'

needs, growth, and well-being—is considered to play a vital role. Hammermeister et al. (2008) examined the applicability of the revised servant leadership profile (Wong, 2004) in the sport domain. Although many similarities between business and sport have been acknowledged (Rieke et al., 2008), the unique servant leadership of coaches remains insufficiently examined (e.g., the servant leadership of coaches may be similar to the coaching philosophy of "athlete first, winning second"). Consequently, sport researchers have used instruments from different fields, and few studies have examined the specific effects of coaches' servant leadership (Hammermeister et al., 2008). Hammermeister et al. (2008), who examined a servant leadership scale consisting of three factors, highlighted the need for a new scale to explore other potential factors in coaching servant leadership. In developing a scale to measure coaches' servant leadership, the causal relationships between various concepts may be more specifically examined and compared according to culture and personal demographics. By clarifying the factors that constitute coaches' servant leadership, coaching that is implemented with the athlete's perspective in mind can be extended in practice. Therefore, this study aimed to develop a valid and reliable scale for measuring coaching servant leadership. First, leadership concepts that are similar to servant leadership (i.e., transformational leadership and authentic leadership) and servant leadership were reviewed, and four phases were identified to develop a scale.

LITERATURE REVIEW

Transformational Leadership

The transformational leadership concept is most frequently compared to servant leadership (Sullivan, 2019). According to Parris and Peachey (2012), Downton (1973) first mentioned transformational leadership, and Burns (1978) drew a distinction between transformational and transactional leadership in a political context. Bass (1985) then conceptualized this by applying transformational leadership to the organizational context. Transformational leaders encourage their followers to achieve substantial results and enhance their leadership capacity in the process (Bass and Riggio, 2006). Transformational leaders help followers develop by responding to their needs, empowering them, and aligning them with their goals and the goals of the organizations (Bass and Riggio, 2006). Bass's model (i.e., the Multifactor Leadership Questionnaire; MLQ) of transformational leadership consists of four I's (Bass, 1985): idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration. While Bass's model has primarily been used to evaluate transformational leadership (Van Knippenberg and Sitkin, 2013), it has been revised to MLQ-5X (Bass and Avolio, 1995), which comprises five factors: Idealized influence (attributed); idealized influence (behaviors); inspirational motivation; intellectual stimulation; and individualized consideration.

The MLQ has also been used in the sport domain since the 1990s (Doherty and Danylchuk, 1996) and has been applied in many studies (Charbonneau et al., 2001; Rowold, 2006; Lee et al., 2013; Price and Weiss, 2013; Kao et al., 2019). In addition to the MLQ, the Differentiated Transformational Leadership Inventory (DTLI; Hardy et al., 2010) has been widely used in the sport domain. This is because Callow et al. (2009) modified the DTLI for the sport context and found that it is composed of seven factors: individual consideration, inspirational motivation, intellectual stimulation, fostering acceptance of group goals and teamwork, high performance expectations, appropriate role model, and contingent reward. Callow's et al. (2009) DTLI is related to many constructs, mainly in the sport psychology field (Arthur et al., 2011; Smith et al., 2013; Vella et al., 2013; Cronin et al., 2015).

Although the idealized influence and intellectual stimulation aspects of transformational leadership are similar to those of servant leadership (Liden et al., 2008), the differences between transformational leadership and servant leadership has been highlighted by several researchers. For example, Parolini et al. (2009) focused on five points—the moral, focus, motive and mission, development, and influence distinctions—and identified the differences between transformational leadership and servant leadership. Specifically, they emphasized the difference between the moral disadvantage of transformational leaders' focus on organizational goals and the moral advantage of servant leaders' focus on their individual followers' needs. Graham (1991) also highlighted the positive and negative aspects of individualized consideration and intellectual stimulation that ensue when leaders neglect their followers' moral development. In brief, transformational leaders are motivated by organizational development, while servant leaders are motivated by their followers' growth. Regarding these differences, Van Dierendonck et al. (2014) empirically verified that servant leadership is significantly associated with the satisfaction of followers' psychological needs while transformational leadership is not.

Authentic Leadership

The conceptualization of authentic leadership by Luthans and Avolio (2003) and the detailed description of the components by Avolio and Gardner (2005) have been instrumental in the development of authentic leadership. Further refinements by Walumbwa et al. (2008) led to the most commonly used definition of authentic leadership (Banks et al., 2016) as "a pattern of leader behavior that draws upon and promotes both positive psychological capacities and a positive ethical climate, to foster greater self-awareness, an internalized moral perspective, balanced processing of information, and relational transparency on the part of leaders working with followers, fostering positive self-development (p. 94)." The authentic leadership questionnaire (ALQ) developed by Walumbwa et al. (2008) comprises four factors: self-awareness, relational transparency, internalized moral perspective, and balanced processing. Neider and Schriesheim (2011) supported the ALQ's construct validity and developed the authentic leadership inventory (ALI) based on Walumbwa's et al. (2008) theoretical framework and construct definitions. While few studies have examined authentic leadership in sport, ALQ has been used to verify the effects of head coaches' authentic leadership on athletes' psychological capital and team engagement (McDowell et al., 2018) and on athletes' autonomy, trust in their coach, enrollment, and commitment (Bandura and Kavussanu, 2018). Kim et al. (2017) applied ALI to examine the effect of head coaches'

authentic leadership on assistant coaches' psychological capital, job satisfaction, and life satisfaction.

Authentic leadership and servant leadership share several similarities. Lemoine et al. (2019) identified moral behavior and the enhancement of followers' personal growth as commonalities between the two. While both leadership styles positively impact followers, servant leaders are more strongly motivated to serve others (Sullivan, 2019). Authentic leaders are interested in self-awareness and self-coordination, while servant leaders focus on the interests of others (Lemoine et al., 2019). Being true to oneself is not entirely consistent with the nature of servant leadership. Authentic leaders may feel a strong sense of responsibility for developing their organizations rather than focusing on their followers' needs and development (Robinson et al., 2018).

Servant Leadership

The servant leadership approach consists of multiple dimensions (e.g., rational, relational, ethical, emotional, and spiritual) that empower followers to grow (Sendjaya, 2016; Eva et al., 2019). Greenleaf (2007) stated, "The servant-leader is servant first. It begins with the natural feeling that one wants to serve, to serve first. Then conscious choice brings one to aspire to lead" (p. 83). Servant leaders perceive the success not only of the organization but also of all their stakeholders as their moral responsibility (Greenleaf, 2002).

According to Eva et al. (2019), the existing research on servant leadership can be categorized into three phases. The first phase is the development of the concept by Greenleaf (1970) and Spears (1998). For example, Spears (1998) identified 10 characteristics of servant leadership: listening, empathy, healing, awareness, persuasion, conceptualization, foresight, stewardship, commitment to the growth of people, and building community. The second phase focuses on scale development and examines the relationship between servant leadership and other constructs. More scales have been developed for servant leadership scales than for other leadership styles (Laub, 1999; Page and Wong, 2000; Ehrhart, 2004; Barbuto and Wheeler, 2006; Liden et al., 2008; Sendjaya et al., 2008; Van Dierendonck and Nuijten, 2011). However, Eva et al. (2019) reviewed existing servant leadership scales in terms of Hinkin's (1995) scale development procedures (i.e., item generation, content adequacy assessment, questionnaire administration, factor analysis, internal consistency assessment, construct validity, and replication) and recommended the global servant leadership scale (SL-7; Liden et al., 2008), the servant leadership behavioral scale (SLBS-6; Sendjaya et al., 2008), and the servant leadership survey (SLS; Van Dierendonck and Nuijten, 2011), which implemented all of these procedures (see **Table 1**). Servant leadership research is currently entering its third phase, in which the focus has shifted toward the development of the theoretical model.

Hammermeister et al. (2008) surveyed collegiate athletes and developed the revised servant leadership profile for sport (RSLP-S), which consists of three factors: trust/inclusion, humility, and service. An overview of studies in which athletes assessed their coaches' servant leadership revealed that Rieke et al. (2008), Vidic and Burton (2011), Gillham et al. (2015), and Wang et al. (2021) all applied the RSLP-S. However, in the absence of studies that have followed procedures from item collection to scale development in the sport context, sport researchers have used various servant leadership scales developed for other contexts. For example, Peachey et al. (2018) and Lee (2019) used Ehrhart's (2004) single-factor scale. Lee et al. (2018) used Barbuto and Wheeler's (2006) scale, and Burton et al. (2017) used Van Dierendonck and Nuijten's (2011) scale. Since no robust measurement scales are currently in place in the sport domain, servant leadership research in the sport domain is considered to be in Phase 2, as Eva et al. (2019) have pointed out. In addition to servant leadership research targeting athletes, research on coaches (Dahlin and Schroeder, 2021; Robinson et al., 2021; Vinson and Parker, 2021) and employees of sport organizations (Megheirkouni, 2020; Svensson et al., 2021; Swanson et al., 2022) has also accumulated.

One of the major issues in servant leadership research is the lack of a definition (Eva et al., 2019). Since Greenleaf provided no clear definition, each researcher has used definitions and scales that align with their claims (Eva et al., 2019). Therefore, no consensus has been reached regarding the definition of servant leadership (Burton and Peachey, 2013). Eva et al. (2019) define servant leadership as "an (1) other-oriented approach to leadership (2) manifested through one-on-one prioritizing of follower individual needs and interests, (3) and outwards reorienting of their concern for self toward concern for others within the organization and the larger community (p.114)." This definition reflects the three characteristics that constitute servant leadership (i.e., motive, mode, and mindset). First, servant leaders are externally rather than internally motivated (Eva et al., 2019). Second, the servant leader mode reflects the perception that each follower is unique and has a different personality (Eva et al., 2019). Third, the servant leader mindset supports the growth of both followers and resources within the organization (Eva et al., 2019). Furthermore, servant leaders invest in the growth and wellbeing of others for the common good (Page and Wong, 2000) while promoting their followers' growth (Greenleaf, 2002), and providing services (Sendjaya, 2016). In the sport context (particularly, youth and college sport), "followers" are athletes, and the "common good" is considered to be the team's goal and purpose. Thus, in this study, coaching servant leadership is defined as an athlete-first approach to leadership that prioritizes athletes' needs and interests and serves them for a common goal of the team by investing in their growth and wellbeing.

While various scales have been developed by multiple researchers to measure servant leadership, Van Dierendonck (2011) identified six characteristics that constitute servant leadership based on a literature review: empowering and developing people, humility, authenticity, interpersonal acceptance, providing direction, and stewardship. Modifying the words to suit the sport context, each characteristic may be defined as follows (Van Dierendonck, 2011):

Empowering and developing people: motivation that focuses on enabling athletes, respecting them, and encouraging their growth.

Humility: the ability to put one's achievements and talents in an appropriate perspective and willingness

TABLE 1 | Three servant leadership scales recommended by Eva et al. (2019).

Authors	Name of scale	Number of factors and items	Factors	Sample
Liden et al. (2008)	Global servant leadership scale (SL-7)	7 factors (28 items)	Emotional healing Creating value for the community Conceptual skills Empowering Helping subordinates grow and succeed Putting subordinates first Behaving ethically	Two samples • University students • Company employees and supervisors
Sendjaya et al. (2008)	Servant leadership behavioral scale (SLBS-6)	6 factors (35 items)	Voluntary subordination Authentic self Covenantal relationship Responsible morality Transcendental spirituality Transforming influence	One sample • Graduate students
Van Dierendonck and Nuijten (2011)	Servant leadership survey (SLS)	8 factors (30 items)	Empowerment Accountability Standing back Humility Authenticity Courage Forgiveness Stewardship	Eight samples • Participants of the open online survey • Participants of the open online survey • High school teachers • Combined sample from diverse occupations • Participants of the open online survey • Participants of the open online survey • Employees at gas stations • Online panelists

to learn from others. It also demonstrates to athletes through words and actions that meeting their needs is a priority.

Authenticity: expressing oneself in line with one's thoughts and feelings and a commitment to honesty and self-responsibility.

Interpersonal acceptance: cognitive acceptance of athletes and demonstration of warmth and compassion.

Providing direction: possessing knowledge of the sport and coaching protocol and providing athletes with appropriate direction; creating new methods and approaches to old problems.

Stewardship: willingness to take responsibility and serve the team and athletes on behalf of one's self-interest. It also includes behavior that serves as a normative model for athletes.

Based on the above review, this study aimed to develop a coaching servant leadership scale in four phases following Hinkin's (1995) guidelines. In Phase 1, both deductive and inductive approaches were applied to collect items that potentially constitute coaching servant leadership. In Phase 2, the items' content validity was examined using Lawshe's (1975) content validity ratio. When Phases 1 and 2 were conducted, the items were categorized based on Van Dierendonck's (2011) classification and definitions. Phase 3 included exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to determine the factor structure of the measurement scale and to examine its fit with the data. Construct validity was further tested by assessing convergent validity, discriminant validity, and criterion-related validity. In Phase 4, the coaching servant leadership scale was replicated in another country (i.e., the United States) to enhance its generalizability.

METHODS

Item Generation (Phase 1)

The inductive ten-statement testing method was applied with reference to Ito and Walker (2014) and Laub (1999). Ito and Walker (2014) asked "What is leisure?" and required participants to complete ten statements to collect leisure-related data. Laub (1999) asked participants "What do you judge to be the characteristics of a servant leader?" and had them identify ten characteristics. In the present study, the participants were asked, "What characteristics of a coach do you judge to indicate that they are a servant leader?" The participants consisted of 103 coaches and 34 university students who majored in sport pedagogy, sport psychology, or sport management at the author's university. The coaches were surveyed by the online survey panelists of a major survey company in Japan. Of the coaches' sample, 80.6% of the respondents were male (female = 19.4%) and their average age was 42.6 years ($SD = 13.1$).

For the deductive approach, items were collected from previous studies (Liden et al., 2008; Sendjaya et al., 2008; Van Dierendonck and Nuijten, 2011) recommended by Eva et al. (2019) and the previous study (Hammermeister et al., 2008) that have been shown to be applicable to sport. The statements obtained from both approaches were classified based on the six characteristics proposed by Van Dierendonck (2011). An expert review was conducted by the author and two doctoral students specializing in leadership and repeated until a consensus was reached.

Content Adequacy Assessment (Phase 2)

To test the content validity of the items obtained in Phase 1, the content validity ratio (CVR) was calculated using responses

from the experts following the method used by Lawshe (1975) and Grant and Davis (1997). The panel experts consisted of one associate professor, one assistant professor, and eight doctoral students. They were explained the definitions of servant leadership and the six characteristics by the author, and rated how well each item represented the characteristics using a four-point scale from 1 (it is not appropriate to measure this characteristic on this item) to 4 (it is appropriate to measure this characteristic on this item). The CVR value can range from −1 to +1, and a value of 0 means that half of the respondents rated the item as necessary. If the number of respondents is 10, a minimum CVR of 0.62 is required to satisfy the five percent level (Lawshe, 1975).

Factor Analysis and Construct Validity Testing (Phase 3)

The sample for Phase 3 was assembled by online survey panelists from a survey company in Japan. A total of 936 high school athletes belonging to high school athletic clubs participated in the survey. In the screening prior to the survey, the participants were confirmed as members of their high school athletic clubs, with head coaches who coached them regularly. The mean age of the sample was 16.8 years ($SD = 0.87$; 36.4% male and 63.6% female). Sports comprising more than 5% of the sample included basketball ($n = 124$), soccer ($n = 90$), volleyball ($n = 86$), track and field ($n = 79$), badminton ($n = 77$), baseball ($n = 53$), and tennis ($n = 48$).

The sample was randomly split into two datasets to conduct EFA and CFA. As a general rule when conducting EFA, the sample size required is five to seven times the number of variables to be analyzed (Hair et al., 2010; Terwee et al., 2012). In this study, considering the number of samples obtained, the ratio was set at 7:1. Thus, the first dataset ($n = 518$) was used for EFA and the second ($n = 418$) was used for CFA. In the EFA, the appropriateness of factor analysis was examined based on two criteria: the Kaiser–Meyer—Olkin sampling statistic (KMO) and Bartlett's test of sphericity (BTS). According to Hair et al. (2010), the KMO value ranges from 0 to 1 and is close to 1 if each variable is predicted without errors associated with other variables: a value of 0.80 or above is considered meritorious. The BTS shows the statistical significance of significant correlations between several variables in the correlation matrix. EFA was conducted using maximum likelihood estimation with the promax rotation method.

For CFA, based on Kline's (2016) recommendation, the model fit was evaluated using the following fit indices: the normed chi-square (χ^2/df), comparative fit index (CFI), root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), and Akaike information criterion (AIC). According to Hair et al. (2010), χ^2/df ratios of 3:1 or less are associated with a better-fitting model; CFI values above 0.90 are associated with a model that fits well; RMSEA values of <0.08 are considered good; and SRMR values of 0.08 or less are associated with a good fit. Convergent validity was also confirmed based on the criteria that construct reliability (CR) is 0.70 or more and average variance extracted (AVE) is 0.50 or more. Discriminant validity was examined by comparing each factor's AVE and the square of the correlation between factors.

Of the 936 respondents, 687 proceeded to the next survey; that is, the data for the items on coaching servant leadership and the other variables used to test criterion-related validity were obtained from separate surveys. Hinkin (1998) suggested that criterion-related validity can be confirmed by examining the relationships between new measures and other variables that are theoretically correlated with them. In a review of existing research, Eva et al. (2019) identified behavioral outcomes (e.g., organizational citizenship behavior), attitudinal outcomes (e.g., commitment), leader-related outcomes (e.g., trust in the leader), and performance outcomes (e.g., team performance) as outcome variables of servant leadership. Team citizenship behavior (Martínez, 2013; Martínez and Tindale, 2015), team commitment (Kim et al., 2016), satisfaction with a head coach (Myers et al., 2011), and team efficacy (Bruton et al., 2016) were examined with respect to their relationships in the sport context. Team citizenship behavior was measured using 13 items (e.g., "I encourage other teammates when they are down;" $\alpha = 0.82$); team commitment was measured using five items (e.g., "I would be very happy to spend the rest of my school years with this team;" $\alpha = 0.79$), satisfaction with a head coach was measured using three items (e.g., "How much do you like playing for your coach?;" $\alpha = 0.83$), and team efficacy was measured using one item (i.e., "Rate your team's confidence in their ability to perform to a high level sufficient to achieve success in their next competitive performance"). The participants scored all variables except team efficacy on a seven-point Likert scale; team efficacy was rated on a scale between 0 (not at all confident) and 100 (completely confident). The analyses were conducted using IBM SPSS Statistics 24 and IBM SPSS Amos 24.

Replication in Another Country (Phase 4)

In Phase 4, an online survey was conducted in the United States among 278 athletes (113 males and 165 females) who belonged to an athletic club at a university. They ranged in age from 18 to 25 years (mean = 20.80 ± 1.83 years), and were freshmen ($n = 42$, 15.1%), sophomores ($n = 62$, 22.3%), juniors ($n = 76$, 27.3%), seniors ($n = 93$, 33.5%), or fifth-years ($n = 5$, 1.8%). Their teams belonged to the National Collegiate Athletic Association (NCAA) ($n = 163$), the United States Collegiate Athletic Association (USCAA) ($n = 32$), the National Junior College Athletic Association (NJCAA) ($n = 27$), the National Association of Intercollegiate Athletics (NAIA) ($n = 18$), and others. They also participated in Division 1 ($n = 87$), Division 2 ($n = 135$), and Division 3 ($n = 56$). Sports that comprised more than 5% of the sample included basketball ($n = 70$), soccer ($n = 38$), indoor volleyball ($n = 29$), football ($n = 25$), and tennis ($n = 18$).

Coaching servant leadership was measured using 17 items obtained from the results of Phase 3. Since the surveys in Phase 3 were conducted in Japanese, a back-translation procedure was performed before proceeding to Phase 4. First, the author translated the measurement items into English. Second, another researcher in leadership—a native speaker of Japanese who is fluent in English—translated them from English into Japanese.

Finally, the original and translated items were examined separately by a professional translator who is a native speaker of Japanese and a native speaker of English, and the linguistic validity was confirmed.

RESULTS

Item Generation (Phase 1)

The items were collected using both a deductive (i.e., literature review) and inductive (i.e., surveys on coaches and university students) approach, and 844 statements were extracted, removing items with overlapping meanings unrelated to servant leadership. The 98 items obtained were grouped and classified into Van Dierendonck's (2011) six categories (see **Figure 1**).

Content Adequacy Assessment (Phase 2)

To test content validity, the CVR was calculated based on the ratings of 10 panel experts. The criteria were not satisfied by 24 items, which were deleted. The wording of some items was modified, and two items were moved from "providing direction" to the "stewardship" category based on the panel experts' comments. At this point, 74 items were judged to be conceptually valid.

Factor Analysis and Construct Validity Testing (Phase 3)

The EFA was conducted on dataset 1. First, the KMO (KMO = 0.96) and the BTS ($p < 0.001$) met the criteria, demonstrating the samples' appropriateness in dataset 1 for EFA. Next, based on Van Dierendonck's (2011) classification, the number of factors was fixed at six, and EFA was conducted using maximum likelihood estimation with the promax rotation method. Items with a minimum factor loading of <0.5 and for which the difference in factor loadings between the two factors was <0.2 were considered for deletion (Ferguson and Cox, 1993; Hair et al., 2010). Since the analysis was exploratory, strict criteria for item selection were deemed appropriate to create an efficient and reliable scale for use in this study and in future studies. The final factor analysis resulted in six factors with 17 items and explained 80.1% of the total variance. Each factor was named and defined as follows: acceptance (accepting athletes and creating an environment that facilitates communication; four items; $\alpha = 0.95$), shared vision (sharing the team's goals with the athletes and providing them with clear direction; three items; $\alpha = 0.92$), empowerment (drawing out the athletes' potential and encouraging their growth; three items; $\alpha = 0.92$), dedication (prioritizing the athletes over oneself; three items; $\alpha = 0.92$), humility (having the willingness to learn from others without overestimating oneself; two items; $\alpha = 0.80$), winning second (being respectful to all involved in sport and contributing to the character building of athletes; two items; $\alpha = 0.90$). The items, factor loadings, and descriptive statistics for coaching servant leadership are presented in **Table 2**. These 17 items across six factors were subject to CFA in dataset 2.

To test whether the factor structure obtained by the EFA fit the data, CFA was conducted using dataset 2 (see **Table 3**). First, a one-factor model with all items loaded on one factor was tested. The chi-square was 1190.15, $df = 119$, $\chi^2/df = 10.00$, CFI = 0.85, RMSEA = 0.15, SRMR = 0.05, AIC = 1,258.15. Next, the six-factor first-order model was tested and showed a satisfactory fit: $\chi^2 = 246.85$, $df = 120$, $\chi^2/df = 2.06$, CFI = 0.98, RMSEA = 0.05, SRMR = 0.02, AIC = 348.852. Comparison of the one-factor and six-factor first-order models revealed that the six-factor first-order model was reasonable for the coaching servant leadership scale [$\Delta\chi^2(\Delta df) = 943.30(1)$, $p < 0.001$].

The convergent and discriminant validity of the six-factor first-order model was examined. As presented in **Table 4**, all standardized factor loadings were above 0.70, ranging from 0.77 to 0.92. The CR ranged from 0.84 to 0.94, and the AVE ranged from 0.72 to 0.81 within each factor. Thus, convergent validity was established. Furthermore, comparing the AVE scores with the squared correlations between the two factors indicated that all factors exhibited discriminant validity (see **Table 5**). However, since highly correlated latent factors were found, the six-factor first-order and six-factor second-order models were compared. As **Table 3** illustrates, the six-factor second-order model exhibited an adequate fit: $\chi^2 = 271.02$, $df = 113$, $\chi^2/df = 2.34$, CFI = 0.98, RMSEA = 0.06, SRMR = 0.03, AIC = 351.021. The first-order factors loaded significantly on the second-order factor ($p < 0.001$) and ranged from.87 to.92. Although no significant difference emerged in the $\Delta\chi^2$ test, the six-factor first-order model showed a slightly better fit to the data than the six-factor second-order model. Even if the second-order factor model could effectively explain the model, it would not show a better fit than the first-order factor model (Marsh and Hocevar, 1985). Earlier studies tended to explain servant leadership using a second-order factor model (Sendjaya and Cooper, 2011; Zhang et al., 2016), and since the factor correlations in this study were also high, a second-order factor model was considered better for explaining coaching servant leadership.

To test criterion-related validity, the correlations between each coaching servant leadership variable and the four outcome variables were calculated (see **Table 6**). The results indicated that all coaching servant leadership variables were correlated with four outcomes. Satisfaction with a head coach showed the strongest relationship, with correlations ranging from 0.60 to 0.69. Thus, the criterion-related validity of the coaching servant leadership scale was confirmed.

Replication in Another Country (Phase 4)

The scale's generalizability was tested via CFA among university athletes in the United States. Since the second-order factor model was confirmed appropriate in Phase 3, CFA was performed with coaching servant leadership as the second-order factor and indicated that the overall fit of the six-factor second-order model was satisfactory: $\chi^2 = 192.85$, $df = 113$, $\chi^2/df = 1.71$, CFI = 0.97, RMSEA = 0.05, SRMR = 0.04. The first-order factors loaded significantly on the second-order factor ($p < 0.001$) and ranged from 0.76 to 0.94. The standardized factor loadings from the first-order factors to the observed variables ranged from 0.63 to 0.87. The CR for each first-order factor ranged from 0.74 to 0.84. Next, the $\Delta\chi^2$ test was performed to compare the six-factor second-order model with the one-factor model. The test revealed that the six-factor second-order model was superior to the one-factor model [$\Delta\chi^2(\Delta df) = 164.95(6)$, $p < 0.001$].

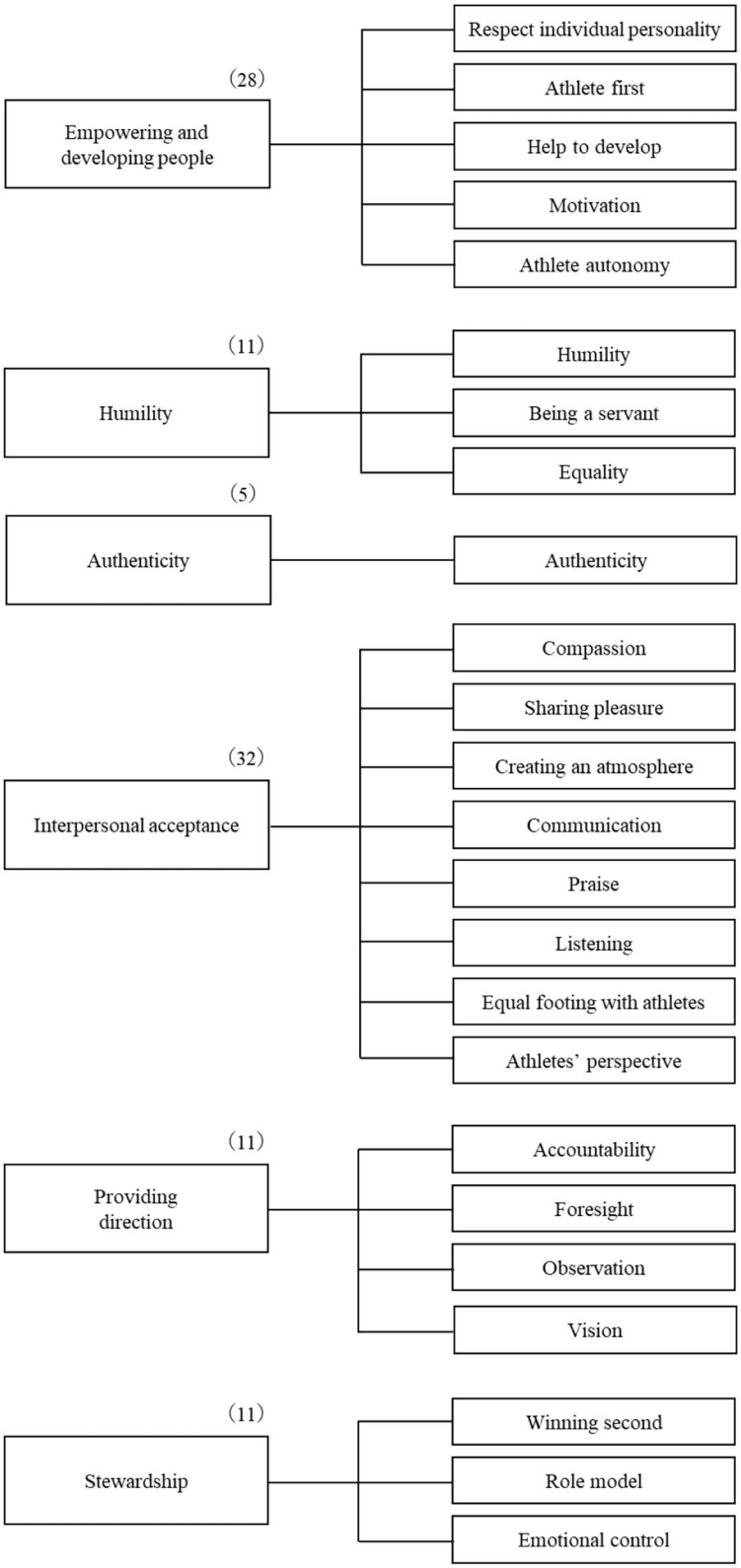

FIGURE 1 | Classification of qualitative data based on the six categories proposed by Van Dierendonck (2011). Each number in parentheses indicates the number of items collected.

TABLE 2 | Results of exploratory factor analysis and descriptive statistics.

	1	2	3	4	5	6	Mean	SD	Skewness	Kurtosis
Acceptance (α = 0.95)										
My head coach makes it easy for athletes to communicate with him/her (A1)	**0.98**	0.05	0.05	−0.11	−0.02	−0.03	4.24	2.06	−0.23	−1.24
My head coach can see things from the athletes' perspective (A2)	**0.76**	0.09	0.11	−0.06	−0.04	0.08	4.39	2.04	−0.35	−1.11
My head coach finds time to listen to the athletes' concerns (A3)	**0.68**	0.04	−0.01	0.21	0.02	0.03	4.57	1.97	−0.46	−0.96
My head coach proactively listens to the athletes' opinions (A3)	**0.67**	0.00	−0.03	0.18	0.08	0.07	4.60	2.01	−0.46	−1.00
Shared vision (α = 0.92)										
My head coach shares the athletes' goals (SV1)	0.15	**0.91**	−0.04	0.00	0.01	−0.11	4.86	1.99	−0.70	−0.70
My head coach understands the goals of the team (SV2)	0.04	**0.70**	−0.02	0.07	0.12	0.07	5.03	1.93	−0.88	−0.36
My head coach has a long-term vision for the team and not only short-term objectives (SV3)	−0.04	**0.68**	0.11	0.07	−0.07	0.17	4.95	1.93	−0.77	−0.53
Empowerment (α = 0.92)										
My head coach is aware of what limits the athletes' growth (E1)	0.12	0.02	**0.82**	0.03	0.01	−0.10	4.39	1.97	−0.37	−1.05
My head coach helps athletes realize their full potential (E2)	0.02	−0.02	**0.81**	−0.01	0.08	0.06	4.60	1.90	−0.50	−0.83
My head coach brings out the best in athletes (E3)	0.03	0.04	**0.68**	0.08	0.06	0.06	4.71	1.93	−0.59	−0.77
Dedication (α = 0.92)										
My head coach is happy to spend his/her private time helping the athletes practice (D1)	−0.12	0.25	0.01	**0.78**	−0.05	−0.01	4.76	1.93	−0.52	−0.85
My head coach puts the athletes' needs and interests ahead of his/her own (D2)	0.20	−0.08	−0.04	**0.77**	0.06	0.05	4.52	1.86	−0.39	−0.86
My head coach supports the athletes no matter what situation they are in (D3)	0.07	0.00	0.14	**0.75**	0.00	−0.01	4.66	1.87	−0.48	−0.80
Humility (α = 0.80)										
My head coach understands his/her weaknesses (H1)	−0.02	−0.02	0.01	−0.04	**0.80**	0.05	4.20	1.87	−0.20	−0.95
My head coach learns from criticism and failures (H2)	0.02	0.08	0.11	0.05	**0.68**	−0.05	4.48	1.90	−0.39	−0.91
Winning second (α = 0.90)										
My head coach values sportspersonship more than winning (WS1)	0.06	−0.01	−0.05	−0.02	0.05	**0.90**	4.77	1.96	−0.62	−0.77
My head coach provides athletes with opportunities to learn, even if there are no immediate results (WS2)	0.05	0.11	0.09	0.07	−0.04	**0.67**	4.94	1.90	−0.76	−0.51

Factor loadings > 0.50 are in boldface.

TABLE 3 | Summary of model comparisons.

Models	$\chi^2(df)$	χ^2/df	$\Delta\chi^2(\Delta df)$	CFI	RMSEA	SRMR	AIC
Six-Factor first-order	246.85(120)	2.06	–	0.98	0.05	0.02	348.852
Six-Factor second-order	271.02(113)	2.34	24.17(7)	0.98	0.06	0.03	351.021
One-Factor	1,190.15(119)	10.00	943.30***(1)	0.85	0.15	0.05	1,258.15

The six-factor second-order model and one-factor model are compared to the six-factor first-order model.
$^{***}p < 0.001$.

As with Phase 3, the correlation coefficients between the six coaching servant leadership variables and the four outcome variables were calculated to test criterion-related validity. Satisfaction with a head coach ($r = 0.37-0.60$), team citizenship behavior ($r = 0.49-0.59$), and team commitment ($r = 0.31-0.55$) were significantly related to each coaching servant leadership variable. While team efficacy was not significantly related to humility ($r = 0.11$), it was significantly related to all other coaching servant leadership variables ($r = 0.14-0.19$). Hence, the criterion-related validity of coaching servant leadership was demonstrated in a sample of university athletes in the United States.

DISCUSSION

This study aimed to develop and test a coaching servant leadership scale. First, a pool of items was generated using deductive (i.e., literature review) and inductive (i.e., surveys among coaches and university students) approaches. Next, the items were narrowed down for the initial analysis based on experts' assessment of content validity. Third, after several items were removed by EFA, CFA supported the six-factor structure, providing evidence of construct validity. Fourth, the scale's criterion-related validity was established as the relationships between each coaching servant leadership variable and the four outcome variables were confirmed. Finally, a survey was conducted among university athletes in the United States to enhance the scale's generalizability. Consequently, a coaching servant leadership scale consisting of six factors was developed.

Based on Van Dierendonck's (2011) classification, the study's findings supported the reliability and validity of the coaching servant leadership scale. This scale also corresponds to Page and Wong's (2000) conceptual framework for measuring servant leadership [i.e., character-orientation ("What kind of person is

TABLE 4 | Results of confirmatory factor analysis for the coaching servant leadership scale.

Factors	Items	FL	CR	AVE
Acceptance	A1	0.90	0.94	0.80
	A2	0.88		
	A3	0.89		
	A4	0.91		
Shared vision	SV1	0.91	0.93	0.81
	SV2	0.92		
	SV3	0.87		
Empowerment	E1	0.86	0.92	0.79
	E2	0.90		
	E3	0.90		
Dedication	D1	0.84	0.91	0.77
	D2	0.90		
	D3	0.90		
Humility	H1	0.77	0.84	0.72
	H2	0.92		
Winning second	WS1	0.85	0.85	0.74
	WS2	0.88		

FL, factor loadings; CR, construct reliability; AVE, average variance extracted.

TABLE 5 | Average variance extracted, correlations, and squared correlations.

	A	SV	E	D	H	WS
A	**0.80**	0.63	0.72	0.67	0.66	0.71
SV	0.79	**0.81**	0.66	0.60	0.54	0.70
E	0.85	0.81	**0.79**	0.68	0.64	0.66
D	0.82	0.77	0.82	**0.77**	0.68	0.56
H	0.81	0.73	0.80	0.82	**0.72**	0.51
WS	0.84	0.84	0.82	0.75	0.71	**0.74**

A, acceptance; SV, shared vision; E, empowerment; D, dedication; H, humility; WS, winning second.
Bold values in diagonal are the average variance extracted; values below the diagonal are correlations; values above the diagonal are squared correlations.
All correlations significant $p < 0.001$.

TABLE 6 | Correlations between coaching servant leadership and outcome variables.

	S	TCB	TC	TE
Acceptance	0.69***	0.46***	0.32***	0.31***
Shared vision	0.67***	0.43***	0.34***	0.37***
Empowerment	0.69***	0.43***	0.36***	0.35***
Dedication	0.62***	0.44***	0.29***	0.34***
Humility	0.60***	0.33***	0.27***	0.27***
Winning second	0.62***	0.46***	0.30***	0.27***

S, satisfaction with a head coach; TCB, team citizenship behavior; TC, team commitment; TE, team efficacy.
****$p < 0.001$.*

the leader?"), people-orientation ("How does the leader relate to others?"), task-orientation ("What does the leader do?"), and process-orientation ("How does the leader impact organizational processes?")]. Specifically, dedication and humility are included in character-orientation. Character-orientation concerns the development of a servant's attitude, focusing on the leader's values, credibility, and motivation (Page and Wong, 2000). A servant leader puts their accomplishments and talent into appropriate perspective and is willing to learn from others' expertise (Van Dierendonck, 2011). A servant leader also prioritizes the needs of others beyond their own and serves others to help them grow (Ehrhart, 2004; Liden et al., 2008). Those who are served are more likely to become servant leaders themselves (Greenleaf, 2007). Thus, humility and dedication are key factors in coaching servant leadership, both in terms of building the coach's own character and influencing athletes. Acceptance and empowerment correspond to people-orientation, which is related to the development of human resources. This concept focuses on how a leader relates to others and their commitment to developing them (Page and Wong, 2000). Van Dierendonck and Nuijten (2011) stated that acceptance is about empathy, which leads to high levels of relationship building. The core of servant leadership is its transformational influence on followers, which includes empowering them (Sendjaya et al., 2008). That is, a coach who implements servant leadership will warmly accept their athletes and create an environment conductive to communication. They can then motivate athletes to encourage their growth and autonomy. Shared vision overlaps with task-orientation, while winning second is related to process-orientation. Task-orientation focuses on leadership tasks and skills that are necessary for success. According to Page and Wong (2000), a servant leader engages the entire team in the process of creating a shared vision, encouraging each individual to apply their unique talents to achieve the vision autonomously. A shared vision also promotes teamwork (Page and Wong, 2000)—an essential element for sport teams. It can also be related to satisfying athletes' psychological needs and promoting athletes' intrinsic motivation, in accordance with self-determination theory (Deci and Ryan, 2002). Process-orientation focuses on the leader's ability to model and develop flexible, efficient, and open systems in the process of building an organization (Page and Wong, 2000). Winning second, one of the factors that constitute coaching servant leadership, appears to be unique to the sport field. This implies the need for an athlete-centered coaching philosophy and does not imply that striving to win is a bad thing. Coaches who are athlete-centered prioritize the athlete's physical and social development as well as their enjoyment (McGladrey et al., 2010). According to Walton ((n.d.)), John Wooden, the famous American basketball coach, derived his joy and happiness from the success of others. He said that he learned from Abraham Lincoln and Mother Teresa that "a life not lived for others is not a life." This statement accurately reflects the ideals of servant leadership.

The present study confirmed that the correlations between the coaching servant leadership factors were high, while the one-factor model showed a poor fit with the data. Therefore, the second-order model's fit with the data was as good as that of the first-order model. This result is consistent with earlier studies

(Liden et al., 2008; Sendjaya and Cooper, 2011; Van Dierendonck and Nuijten, 2011): the evidence demonstrates that coaching servant leadership is a hierarchical model that is captured by holistic and multi-dimensional constructs.

Criterion-related validity testing of the scale revealed significant positive correlations between each coaching servant leadership factor and the four outcome variables identified by Eva et al. (2019), with the exception of humility and team efficacy in the US sample. This result indicates that coaching servant leadership can be positively related to various psychological aspects of athletes. Existing research also reports that servant leader coaches have a more positive impact on athletes' satisfaction, intrinsic motivation, and mental skills than non-servant leader coaches (Rieke et al., 2008). Since servant leadership research in the sport domain lags behind business management, further research on its impact on athletes is recommended as an avenue for future study.

Practical Implications

This study's findings indicate several important practical implications that are beneficial to the coaching research and coaching scene. First, this study identified the factors of coaching servant leadership that positively impact athletes' growth and wellbeing. In addition to the servant leadership of coaches identified by Hammermeister et al. (2008), the identification of new factors in this study represents a major step forward in sport leadership research. As mentioned earlier, winning is not everything for athletes and sport teams. Although striving to win is not wholly bad, excessive emphasis on victory increases the likelihood that multiple ethical issues will arise. Servant leaders who focus on athletes reportedly contribute to the creation of an ethical climate in sport organizations (Burton et al., 2017). Thus, coaches are encouraged to refer to this scale as a means of learning about coaching servant leadership with the aim of applying it to developing athletes and building teams.

Second, the study revealed the relationships between coaching servant leadership and various athlete variables. This finding indicates that coaching servant leadership is likely to have a positive impact on athletes in actual sport settings. Servant leadership is viewed with concern partly based on the fear that it will produce mentally weak athletes, which has been empirically refuted by Rieke et al. (2008). It is anticipated that coaching servant leadership will improve coaching quality and provide coaches with opportunities to build good relationships with athletes.

Limitations and Future Research

Several limitations must be considered in interpreting the present study's results. First, an online survey was conducted to assemble a large sample of athletes. Although various data were obtained, these data may have been biased. Furthermore, since no multi-level data could be collected, team-level analysis was not possible. Future studies should collect samples at the team-level and apply multi-level analysis to examinations of coaching servant leadership. Moreover, it would be desirable to study not only youth and university sport but also athletes and coaches in other contexts, such as sport clubs. Second, although the study was preceded by as many careful procedures as possible, the present study alone does not necessarily verify that the coaching servant leadership scale, consisting of six factors and 17 items, is a robust instrument. Earlier servant leadership studies have reconsidered the number of factors and developed short forms (Liden et al., 2015; Sendjaya et al., 2019). Further research may be required to examine and refine this matter.

In conclusion, the present study is the first in the sport domain to apply both deductive and inductive approaches to generate items and develop a coaching servant leadership scale. The scale's applicability was confirmed not only for Japan but also for the United States. This finding contributes considerably to servant leadership research in the sport domain. The accumulation of future research, including empirical examination of the theoretical models and their application to coaching practice, is anticipated.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Research Ethics Board of Kobe Shinwa Women's University. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Gender Differences in the Relationships Between Coach Transformational Leadership and Player Satisfaction and Commitment: A Meta-Analytic Review

Hyun-Duck Kim[1] *and Angelita Bautista Cruz*[2]*

[1] Department of Sport Marketing, Keimyung University, Daegu, South Korea, [2] Department of Physical Education, Keimyung University, Daegu, South Korea

This study meta-analyzed the relationships between coach transformational leadership and player satisfaction and commitment. We also examined the potential moderating effect of player gender on these relationships. In total, 182 effect sizes were obtained from 26 studies comprised of 6,715 participants. The analyses revealed that the overall direct effect of transformational leadership was moderate on both athletic satisfaction and exercise commitment. The effect of charismatic construct of transformational leadership was moderate on athletic satisfaction as well as exercise commitment. Finally, player gender was found to moderate the effects of the relationship between transformational leadership and athletic satisfaction and exercise commitment of players. Specifically, female players' satisfaction and commitment were more positively affected by transformational leadership compared with their male counterparts. Our findings suggests that effective leadership in sports is dependent on the interaction among leadership behaviors of the coach, personal characteristics of the players, and situational factors and highlights the importance of transformational leadership as an important requirement for creating a more positive and sustainable sports environment.

Keywords: MLQ, exercise commitment, athletic satisfaction, sustainable coach leadership, coach-athlete interaction, gender dyad

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Fraser Carson, LUNEX University, Luxembourg

***Correspondence:**
Angelita Bautista Cruz
angelitabautistacruz@gmail.com

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INTRODUCTION

Studies on sports leadership have been ongoing for the past several decades because the complexities and multifaceted components of sports can have profound implications on the athletic participation of players or teams (Gilbert and Trudel, 2004; Weinberg and Gould, 2015; Kim and Cruz, 2016; Turnnidge and Côté, 2018; Sheehy et al., 2019; Evans and Pfister, 2021; Michalski and Lee, 2021). In a sports environment, coaches are sports leaders with diverse functions for achieving the desired goals, objectives, and performance pursuits of a player or team (Weinberg and Gould, 2015). These functions are not restricted to imparting technical and tactical knowledge, but also extend to offering support, motivation, and encouragement to players, advocating high performance expectations,

and displaying the integrity and proper conduct fitting of a coach (Morton et al., 2014). This behavior, when perceived by players, is believed to affect their sport-related cognition and performance (Price and Weiss, 2013; Stenling and Tafvelin, 2014; Bormann et al., 2016; Kim and Cruz, 2016; Cheval et al., 2017; Ekstrand et al., 2018). It is therefore imperative to understand how leadership behaviors displayed by sports coaches relate to player cognitive and behavioral responses in order to identify which coaching behaviors promote or undermine sport-related outcomes in players. Identifying the degree on how leadership behaviors of coaches affect players' sport-related outcomes can facilitate the creation of appropriate intervention programs related to coach leadership development.

Sports coaches are generally recognized as leaders in sports that can spearhead players to reach their maximum potential in achieving sports success. In contrast, coaches as a leader can also be a potential factor influencing players' poor performance. Accordingly, researchers in the area of sports leadership are continuously investigating the process of how leadership of coaches influence sport-related outcomes of players. Leadership in sports is commonly explained with the Chelladurai's multidimensional model of leadership (MML) (1990). The MML is a leadership framework specifically developed for sports and physical activity, which suggests that the satisfaction and performance of players are dependent on coaches' leadership behaviors, and these behaviors are determined by three variables: the situation, leader, and member (Chelladurai, 1990). To measure leadership behaviors following this framework, the Leadership Scale for Sport (LSS) (Chelladurai and Saleh, 1980) was developed to evaluate a coach's training and instruction, decision-making style, and motivational behaviors in a sporting environment. Based on the results of leadership studies following this perspective, satisfaction and performance were indeed found to be associated with coach leadership behavior (Aoyagi et al., 2008; Prati and Pietrantoni, 2013; Kao et al., 2015; Kim and Cruz, 2016). Other consequences of leadership have also been found to be affected by leadership behaviors, such as cohesion (Kim and Cruz, 2016; Nascimento-Junior et al., 2018), motivation (Amorose and Horn, 2000; DoYoung et al., 2010), and commitment (Im et al., 2012; Berestetska, 2016). The results from these studies provide evidence supporting the MML framework in explaining effective leadership in a sporting context, particularly in understanding the leadership styles and behaviors of coaches, which affect player athletic participation.

Recently, the transformational leadership perspective has been applied to the sports context by researchers to understand leader effectiveness in sports. Transformational leadership is a leadership perspective adopted from organizational psychology (Bass, 1985, 1990, 1997; Bass and Riggio, 2006) that posits that the impact of leaders on follower motivation, morality, and performance is based on how the leader demonstrates transformational leadership. Transformational leadership has four interrelated components: (1) idealized influence, also referred to as charisma, which describes the leader's positive charisma that fosters trust and confidence in followers and leader's values that emphasize commitment to the organization's goals, (2) inspirational motivation, which refers to a leader's capacity to inspire followers to achieve their fullest potential and to properly communicate the importance of each follower's role in the successful operation of organizational goals, (3) intellectual stimulation, which refers to a leader's ability to encourage creativity and develop independent thinking in followers, and (4) individualized consideration, which relates to a leader's rapport and compassion for follower needs and concerns (Bass, 1997; Antonakis et al., 2003; Rowold, 2006). Moreover, this leadership perspective provides additional contribution to the influence of transactional leadership, which describes a leader's use of positive reinforcement (e.g., rewards or praise) when a follower performs desirable or positive behaviors and a leader's observant behaviors in recognizing any deviances from the set rules and regulations and taking immediate actions to correct them (Bass, 1997). The application of this leadership perspective in the sporting context was first introduced by Zacharatos et al. (2000), who were later followed by other researchers (Jang and Kim, 2008; Kim and Won, 2012; Choi, 2017; Kim et al., 2018; Sun and Lee, 2019).

In order to understand the concepts explaining transformational leadership, a measurement tool was developed called the Multifactor Leadership Questionnaire (MLQ-5X) (Bass and Avolio, 2000). The MLQ-5X is a widely used instrument to assess transformational leadership behaviors (Lowe et al., 1996; Rowold, 2006; Price and Weiss, 2013; Batista-Foguet et al., 2021; Kao et al., 2021; Malloy and Kavussanu, 2021). This instrument has nine factors: five on transformational leadership behavior, three on transactional leadership behavior, and one on laissez-faire leadership behavior.

The five transformational leadership factors are idealized influence-attributed, idealized influence-behavior, inspirational motivation, intellectual stimulation, and individualized consideration. Furthermore, the idealized influence and inspirational motivation factors of transformational leadership share similar concepts and are identified as charismatic dimensions of transformational leadership.

The three factors of transactional leadership are as follows: (1) contingent rewards, (2) active management by exception, and (3) passive management by exception. Contingent reward pertains to a leader's use of positive reinforcement (e.g., rewards or praise) when a follower performs desirable or positive behaviors. Active management by exception describes a leader's observant behaviors in recognizing any deviances from the set rules and regulations and taking immediate actions to correct them, whereas passive management by exception denotes the leader's actions to rectify mistakes only after the errors have been detected. Finally, laissez-faire is the most passive leadership approach, and has even been described as the absence of leadership (Antonakis et al., 2003; Rowold, 2006).

This MLQ instrument has been adopted in various sports setting to assess transformational leadership of coaches worldwide and findings showed that the psychological states of players can be affected by their coach's transformational leadership qualities (Cho and Ha, 2009; Eun, 2009; Hur, 2010; Lee et al., 2011; Seo, 2012; Choi et al., 2013; Lee and Yeo, 2013; Bum and Shin, 2015; Ryu and Park, 2021). In Korea for instance, charismatic and exceptional management behaviors among archery coaches significantly affect player commitment

to exercise (Ryu and Park, 2021). Jang et al. (2011) reported that the transformational leadership of coaches has a significant effect on taekwondo player commitment. Interestingly, they also found that player exercise commitment was substantially affected by their coach's transactional leadership behavior. Cho and Ha (2009) found that both idealized influence-attributes and behavior and inspirational motivation transformational leadership of coaches were positively associated with sport commitment in tennis players.

Aside from commitment, player's satisfaction was also found to be affected by transformational leadership of coaches. Kim et al. (2018) reported that the transformational leadership constructs individual consideration, inspirational motivation, and idealized influence were associated with the sports satisfaction of taekwondo athletes. Kim and Won (2012) demonstrated that individual consideration, idealized influence, and intellectual stimulation significantly predicted player satisfaction. Hur (2010) found that not only coaches' inspirational motivation but also their idealized influences in building collective identity (behavior), trust, and confidence (attributed) significantly predicted satisfaction among skiers. The results of these studies provide evidence not only of the positive association but also the mixed results of transformational leadership with sport-related psychological variables of satisfaction and commitment. Sports satisfaction describes a sport participant's positive emotional state based on the assessment of the structures, processes, and outcomes related to one's athletic experiences (Chelladurai and Riemer, 1997). Sports commitment, on the other hand, defines a player's desire to continue participating in sports (Scanlan et al., 1993). These psychological states are considered important sports variables and are frequently examined, as they can facilitate a sports participant's wellbeing and performance (Gillet et al., 2009; Vella et al., 2013; Stenling and Tafvelin, 2014; Kao and Tsai, 2016; Kim and Cruz, 2016; Contreira et al., 2019; Davis et al., 2021).

Overall, the results of these studies provide empirical evidence in understanding sport leadership following the transformational leadership approach as well as identifying how each construct of transformational leadership can influence the sport-related psychological outcomes of Korean players, particularly satisfaction and commitment. Being explicitly aware of this knowledge therefore is vital for sports coaches and practitioners to better predict coach effectiveness. Furthermore, how players respond to the behaviors displayed by coaches can serve as important information that should be considered when creating educational programs designed to optimize the leadership capabilities of coaches. Hence, recognizing which leadership behavior positively or negatively corresponds to player's psychological outcomes can help coaches create effective and tailored strategies that would develop higher levels of coach-player relationships leading to improve psychological states and even performance of players. However, with the numerous leadership studies conducted following the transformational leadership perspective in a sporting environment and using the MLQ to evaluate the leadership behaviors of coaches in Korea, it is surprising that no study has been conducted to consolidate these findings. Given that players' perceptions of satisfaction and commitment can be influenced by the leadership of coaches, it is therefore worth examining the overall strength of the association between transformational leadership behaviors and satisfaction and commitment and the relative strength of each dimension of transformational leadership on these two psychological outcomes by analyzing pertinent quantitative data using meta-analysis. Furthermore, in a previous meta-analysis that examined the relationship between coach leadership styles and two psychological variables that focused on a single instrument (the LSS), it was found that the effects of coach leadership styles and behaviors were large for women but small for men, suggesting a moderating role of the gender of players on the relationship between leadership behaviors and psychological outcomes (Kim and Cruz, 2016). Given these findings, it is plausible that the impact of transformational leadership behaviors on player satisfaction and commitment may also be moderated by gender of players and thereby warrants exploration.

Therefore, the aim of this study was to systematically review the Korean literature related to transformational leadership and to examine the relationships between transformational leadership and satisfaction and commitment. The following are the research questions of this study: (1) What are the overall effect sizes (ES) of the relationship between transformational leadership and satisfaction and commitment? (2) What are the ES of each construct of transformational leadership on the outcome variables?, and (3) What are the ES of the relationships between transformational leadership and the outcomes variables in male and female players?

METHODOLOGY

This meta-analysis was conducted in accordance with Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines (Panic et al., 2013). The meta-analysis method has been widely adopted by researchers from a variety of scholarly domains to combine findings obtained from studies on similar subjects (Glass, 1976; Dempfle and Loesgen, 2004; Ustunel et al., 2021). Meta-analysis is generally known as analysis of analyses (Glass, 1976). This method generates a general ES and confidence interval for the cumulative evidence resulting from the combination of two or more studies (Borenstein et al., 2021). Effect size is a statistical index that represents the degree of relation among study variables within the study (Hedges and Pigott, 2004; Borenstein et al., 2021). For this study, the random-effects model was adopted because it was assumed that the results of the selected studies were heterogeneous (Petitti, 2001).

Inclusion Criteria and Coding Data

A systematic search of Korean coaching leadership studies was carried out. To retrieve the literature for this analysis, searches were conducted in Google Scholar and Korean online library databases (i.e., KRpia, DPpia, KISS, and KOSSDA) using the keywords "coach," "coaching," "leadership," "sport(s)," "athlete/athletic satisfaction," "commitment," and their Korean equivalents. Once all the references were generated, the titles, keywords, abstracts, and full text versions were screened by

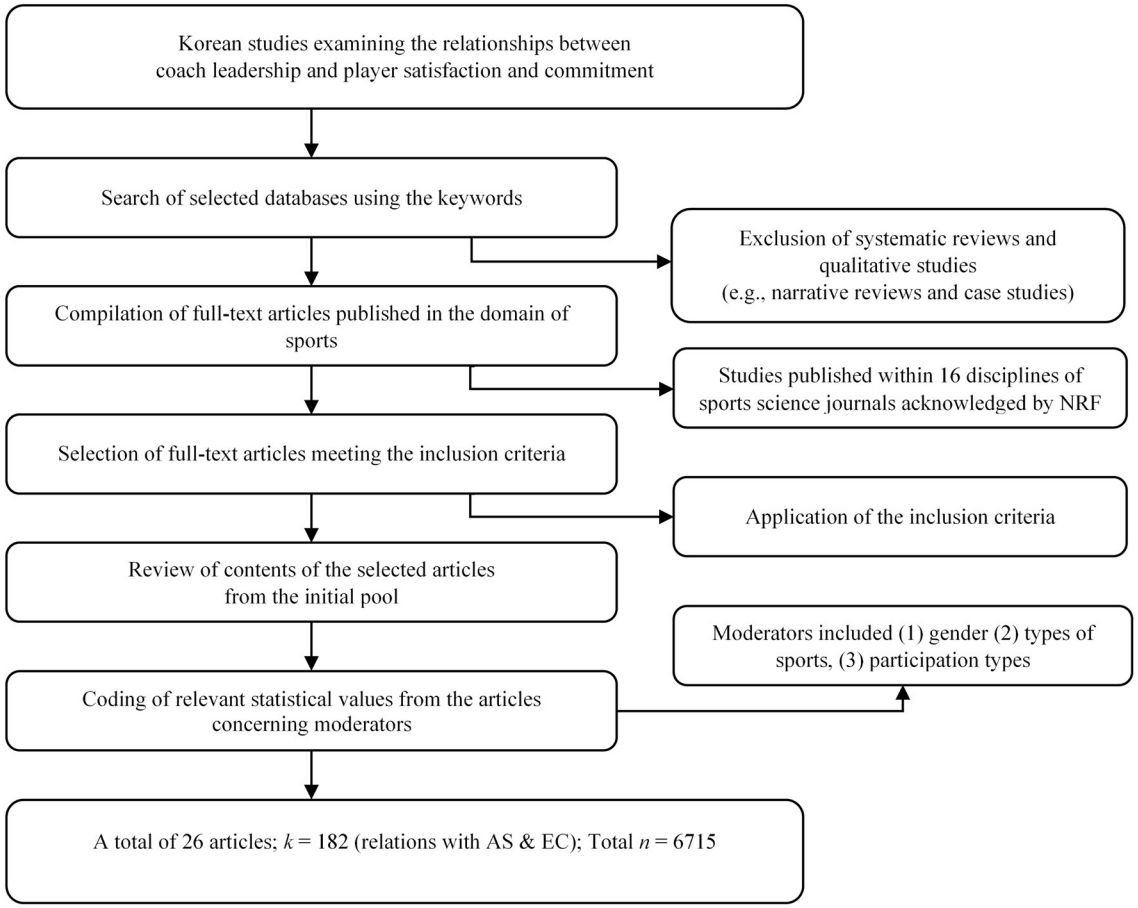

FIGURE 1 | Flow diagram of study selection process.

the authors. The criteria for inclusion of a study were as follows: (1) full-text articles examining the relationships among study variables (i.e., subdimensions of MLQ, satisfaction, and commitment); (2) studies with adequate sampling sizes and correlation coefficient scores to estimate the standardized ES; (3) studies verifying the gender ratio of sample as moderator. Those that did not contain prevalence data were excluded from the final analyses. At the end of the search and screening, 26 studies were collected from 6,715 samples (**Figure 1**).

Data Analysis

In this study, correlation-based ES classification was adopted to calculate the ESs, using Comprehensive Meta-Analysis Ver. 3.0. I^2 statistics were estimated to verify the proportions of inconsistencies across the selected studies that were not explained by random change, and Cochran's Q tests were performed to evaluate the heterogeneity among the underlying variables (**Supplementary Table 1**). For all meta-analyses, the significance level was set at 0.05, upon which the analyses were performed, and as significant heterogeneity was noted across the studies selected, the random-effects model was carried out as suggested by Borenstein et al. (2021). An ES $\geq$ 0.4 is interpreted as a large ES, 0.25–3.99 a moderate ES, and <0.25 as a small ES (Mayers, 2013).

RESULTS

The overall ESs of coach leadership behavior, as assessed with the MLQ, for each gender on player satisfaction and exercise commitment are summarized in **Table 1**.

There were 6,715 participants from 26 studies included in this meta-analysis. The studies selected all used the MLQ as a measurement tool (Bass and Avolio, 1997). The MLQ is the most widely accepted and validated psychologically sound measurement tool for verifying coach leadership behaviors in the field of Korean coaching science. According to the random-effects model, the overall ES of coach leadership behavior on player satisfaction was higher in women ($ES = 0.380$; 95% CIs $= 0.326, 0.431$; $k = 26$; $p = 0.05$) than in men ($ES = 0.293$; 95% CIs $= 0.227, 0.356$; $k = 40$; $p = 0.05$). For coach leadership behavior and exercise commitment, it was also found that the ES value of the women ($ES = 0.415$; 95% CIs $= 0.359, 0.468$; $k = 30$; $p = 0.05$) was higher than that of the men ($ES = 0.336$; 95% CIs $= 0.306, 0.367$; $k = 86$; $p = 0.05$) (**Table 1**). Q (i.e.,

TABLE 1 | Results of meta-analysis of the relationships between coach leadership behavior (MLQ) and player satisfaction and exercise commitment by gender.

	Gender	*k*	ES	−95%CI	+95%CI	*Q*	I^2
Player Satisfaction	Overall	66	0.337	0.277	0.394	330.500	87.800
	Male	40	0.293	0.227	0.356	512.629	92.392
	Female	26	0.380	0.326	0.431	148.388	83.152
Exercise Commitment	Overall	116	0.376	0.333	0.418	415.700	86.900
	Male	86	0.336	0.306	0.367	577.372	85.278
	Female	30	0.415	0.359	0.468	253.941	88.600

k, number of correlations; Q, the homogeneity statistics; CI, confidence intervals; ES, weighted random effect size.

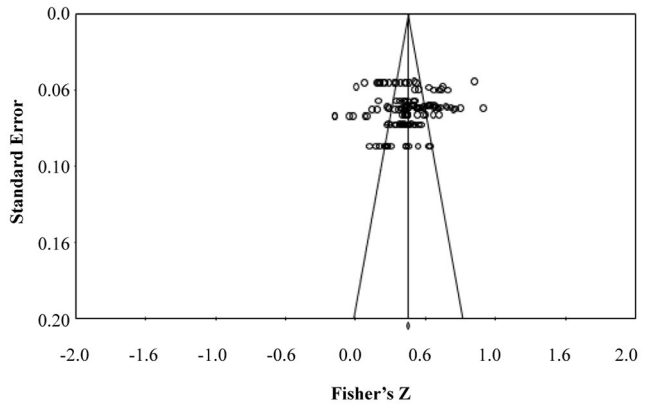

FIGURE 2 | Funnel plot of standard error by Fisher's *Z*.

an index of variation, "Cochrane's Q") and I^2 statistics were performed to confirm the homogeneity of the data with a 95% confidence interval (Borenstein et al., 2021). The *Q-statistics* itself cannot be used as the sole index of data heterogeneity because it is only a measure of variation between observed effects and weighted average effects in terms of meta-analysis (Borenstein et al., 2009). According to Higgins et al. (2003), the values of *the* I^2 statistic (expressed as a percentage with a range from 0 to 100%) are useful and relative criteria for a decision on the degree of heterogeneity. Since most of the I^2 statistics ranged above 75% and all of the significant levels of *Q* statistics were statistically significant, the studies in this meta-analysis were considered to be studies of the same population and deemed to have some degree of heterogeneity, as indicated by Hak et al. (2016). Additionally, we utilized multiple standard methods to examine the data for publication bias and heterogeneity. As depicted in **Figure 2**, all data points of the selected studies fell within 95% confidence intervals. In other words, we were confident that publication bias was unlikely in our meta-analysis.

Table 2 presents the ESs of the subdimensions of coach leadership behavior on player satisfaction and exercise commitment overall and by gender. The five subdimensions of coach leadership behavior indicated gender differences in the value of ES for both player satisfaction and exercise commitment. The most significant finding from this study was that for players' satisfaction, the sub-dimensions "Charismatic" ($ES = 0.420$; 95% CIs = 0.316, 0.513; $k = 8$; $p = 0.05$), "Individual Consideration" ($ES = 0.360$; 95% CIs = 0.204, 0.498; $k = 5$; $p = 0.05$), "Intellectual Stimulation" ($ES = 0.421$; 95% CIs = 0.348, 0.488; $k = 8$; $p = 0.05$), "Management by Exception" ($ES = 0.126$; 95% CIs = 1.90E−02, 0.265; $k = 1$; $p = 0.05$), and "Contingent Reward" ($ES = 0.292$; 95% CIs = 0.190, 0.387; $k = 4$; $p = 0.05$) showed higher ESs for female players compared with male players. In more detail, the biggest difference in the ES value on player satisfaction between the gender groups was explained by Contingent Reward," followed by "Intellectual Stimulation," "Individual Consideration," "Charismatic," and lastly "Management by Exception." The data presented in **Table 2** also indicates that the sub-dimension of "Individual Consideration" ($ES = 0.464$; 95% CIs = 0.357, 0.559; $k = 7$; $p = 0.05$) had the highest ES on "Exercise Commitment" for female players followed by "Charismatic" ($ES = 0.455$; 95% CIs = 0.340, 0.557; $k = 10$; $p = 0.05$), "Intellectual Consideration" ($ES = 0.367$; 95% CIs = 0.284, 0.444; $k = 10$; $p = 0.05$), and "Contingent Reward" ($ES = 0.313$; 95% CIs = 0.198, 0.418; $k = 3$; $p = 0.05$).

DISCUSSION

This study examined the influence of coach transformational leadership, as assessed by the MLQ instrument, on player satisfaction and commitment using a systematic meta-analysis approach. The overall results showed that transformational leadership had significant positive and moderate effects on both player satisfaction and commitment. This finding indicates that player satisfaction and commitment can be moderately enhanced when coaches frequently demonstrate transformational leadership behaviors such as actively listening to players' needs and concerns, articulating the vision of the team in an inspiring way, challenging players to go beyond their capacities, and showing admirable behaviors. This result is consistent with previous studies that also found a positive relationship between transformational leadership and members' psychological outcomes of satisfaction and commitment (Chin, 2007; Jackson et al., 2013; Nohe and Hertel, 2017; Gui et al., 2020).

Transformational Leadership Constructs

Among the constructs of transformational leadership, charismatic and intellectual stimulation yielded positive

TABLE 2 | Results of meta-analysis of the relationships between subfactors of the MLQ and player satisfaction and exercise commitment by gender.

	Factor	Gender	*k*	ES	−95%CI	+95%CI	*Q*	I^2
Player Satisfaction	Charismatic	Overall	26	0.399	0.307	0.484	104.404	87.523
		Men	18	0.378	0.297	0.454	159.940	89.371
		Women	8	0.420	0.316	0.513	48.867	85.675
	Individual Consideration	Overall	13	0.297	0.132	0.447	80.845	91.470
		Men	8	0.234	0.060	0.395	127.056	94.490
		Women	5	0.360	0.204	0.498	34.632	88.450
	Intellectual Stimulation	Overall	18	0.342	0.246	0.432	60.628	81.175
		Men	10	0.263	0.142	0.375	96.544	90.677
		Women	8	0.421	0.348	0.488	24.710	71.672
	Management by Exception	Overall	2	0.121	−0.018	0.254	000	000
		Men	1	0.115	−0.016	0.242	2.46E−15	000
		Women	1	0.126	−0.019	0.265	1.15E−14	000
	Contingent Reward	Overall	7	0.180	0.055	0.301	7.753	67.992
		Men	3	0.068	−0.081	0.214	7.378	72.894
		Women	4	0.292	0.191	0.387	8.127	63.088
Exercise Commitment	Charismatic	Overall	46	0.413	0.328	0.491	212.948	90.457
		Men	36	0.371	0.315	0.423	310.933	88.744
		Women	10	0.455	0.340	0.557	114.963	92.171
	Individual Consideration	Overall	20	0.397	0.295	0.491	93.131	89.385
		Men	13	0.330	0.232	0.422	138.514	91.336
		Women	7	0.464	0.357	0.559	47.747	87.434
	Intellectual Stimulation	Overall	24	0.362	0.280	0.438	83.481	85.736
		Men	14	0.356	0.275	0.432	114.5871	88.654
		Women	10	0.367	0.284	0.444	52.375	82.816
	Management by Exception	Overall	–	–	–	–	–	–
		Men	9	0.277	0.201	0.349	31.085	74.264
		Women	–	–	–	–	–	–
	Contingent Reward	Overall	17	0.312	0.214	0.404	54.981	77.259
		Men	14	0.311	0.228	0.390	103.896	87.487
		Women	3	0.313	0.198	0.418	6.066	67.031

k, number of correlations; Q, the homogeneity statistics; CI, confidence intervals; ES, weighted random effect size.

and moderate effects on player satisfaction. Also, Individual consideration, contingent reward, and management by exemption were positively correlated with satisfaction, but with small ESs. This result suggests that all leadership behaviors, whether transformational or transactional, can positively affect player satisfaction. The present findings corroborate previous meta-analyses conducted by Chin (2007), Nohe and Hertel (2017), and Gui et al. (2020), who found a positive association between transformational leadership and satisfaction. However, previous investigations have not addressed how each leadership construct contributes to followers' satisfaction levels. The current study also supports the results of a meta-analysis on the relationship between coach leadership and satisfaction (Kim and Cruz, 2016). However, the data analyzed came from articles that used the LSS as a measurement tool to assess leadership behaviors. Hence, our study results not only go beyond the direct effect between transformational leadership and satisfaction, but also provide a different perspective in understanding leadership in sports by examining the relative strength of the influence of leadership behaviors on player athletic satisfaction based on the constructs assessed by the MLQ.

Similarly, all five constructs of leadership had a significant and positive relationship with player commitment. Interestingly, the strength of the relationship between each leadership construct and commitment yielded moderate-to-large ESs. This finding suggests that when coaches generally inspire, motivate, intellectually stimulate, provide positive feedback and reinforcement, and influence players to achieve their sports goals, the higher the desire of players to continue their sports participation or stay committed with the sport/team. Therefore, coaches should emphasize these behaviors to ensure that players maintain high level of sport commitment. This result confirms similar studies that indicated that the charismatic stimulation, intellectual stimulation, individual consideration, contingent reward, and management by exemption constructs of leadership positively influence the commitment level of followers (Jackson et al., 2013).

A noteworthy finding of this study was the stronger effects of transformational leadership behaviors on player commitment compared with satisfaction. In particular, management by exception and contingent reward had moderate effects on commitment, whereas they only had small effects on satisfaction. These findings indicate that players tend to show higher commitment in their athletic participation rather than feel satisfied with their sports experiences when coaches display more frequent transactional behaviors in addition to transformational leadership behaviors. This result may be attributed to the player's individual traits, particularly their sensitivity to environmental and motivational stimuli that can facilitate the enhancement of sport commitment. When coaches instruct and give feedback to players based on their athletic needs and appropriately reward performance accomplishments, players who are receptive to these external and motivational stimuli would clearly notice the positive behavioral cues exhibited by their coaches. Consequently, these players are more likely to have a higher desire to stay committed and continue sports participation since the transformational leadership behaviors that coaches display are more congruent with their needs and motivations. This notion is in line with those of other scholars who proposed that one's sensitivity toward environmental stimuli, in this case, the degree of perceptions toward the leader's individual consideration and contingent reward leadership, may be influenced by a person's characteristics (De Meyer et al., 2016; Stenling et al., 2017). Hence, aside from the demonstrating transformational leadership behaviors, coaches are advocated to provide higher degree of instructional feedback and to appropriately reward performance accomplishments of players, since players who are receptive to these external and motivational stimuli would clearly notice the positive behavioral cues exhibited by their coaches and eventually have higher desire to continue sports participation.

Another plausible reason for players' higher level of perceived commitment than satisfaction is due to coach transformational behaviors that are aligned to players' preference. Studies showed that elite level and mature players favor a coach that is efficient, well-structured, encouraging, and constructive in giving feedback (Weinberg and Gould, 2015; Cruz and Kim, 2017), which relatively depict behaviors relating to active management by exception and contingent reward. Since players included in the selected studies were mostly competitive Korean players, it seemed that their perceived commitment level were greatly affected when coaches showed not only idealized influence, intellectual stimulation, inspirational motivation, and individual consideration behaviors, but more so when coaches displayed constant management by exception and contingent reward leadership behaviors. Based on the current results, for players to stay highly positive and committed to their sport participation, coaches should not only inspire and challenge players to accomplish their goals, but also identify players' strengths and weaknesses in order to create training programs that are aligned with their needs that would further optimize their performance. The current finding also verifies the concept of transformational leadership that personal motivation and morale of followers are enhanced when leader offer tasks to followers that would further develop their strengths as well improve their limitations (Bass, 1997).

Gender Differences in the Relationships Between Transformational Leadership Behaviors and Player Satisfaction and Commitment

The results showed that the transformational leadership of coaches has significant and positive effects on satisfaction and commitment of players but with greater effect on women than men. Moreover, all the leadership constructs had larger ES in women compared with men, particularly intellectual stimulation and charismatic leadership for satisfaction and individual consideration and charismatic leadership for commitment. This result suggests that female players' athletic satisfaction and commitment are likely to increase to a greater extent than male players when they perceive that their coaches frequently demonstrate leadership behaviors that are charismatic, intellectually stimulating, considerate, and kind with regard to their sport participation and performance. The difference in the magnitudes of the relationships between leadership behaviors, and satisfaction and commitment in male and female players may be explained by variations in their preferences for these leadership behaviors and how they correspond (or diverge) with their actual perceptions of coach behaviors. In a study on leadership preferences in collegiate athletes, men reported a higher preference for social support and autocratic behavior, whereas women conveyed a stronger preference for positive feedback and situational consideration (Witte, 2011). Koh and Wang (2015) reported that the behaviors of coaches related to goal setting, mental preparation, and competition strategies were greatly perceived by male players compared with female players. These specific behaviors were also found to be positively correlated with satisfaction. Rodrigues et al. (2020) found that coaches who emphasized task and ego motivational climates positively facilitated the psychological satisfaction and behavioral regulation of male players, but not female players. Hence, male players who preferred more autocratic or transactional leadership and a lower degree of transformational leadership behaviors but perceived their coaches as demonstrating too much or too little of these preferred behaviors tended to be less satisfied and committed with their athletic participation because the actual behaviors of the coaches did not match their preferences and vice versa. In contrast, female players in the present study could have had coaches who demonstrated positive leadership behaviors, such as intellectual stimulation, charismatic stimulation, and individual consideration, which were congruent with their preferences, resulting in higher commitment and satisfaction. This notion is supported by a previous meta-analysis (Kim and Cruz, 2016) that showed that the magnitude of the relationship between coach leadership and athletic satisfaction was stronger in women than in men. In particular, females perceived higher levels of satisfaction when their coaches exhibit a lower degree of autocratic behavior but higher degrees of positive feedback, social support, and training and instruction.

Another possible reason for the stronger influence of coach leadership behaviors on female player satisfaction and commitment compared with males is coach-player gender interaction. Cruz and Kim (2017) demonstrated that female players with male coaches tended to prefer democratic, autocratic, and social support leadership behaviors more than those with female coaches. Murray et al. (2018) found that male coaches supervising female players were perceived to display a greater level of relationship quality (complementarity). They also reported that female players perceived their coaches, whether male or female, as displaying a greater level of affective empathy. Hence, the gender difference in the degree of perceived satisfaction and commitment in players may have been brought about by coaches who emphasized and promoted greater interpersonal relationships when interacting with players *via* their leadership behaviors. These interpersonal relationship-promoting behaviors were then clearly observed and positively perceived by female players than by males because these leadership behaviors were generally preferred by females.

Overall, the present findings underscore the importance of congruency between player preferred and perceived actual leadership behaviors as well as the coach-player dyad, particularly opposite gender interaction (e.g., male coach-female player), in developing positive psychological states in sports players. The current results also support both the Multidimensional Model of Leadership (Chelladurai, 1990) and transformational leadership perspectives which posit that positive changes are likely to occur when leader behaviors are congruent with followers/members preferences and when leaders align responsibilities to followers based on their strengths and weaknesses (Bass, 1990; Newland et al., 2015).

Theoretical and Practical Implications

The results of this study contribute to the sport psychology and sports leadership literature by shedding light on the overall direct effect of coach leadership behavior on player satisfaction and commitment by consolidating previous studies and examining them using meta-analysis. In other words, transformational leadership can positively enhance players' psychological states. Recently, coach leadership has been identified as an important factor in creating a sustainable sports environment. A sustainable sports environment is described as a sport setting wherein coaches provide players with well-planned training programs based on skill level, support players' personal development, build sincere relationships with players, and focus more on their wellbeing and health rather than performance results (Dohsten et al., 2020; Dohlsten et al., 2021). Therefore, in order to create a more sustainable environment for players, coaches and sport practitioners working with players should be aware of and frequently demonstrate transformational leadership behaviors that inspire and motivate players to achieve their sport-related objectives and encourage players to accomplish these target goals beyond expectations. In such manner, players would not feel disappointed or resentful, or experience a sense of futility with their sports experiences (i.e., not accomplishing their goals), but rather feel proud and gratified with their accomplishments, view failures as opportunities for growth, and continue with their sports participation. Furthermore, as coaches are also found to cause dropout among players in competitive and elite sports (Andronikos et al., 2019; Thomas et al., 2021), the leadership role of the coach in providing support and motivation to the overall wellbeing of players is even more vital in order to sustain or further enhance players' commitment and satisfaction level.

Using a meta-analysis approach, this study sheds new light on identifying the contribution of each transformational leadership construct measured by MLQ in influencing player satisfaction and commitment, thereby extending current knowledge in sport leadership in general and transformational leadership in particular. It is therefore suggested that coaches who want their players to have a high level of satisfaction and commitment or strive to transform players' sports-related attitudes, values, and morale should display a high degree of charismatic, intellectual stimulation, and individual consideration leadership behaviors for these behaviors are found to have large to moderate effects in developing positive psychological states in players.

Finally, by examining player gender as a moderating factor in the relationship between transformational leadership and satisfaction and commitment, the present study provides additional knowledge on how the overall influence and each construct of coach transformational leadership on player levels of satisfaction and commitment may vary between male and female players. The findings showed that the satisfaction and commitment of female players are positively affected to a greater extent than those of male players when coaches display transformational leadership behaviors. As such, coaches should be mindful of how to appropriately interact with male and female players by showing more frequent individual consideration, charismatic, and intellectual stimulation leadership behaviors to female players because they are more sensitive to these behaviors, resulting in higher levels of satisfaction and commitment than males. To achieve this in a Korean sport setting for instance, coaches should neither ignore nor insult ideas and opinions when handling female players. Rather, they should promote open communication, provide positive guidance and encouragement, and show trust and respect. On the other hand, coaches working with male players may also provide players with previous suggestions, but at the same time focus more on giving direct instructions, constructive feedback, and contingent rewards. Finally, a formal and regular leadership development program is a viable approach to help coaches optimize their attitude- and relationship-building competencies, so they know what effective strategies are appropriate to use when interacting with players with distinct qualities and needs, how to employ these strategies, and when to implement these plans that would facilitate positive sport-related outcomes and avoid turnover.

Limitations and Future Directions

While the study provided new perspectives on leadership in sports, there are also some important limitations. First, since the study only consolidated previous studies that used a multifactor leadership questionnaire instrument to evaluate the transformational leadership of coaches, the results are limited to the constructs within this measurement tool. Hence, it is suggested that future studies should examine other instruments

that also assess transformational leadership in sports, such as the Transformational Leadership Inventory (TLI) (Podsakoff et al., 1990) and determine not only the overall but also each construct's impact on the psychological states of players.

Second, the published articles all came from Korean journal publications, and thus the findings can only be generalized to this set of population and sport settings. However, the results may also be applicable to countries with similar cultures, particularly those with high collectivism. As such, a cross-cultural approach in examining the relationships between transformational leadership and both player satisfaction and commitment may be a worthy endeavor. A previous meta-analysis (Jackson et al., 2013) has shown that culture is a significant moderator between transformational leadership and the psychological state of followers.

Lastly, the present meta-analysis was limited to the influence of transformational leadership on the psychological outcomes of player athletic participation. Other outcomes related to transformational leadership, such as cohesion (Cronin et al., 2015; Bosselut et al., 2018; Erikstad et al., 2021) and wellbeing (Stenling and Tafvelin, 2014; Bormann et al., 2016; Krukowska, 2016) were not examined because of the lack of published articles that used the MLQ as the main instrument. Hence, future meta-analytic research will be possible if there are sufficient numbers of articles to conduct such examinations.

CONCLUSIONS

This meta-analysis found that transformational leadership has a positive and moderate impact on athletic satisfaction and commitment. Transformational leadership constructs, particularly charismatic and intellectual stimulation, have moderate effects, whereas individual consideration, contingent reward, and management by exemption have small effects on player satisfaction. Charismatic behavior has a large impact, whereas individual consideration, intellectual stimulation, contingent reward, and management by exemption have moderate effects on player commitment. Finally, the positive impact of transformational leadership behaviors on player satisfaction and commitment was stronger in female players than in male players. Hence, effective leadership in sports is dependent on the interaction among leadership behaviors of the coach, personal characteristics of the players, and situational factors and highlights the importance of transformational leadership as an important requirement for creating a more positive and sustainable sports environment.

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.

AUTHOR CONTRIBUTIONS

HK and AC conceptualized the research project and contributed to the writing of the manuscript (from the initial draft to the final manuscript). HK analyzed the data. Both authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.915391/full#supplementary-material

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Exploring the Multidisciplinary Factors Affecting Sports Talent Identification

Changqing Xiang[1,2], *Tengku Fadilah Tengku Kamalden*[1]*, *Hejian Liu*[3]* and *Normala Ismail*[4]

[1] Department of Sport Studies, Faculty of Educational Studies, Universiti Putra Malaysia, Serdang, Malaysia, [2] Office of Scientific Research, Guangzhou University, Guangzhou, China, [3] School of Education, Guangzhou University, Guangzhou, China, [4] Department of Science and Technical Education, Faculty of Educational Studies, Universiti Putra Malaysia, Serdang, Malaysia

Talent is one of the most significant factors to promote the development of sports undertakings. The present study aimed to explore the factors affecting the identification of sports talents in China's physical education curriculum. Based on the literature review, this study puts forward a model to examine the influencing factors of sports talent identification in China's physical education curriculum using structural equation modeling and uses the structural equation modeling and factor analysis method to verify the hypothesis combined with the results of 310 effective questionnaires. The article summarizes influencing factors from four aspects, namely, physical, psychological, coach, and environmental factors. On the basis of relevant literature, the hypothesis model was established by structural equation modeling. The results show that the main factors affecting the identification of sports talents in the physical education curriculum are personal physical quality performance, psychological quality, coach's knowledge, and the identification policies of schools to sports talents. The conclusion of this study can provide guidance for the reform of the physical education curriculum, the growth of sports talents, and the development of sports talents in China.

Keywords: sport talent, factors, physical education, identification, SEM

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***Correspondence:**
Tengku Fadilah Tengku Kamalden
tengku@upm.edu.my
Hejian Liu
liuhejian@gzhu.edu.cn

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INTRODUCTION

The sports talent identification (TID) refers to the discovery of potential athletes in a heterogeneous population that are currently not involved in a specific sport (Vaeyens et al., 2008). TID is a key area within sports development, and TID is an inseparable from the growth of athletes. As a key part of cultivating sports talents, the physical education (PE) curriculum plays a significant role in transporting sports reserve forces for national sports. At the same time, TID could be a helpful tool to stimulate lifelong sports participation and reduce dropouts because it can reveal an optimal connection between sports, individual strengths, and personal preferences (Pion et al., 2015). Meanwhile, there are some differences talent detection, identification, development, and selection. Talent detection is the first stage involved in the conversion of a talented player into an elite sportsman (Ricard et al., 2018), and talent detection intends to support lifelong sports participation, reduce dropouts, and stimulate sports at the elite level (Faber et al., 2017). TID is predicting students or players who have the potential skills to development into elite athletes (Williams and Reilly, 2000); talent development processes involve experienced, well-qualified coaches' careful training, academic education (Ford et al., 2020), athletic rehabilitation, athletic load capacity control, and professional sports skills guidance to athletes; and talent selection mainly concerns about choosing

the most appropriate (group of) athletes to complete a specific task (in a team) in sports (Williams and Reilly, 2000). In short, talent detection, identification, development, and selection compose the whole process that runs through different stages of sports talent, and each their own characteristics and requirements.

Although China is a big sports country, there is still a long way to go between China and a powerful sports country. In October 2020, the Chinese government issued the "Opinions on Comprehensively Strengthening and Improving School Physical Education in the New Era," which put forward that school PE, as a basic project to improve students' all-sided quality, is vital to accelerate the modernization of education and build a powerful country in education and sports, and on this account establish and improve the sports competition system and talent training system, in order to identifying and cultivating more excellent sports reserve talents.

School PE should gradually strengthen the selectivity and hierarchy, further enhance students' interest and behavior in participating in sports, and pay more attention to lifelong PE for students; competitive sports should be popular again in school PE, and the detection of sports talents should be an indispensable part of the school PE curriculum. Bailey and Morley (2006) have presented a model of talent in PE, indicating that excellent school PE helps implement effective talent development plan, and clarified the purpose and value of PE.

At the same time, sports talents are greatly restricted by age characteristics, and the improvement of sports performance can be made within the appropriate age range (Haycraft et al., 2018); therefore, sports talent needs to be identified at early stages so that they can be nurtured to develop elite athletes. Therefore, the aim of the present study was to explore the factors that affect the TID in the school PE curriculum.

Sport TID Research

The notion of talent and its development have been explored in other domains, and while providing some intriguing and relevant elements for those working in sport settings, these domains may be insufficient to capture the complexity of talent in sports (Joseph et al., 2019). Many scholars have carried out much relevant research on TID before including multidisciplinary, longitudinal, prospective, or qualitative studies, such as the investigation and research on the process of sports professional TID (Ford et al., 2020), the current model and future development direction of TID in sports (Vaeyens et al., 2008), and the predictive factors in the process of TID (Williams et al., 2020). In terms of the concept and content of sport talent, it is to point to a career in sports, sports professional knowledge, skills, and technical talents, mainly includes the athletes, coaches, sports scientific research personnel, sports management, sports teacher, entrepreneur, and sports agent for the development of undertakings of physical culture and sports as well as promote social progress, has made certain contribution or have some contribution to the potential of people. TID is a multi-factorial process (Ricard et al., 2018) and relate to identifying people who participate in sports with the potential to become professional athletes through training and cultivating.

According to the theory of subject knowledge, a multidisciplinary approach is used for TID including physical, technical, and psychological predictor variables in players (e.g., adult height, maturity, sprinting, dribbling skills, and intrinsic motivation) (Williams and Reilly, 2000; Ford et al., 2020). Hence, TID is a linear process, where sports competitions source athletes for the existing vacancies. This linear process is reactive in its nature and gift, thus lead to increased time to finding and cost to cultivating. From of the aforementioned discussion, we can know that there is increasing research on sport TID carried out around the concept, method, content of sport TID, and other aspects related to TID. As an important part of cultivating sports talents, PE class plays a significant role in transporting sports reserve forces for national sports, as well as sport TID.

Influencing Factors of Sport TID

In this process, TID is associated with many aspects including not only anthropology, pedagogy, physiology, and psychology but also sociology and coaching science (Williams and Drust, 2012). In another words, TID is an important stage of talent growth, and in this complex and multidimensional process and is affected by multi-dimensional factors. There have been many research studies on TID in the past decade, including methods of TID (Vladan et al., 2009; Clarke et al., 2018; Kyle et al., 2019; Williams et al., 2020) and identification factors (Norikazu and Taigo, 2016; Gledhill et al., 2017; Dodd and Newans, 2018; Lai and Ishizaka, 2020). Among them, physical factors are more discussed in TID. Genetic factors are considered to play a critical role in athletic performance and related phenotypes (Miah and Rich, 2006; Ahmetov et al., 2016; David et al., 2017). There is a consensus in the scientific and sporting communities that genetic factors contribute to athletic performance. According to research, at least 155 genetic markers were found to be related to elite athlete performance (93 genetic markers related to endurance and 62 genetic markers related to power/strength). Meanwhile, genome-wide association studies (GWASs) are the most commonly used method to identify athletic performance in athletes (Ahmetov et al., 2016). Components like height, body fat percentage, size of palm, dynamic balance, static balance, and hand strength were the key elements in TID of badminton (Mojtaba et al., 2012). Therefore, anthropometric factors index plays a crucial role in TID process.

Psychological factors are also very significant in the process of TID and talent development, and a focus that has grown markedly over the last decade or more. Saby et al. (2020) used a longitudinal method to examine changes in appraisals, emotion regulation, and emotions in adolescent soccer players based at a competitive season in France and found intertwined psychological constructs in a dynamic relationship allowing athletes to continuously adjust to their constantly changing everyday demands. Similarly, Saward et al. (2016) used a mixed-longitudinal prospective method to examine the psychological characteristics associated with elite youth soccer players aged 8–18 years in three seasons. Apart from these, Rongen et al. (2020) used a prospective longitudinal cohort design to track psychosocial outcomes of academy involvement in male youth elite soccer players and suggested that negative psychosocial

impacts of soccer academy involvement did not materialize in this context. Enrique and William (2006) through 24 in-depth semi-structured interviews with adolescents who involved in competitive sports concluded that motivational roles are related to the interpersonal influence on adolescents' sports motivation.

Compared with the first two factors, sociological factors are less discussed, but there are still some research on this. For instance, self-regulation and adaptive volitional behaviors appear to be key intra-individual factors associated with talent development (Haugaasen et al., 2014), and a number of talent development environmental factors (e.g., media coverage, sports participation rate, birthplace, long-term development, and quality preparation) also exist in sports (Li et al., 2014). On the whole, according to the current research, there are many factors affecting the sport TID, mainly physiological, psychological, and sociological factors, which play a vital role in both the identify of sports talents and the development of sports talents.

Current Study

Although there are a great deal of studies on the influencing factors of sport TID, most of them focus on a specific aspect, such as the relative age effect (RAE), athletes' psychological characteristics, and students' growing environment around these factors. This study used the relevant literature to analyze the multidisciplinary factors affecting sport TID as much as possible and verified these influencing factors through structural equation modeling as a way to better improve the success rate of sports talent. In this study, on the basis of a questionnaire survey, a Likert scale was used to assign scores to the listed influencing factors, and the data collected by questionnaire were analyzed. The questionnaires were distributed to PE teachers, sports administrators, and coaches, who were asked to rate the degree of influence of the factors in the questionnaire. The analysis of the data shows that physical, psychological, coach, environmental factors all have a positive impact on the sport TID.

As an integral part of education, PE is a purposeful, planned, and organized educational process conducted through physical activities and other auxiliary means (Mountakis, 2001). In a systematic review, Prieto-Ayuso et al. (2020) showed that methods and instruments for talent identification in PE are changing, so it is important to select appropriate programs to deal with gifted children. In addition, PE teachers in the development of the scale can help speed up the identification of potential talents (Platvoet et al., 2015); however, teachers in school PE still face certain difficulties within the identification process (Bailey et al., 2009).

In another aspect, there are many factors influencing sport TID in the school PE curriculum, due to the complex environment and existing regulations. Thus, based on the literature, expert consultation, and the factors associated with TID, a questionnaire was designed and distributed through online and offline. Researchers should have a reasonable theoretical basis and specific literature support when setting up models (Hoyle and Panter, 1995; Boomsma, 2000; McDonald and Ho, 2002). The setting of the model in this study includes relevant theories of the variables in the research model and the essence of past research. In this research, the authors selected physical, psychological, coach, and environment as four external variables, corresponding to 12 observation variables, respectively, and sport TID is as internal latent variables.

Although the existing literature on sport TID is very extensive, there are still some deficiencies. The development of school PE promotes the sport TID, and the development of sport TID will promote the innovation and progress of the school PE curriculum. However, the sport TID in the school PE curriculum is affected by many factors. For this reason, identifying the factors that affect TID in the school PE curriculum can improve the identification rate of school sports talent and further consolidate the strength of sports reserve talent.

This research aims to reveal factors influencing sport TID in the PE curriculum in China, and the following questions will be discussed in this research:

(1) What is the current situation of sport TID and how to classify the factors influencing sport TID in the school PE curriculum in China?
(2) What are the specific factors that affect TID in the school PE curriculum in China?
(3) How to make the strategy of TID in the school PE curriculum according to the situation of school PE in China?

Hypothesis

Physical quality is not only the foundation guarantee of athletes but also the basis of special sports quality. On the one hand, Norikazu and Taigo (2016) through 2-year follow-up measurements of soccer players found that factors of the anthropometric index such as sprint ability is a useful identification index and muscular power is limited and useful in TID of soccer. On the other hand, physiological aspects included anthropometrical, linear speed, change of direction speed (CODS), maximal anaerobic power, repeated sprint ability (RSA), maximal aerobic power, and maximal lower body strength, and they should be taken into account in the TID of soccer in the testing batteries (Dodd and Newans, 2018). Hence, we propose the following hypotheses:

(1) H1: Physical quality has an influencing on sport TID.
(2) H1a: Height and weight positively affect sport TID.
(3) H1b: Motor ability index advantage positively affects sport TID.
(4) H1c: The quality of the anthropometric index positively effects sport TID.

Psychological influence sport TID means the mentality maturity of the personal are advantaged on performance tests (Vaeyens et al., 2008), psychological factors manifesting itself at various levels, having a predominantly unconscious nature. Likewise, a systematic review also indicated that psychological factors (e.g., adaptive perfectionism, task/mastery orientation, delaying gratification, and coping strategies) are associated with talent development in football and suggested that psychological characteristics of self-regulation, resilience, commitment, and discipline appear to be most impactful on TID (Gledhill et al., 2017). Based on this, this research propose the following hypotheses:

(1) H2: Psychological quality has an impact on sport TID.
(2) H2a: Sports motivation significant affects sport TID.
(3) H2b: Personal qualities positively affect sport TID.
(4) H2c: Students' cognition of sports positively affects sport TID.

In the same way, coaches' knowledge is associated with talent detection, but it is unable to articulate how or in what ways they see talent (Roberts et al., 2019). An increasing number of researchers have explored the value of the "coach's eye" in TID and talent evaluation settings. For instance, a research study through systematic review and meta-analysis describing a model from decision-making concluded that a coach's eye is subjective and experience-based, and these criteria can differ from coach to coach (Lath et al., 2021). In another aspect, in the process of TID, because the coach's eye is based on intuition, coaches often fail to state clear variables and reasons for their selection decisions (Roberts et al., 2019). Therefore, we propose the following hypotheses:

(1) H3: The coach's knowledge has an impact on sport TID.
(2) H3a: The professional level positively affects sport TID.
(3) H3b: Relationship with students positively affects sport TID.
(4) H3c: Management ability positively affects sport TID.

Social and environmental factors that can impact upon TID (Mills et al., 2014): John et al. (2019) through systematic review found that critical life events have an impact on developmental pathways of elite athletes. In the meantime, from another point of view, the organization operation and the human resource management (HRM) system are commonly associated with talent management, whereas talent development can be further enhanced by influencing personal and environmental catalysts (Meyers et al., 2013). Accordingly, this study proposes the following hypotheses:

(1) H4: Social environment has an influencing on sport TID.
(2) H4a: Policy and system guarantee positively affect sport TID.
(3) H4b: The degree of emphasis on talent cultivation positively affects sport TID.
(4) H4c: School sports atmosphere positively affects sport TID.

METHODS

Participants and Procedures

A total of 330 questionnaires were sent and collected. Invalid questionnaires were removed, and the returned questionnaires were carefully reviewed. Finally, 310 questionnaires were determined to be valid, with a questionnaire effective rate of 93.9%.

The information about the respondents in the confirmed valid questionnaire is as follows: (1) Gender and age composition: The female proportion was 48.38%, and the proportion of people under 30 years is 21.3% and that between 30 and 45 years is 36.7%; (2) The situation of professional title: In this survey, the title of professor accounts for 7%, and the title of associate professor was 9%. (3) Occupational distribution: The percentage of PE teachers was 30.64%, coaches were 24.84%, and the rest were PE administration and education administration personnel. (4) Education level: The proportion of those with doctoral degrees was 17.42%. (5) Type of work unit and work experience: The number of respondents working in colleges and universities accounted for nearly half, 48.39%. (6) Work experience: 13.2% had <3 years of experience, 27.9% had 3–5 years, 40.6% had 5–10 years, and 18.3% had more than 10 years of work experience.

The procedure is to distribute the questionnaires online (e.g., e-mail and Google online questionnaire) and offline and collect them after they are filled in. After repeatedly revising and determining the questionnaire, the researchers conducted a questionnaire survey on the factors affecting the sport TID in China's PE curriculum among PE teachers, coaches, and sports experts, and collected the sample data of the questionnaire survey.

The majority of the survey studies of performance relied on the questionnaire for date collection (Doherty, 1998). The respondents of this study are mainly concentrated in Guangdong province, according to the number of staff in the sports system in the Guangdong Provincial Statistical Yearbook 2021 (http://stats.gd.gov.cn/gdtjnj/), there were 1,874 sports coaches, 927 full-time teachers, and 5,224 administrative personnel. Overall, 330 participants were selected for this research. Then through the method of random sampling, an appropriate number of individuals are randomly selected in each subgroup. Last, based on the principle of stratified sampling, 77 people are selected from sports coaches, 38 teachers, and 215 sports management personnel. Hence, the sample size in this study is 330 sports system practitioners (i.e., administrative personnel, coaches, and school PE teachers). Sports experts, administrative personnel, middle school PE teachers, and coaches from Guangdong province were selected to represent the south of China. In this way, the questionnaire was distributed among the school PE and education system practitioners by random sampling.

Measures

For the purpose of ensuring the validity of this questionnaire, it is designed from multiple angles. By reading the relevant literature and expert interviews, combined with the characteristics of school PE classes and talent growth environment, a questionnaire has been designed. After the questionnaire is collected, it is necessary to process information. The design of this questionnaire for this study was structured and multiple-choice type. It was divided into three parts. The first part comprised the basic information of the respondents, including personal information (gender, professional title, age, working unit, and education level) and basic information of the affiliation (affiliation category). These questions ensure the validity of the samples and allow the survey results to be classified and cross-analyzed. The second part is the evaluation of the influencing factors, which includes 12 influencing factors (**Table 1**), with the degree of importance ranging from high impact, moderate impact, low impact, rare impact to no impact, and 5, 4, 3, 2, and 1 points are given, respectively. The third part comprises other factors affecting the detection of sports talents in the school PE curriculum. This part of special measurement is mainly to collect some specific factors of the sports TID in school PE

classes in China of this questionnaire. The aim of the part is to collect respondents' judgments on the degree of influence between variables.

Statistics Analysis

The structural equation model (SEM) is an empirical analysis model method that uses the linear equation system to express the relationship between observation variables and latent variables, as well as the relationship between latent variables. Compared with the traditional linear regression model, the SEM has the advantage of processing multiple variables at a time, allowing latent variables have multiple index variables and resulting in the reliability and validity of index variables, so that the model can adapt to a wider range and be more elastic. In recent years, the SEM has become the main analytical method in many fields such as sports (Marsh, 2007; Rocha and Chelladurai, 2012), education (Violato and Hecker, 2007; Khine, 2013; Green, 2016), and general management (Williams et al., 2009). The measurement model describes the relationship between latent variables and observed variables, while the structural model describes the relationship between latent variables (**Figures 1**, **2**).

Analysis of moment structure (AMOS) can verify various measurement models and different path analysis models. In addition, multi-group analysis and the average structure number test can also be conducted. AMOS has four advantages (Cunningham and Wang, 2005): a graphical interface that helps see the changes that occur in the model and to establish relationships between the surfaces, easy to interpret and understand the meaning of the model diagrams created, a clear and intuitive way to read the results, and a full graphical display of the AMOS results.

In this research, the applicability of the four dimensions of TID was tested by SPSS26.0 according to the principal component reduction data set dimension, in which the KMO test value was 0.902, and the significance probability of the χ^2 statistical value of the Bartlett sphere test was 0.000 (**Table 2**), indicating that the feasibility standard of principal component analysis was fully met.

RESULTS

Each SEM has many latent variables, and the attributes of latent variables should meet the requirements of both validity and reliability (Raykov and Marcoulides, 2006). In order to ensure the suitability, validity, and reliability of the model, SPSS software was used for statistical analysis of the collected questionnaire data. If $p \leq 0.05$, it means that the overall model is not significant, indicating that the model is consistent with the sample data. Otherwise, if $p > 0.05$, it is significant, indicating that the model is inconsistent with the sample data. After meeting the aforementioned requirements, the hypothesis test and modification of the model are conducted.

Based on the widely used criterion of Cronbach coefficient >0.7, the reliability of this model was tested on the basis of Churchill's (1979) criterion that the overall correlation coefficient of the item should not be <0.5. As shown in **Table 3**, Cronbach's α was 0.7, the composite reliability (C.R.) was higher than 0.7, and the average variance extracted (AVE) was also more than 0.5, except for the psychological AVE is less 0.5 (but above a reasonable range of 0.45). In this way, the model has good convergent validity.

TABLE 1 | Measurement items.

Number	Latent variable	Observation variable
A1	Physical	Height and weight
A2		Motor ability index
A3		The quality of anthropometric index
B1	Psychological	The motivation of students to participate in sports
B2		Personal qualities
B3		Students' cognition of sports
C1	Coach	Professional level
C2		The relationship between coaches and students
C3		Moral education and management ability of coaches
D1	Environmental	Policy and system guarantee within the school
D2		Degree of emphasis on talent cultivation
D3		School sports atmosphere

TABLE 2 | KMO and Bartlett sphere test.

Kaiser-Meyer-Olkin measure of sampling adequacy		**0.902**
Bartlett's test of sphericity	Approx. chi-square	1,366.274
	df	66
	Sig.	0.000

TABLE 3 | Reliability analysis.

Latent variables	Observed variables	Standardized factor loading	Cronbach's alpha	C.R.	AVE
Physical	A1	0.832	0.716	0.752	0.507
	A2	0.604			
	A3	0.680			
Psychological	B1	0.674	0.723	0.725	0.475
	B2	0.836			
	B3	0.590			
Coaches	C1	0.815	0.734	0.849	0.652
	C2	0.842			
	C3	0.764			
Environmental	D1	0.567	0.751	0.819	0.614
	D2	0.821			
	D3	0.722			

Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) is a part of SEM analysis and plays a significant role in SEM analysis

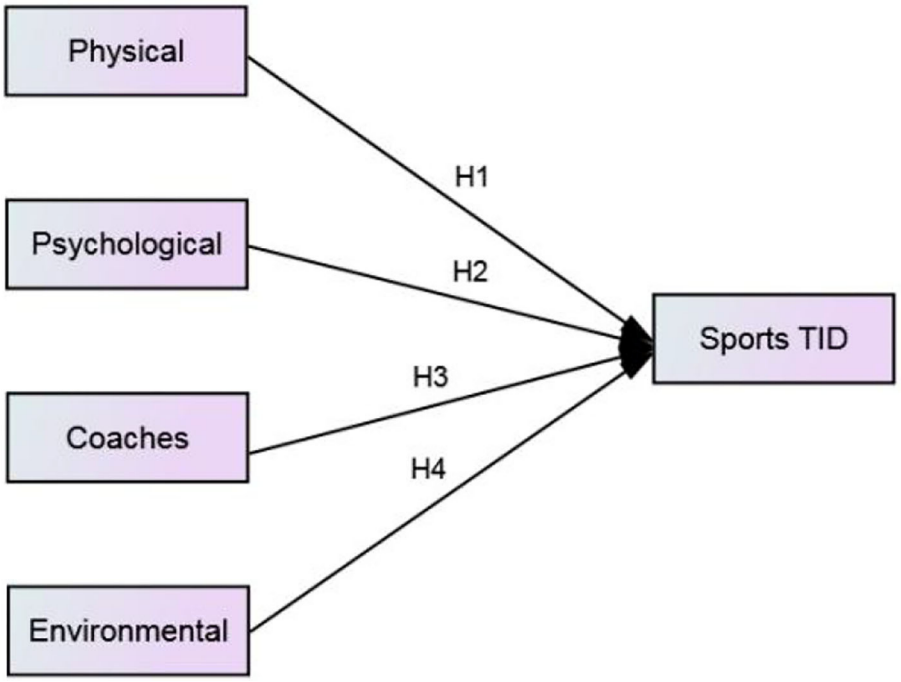

FIGURE 1 | Theoretical model.

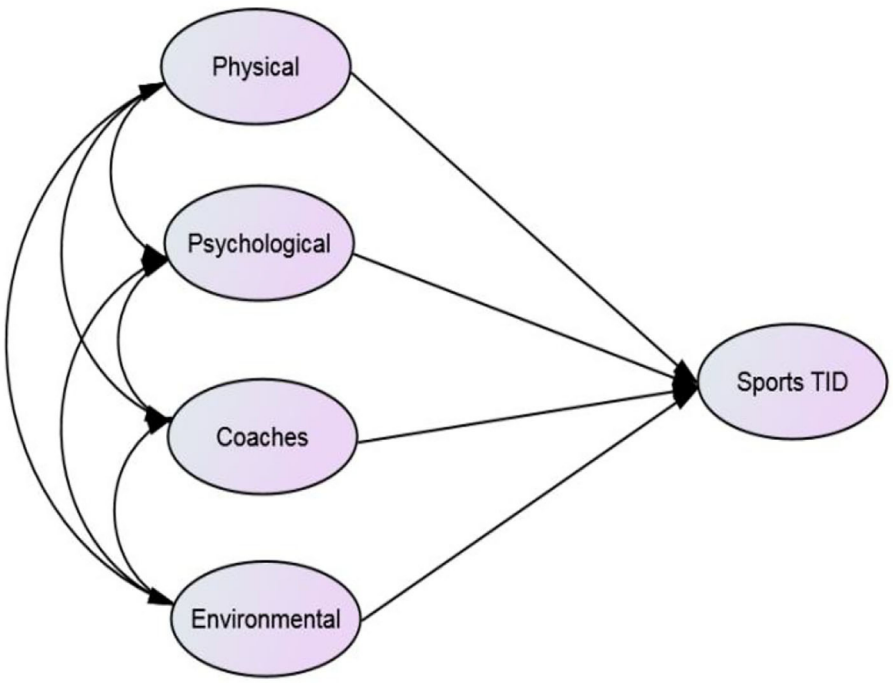

FIGURE 2 | Conceptual model.

(MacCallum and Austin, 2000; Brown, 2006). CFA mainly presents the commonality of factor load and measurement model factor variables in tables. The contents should include standardized and non-standardized load, standard error, significance, composition reliability, extraction of mean variance, and appropriate fitting indicators. Thus, CFA can provide details

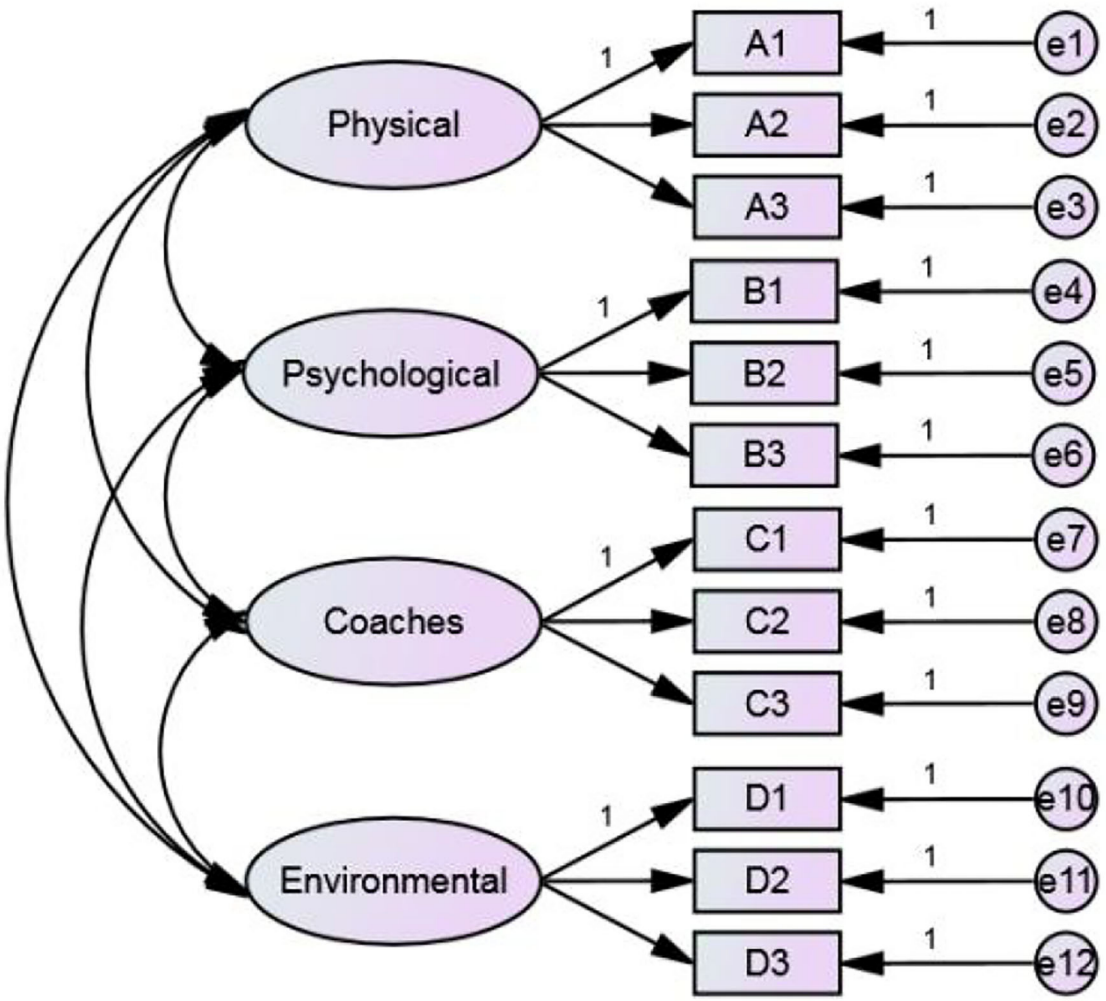

FIGURE 3 | Confirmatory factor analysis model.

about the setting and evaluation of SEM for this study and increase confidence in the research results.

Establishment of SEM

In this hypothetical model, there are four factors, and each factor has three observed variables and a total of 12 observed variables. All factors are the cause of the observed variable, so they point to the observed variable. When the observed variable is estimated by latent variable, there are two parts: explainable variance (variation) and unexplainable variance (variation). The square of the standardized factor load is the explainable variation, and there are 12 errors (unexplained variation) from e_1 to e_{12}. Meanwhile, there is a correlation between latent variables, so there are six covariances (correlation). The four-factor hypothetical model of sport TID is shown in **Figure 3**, which includes four facets and a total of 12 measurement indicators. All latent variables are exogenous variables. Exogenous variables affect endogenous variables (measurement indicators), and there is a complete correlation between latent variables. For this reason, the sport TID model has 12 endogenous variables and 16 exogenous variables (including 12 measurement errors and four exogenous latent variables). Because the four dimensions of sport TID are our hypothetical structure and do not exist in the data, in order to measure the hypothetical structure, the factor load of the first question of each structure is set to 1, and its variance is mapped to each facet of sport TID.

After this study determines that the model can be estimated, the next step is to estimate the model parameters. The model in this research is analyzed by the maximum likelihood estimates (MLEs), which make the estimated results of all parameter values have the highest similarity with the actual data, and the MLE is completed by the iterative program. **Table 3** shows the correlations matrix of all analyzed variables for TID, with three decimal places retained (Hoyle and Panter, 1995), for a total of 310 samples. **Figure 4** shows the non-standardized estimated

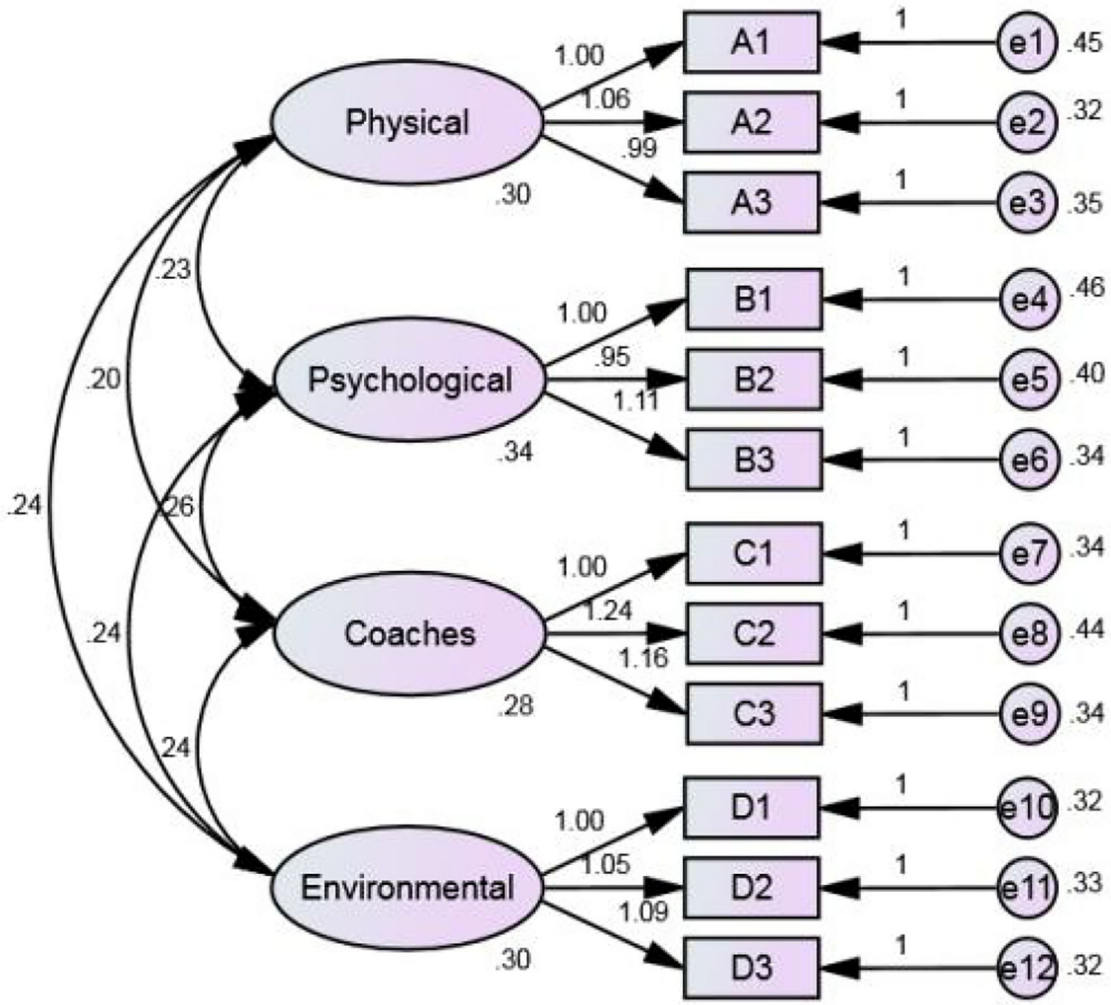

FIGURE 4 | Unstandardized estimates.

results and **Figure 5** shows the standardized estimated results of CFA for sport TID.

Model Test and Analysis

Table 4 lists the main fit indexes obtained from the structural model test in detail. After comparing with the given recommended values of the fitness indicators, the indices of the fit indicators fall within the recommended values, except for the AGFI value, which is just above the recommended value of 0.9. It can be seen that the setting of the theoretical model in this study is acceptable.

Meanwhile, **Table 5** shows the parameter estimates after model testing, including unstandardized estimates, standard errors, significance, and standardized estimates. As shown in **Table 5**, all estimated parameters are significant with standardized estimates ranging from 0.63 to 0.74 and squared multiple correlations (SMC) ranging from 0.39 to 0.54, in accordance with the requirements suggested by Fornell and Larcker (1981).

Totally, four factors were selected by principal component analysis in SPSS, as shown in **Table 6**. A1, A2, and A3 were clustered as one factor and named physical factor. B1, B2, and B3 were clustered as one factor and named psychological factor. C1, C2, and C3 were clustered as one factor and named coaches factor. D1, D2, and D3 were clustered as one factor and named environmental factor. In the meantime, **Table 7** shows the interpretation of the total variance interpretation after rotation. Among them, the cumulative variance contribution rate of the rotation of the first four factors reaches 67.16% (**Table 8**). In general social investigation and research, the contribution rate of more than 60% is also in line with the requirements, which can better explain that these factors can represent the main content and information.

The aforementioned data and models showed that the path coefficient is significant. Physical, psychological, coach, and

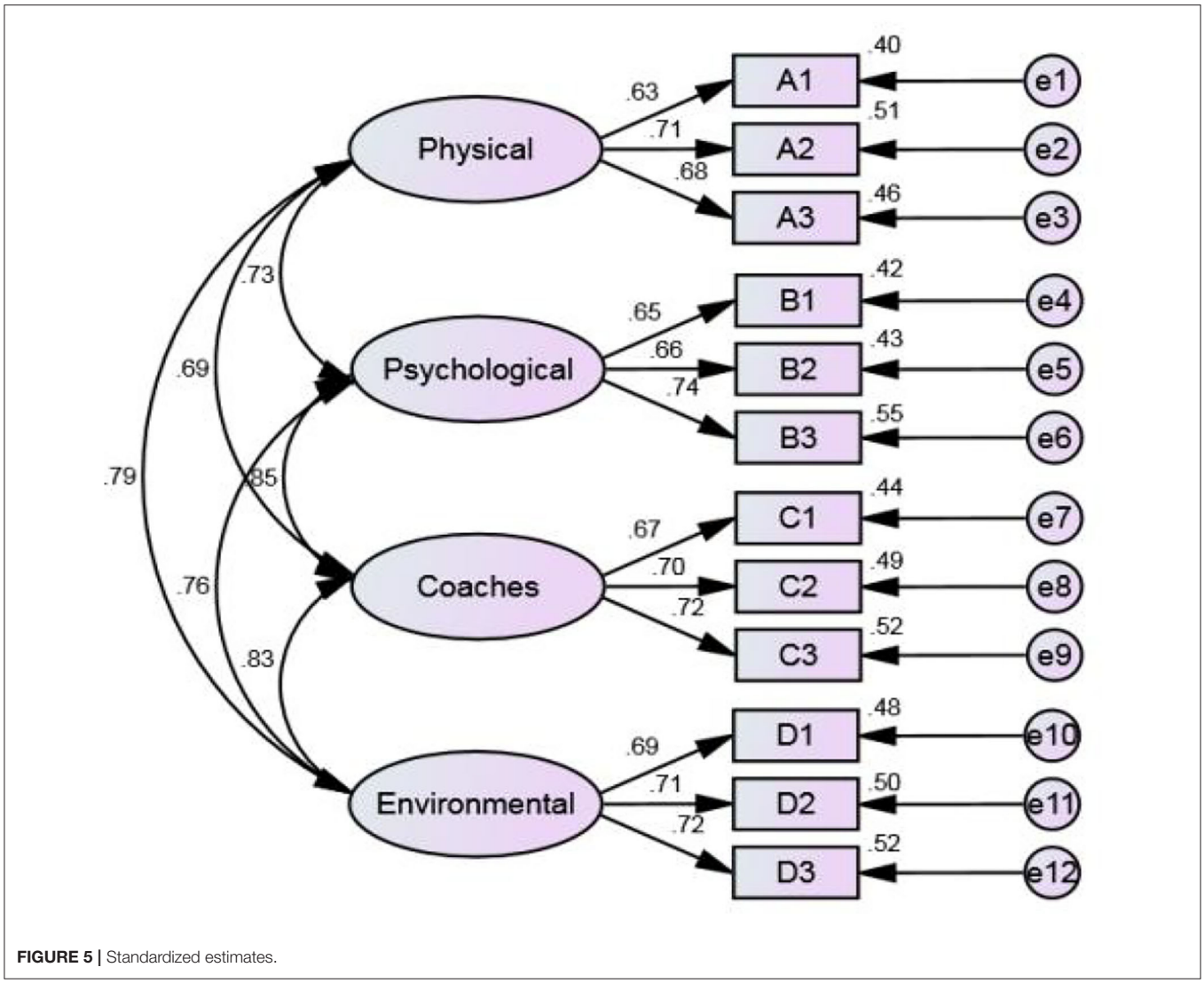

FIGURE 5 | Standardized estimates.

TABLE 4 | Sample correlations (group number 1).

	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
A1	1.000											
A2	0.451	1.000										
A3	0.456	0.466	1.000									
B1	0.353	0.367	0.344	1.000								
B2	0.286	0.315	0.380	0.441	1.000							
B3	0.303	0.344	0.374	0.468	0.487	1.000						
C1	0.348	0.445	0.387	0.329	0.466	0.414	1.000					
C2	0.345	0.306	0.287	0.359	0.333	0.505	0.389	1.000				
C3	0.257	0.317	0.279	0.430	0.353	0.446	0.447	0.601	1.000			
D1	0.357	0.353	0.418	0.352	0.386	0.410	0.487	0.425	0.401	1.000		
D2	0.302	0.481	0.330	0.316	0.343	0.430	0.480	0.314	0.388	0.466	1.000	
D3	0.317	0.449	0.356	0.339	0.338	0.402	0.413	0.428	0.396	0.481	0.556	1.000

TABLE 5 | Fit index value of SEM.

Fit indices	Recommended value	Fitting value
χ^2	The smaller, the better	118.033
χ^2/df	<3.0	2.495
GFI	>0.9	0.939
AGFI	>0.9	0.901
RMSEA	<0.08	0.069
NNFI	>0.9	0.915
IFI	>0.9	0.948
CFI	>0.9	0.947

environmental factors are the four main aspects that affect the sport TID in the PE curriculum in China.

DISCUSSION

In this study, the unstandardized parameter estimates in **Figure 4** and the standardized parameter estimates in **Figure 5** were obtained by AMOS of the hypothesis model. Based on the previous reliability and validity analysis and the validation factor analysis, the model of factors affecting the sport TID was tested and revised in this way. Since the sport TID model is not bad overall, the model does not need any correction. So, from the sport TID model, we can know that the main influencing factors are physical, mental, coaching staff, and environment.

Physical factor has an effect on sport TID, namely, H1 is correct. Physical factors include height and weight, motor ability, and anthropometric indicators. The proportion of motor ability in factor load is the largest, which shows that for the identification of sports talents, students' motor ability is a major influencing factor to find potential athletes, so more attention should be paid to motor ability in the sport TID in future. In addition, students' height and weight, as well as anthropometric index, also play an important and indispensable role in sport TID.

Psychological factor has an impact on sport TID, namely, H2 is correct. Psychological factors include sport motivation, personal quality, and students' cognition of sports. The factor coefficient of personal quality is the largest. This shows that for the sport TID, students' personal quality is crucial, and only a good psychological quality can endure a certain amount of physical training load. Second, students' motivation and cognition for sports can also effectively identify sports talents. Some sports psychology studies still show that sport motivation is an important factor affecting sport TID (Abbott and Collins, 2004; Höner and Feichtinger, 2016).

The coach factor has an effect on sport TID, namely, H3 is correct. The factors of coaches mainly include professional and skill levels, relationship with students, and management ability. As an important medium for cultivating and discovering sports talents, coaches are both organizers and instructors, who play a powerful role in promoting the identification and development of sports talents. Therefore, in the process of sport TID, the factors related to coaches also need to be concerned.

TABLE 6 | CFA parameter estimation results.

Paths	Unstandardized estimate	S.E.	*T*-value	*p*	Standardized estimate	SMC (R^2)
A1 <– Physical	1.000				0.632	0.399
A2 <– Physical	1.060	0.115	9.258	***	0.715	0.511
A3 <– Physical	0.992	0.110	8.988	***	0.679	0.461
B1 <– Psychological	1.000				0.648	0.420
B2 <– Psychological	0.951	0.102	9.290	***	0.657	0.431
B3 <– Psychological	1.112	0.110	10.089	***	0.740	0.548
C1 <– Coaches	1.000				0.667	0.445
C2 <– Coaches	1.242	0.122	10.175	***	0.703	0.494
C3 <– Coaches	1.158	0.111	10.393	***	0.723	0.523
D1 <– Environmental	1.000				0.694	0.481
D2 <– Environmental	1.054	0.099	10.613	***	0.709	0.502
D3 <– Environmental	1.090	0.101	10.791	***	0.724	0.524

****p-value is <0.001.*

TABLE 7 | Rotating component matrix.

Items	Factor loading values				Factor
	1	2	3	4	
A1	0.832				Physical
A2	0.604				
A3	0.680				
B1		0.614			Psychological
B2		0.836			
B3		0.590			
C1			0.815		Coaches
C2			0.842		
C3			0.764		
D1				0.567	Environmental
D2				0.821	
D3				0.722	

The environmental factor has an impact on sport TID, namely, H4 is correct. The environmental factors in this study are mainly at the social level, including policy and systemic guarantees, attention to the sport TID, and the school sport atmosphere. The social environment (e.g., family characteristics and children's growth environment) is relatively a complex factor because the times are constantly updating and changing, which also has a great impact on the sport TID (Bailey and Morley, 2006). Sport TID is for the society demands and for the development of sports. From this aspect, environmental factors are closely related to the sport TID to a large extent. As mentioned before, we must grasp the environmental factors, make good use of social policies, and improve the work of sport TID.

Implication

Comprehensively Develop Students' Physical Quality

The physical qualities of students generally include strength, speed, endurance, agility, and flexibility. Good physical quality

TABLE 8 | Total variance interpretation.

Component	Initial eigenvalue			Rotating the sum of squares and loads		
	Total	% of variance	Cumulation %	Total	% of variance	Cumulation %
1	5.311	44.260	44.260	2.459	20.490	20.490
2	1.062	8.849	53.110	1.891	15.758	36.248
3	0.904	7.533	60.643	1.867	15.559	51.807
4	0.782	6.521	67.164	1.843	15.356	67.164
5	0.671	5.595	72.758			
6	0.601	5.012	77.771			
7	0.548	4.570	82.341			
8	0.523	4.355	86.696			
9	0.476	3.967	90.663			
10	0.418	3.487	94.150			
11	0.389	3.241	97.391			
12	0.313	2.609	100.000			

Extraction method: principal component analysis.

is the basis for mastering sports skills and tactics as well as improving sports performance. The more comprehensive the physical quality, the more conducive to the mastery of sports skills and tactics. The physical quality development of primary and middle school students has its own characteristics, including growth and sensitive period; meanwhile, there is an imbalance in the development of various qualities in different age stages. Thus, when identifying sports talent in the PE curriculum, we should pay attention to the characteristics and sensitive period of students' physical quality development, as well as adopt different physical quality testing methods to identify sports talents in line with the specific conditions of students' age and grade. In addition, anthropometric indicators are also related to students' growth and development, and it is necessary to notice the changes of students' body shape, which are wavy, phased, gender differences, and imbalance. In this way, good use of the important role of anthropometry in the sport TID must be highlighted. With the application of anthropometric data and comprehensively considering the relationship among human body's morphological structure, physiology, physical quality, and talent identification technology, we can improve the success rate of youth sport TID and reduce the missed selection rate.

Grasp the Psychological Status of Students

The psychological state of students is also closely related to the sport TID. The psychological basis of athletes includes two aspects: individual psychological characteristics and sports psychological process. The most vital personality psychological characteristics that determine the traits of students' sports behavior are sport motivation (Clancy et al., 2016), interest in training and competition, cognition of sports, personal personality, and temperament (Bailey and Morley, 2006; Li et al., 2021). The physiological basis of temperament depends on the types of high-level neural activities, which are generally divided into four types: excitatory, lively, quiet, and depression (Wytykowska et al., 2022). These four neural types have different characteristics in people's behavior. Generally speaking, different sports items have different requirements for individual psychological characteristics (Gimeno et al., 2007). However, on the whole, a student who can bear hardships and love sports in his/her heart will certainly have a good psychological performance. At the same time, some students' good psychological performance is innate and affected by genetic factors, but it will also be affected by the acquired influence of society, family, and school education. Therefore, students' psychological state is closely related to the sport TID.

Improve the Professional Quality of Coaches

As an important organizer and executor of sport TID, coaches play an inseparable role in the process of sport TID. It is always said that swift horses are usually found but not the same as the person who has good judgments to spot them. A professional and experienced coach can fully understand and tap a student's sports potential, as well as can predict whether a student has the ability to become an excellent athlete in future. The professional quality and ability of coaches have laid a theoretical and practical foundation for them to identify sports talents. At the same time, the more familiar coaches are with students, the more they can understand students' inner world and whether students truly like sports, so as to better know which students have the qualification to become athletes. Additionally, there is a certain relationship between coaches' management consciousness and sport TID. A coach with strong management consciousness and organizational ability can have good control over students and discover, cultivate, and select talents for the country.

Make Good Use of Social Environment and Policies

Under the background of the policy of "Sports Power" and "Talents Rejuvenate the Country," policy plays a critical role in promoting the work of school PE and TID. In particular, the reform of the school PE curriculum and emphasis on the

training of sports talents have been greatly promoted, which will further accelerate the identification of sports talents. A strong campus sports atmosphere can stimulate more students to participate in sports; with more participation base the more talent can be identified. Hence, for sport TID, the overall external environment is also very important, and it will affect school PE development, talent training, and guarantee from all aspects, which is inseparable with TID. In this way, with the implementation and guidance of the policy, the identification of school sports talents will be more favorable to conduct.

CONCLUSION

With the development of big data, artificial intelligence, and information technologies, sports talents may be more effectively and accurately identified in future, making the identification of sports talents more scientific and effective. Through big data analysis, we can make a comprehensive evaluation on the learning environment, training conditions, physical fitness, competition results, team cooperation, and other indicators of talent growth in each stage; make a scientific evaluation on the development potential of sports talents; and then predict the growth and development of talents. Therefore, we can better identify the types and characteristics of each sports talent and provide corresponding training as well as guidance, which will also be conducive to the growth and development of sports talents, and the most important thing is to ensure the sustainable development of sports. This research analyzed the factors affecting the sport TID in the PE curriculum through the CFA in the SEM. Through the analysis of data and model, it is known that the main factors affecting the identification of sports talents in the PE curriculum include four aspects: physical, psychological, coaches, and environment.

Nevertheless, this study is not without limitations. Because all kinds of schools at all levels have different management systems and processing methods in the detection, cultivation, selection, after-school sports training, sports development, and other aspects of their own sports talents, we should also consider the differences of schools. Except that, in the actual school PE work, there are still other factors affecting the identification of sports talents, such as the level of regional economic development, the investment of school funds, and traditional sports culture. Therefore, the model analysis of this study does not cover all the interfering factors. Consequently, further research need to select more theoretical models and influencing factors, to construct a more comprehensive theoretical framework and better analyze the influencing factors of TID in the school PE curriculum.

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.

AUTHOR CONTRIBUTIONS

CX and HL: conceptualization. CX: methodology, software, resources, writing—original draft preparation, and visualization. CX and TT: validation. CX and NI: formal analysis. HL: investigation, project administration, and funding acquisition. CX, HL, and TT: data curation. HL and TT: writing—review and editing and supervision. All authors have read and agreed to the published version of the manuscript.

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EDITED BY
Marianna Alesi,
University of Palermo, Italy

REVIEWED BY
Danilo Reis Coimbra,
Juiz de Fora Federal University, Brazil
Asterios Patsiaouras,
University of Thessaly, Greece

*CORRESPONDENCE
Elisa Bisagno
elisa.bisagno@unimore.it;
elisa.bisagno@gmail.com

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A developmental outlook on the role of cognition and emotions in youth volleyball and artistic gymnastics

Elisa Bisagno[1]*, Alessia Cadamuro[2], Sandro Rubichi[2], Claudio Robazza[3] and Francesca Vitali[4]

[1]Department of Law, University of Modena and Reggio Emilia, Modena, Italy, [2]Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia, Modena, Italy, [3]Department of Medicine and Aging Sciences, Behavioral Imaging and Neural Dynamics Center, G. d'Annunzio University of Chieti and Pescara, Chieti, Italy, [4]Section of Movement Sciences, Department of Neurosciences, Biomedicine and Movement Sciences, University of Verona, Verona, Italy

Developmental and cognitive psychology recently started to take an interest in the sports domain, exploring the role of either cognitive functions or emotions in youth sport. However, to the extent that cognition and emotions are inextricably linked, studying them jointly from a developmental perspective could inform on their interplay in determining performance in different sports. This research examined the role of general cognitive abilities, attentional style, and emotions (controlling for age and experience), in predicting performance in youth volleyball and artistic gymnastics. A total of 218 female participants, of which 114 volleyball players and 104 artistic gymnasts (11–17 years old) were administered two measures of working memory and six measures of executive functions (namely inhibition, updating, and shifting). They also completed an attentional style and an emotion-related questionnaire. For each volleyball player, an individual performance index based on every gesture performed during the games and controlled for the team performance was computed. As a measure of gymnasts' performance, scores in 2017–2018 competitions were used. Regression analysis showed that the main predictor of the volleyball players' performance (R^2 = 0.23) was a working memory-updating factor (ß = 0.45, p = 0.001), together with experience (ß = 0.29, p = 0.030) and high-arousal unpleasant emotions (ß = 0.30, p = 0.029), which positively predicted performance. Experience (ß = 0.30, p = 0.011), age (ß = −0.036, p = 0.005) and high-arousal unpleasant emotions (ß = −0.27, p = 0.030) were the predictors of gymnasts' performance (R^2 = 0.25). These results represent a first step in understanding if and how youth female athletes of open- and closed-skills sports rely on different psychological abilities. This line of research could offer insight to practitioners regarding which psychological abilities could be more relevant to train depending on the type of sport.

KEYWORDS

working memory, executive functions, attentional style, emotions, youth sport, cognition

Introduction

In the last decade, there has been growing research interest in the role of cognitive functioning in determining sports performance (e.g., Vaughan and Laborde, 2021). However, the relationship between cognition and performance of youth athletes has been almost overlooked [for an exception, see Ishihara et al. (2019)]. Children develop different abilities at different ages, therefore the impact of specific cognitive processes on sports performance may vary across development, as well as across different sports (Vitali et al., 2019a). Also, research examining sports performance that considered emotions has only rarely included the role of cognitive processes (e.g., Raab et al., 2016). Lastly, research studying individual differences in sports performance only rarely involved youth athletes of team sports, given the difficulty in obtaining valid and ecological individual performance measures, and systematically differentiated between open- and closed-skills sports.

Open-skills sports occur in unpredictable environments, like those involving a direct opponent, either individually (e.g., combat sports, tennis) or in team (e.g., volleyball, rugby). In these sports, the movement cannot be completely programmed in advance and the athlete must constantly adapt to the environment, placing a great load on cognitive functioning (Claver et al., 2016; Gu et al., 2019). In contrast, in closed-skills sports (e.g., artistic gymnastics, shooting) the athlete's performance is executed as planned and within a stable environment (Voss et al., 2010; Wang et al., 2013). We argue that the role of cognitive and emotional processes in predicting sports performance may critically depend on the environmental (un)stability and the resulting cognitive load [i.e., the amount of working memory resources involved in a task; see Arsalidou et al. (2013)] that characterize these different types of sports.

As anticipated above, a branch of research in sport psychology examines the effects of sport on cognition, focusing on athletes practicing different sports. In general, these studies show the superiority of athletes from interceptive sports (i.e., sports that require coordination between the athletes' body and an object in the environment) in several cognitive paradigms, both under a sport-specific context [for a meta-analysis, see Mann et al. (2007)] and on general laboratory-based tasks (Voss et al., 2010; Wang et al., 2013). Although the impact of sport in enhancing cognitive abilities is acknowledged, the role of cognition in sports performance is still relatively under-researched, and mainly studied with adult athletes [see Kalén et al. (2021) for a recent meta-analysis].

Developmental studies investigating cognitive functioning in youth athletes are scant and highlight the importance of understanding cognitive functioning in an early phase of development to identify predictors of sports performance. A study testing 8–16-year-old elite soccer players and age-matched non-elite soccer players revealed that measures of inhibition, alerting, and orientation of attention differentiated elite from non-elite players with high accuracy (Verburgh et al., 2014a). Similar results were found in other studies (Huijgen et al., 2015; Vestberg et al., 2017). Specifically, Huijgen et al. (2015) found that elite youth soccer players had better inhibitory control, shifting, and metacognition than their sub-elite counterparts, while Vestberg et al. (2017) found that youth soccer players' performance at the Design Fluency test (a complex executive task) predicted the number of goals scored during the season. Comparable results were found by Sakamoto et al. (2018) in a study with 8–16-year-old soccer players and by Ishihara et al. (2019) in a longitudinal study with junior league tennis players.

An important variable examined by researchers is working memory (WM). The Theory of Constructive Operators (TCO) (Pascual-Leone and Goodman, 1979; Pascual-Leone, 1987) conceptualizes WM, defined within TCO as M capacity, as executive attention with a limited capacity, and provides a precise developmental model of capacity growth. M capacity is the maximum number of schemes (units of cognition) that one individual can co-activate and increases by one unit every 2 years, starting from 3 years of age. Since performing complex motor skills generates a high cognitive load (due to multiple motor schemes to be co-activated), some authors have studied the role of WM in sport [for a review, see Furley and Memmert (2010)]. Bisagno and Morra (2018) conducted a study on a sample of youth female volleyball players within the TCO framework where WM was the main predictor underlying the correct execution of a series of attacks. Findings showed developmental (age-related) thresholds in performing attack gestures of increasing complexity. Furley and Memmert (2012) found that basketball and hockey adult players with higher WM were better than those with lower WM in focusing attention and producing creative solutions in a decision-making task.

Executive functions (EFs) are further relevant cognitive variables, which can be broadly defined as top-down processes that regulate goal-directed, controlled behaviors [Espy, 2004; see also Diamond (2013)]. A prominent theoretical account of EFs was proposed by Miyake et al. (2000) who identified three distinct but interrelated EFs, namely (i) inhibition, which concerns both the ability to suppress a preponderant or automatic response and the ability to suppress interfering mental representations and distracting stimuli; (ii) updating, that refers to the active updating of the information in WM; and (iii) shifting, which is described as the ability to flexibly move from one mental set to another. Research on the role of EFs in sports performance has mainly focused on inhibition. In a study with youth soccer players (Verburgh et al., 2014a), high talented athletes performed significantly better than amateurs of the same age in inhibitory tasks. Similar results were observed with volleyball players (Lipoma et al., 2006), and in other open-skills sports (Wang et al., 2013). Literature related to sports performance concerning shifting and updating is scarce. Krenn et al. (2018) compared volleyball players with athletes

of less strategic sports on an N-back task (updating), finding a better response time for the first. Indirectly suggesting a role of shifting, some studies highlighted an advantage of volleyball players in re-orienting attention (e.g., Castiello and Umiltà, 1990). There is a need to consider jointly the three EFs to understand their role in sports performance.

Another relevant variable is attentional style, defined as the individual's disposition to preferably adopt a certain attentional focus (Nideffer, 1976). The theory of attentional style and the test derived from it [Test of Attentional and Interpersonal Style, TAIS (Nideffer, 1976, 2002)], largely used in sport psychology, were developed to provide a framework for understanding and predicting the conditions under which individuals perform at their best. According to Nideffer, attention has two bipolar, orthogonal dimensions: width and direction. Crossing them, four attentional styles are identified: (i) focused or narrow external; (ii) aware or broad external; (iii) systematic or narrow internal; and (iv) strategic or broad internal. Nideffer (1990) suggested that, according to the type of sport, a style may be preferred to others. In open-skills sports, a "broad and external" focus would be more useful to respond effectively to sudden stimuli (Bosel, 1998). Conversely, the athletes practicing closed-skills sports would prefer a "narrow and internal" focus (Nideffer, 2007). The relation between attentional styles and sports performance has been widely debated in the literature (Vallerand, 1983; Kerr and Cox, 1990). Therefore, we tested the attentional style as a predictor of sports performance.

Taken alone, however, the general cognitive prerequisites described above (i.e., WM capacity, EFs, and attentional style) are not sufficient to explain sports performance, which is also highly impacted by emotional aspects. Emotions are complex and organized response patterns, favoring one individual's adaptation to the environment (Ekman, 1992). The Circumplex model of emotions (Russell, 1980) proposes that affective states arise from the appraisal of sensations based on arousal (high vs. low) and hedonic tone (pleasant vs. unpleasant). Athletes are usually able to easily express how they feel in terms of pleasant or unpleasant emotions even under pressure (Vitali et al., 2019b).

Emotions in sport have been studied over the past 50 years, highlighting the importance of both pleasant and unpleasant emotions on specific components of performance (e.g., attention and memory). Research showed how some emotions typically considered dysfunctional (e.g., anxiety and anger) can be predictive of a good performance for certain athletes and types of sports, even if unpleasant (Campo et al., 2012; Ruiz et al., 2016). On the other hand, Mahoney and Avener (1977) observed that disciplines requiring high precision, like gymnastics, are facilitated by low-arousal emotions. These studies suggest that the role of emotions related to sports performance is not invariant but rather linked to the type of sport. Athletes of open-skills sports may benefit more from high-arousal emotions, even if unpleasant (e.g., anxiety), to better react to rapid environmental changes. Conversely, athletes of closed-skills sports could profit from low-arousal emotions since they need to calmly focus on their bodily control.

An important drawback of existing research is that the additive and/or interactive role of cognition and emotions has rarely been studied together. However, some studies suggest that emotions with high arousal and unpleasant hedonic tone (e.g., anxiety) are debilitating (Hill et al., 2010), and can lead the athlete to choke under pressure since they burden WM by generating intrusive thoughts (Baumeister, 1984), or because athletes use part of their WM to inhibit these feelings (Beilock, 2007). We argue that this examination is key to future research because both cognitive and affective factors influence sports performance and examining them in isolation can result in biased estimates of their reciprocal role.

We, therefore, conducted a cross-sectional study with a group of youth female athletes to test cognitive and emotional processes as predictors of sports performance. We examined the additive role of these factors as well as the interplay between WM and emotions. Crucially, we considered two different types of sport, that is, an open-skills sport (i.e., volleyball) and a closed-skills sport (i.e., artistic gymnastics). The purpose of this study was three-fold: (i) applying a developmental framework to the study of the predictors of sports performance; (ii) investigating both cognition and emotions in relation to sports performance; and (iii) comparing open- and closed-skills sports. In particular, we considered WM within the TCO framework, EFs, and attentional style whose addictive effect has never been studied to the best of our knowledge. We also focused on arousal and hedonic tone of pleasant and unpleasant emotions according to the Circumplex model. For both volleyball players and artistic gymnasts, we based the performance measures on the participants' actual competitions during the 2017–2018 sports year.

The hypotheses of our study were the following:

> (H1) M capacity was expected to predict performance for volleyball players but not for artistic gymnasts because volleyball players are expected to deal with a greater cognitive load during performance (e.g., Claver et al., 2016).

> (H2) Inhibition was expected to predict volleyball players', but not artistic gymnasts' performance (e.g., Wang et al., 2013). Predictiveness of updating and shifting was studied in an exploratory way.

> (H3) A broad-external attentional focus was expected to predict volleyball players' performance, while a narrow-internal focus was expected to be predictive of the artistic gymnasts' performance (Nideffer, 1990).

(H4) Artistic gymnasts' performance was expected to be predicted positively and negatively by low arousal-pleasant hedonic tone emotions and high arousal-unpleasant hedonic tone emotions, respectively (e.g., Mahoney and Avener, 1977). High-arousal emotions, both pleasant and unpleasant, were expected to have a positive effect on volleyball players' performance (e.g., Campo et al., 2012).

(H5) Finally, based on the choking-under-pressure theories (e.g., Hill et al., 2010), we predicted a moderation effect of high arousal-unpleasant hedonic tone emotions on the relation between WM and sports performance.

To the best of our knowledge, no studies have so far investigated performance in youth sport by considering different sports and simultaneously using different cognitive and emotional predictors. Identifying how cognitive and emotional processes may differentially impact sports performance at different ages and for different types of sports can help design both developmentally oriented and sport-specific psychological interventions.

Materials and methods

Participants

The sample consisted of 218 youth female athletes, of which 114 volleyball players (Under 12 to Under 18), and 104 artistic gymnasts (23 in the *Gold* and 81 in the *Silver* category), aged between 11 and 17 years (M = 14.06 years, SD = 1.73), recruited from clubs in Northern Italy. Both sports are predominantly practiced by female athletes. Thus, we included only female participants to avoid gender-related biases. We chose the age range according to two research needs: firstly, guaranteeing a high developmental variability to detect a developmental trajectory in cognitive functioning, and secondly including sufficiently meta-conscious participants for the compilation of self-report measures. Moreover, to ensure that all participants experienced a fair amount of deliberate practice and competitions, we enrolled athletes with at least 3 years of experience in their sport. The two sub-samples of volleyball players and artistic gymnasts were comparable with respect to the age (t = 1.72, p = 0.09), but not to the years of sport experience (t = 5.42, p < 0.001), with artistic gymnasts (M = 7.56, SD = 2.77) having more sports experience than volleyball players (M = 5.66, SD = 2.36). This is not surprising and coherent with artistic gymnastics being a sport with particularly early specialization.

Procedure

Data related to cognitive variables were collected from November 2017 to April 2018 by the first author of this article with the help of two trainees during three individual meetings lasting about 40 min with each athlete. The meetings were held in meeting rooms and/or empty locker rooms to guarantee a quiet and appropriate setting for the participants to concentrate. One meeting per week (out of three average training days) was scheduled. A questionnaire regarding emotions was collectively administered within volleyball players' and gymnasts' groups, usually in the gym before practice, taking approximately 15 min. All the procedures were conducted according to the Declaration of Helsinki. The study was approved by the ethics committee of the University of Verona (Italy) (DEDIPAC WP3.2). Parents provided informed consent for participation.

Measures

Cognition and emotions assessment

working memory

We administered three WM capacity tasks designed consistently with an attention-based view of WM, namely (a) the Mr. Cucumber Test (Case, 1987); (b) the Figural Intersection Test (FIT) (Pascual-Leone and Baillargeon, 1994), which both involve visual material; and (c) the Direction Following Task (DFT) (Pascual-Leone and Johnson, 2005), which involves verbal stimuli of increasing complexity, in its Italian adaptation (Morra et al., 2013). The same measures were used in previous research with youth volleyball players; for details on scoring see Bisagno and Morra (2018).

Inhibition

We used two computerized tasks, namely a Color-word Stroop Task (Friedman et al., 2008) implemented in E-Prime, and an Arrow Flanker Task (Ridderinkhof et al., 1997), acquired from Inquisit 5 Lab. In the Stroop task participants are asked to verbally name the color of each stimulus of a series as quickly and accurately as possible. In the incongruent trials, stimuli are color-word printed in a different color, so that the participant needs to inhibit the reading automatism. In the Flaker task, the participant must indicate, by pressing on the keyboard as quickly and accurately as possible, the direction of an arrow flanked by two distractors.

Shifting

We adopted a computerized Color/Shape Task (Miyake et al., 2004) administered *via* Inquisit 5 Lab, adapting it to reduce the number of conditions. In each trial of this task, the participants see a shape (i.e., circle or triangle) superimposed on a square (i.e., red or green), and are asked to categorize the stimulus according to the cue presented to them (i.e., the word

"shape" or "color", which appears before the stimulus itself). We also administered a paper-pencil Trail Making Test, parts A and B (TMT) (Reitan, 1958). Within the TMT-A, participants are asked to connect in ascending order 25 digits scattered on the sheet, while in the TMT-B the targets are both numbers and letters, and the participant must alternate them (i.e., 1, A, 2, B, etc.), being as fast and accurate as possible. For both TMT-A and B completion time is recorded by the experimenter. Shifting is calculated as TMT-B completion time minus TMT-A completion time.

Updating

We used two computerized tasks, namely a Keep-Track Task (Friedman et al., 2008) implemented in E-Prime and an N-Back Task acquired from Inquisit 5 Lab [adapted from Jaeggi et al. (2010)]. In the Keep Track, fifteen words belonging to six categories are presented serially in random order. Target categories remain visible at the bottom of the screen. The participant's task is to remember the last word presented per each of the target categories. In the N-back, participants are shown a sequence of shapes and are asked to press on the keyboard each time the current stimulus is identical to the one presented in *N* positions earlier. There are three levels of increasing difficulty, from 2 to 4-back. In our task, the stimuli were simplified compared to the original version to be better suitable for our younger participants [Jaeggi et al. (2010) tested young adults].

Attentional style

We administered the short Italian version of the TAIS (Lipoma et al., 2006) twice (T1 and, after 1 month, T2). The test consists of twelve items (measured on a 0–4 Likert scale), and it is composed of six subscales of two items each, namely Broad External Focus (BET, $\alpha = 0.79$; e.g., "In a room full of children or on a playground, I can keep track of what everyone is doing."), Broad Internal Focus (BIT, $\alpha = 0.79$; e.g., "I can generate many ideas with just a little information."), Overload of External or Internal stimuli (OET, $\alpha = 0.69$; "When people talk to me, I am distracted by what I hear and the things around me." and OIT, $\alpha = 0.82$; "When people talk to me, I am distracted by my thoughts and ideas."), Narrow focus (NAR, $\alpha = 0.64$; "I find it easy to prevent my thoughts from interfering with what I am listening or watching."), and Reduced focus (RED, $\alpha = 0.76$; "I find it difficult to clear my mind of a thought or idea."). The overall score on each scale is the sum of the scores on two items.

Emotions

We created an *ad-hoc* short 12-items "Circumplex" questionnaire. To do so, based on Russell's (1980) conceptualization, we selected the 12 most used emotion descriptors, three from each quadrant deriving from the interaction between arousal and hedonic tone dimensions. The descriptors were presented to participants as a list and the players were asked to evaluate (on a 1 to 7 Likert scale) how often, in their general experience as athletes, before a competition they felt: tense, stressed, angry (high-arousal, unpleasant hedonic tone; $\alpha = 0.65$); discouraged, depressed, tired (low-arousal, unpleasant hedonic tone; $\alpha = 0.55$); serene, relaxed, calm (low-arousal, pleasant hedonic tone; $\alpha = 0.81$); and stimulated, excited, happy (high-arousal, pleasant hedonic tone; $\alpha = 0.72$). The confirmatory factor analyses that detail how we derived the emotional predictors are presented in the Results Section "Emotion-related measures."

Performance measures

For what concerns volleyball players, we video-recorded at least three matches for each player during the 2017–2018 championship. Except for isolated cases (e.g., equipment malfunctioning), the matches recorded for each team were all those of the "second round" of the sporting season. Two raters (both volleyball coaches) independently evaluated each athlete's performance for every single contact with the ball, according to a-priori-defined criteria. Specifically, every time that a participant made contact with the ball (i.e., serve, pass, set, or hit—the block was not scored unless it ended the action), that skill was evaluated with the attribution of 0 points, 0.5 points, or 1 point that were in the end summed up for each set. From these scores, an individual performance ratio index (IR) was calculated for each participant. We also collected team performance (TP) for each Set. The final weighted index of performance (WIP) was calculated for both observers by saving the residuals of the regression of IR on TP. Full details about this procedure can be found in Bisagno et al. (2019).

Regarding artistic gymnasts, we collected for each participant all scores on all the apparatus (i.e., balance beam, floor, uneven bars, and vault) in individual and team competitions held in 2017–2018.

Data analyses

As preliminary analyses, Exploratory (EFA) and Confirmatory Factor Analyses (CFA) using SPSS 25 (IBM, Armonk, NY, United States) and LISREL 8.80 were conducted to identify latent variables from the different observed variables from cognitive, attentional, and emotion-related measures. Regarding performance measures, an individual index of performance for each volleyball player (Bisagno et al., 2019), as well as for each gymnast was calculated.

To test the hypotheses coherently with a developmental framework, a series of hierarchical regression analyses with Performance measures as dependent variables were used, adopting a stepwise method. To test the "choking under

pressure" hypothesis, moderation analysis was conducted. Specifically, regression was applied using the PROCESS version 3.5 computational tool for SPSS by Hayes (2022, Model 1); bootstrapping procedures with 5,000 resamples were used to test the significance of the indirect effects. Additional analyses were performed to explore different possible links between emotions and cognition by looking specifically at the role of arousal. To do so, we calculated two indices (i.e., scores on High+ *minus* scores on Low+) and arousal in unpleasant emotions (i.e., scores on High− *minus* scores on Low−). We then divided the volleyball athletes into four groups, according to whether their scores were above or below the mean score in both indices, as follows:

- Group A: below the mean in arousal in both + and − emotions;
- Group B: below the mean in arousal in + but above the mean in − emotions;
- Group C: below the mean in arousal in − but above the mean in + emotions;
- Group D: above the mean in arousal in both + and − emotions.

We then calculated the correlations between the Mcap-Upd and the volleyball performance within each group.

As additional analyses, we explored the differences between age groups and sports, as well as their interaction. A 3 × 2 (11–12/13–14/15–17 years old × volleyball/artistic gymnastics) multivariate analysis of variance (MANOVA) was conducted on all predictors. Follow-up analysis of variance (ANOVA) was then used to identify significant differences.

Results

Cognitive measures

Based on the EFA and CFA, with respect to the cognitive variables, the best fitting model was a two-factor model assuming a M capacity-Updating factor and an Inhibition-Shifting one [$\chi^2(53) = 63.73$, $p = 0.13$, RMSEA = 0.04, SRMR = 0.05, CFI = 0.98, GFI = 0.95]. Loadings are presented in **Table 1**. From the factor scores of the observed variables, we then derived two composite predictors, namely an M capacity-Updating (Mcap-Upd) factor, and an Inhibition-Shifting factor (Inh-Shift).

For the TAIS measures, the best fitting model comprised four factors [$\chi^2(45) = 55.76$, $p = 0.13$, RMSEA = 0.03, SRMR = 0.04, CFI = 0.99, GFI = 0.96]: External Attentional Style Focus (Ext. Focus); Internal Attentional Style Focus (Int. Focus); Narrow Attentional Style Focus (Narrow Focus), and a Dysfunctional Attentional Style (Dysfunctional), given by the mean score of all the dysfunctional attentional focuses (OIT, OET, RED subscales) at both T1 and T2 (see **Table 2** for the loadings).

TABLE 1 Lambda-X matrix of the factor loadings for the two-factor model of general cognitive measures.

	M Cap-Upd	Inh-Shift
Cucumber	0.50	—
	(0.07)	
	7.09	
DFT	0.69	—
	(0.07)	
	10.55	
FIT	0.68	—
	(0.07)	
	10.35	
Keep-Track errs.	−0.52	—
	(0.07)	
	−7.41	
N-Back errs.	−0.63	—
	(0.07)	
	−9.43	
Stroop errs.	—	0.43
		(0.07)
		5.81
Stroop cost	—	0.17
		(0.07)
		2.20
Flanker errs.	—	0.42
		(0.07)
		5.59
Flanker cost	—	0.24
		(0.08)
		3.17
C/S errs.	—	0.73
		(0.07)
		10.10
C/S cost	—	0.05
		(0.08)
		0.68
TMT cost	—	0.42
		(0.07)
		5.30
Φ (PHI) = −0.82 (0.06); −13.48		

For each parameter, the Table shows the estimated value (the standard error), and the corresponding z. The C/S cost had a non-significant load on the Ihn-Shift factor. For this reason, we also computed a CFA with only eleven variables. The results did not differ, and the C/S cost was, therefore, not excluded.

Emotion-related measures

Confirmatory factor analyses for the emotion-related measures indicated as the best-fitting a four-factor model, coherent with Russel's model [$\chi^2(48) = 136.72$, $p < 0.001$, RMSEA = 0.09, SRMR = 0.08, CFI = 0.93, GFI = 0.91]. The first factor included low arousal and pleasant hedonic tone emotions, with the highest loading for "Relaxed" ($\lambda = 0.84$).

TABLE 2 Lambda-X matrix of the factor loadings for the four-factor model of the attentional style predictors.

	External focus	Internal focus	Narrow focus	Dysfunctional style
BET T1	0.72	—	—	—
	(0.08)			
	9.14			
OET T1	—	—	—	0.56
				(0.07)
				7.63
BIT T1	—	0.89	—	—
		(0.09)		
		9.56		
OIT T1	—	—	—	0.67
				(0.07)
				9.32
NAR T1	—	—	0.78	
			(0.11)	
			6.59	
RED T1	—	—	—	0.60
				(0.07)
				8.20
BET T2	0.92	—	—	—
	(0.08)			
	9.14			
OET T2	—	—	—	0.64
				(0.07)
				8.88
BIT T2	—	0.73	—	—
		(0.09)		
		8.53		
OIT T2	—	—	—	0.65
				(0.07)
				9.03
NAR T2	—	—	0.60	—
			(0.10)	
			6.23	
RED T2	—	—	—	0.65
				(0.07)
				9.11

For each parameter, the Table shows the estimated value (the standard error), and the corresponding z.

TABLE 3 Lambda-X matrix of the factor loadings for the four-factor model of the emotions predictors.

	High arousal	High arousal	Low arousal	Low arousal
	Hedonic tone −	Hedonic tone +	Hedonic tone −	Hedonic tone +
Stressed	0.80	—	—	—
	(0.06)			
	13.04			
Relaxed	—	—	—	0.84
				(0.06)
				14.64
Downhearted	—	—	0.63	—
			(0.08)	
			7.65	
Happy	—	0.78	—	—
		(0.08)		
		9.92		
Tense	0.73	—-	—	—
	(0.06)			
	11.73			
Tired	—	—	0.39	—
			(0.08)	
			4.96	
Excited	—	0.44	—	—
		(0.08)		
		5.85		
Calm	—	—	—	0.82
				(0.06)
				14.14
Stimulated	—	0.59	—	—
		(0.08)		
		7.85		
Depressed	—	—	0.45	.—
			(0.08)	
			5.66	
Angry	0.20	—-	—	—
	(0.07)			
	2.78			
Serene	—	—	—	0.66
				(0.06)
				10.58

The second factor included low arousal and unpleasant hedonic tone emotions, with the highest loading for "Discouraged" (λ = 0.63). The third factor included high arousal and pleasant hedonic tone emotions, with the highest loading for "Happy" (λ = 0.78). Lastly, the fourth factor included high arousal and unpleasant hedonic tone emotions, with the highest loading for "Stressed" (λ = 0.80) (see Table 3 for all loadings). We derived four predictors from the "Circumplex" questionnaire: mean score of the emotions with low arousal and pleasant hedonic tone (Low+: Serene, Relaxed, Calm); mean of the emotions with low arousal and unpleasant hedonic tone (Low−: Discouraged, Depressed, Tired); mean of the emotions with high arousal and pleasant hedonic tone (High+: Stimulated, Excited, Happy); and mean of the emotions with high arousal and unpleasant hedonic tone (High−: Tense, Stressed, Angry).

As control variables, we included age and experience in years of sport practice. Descriptive characteristics of final predictors are presented in Table 4.

Performance measures

For each volleyball player, we calculated a weighted individual index of performance (WIIP). For both observers, the WIIP index was given by the residuals of the regression of the participant's individual ratio (IR) points on ball touches on the weighted game (WG) index. This procedure was meant to weigh the individual volleyball player's performance on team performance. We then assessed the inter-rater agreement between the two judges, namely $r = 0.84$, $p < 0.001$. Therefore, for volleyball performance, we computed a final performance measure for each volleyball player using the mean WIIP between Observer 1 and Observer 2 (Volleyball Performance). A detailed description of the methodology used in the present study is presented in Bisagno et al. (2019).

With respect to the artistic gymnasts' performance, we computed z-scores for each apparatus (i.e., balance beam, floor, uneven bars, and vault). The final performance measure for each artistic gymnast is the mean of her z-scores (Gymnastics Performance).

Main results

Volleyball players

As can be seen in Table 5, in the volleyball players sample, even controlling for age and sport experience, the correlation between the Mcap-Upd factor and the Inh-Shift remained moderately negative ($r = -0.58$, $p < 0.001$). More importantly, the Mcap-Upd factor was the only variable with a significant (weak to moderate) correlation with the volleyball players' performance ($r = 0.33$, $p < 0.001$). This is preliminary evidence for the involvement of general cognitive resources in sport performance.

TABLE 4 Observed variables and derived predictors descriptive characteristics.

Raw data	Mean	St. dev.	Derived predictor	Mean	St. dev.
Mr Cucumber	6.01	1.18	Mcap-Upd	0.00	0.71
DFT	5.26	1.30			
FIT	6.09	1.34			
Keep track (errors %)	0.35	0.12			
N-back (errors %)	0.27	0.08			
Stroop (incongruent errors)	3.07	2.64	Inh-Shift	0.00	0.60
Stroop cost (milliseconds)	143.30	70.00			
Flanker (incongruent accuracy)	0.97	0.04			
Flanker cost (milliseconds)	55.33	36.91			
Color/Shape (shift errors)	0.29	0.12			
Color/Shape cost (milliseconds)	123.32	114.06			
TMT cost (seconds)	30.24	18.93			
BET	4.84	1.36	Ext. focus		
BIT	4.94	1.41	Int. focus		
NAR	3.93	1.68	Narrow focus		
OIT	3.53	1.73	Dysfunctional	3.43	1.16
OET	3.22	1.44			
RED	3.51	1.57			
Stressed	4.33	1.73	High−	4.48	1.36
Tense	5.27	1.64			
Angry	2.27	1.42			
Happy	5.12	1.44	High+	4.93	1.11
Excited	4.55	1.54			
Stimulated	4.91	1.41			
Depressed	1.55	0.90	Low−	2.34	0.87
Discouraged	2.66	1.31			
Tired	2.76	1.44			
Relaxed	2.90	1.41	Low+	3.16	1.36
Calm	2.81	1.66			
Serene	3.92	1.71			

"Mcap-Upd" and "Inh-Shift" have mean zero because they are factorial scores.

TABLE 5 Zero-order and partial correlations between predictors and the volleyball players' performance.

	[1] Mcap-Upd	[2] Inh-Shift	[3] Ext. focus	[4] Int. focus	[5] Narrow focus	[6] Dysfunc. focus	[7] High+ emotions	[8] High – emotions	[9] Low+ emotions	[10] Low— emotions	[11] Volley perf.	Age	Years exp.
[1]	1	−0.607***	0.213*	0.222*	0.202*	−0.167	0.034	0.018	0.037	0.039	0.323***	0.385***	0.205*
[2]	−0.575***	1	−0.079	−0.046	−0.210*	−0.010	0.206*	−0.108	−0.008	−0.157	−0.179	−0.256***	−0.188*
[3]	0.243*	−0.081	1	0.247**	0.098	−0.197*	0.282**	−0.106	0.131	−0.242**	0.177	0.001	0.062
[4]	0.267**	−0.056	0.242*	1	0.238*	−0.127	0.108	−0.094	0.118	−0.086	−0.027	−0.035	0.028
[5]	0.237*	−0.227*	0.098	0.237*	1	−0.354***	0.129	−0.184	0.217*	−0.264**	−0.032	−0.036	−0.018
[6]	−0.223*	0.022	−0.210*	−0.133	−0.356***	1	−0.161	0.295**	−0.308**	0.352***	−0.014	0.120	0.156
[7]	0.002	0.238*	0.283**	0.110	0.133	−0.176	1	−0.217*	0.299**	−0.466***	−0.042	0.087	0.072
[8]	−0.004	−0.097	−0.105	−0.091	−0.182	0.294**	−0.223*	1	−0.729***	0.487***	0.117	0.054	0.030
[9]	0.041	−0.002	0.125	0.114	0.218*	−0.324***	0.298**	−0.732***	1	−0.310**	−0.002	0.021	0.071
[10]	−0.021	−0.125	−0.244**	−0.081	−0.261**	0.344***	−0.485***	0.485***	−0.316**	1	−0.009	0.145	0.091
[11]	0.330***	−0.157	0.166	−0.037	−0.031	−0.047	−0.056	0.115	−0.019	−0.024	1	0.116	0.203*

Zero-order (Pearson) correlations above diagonal. Partial correlations controlled for age and years of sports experience below diagonal. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

We, therefore, ran a hierarchical regression analysis with Volleyball Performance as the dependent variable. Based on a developmental rationale, we entered age and years of sport experience as a first block, Mcap-Upd, and Inh-Shift, which are cognitive functions with a developmental trajectory in a second block, and the attentional styles and emotion-related variables in a third block using a stepwise method. This model accounted for 15% of the variance. Coherently with our predictions, the Mcap-Upd factor was the main predictor (ß = 0.38, $p < 0.001$). The years of sport experience had a ß of 0.28, $p = 0.020$, while age was non-significant. Subsequently, we also ran a regression analysis entering all the twelve variables (Table 6) in one block, which explained 23% of the variance. Again, the main predictor was Mcap-Upd (ß = 0.45, $p = 0.001$), together with the years of sport experience (ß = 0.29, $p = 0.030$), and high arousal and unpleasant hedonic tone emotions (ß = 0.30, $p = 0.029$). This predictor became significant with all predictors entered simultaneously and, therefore, controlling for each other and this result was consistent with the idea that high-arousal emotions were predictive of better outcomes in open-skills sports. These results confirmed H1 and H4. Contrary to H2 and H3, Inh-Shift was not included among the predictors, as well as the attentional styles. Taken these analyses together, the prominent role of WM and updating as predictors of performance in youth volleyball players was the main finding regarding this subsample.

Based on H5, we then tested possible moderation effects of emotions on the relation between WM and performance. First, we tested the "choking under pressure" hypothesis. We considered Volleyball Performance as the dependent variable, Mcap-Upd as the independent variable, and emotions with high arousal and unpleasant hedonic tone (High—) as the moderator. Neither the High— factor [B = 0.01 (0.01), p = ns, 95% CI [−0.005, 0.019]], nor the interaction [B = 0.00 (0.01), p = ns, 95% CI [−0.020, 0.013]] accounted for further variance. Thus, we found no evidence of a

TABLE 6 Regression analysis with the volleyball performance as the dependent variable, and all predictors and control variables entered in the equation.

Predictors		Volleyball performance $R^2 = 0.23$
		B
General cognitive abilities	M capacity-updating	0.446**
	Inhibition-shifting	0.115
Attentional style	External	0.131
	Internal	−0.138
	Narrow	−0.084
	Dysfunctional	0.032
Emotions	High+	−0.167
	High—	0.302*
	Low+	0.209
	Low—	−0.175
Control variables	Age	−0.228
	Years of experience	0.291*

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

detrimental effect of the High— emotions on the relationship between WM and performance and, therefore, H5 was not supported. Moving from these unexpected results, we then further explored possible links between emotions and cognition with additional analyses by looking at the effect of arousal in the four groups described in the Data Analyses section:

- Group A: $n = 40$;
- Group B: $n = 20$;
- Group C: $n = 12$;
- Group D: $n = 42$.

In groups A and B, the Mcap-Upd and the volleyball performance were uncorrelated ($r = 0.15$ and $r = 0.26$,

TABLE 7 Zero-order and partial correlations between predictors and the artistic gymnasts' performance.

	[1] Mcap-Upd	[2] Inh-shift	[3] Ext. focus	[4] Int. focus	[5] Narrow focus	[6] Dysfunc. focus	[7] High+ emotions	[8] High – emotions	[9] Low+ emotions	[10] Low– emotions	[11] Gym perf.	Age	Years exp.
[1]	1	−0.554***	0.242*	0.077	0.007	−0.072	0.017	0.142	−0.082	−0.044	0.056	0.463***	0.352***
[2]	−0.436***	1	−0.237*	−0.110	−0.114	−0.013	−0.027	−0.161	0.032	0.060	−0.038	−0.403***	−0.410***
[3]	0.202*	−0.193	1	0.378***	0.352***	−0.338	0.192	−0.029	0.150	−0.181	0.018	0.123	0.135
[4]	0.130	−0.143	0.391***	1	0.156	−0.247*	0.258**	0.012	0.002	−0.078	−0.061	−0.109	0.047
[5]	0.047	−0.158	0.365***	0.145	1	−0.184	−0.194	−0.054	0.038	−0.087	−0.024	−0.084	−0.014
[6]	−0.182	0.072	−0.371***	−0.235*	−0.172	1	−0.075	0.189	−0.062	0.276**	−0.017	0.182	0.104
[7]	0.028	−0.033	0.194	0.255*	−0.198*	−0.072	1	−0.090	0.257**	−0.235*	−0.035	−0.023	0.015
[8]	−0.026	−0.010	−0.082	0.043	−0.030	0.138	−0.090	1	−0.556***	0.369***	−0.342***	0.335**	0.243*
[9]	−0.008	−0.031	0.172	−0.024	0.021	−0.032	0.255*	−0.543***	1	−0.219*	0.275**	−0.175	−0.052
[10]	−0.122	0.140	−0.205*	−0.075	−0.081	0.261**	−0.237*	0.349***	−0.208*	1	−0.124	0.117	0.120
[11]	0.139	−0.071	0.023	−0.121	−0.052	0.018	−0.050	−0.331***	0.245*	−0.125	1	−0.192	0.101

Zero-order (Pearson) correlations above diagonal. Partial correlations controlled for age and years of sports experience below diagonal. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

respectively). In group C, the correlation was moderately high ($r = 0.64$, $p = 0.020$), while in group D it was low ($r = 0.32$, $p = 0.039$). These findings suggested that emotional arousal played a role in moderating the relationship between WM and volleyball performance not in isolation, but in a specific combination with the hedonic tone. In other words, we did not find a direct moderating effect of High– emotions on the relationship between WM and performance but there was evidence of a moderating effect of specific joint emotional patterns.

Artistic gymnasts

We looked at the correlations between cognitive and emotional measures as predictors of artistic gymnasts' performance (Table 7). The emotional predictors were the only variables related to the artistic gymnasts' performance: Low+ emotions (i.e., serene, relaxed, calm) showed a positive correlation ($r = 0.25$, $p = 0.011$), while High– emotions (i.e., tense, stressed, angry) showed a negative correlation ($r = -0.33$, $p < 0.001$) with the gymnast' scores.

Similarly to the volleyball players, we ran a regression analysis entering age and years of sport experience as a first block, Mcap-Upd and Inh-Shift in a second block, and the attentional styles, and emotion-related variables in a third block with a stepwise method. The model ($R^2 = 0.20$) showed that the high-arousal unpleasant emotions were the main predictor (ß = −0.34, $p = 0.001$), followed by the years of sports experience (ß = 0.32, $p = 0.003$) and by age, which were negative predictors (ß = −0.25, $p = 0.023$). This could be due to the high portion of variance shared with the years of sports experience and means that younger artistic gymnasts either performed generally better than older ones or were judged more favorably. In a second regression analysis (Table 8) we entered all the twelve variables at once. This model accounted for 25% of the variance, and the main predictor was, in this case, age (ß = −0.36, $p = 0.005$), followed by years of sport experience (ß = 0.30, $p = 0.011$) and high arousal and unpleasant hedonic tone emotions (ß = −0.27, $p = 0.030$).

In line with H1, Mcap-Upd did not predict the performance for artistic gymnasts (while it did for volleyball players). Interestingly and partly in accordance with H4, High– emotions (but not Low+ emotions) were the only significant psychological predictors of gymnasts' performance. As further support to our hypothesis that emotions play a key role in determining artistic gymnasts' performance, we additionally examined if they discriminated between higher and lower-level athletes. We, therefore, ran *t*-tests to detect potential differences between Gold and Silver artistic gymnasts with respect to the predictors. The only significant differences were indeed found in emotions, namely Low+ ($t = 2.68$, $p = 0.030$) and High– ($t = -3.63$, $p < 0.001$). In competition, Silver athletes experienced less

TABLE 8 Regression analysis with the artistic gymnastics performance as the dependent variable, and all predictors and control variables entered in the equation.

Predictors		Gym performance $R^2 = 0.25$
		B
General cognitive abilities	M capacity-updating	0.145
	Inhibition-shifting	−0.035
Attentional style	External	0.060
	Internal	−0.092
	Narrow	−0.093
	Dysfunctional	0.067
Emotions	High+	−0.113
	High–	−0.270*
	Low+	0.110
	Low–	−0.034
Control variables	Age	−0.360**
	Years of experience	0.296*

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

Low+ (M_G = 3.17, M_S = 2.40), and more High− (M_G = 4.25, M_S = 5.20). Consistent with the previous regression analyses, this pattern can be interpreted as further proof that emotional control was the main psychological prerequisite for success in artistic gymnastics.

Additional results

In the end, we analyzed in an exploratory fashion the differences between age groups and sports, as well as their interaction with a 3 × 2 [11–12/13–14/15–17 years old × volleyball/artistic gymnastics] multivariate analysis of variance (MANOVA) on all predictors. Findings revealed significant multivariate effects for 11–12 vs. 13–14 and 15–17 years old, Wilks λ = 0.68, $F_{(20,418)}$ = 4.53, $p < 0.001$, ω_p^2 = 0.14 (large effect size), and for volleyball vs. artistic gymnastics, Wilks λ = 0.78, $F_{(10,209)} = 5.95$, $p < 0.001$, $\omega_p^2 = 0.18$ (large effect size), but no "sport × age group" interaction, Wilks λ = 0.90, $F_{(20,418)} = 1.15$, p = ns, $\omega_p^2 = 0.01$. Follow-up ANOVAs revealed significant univariate differences between age groups (see Table 9). Coherently with their developmental nature, age-related differences were found with respect to Mcap-Upd and Inh-Shift. Specifically, the 15–17-year-olds showed more efficient working memory and executive functioning than the 11–12- and 13–14-year-old athletes (both $p < 0.001$, medium-to-large effect sizes). Moreover, univariate differences were found on Int. Focus, as well as on High− emotions and Low− emotions. The older age group seemed to adopt an internal attentional focus more than the younger groups (both $p < 0.050$, small effect size). This group also experienced less High− but more Low− emotions prior to competition compared to younger athletes (both $p < 0.050$, small effect size).

TABLE 9 Univariate comparisons between 11–12 years old (n = 72), 13–14 years old (n = 76), and 15–17 years old (n = 76) on all the predictors.

	Age group	Mean	Std. dev.	F	ω_p^2
M Cap-Upd	11–12 years old	−0.33	0.59	23.858***	0.171
	13–14 years old	−0.08	0.66		
	15–17 years old	0.39	0.68		
Inh-Shift	11–12 years old	0.17	0.55	11.257***	0.083
	13–14 years old	0.08	0.66		
	15–17 years old	−0.24	0.49		
External	11–12 years old	4.66	1.17	1.294	0.003
	13–14 years old	4.96	1.33		
	15–17 years old	4.90	1.17		
Internal	11–12 years old	4.83	1.36	4.408*	0.029
	13–14 years old	5.26	1.16		
	15–17 years old	4.71	1.31		
Narrow	11–12 years old	4.01	1.52	0.783	−0.002
	13–14 years old	4.02	1.47		
	15–17 years old	3.77	1.33		
Dysfunctional	11–12 years old	3.24	1.18	2.395	0.012
	13–14 years old	3.39	1.18		
	15–17 years old	3.65	1.09		
High+	11–12 years old	4.93	1.15	0.179	−0.007
	13–14 years old	4.87	1.11		
	15–17 years old	4.98	1.08		
High−	11–12 years old	4.43	1.34	5.291**	0.032
	13–14 years old	4.22	1.39		
	15–17 years old	4.80	1.31		
Low+	11–12 years old	3.18	1.28	0.740	−0.002
	13–14 years old	3.24	1.39		
	15–17 years old	3.06	1.41		
Low−	11–12 years old	2.28	0.84	4.565*	0.031
	13–14 years old	2.15	0.87		
	15–17 years old	2.57	0.86		

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

Regarding sports, differences emerged between volleyball players and artistic gymnasts with respect to Inh-Shift, High+ emotions, High− emotions, and Low+ emotions (see **Table 10**). Specifically, artistic gymnasts showed better inhibitory and shifting skills ($p < 0.050$, small effect size). Volleyball players, on the other hand, reported less High− emotions ($p < 0.001$, medium effect size), suggesting they were less stressed and tense before competing. Volleyball players also reported more pleasant emotions, both with high ($p < 0.010$, low effect size), and low arousal ($p < 0.001$, large effect size).

Discussion

In this study we aimed to examine the role of cognitive and emotional predictors on sports performance in two sub-samples of youth female athletes practicing volleyball or artistic gymnastics. The Mcap-Upd factor emerged as the main variable that positively predicted successful performance in volleyball. Conversely, High− emotions was the only variable that negatively predicted artistic gymnasts' performance. This contrast between volleyball players' performance, for which the main predictor was represented by a general cognitive construct, and artistic gymnasts' performance, for which the main predictor was represented by their emotional pattern, was consistent with our first hypothesis implying a lower cognitive load for closed-skills sports (Claver et al., 2016).

In volleyball, which is an open-skills sport, the player cannot fully rely on automatisms, because the surrounding environment changes constantly and the athlete is forced to adapt to new stimuli constantly and rapidly. The ability to coordinate and integrate mental schemes becomes fundamental, as well as the ability to update them. This result was also coherent with and added up to other studies that explored the role of WM in motor learning in youth athletes (e.g., Bisagno and Morra, 2018), and decision making in sport (e.g., Furley and Memmert, 2012). Further explanation of the different roles that WM plays in predicting performance in volleyball and artistic gymnastics is offered by dual-process theories (Furley et al., 2015). According to dual-processes theories, Type 1 processes are autonomous and do not rely on WM. In contrast, Type 2 processes require WM to produce an appropriate response to environmental stimuli. What makes a difference between closed- and open-skills sports is also the number of situations in which Type 2 processes are activated. So, if in open-skills sports like volleyball Type 2 processes are heavily involved, in closed-skills sports like artistic gymnastics the performance consists of highly trained routines that do not require a high amount of attentional control. On the contrary, this might even disrupt a fluent execution, causing the so-called "paralysis by analysis" (Baumeister, 1984), which occurs when overinvesting cognitive resources leads athletes to struggle in performing how they otherwise perform routinely.

The Inh-Shift factor predicted neither the artistic gymnasts' nor, contrary to H2, the volleyball players' performance. This result was partially in contrast with studies finding a superiority of open-skills sports' athletes on inhibition (e.g., Wang et al., 2013). Possible explanations for this discrepancy relied on the specific measures we used to test inhibition (previous studies mainly used only response inhibition tasks), or on the factor structure that emerged, which combines inhibition and shifting tasks together. Contrary to H3, also attentional styles were not predictive. This possibly depended on the young age of our sample. Previous studies only investigated elite adult samples (e.g., Nideffer, 1990). Findings suggest that the type of sport can "shape" the attentional focus, so that certain attentional patterns emerged only in elite athletes or specific sports. Still, our research aligned with those studies that do not identify specific attentional patterns as predictors of sports performance in certain sports (e.g., Vallerand, 1983).

In line with H4 and previous research (e.g., Mahoney and Avener, 1977; Pellizzari et al., 2011), the best predictor of artistic gymnasts' performance was High− emotions, which entered the model with a negative coefficient. This result suggested that what makes the difference in artistic gymnastics was indeed the ability to deal with pre-competitive stress. Another hint in this direction emerged from the comparison between categories, showing that emotional patterns also distinguished between

TABLE 10 Univariate comparisons between artistic gymnasts (n = 104) and volleyball players (n = 114) on all the predictors.

	Sports	Mean	Std. dev.	F	ω_p^2
M Cap-Upd	Gymnastics	−0.03	0.68	0.168	−0.003
	Volleyball	0.03	0.74		
Inh-Shift	Gymnastics	−0.08	0.57	4.448*	0.014
	Volleyball	0.08	0.61		
External	Gymnastics	4.68	1.22	3.230	0.010
	Volleyball	4.98	1.23		
Internal	Gymnastics	4.79	1.19	2.894	0.008
	Volleyball	5.06	1.35		
Narrow	Gymnastics	3.89	1.40	0.187	-0.004
	Volleyball	3.97	1.47		
Dysfunctional	Gymnastics	3.54	1.05	1.977	0.004
	Volleyball	3.33	1.25		
High+	Gymnastics	4.67	1.03	10.336**	0.040
	Volleyball	5.15	1.14		
High−	Gymnastics	4.99	1.17	32.982***	0.121
	Volleyball	4.04	1.37		
Low+	Gymnastics	2.57	1.03	45.056***	0.164
	Volleyball	3.68	1.40		
Low−	Gymnastics	2.40	0.87	1.112	0.000
	Volleyball	2.29	0.88		

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

Silver and Gold athletes. The first ones appeared to experience less Low+ and more High− emotions. Since Gold athletes were those who compete at a higher level, this difference can be interpreted as further proof that controlling unpleasant emotions is a fundamental prerequisite for artistic gymnasts to succeed. Considering that Gold athletes started competing professionally at a very young age, emotion regulation training would, therefore, be particularly appropriate for these athletes. Again in line with H4, significant results for emotional aspects in volleyball players (High− emotions with a positive ß) were consistent with the idea that emotions typically considered unpleasant and dysfunctional (e.g., anger, anxiety) can also be predictive of good performance when they are functional for performance, for example in contact sports (Campo et al., 2012). Open-skills sports can therefore benefit from highly arousing emotions, even if unpleasant. Conversely, closed-skills sports could profit from a lower level of High− emotions for a better control.

Regarding the hypothesis that High− emotions can moderate the relationship between WM and sports performance (H5), we found mixed results. Some research evidence suggested that the relationship between emotions and WM can impact performance. With reference to the two modes of an athlete (Furley et al., 2015), according to reinvestment theory (e.g., Baumeister, 1984; Beilock, 2007), anxiety could burden WM and, therefore, determine "paralysis by analysis" that, in turn, would lead the athlete to massively rely on Type 2 mechanisms (those that require the manipulation of a high cognitive load), even when not needed or even harmful. We did not find a direct moderation effect of high-arousal unpleasant emotions on the relationship between Mcap-Upd and performance in the volleyball players' sample. A possible explanation was that discrete emotions (e.g., High− emotions) or the hedonic tone dimension alone were not enough to capture the negative moderation effect. Indeed, we found a significant correlation between WM and performance in participants who scored below of the difference between High− and low-arousal of unpleasant emotions and above the mean of pleasant emotions, and in participants who scored above the mean in the difference between High− and low-arousal emotions in both pleasant and unpleasant emotions. These results suggested a combined moderating role of emotions on the relationship between WM and performance. In other words, being happy to compete can buffer the dysfunctional effect of unpleasant emotions (e.g., anxiety) toward performance.

We also explored age and sport differences among youth athletes. According to the literature, 15–17 years-old athletes showed a better performance than younger athletes (11–14 years old) in WM, updating, and inhibition-shifting tasks. This is consistent with both the TCO (Pascual-Leone and Goodman, 1979; Pascual-Leone, 1987), and the developmental framework of EFs suggesting development until early adulthood (Best and Miller, 2010). Moreover, older athletes also tend to adopt an internal attentional focus more than younger athletes, and experience less High− but more Low− emotions prior to competition. This could be linked to older athletes' better than younger athletes' inhibitory skills that allow them to better focus on their internal resources and regulate their arousal levels.

The finding that artistic gymnasts performed slightly better on the inhibition-shifting tasks than volleyball players did is in contrast with previous research showing that elite athletes practicing open-skill sports perform better in inhibition (e.g., Krenn et al., 2018). However, this could be due to a generally higher level of sports experience, at the same age, of the artistic gymnasts, as suggested in a recent study (Holfelder et al., 2020). Lastly, compared to artistic gymnasts, volleyball players experienced less High− emotions, and more High− (i.e., excitement) and low-arousal (i.e., calm) pleasant emotions. This is in line with a recent study (Pluhar et al., 2019) reporting team sports athletes to be less likely to suffer anxiety or depression than individual sports athletes. These data could be read from a social perspective and liked to perceived social support (Nixdorf et al., 2016), and diffusion of responsibility (Latané and Darley, 1968). Indeed, team sports athletes tend to benefit from perceived social support more than individual sports ones (Rosenfeld and Richman, 1997). Freeman and Rees (2010) found that the stress buffer generated by social support in team sports is also predictive of better self-confidence at an individual level. Moreover, some researchers suggested that team sports offer to the athlete an opportunity to diffuse responsibility among teammates, minimizing the identifiability of one's performance, and therefore reducing pre-competitive anxiety (Scanlan and Lewthwaite, 1984; Freeman and Rees, 2010). Thus, pre-competitive anxiety seems helpful for volleyball players' performance. Moreover, sharing the experience with teammates may evoke happier and less stressful feelings before a competition.

Conclusion

This research presents some limitations. First, we studied only youth female athletes. Further studies should be carried out considering gender differences, as well as developmental processes, in youth sport. Considering gender as mainstreaming, the integration of a gender perspective in every phase of research development is a priority for sport sciences (Bonato et al., 2022). A second limitation pertains to the measures used to assess predictors. In particular, the measures of inhibition and shifting were not highly correlated, and this could have made the composite measure less reliable. Future research should consider using different EFs measures to better explore the role of EFs in predicting youth sports performance. Moreover, given that our purpose was to measure the emotions generally experienced by athletes prior to a competition, we asked participants to recall how they usually felt before competing. However, since many

factors could impact players' emotions experienced in different competitions, future studies could assess individual emotions prior to several competitive events. Third, a wider sample of participants would allow to systematically test the moderation of emotions on all cognitive predictors.

Despite the limitations, to the best of our knowledge, this is the first investigation that offers an integrated approach to the study of cognitive and emotional predictors in youth sport, considering the differences between open- and closed-skills sports. This research has outlined a clear distinction between the prerequisites necessary for effective performance in an open- and a closed-skills sport: general cognitive skills, such as WM capacity and updating, represent fundamental predictors of performance in volleyball, being a sport in which the athletes need to manage constantly a high load of information. Conversely, in artistic gymnastics, what matters most is the ability of gymnasts to manage pre-competitive anxiety. From a practical point of view, this evidence could result in customized psychological skills training programs tailored to match the sport's mental requests for youth athletes.

Surprisingly, developmental research has neglected the examination of sports performance [see Kalén et al. (2021)], while sport is an important area for developmental psychology. This research, feeding into a rather small research line (Vestberg et al., 2012, 2017; Verburgh et al., 2014b; Huijgen et al., 2015; Ishihara et al., 2018) provides insights into the relation between cognition, emotions, and performance in youth sport, from a developmental perspective and with an ecological approach to the study of sports 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 human participants were reviewed and approved by University of Verona (Italy) DEDIPAC WP3.2. Written informed consent to participate in this study was provided by the participants or their legal guardian/next of kin.

Author contributions

EB and FV contributed to the conception and design of the study. EB organized the database and wrote the first draft of the manuscript. EB, FV, and CR performed the statistical analysis. FV, CR, AC, and SR contributed to sections of the manuscript. All authors contributed to the manuscript revision and read and approved the submitted version.

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Conflict of interest

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

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Manuel Gómez-López,
University of Murcia, Spain

REVIEWED BY
Alfonso de la Rubia,
Polytechnic University of Madrid, Spain
Helena Vila,
University of Vigo, Spain

*CORRESPONDENCE
Patrik Drid
patrikdrid@gmail.com

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Mental skills in Serbian handball players: In relation to the position and gender of players

Damjan Jakšić[1], Jovana Trbojević Jocić[2], Stefan Mariči̇ć[1], Bülent O. Miçooğullari[3], Damir Sekulić[4], Nikola Foretić[4], Antonino Bianco[5] and Patrik Drid[1]*

[1]Faculty of Sport and Physical Education, University of Novi Sad, Novi Sad, Serbia, [2]Matica Srpska, Novi Sad, Serbia, [3]Physical Education and Sport Department, Nevşehir Hacı Bektaş Veli University, Nevşehir, Turkey, [4]Faculty of Kinesiology, University of Split, Split, Croatia, [5]Sport and Exercise Sciences Research Unit, University of Palermo, Palermo, Italy

Objectives: Despite the potential link between mental skills and athletic performance, little is done to examine handball players' present level of mental skills concerning their performance. To begin with, the study has three folded aims; the first one is to examine the factor structure of Bull's Mental Skills Questionnaire, which was developed in the United Kingdom to measure selected mental skill, of Serbian athlete population. The second aim is to determine gender differences in those mental skills, and the third aim is to determine differences between the playing positions in the mental skills of handball players to create a mental profile of Serbian handball players.

Materials and methods: The sample consisted of 170 handball players, aged 14 to 39, who have played handball at the semi-elite, competitive-elite, and successful-elite level. The modified exploratory factor analysis was used to determine the latent dimensions of the Bull's Mental Skills Questionnaire. For examining gender differences in the manifestation of mental skills Mann–Whitney *U* test was used.

Results: Compared to the original structure of the questionnaire, which singles out seven factors of mental skills (imagery ability, mental preparation, self-confidence, anxiety and worry management, concentration ability, relaxation ability, and motivation), five factors were singled out in the sample of Serbian male and female handball players (anxiety and concentration management—α = 0.74; self-confidence—α = 0.75; relaxation ability—α = 0.66; mental preparation—α = 0.68, and imagery ability—α = 0.66). With these five subscales as dependent variables, results of the Mann–Whitney *U* test show that there are significant gender differences in variable anxiety and concentration management (U = 2893.5, p = 0.049) and relaxation ability (U = 2833.0, p = 0.031). Female handball players score higher on anxiety and concentration management and lower on relaxation ability. When playing positions are in question, results of Kruskal–Wallis's one-way analysis of variance, i.e., Mann–Whitney's *post hoc* analysis, suggest that statistically

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significant differences were observed between wings and center backs and wings and goalkeepers in the imagery ability.

Conclusion: The Bull's Mental Skills Questionnaire in Serbian sample of handball players show satisfactory psychometric characteristics but has singled out five factors of mental skills compared to the original questionnaire.

KEYWORDS

Bull's questionnaire, mental preparation, handball, gender, team position, mental skills

Introduction

With the development of modern sports, there was a need to further explore the processes, characteristics, and skills of successful athletes in relation to those who do not reach the elite level. The increasingly advanced physical dispositions of today's athletes have indicated that at the top competitive level, the difference between victory and defeat sometimes depends on psychological factors. Among the elite athletes in various sports, the winners of Olympic medals, the following differentiating characteristics were singled out: personal dispositions (such as optimism, adaptive perfectionism, sports intelligence, etc.); psychological skills or states (self-confidence, concentration, an optimal level of arousal, etc.); cognitive and behavioral techniques which athletes use for the purpose of achieving desirable psychological states (goal setting, self-talk, imagination, etc.) (Gould and Maynard, 2009).

However, when discussing the psychological characteristics of successful athletes, the term mental toughness is most often used. This term has been used for more than 20 years, along with terms such as mental strength, mental preparation, mental skills, and psychological skills. The impossibility of defining a clear and precise construct that would refer to the mental profile of highly successful athletes is still one of the challenges of sports psychology. Namely, while some researchers believe that mental toughness is a personality trait, others argue that it is a skill subject to learning, which is relatively stable, but also in interaction with environmental impacts (Gucciardi et al., 2015). In this manner, mental toughness remains primarily a subjective concept, which is most often viewed as a set of beliefs and behaviors of athletes that help them to overcome and master training and competitions (Liew et al., 2019).

One of the first studies to study the mental toughness of athletes is based on the idea that environmental factors (such as parental behavior and relationship with parents, experiences while growing up, socio-cultural background, etc.) form the basis of mental toughness consisting of three categories: strong character, strong attitude, and strong mind (Bull et al., 2005). The environment influences the formation of a strong character through which strong attitudes are manifested, and as the final result, a strong mind appears as a key psychological characteristic of mental toughness (Petrović and Trbojević, 2020). The mental toughness observed in this manner can be manifested in situations of a reversal, critical moments, and situations that require endurance and involve risk management (Bull et al., 2005). In sports, especially in modern handball, where fast reaction, precision, and application of various motor movements are required, along with the quick assessment of the situation and decision-making, these situations are more than everyday occurrence in competitions. In these situations, the athletes have the task of maintaining their self-confidence in moments when the game and their achievement are not favorable, remaining focused during, e.g., shooting the seven-meter throw and regulating emotions under pressure, to endure to the end in a physically demanding match, and to take responsibility for their own actions and decisions. According to Bull and associates, the realization of these tasks is possible due to a strong mental mind.

One of the most current models of mental toughness, which is largely empirically confirmed (e.g., Gucciardi et al., 2009), is a model of Jones et al. (2007), who define mental toughness as innate or learned psychological acuity allowing an athlete to cope more successfully with the demands of the sport than its opponent. This psychological acuity contributes to an athlete being more successful than other athletes in determination, focus, self-confidence, and stress coping (Jones et al., 2002). This understanding and interpretation of mental toughness are one of the most accepted definitions, with critics noting that it also primarily refers to the description of what it allows athletes to do and not what it really is (Crust, 2007). To determine what mental skills make successful athletes, Jones et al. (2007) interviewed Olympic and world gold medalists in various sports. Based on the interviews, the authors singled out four groups of attributes of the mental toughness of successful athletes (**Table 1**). The categories set up in this manner show that there is one general dimension of mental toughness that refers to the general state of mind—a mindset and three dimensions that are characteristic for a certain period of time during sports. According to this model, an athlete uses specific psychological skills for a certain process in sports. Such isolated attributes of mental toughness are consistent with previous studies where the importance of

TABLE 1 Attributes of mental toughness (Jones et al., 2007).

General attitude/ mindset dimension	Training	Competition		Post-competition
Belief	Long term goals as the source of motivation	Belief	Staying focused	Handling failure
Focus	Controlling the environment	Regulating performance	Handling pressure	Handling success
	Pushing yourself to the limit	Awareness and control of thought and feelings	Controlling the environment	

self-confidence, attention, regulation of emotions, and anxiety is emphasized, with the use of techniques such as self-talk, goal setting, visualization, and imagination (Petrović and Trbojević, 2020).

Having in mind the diversity in understanding mental toughness, in this research, we integrate the previously mentioned understandings, and we start from the notion of mental skills, which we regard as a set of learned or innate beliefs, attitudes, emotions, and behaviors that are specific to the sports setting and affect the way an athlete approaches the sport and reacts to different situations of achievement and pressure to achieve success in sports.

One of the questionnaires that found its practical and empirical use in sport is Bull's Mental Skills Questionnaire (Bull et al., 1996), which was developed in the United Kingdom to measure imagery ability (IA), mental preparation (MP), self-confidence (SC), anxiety and worry management (AWM), concentration ability (CA), relaxation ability (RA), and motivation (M) (Bull et al., 1996). Even though there is a number of tools (questionnaires) that test in some way athlete's mental skills, Bull's questionnaire has a more comprehended view of mental skills and has been validated in South Africa and the United Kingdom context (Edwards and Steyn, 2011; Edwards et al., 2011; Edwards and Edwards, 2012), as well as in Turkey (Miçooğullari et al., 2021). The questionnaire was used in different research questions, such as defining psychosocial skills as important for talent development (exp. Olszewski-Kubilius et al., 2019), the relation between mental skills and psychological well-being (exp. Edwards and Steyn, 2008); the relation between mental skills and bowling accuracy (exp. Khan and Mitra, 2020). But, most of these studies haven't applied BMSQ in team sports such as handball. One of the studies that used BMSQ in team sports investigated if athletes from individual sports and athletes from team sports differed in mental skills (Demir et al., 2020) and showed that there were meaningful differences between sport types and mental skills, but there were no meaningful differences between gender and mental skills. Athletes engaged in team sports had higher scores on mental preparation and self-confidence (Demir et al., 2020). Handball is an indoor, collective, and highly dynamic sport involving complex and sudden changes that require quick reaction and a broad focus of attention to adequately assess the position of the opponents and teammates. Research on the mental skills of handball players is still in its infancy, and one recent study compared the mental skills of American football and handball players and found that football players achieve statistically higher scores on confidence, control, and total mental toughness than handball players and that football players achieve lower scores at constancy and anxiety levels compared to handball players (Ekmekçi and Miçooğulları, 2018).

As stated, research into the mental skills of top athletes is a current topic in sports and sports psychology. Regarding data relating to handball, a slightly smaller number of studies can be found that relate to the examination of the psychological characteristics of handball players. Concentration, anxiety management, self-confidence, and motivation have been singled out as specific psychological skills in handball (Thomas et al., 1999; Kiss and Balogha, 2019).

Research on gender differences in athletes' mental skills shows inconsistent data. Namely, although some studies indicate significant gender differences in the degree of emotional regulation in favor of male handball players (e.g., Kristjánsdóttir et al., 2018), no gender differences in the degree of anxiety as a personality trait were found in the sample of Serbian male and female handball players, and male and female Serbian handball players were found to achieve average scores on anxiety as a personality trait (Jakšić et al., 2020). Some studies have found that female football players react and perceive more intense stress and that they experience less control in stressful situations (Kaiseler et al., 2012). Similarly, in the sample of junior female handball players of the Ukrainian national team, the result shows that female handball players achieve higher scores on competitive anxiety and are more prone to self-blame compared to male handball players (Ivaskevych et al., 2019). In the sample of the junior Hungarian handball team, the authors found that male handball players achieved significantly higher scores on Coping with Adversity and Freedom from worry, while female handball players scored higher scores on Goal Setting/Mental Preparation and Coachability (Ökrös et al., 2020). The results suggest that male handball players have fewer concerns about performance and that they have more adaptive coping mechanisms than female handball players, as well as that female handball players, have a more pronounced ability to set goals and use mental preparation as part of their sports experience. Also, compared to male handball players, female handball players follow the instructions of the coach to a greater

extent and better cope with constructive criticism by coaches compared to male handball players.

When it comes to different playing positions in handball and mental skills, research shows that goalkeepers, wings, and playmakers react faster when selecting adequate figures than those in the pivot or back positions (Kiss and Balogha, 2019). On the other hand, one of the few studies that examined the differences in certain psychological characteristics of Hungarian junior male and female handball players in terms of age and the playing position found that playmakers score highest in terms of Ability to concentrate, Coping with Adversity, Peaking under Pressure, Goal Setting/Mental Preparation, Coachability which speaks to the high mental skills of the players in this position (Ökrös et al., 2020). Namely, the playmaker is the leader of the game and, therefore, must be able to change the focus of attention from a wide to narrow focus, stay calm in tense situations and develop an action. Wings achieve slightly higher scores on self-confidence and achievement motivation compared to other playing positions, while goalkeepers score the lowest scores on these characteristics.

One of the goals of this research is to examine the factor structure of Bull's Mental Skills Questionnaire. The questionnaire has not been applied to a sample of Serbian handball players so far. Research conducted outside the Serbian population so far on this questionnaire shows a satisfactory factor structure and application to athletes (Edwards et al., 2014). Bull's questionnaire was selected because it measures a wide range of mental skills which postulate the previously mentioned notions of mental toughness. The second goal of this research is to determine gender differences in the mental skills of handball players. The third goal of the study is to determine differences in relation to the playing positions in the mental skills of handball players in order to create a mental profile of Serbian handball players.

Materials and methods

Study design

We used a cross-sectional correlational design to collect self-report data on mental skills from Serbian handball players.

Sample

The research includes male and female handball players of various competitive ranks. The sample consisted of 170 handball players; male players (N = 99) and female handball players (N = 71), aged 14–39 ($\bar{X}$ = 22.03), who have played handball on at the semi-elite, competitive-elite, and successful-elite level[1] [according to Swann et al. (2015)] between 1 and 25 years ($\bar{X}$ = 9.39). According to the playing position, the sample consisted of goalkeepers (N = 24), wings (N = 44), center backs (N = 27), backs (N = 48), and pivots (N = 27).

Variable

Sociodemographic variables included: gender (male/female), and age (continues variable). Sport participation variables included: level of sports participation (professional or semi-professional), years of training handball (continues variable), and players' position (pivot, wing, goalkeeper, back). Mental skills variables included subscales of Bull's Mental Skills Questionnaire.

Instruments

The Bull's Mental Skills Questionnaire was developed in the United Kingdom to measure imagery ability (IA, items 1–4), mental preparation (MP, items 5–8), self-confidence (SC, items 9–12), anxiety and worry management (AWM, items 13–16), concentration ability (CA, items 17–20), relaxation ability (RA, items 21–24) and motivation (M, items 25–28) from which a total scale score is derived (Bull et al., 1996). The questionnaire consists of 28 items and assesses participants along a 6-point Likert scale, requiring item responses ranging from "strongly agree" to "strongly disagree."

Procedure

Prior to conducting the study, consent was obtained for the use of The Bull's Mental Skills Questionnaire, which was then translated into Serbian for the first time. The translation was done by two researchers: one Ph.D. psychologist and one Ph.D. sports researcher. Evaluators have gone through short training about the proper administration of the questionnaire. During 2018 and 2019, data were collected from handball clubs in the territory of Serbia. Respondents were instructed on the goal of the research, and only athletes who expressed a desire to be part of the research participated. All participants were provided with anonymity, and all ethical principles of research

1 Semi-elite athletes are those whose highest level of participation is below the top standard possible in their sport (e.g., in talent-development programs, competing at second-tier standard or below, etc.); competitive-elite athletes regularly compete at the highest level in their sport (e.g., top divisions/leagues) but have not had any success at that level; successful-elite athletes compete at the highest level, and have experienced some (infrequent) success at that standard (e.g., winning an event or a medal) (Swann et al., 2015).

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were observed. The studies involving human participants were reviewed and approved by the ethical board of the University of Novi Sad, Serbia (Ref. No. 46-06-02/2020-1). Respondents filled out the questionnaire *via* pen and paper in the presence of the evaluator.

Statistical analysis

The modified exploratory factor analysis was used to determine the latent dimensions of the Bull's Mental Skills Questionnaire. Namely, as the data of the questionnaire are of the ordinal type, in the first phase, it was necessary to calculate the correlations between all items by Spearman's procedure, then import the obtained intercorrelation matrix and perform a factor analysis on it. The resulting intercorrelation matrix was then rotated into a more favorable parsimonious promax solution, and the number of significant principal components was determined using multiple criteria (Kaiser–Guttman, parallel analysis, Scree). The most logical solution was taken as acceptable. Differences between male and female handball players in the manifestation of mental skills were obtained by applying the Mann–Whitney *U* test, and the criterion of statistical significance was defined at $p \leq 0.05$. Using the Kruskal–Wallis one-way analysis of variance, differences depending on playing positions were determined, and the *post hoc* analysis was followed by the Mann–Whitney test with the same boundary criterion of statistical significance. For all these statistical analyses and procedures, IBM SPSS Statistics version 26 was used and software package R ver. 4.1.1 while using the following libraries: psych, corrgram, nFactors, ggplot2.

Results

Goal 1: Psychometrics analysis of Bull's Mental Skills Questionnaire

Tables 2, 3 show the main components of the analyzed questionnaire. Based on the conducted factor analysis of the pattern matrix, five factors were defined in relation to seven that the authors of the questionnaire assume. The first factor consists of items related to the athlete's ability to concentrate and the intensity of anxiety and worry they experience. This factor is formed by the items in the original setting on the Anxiety and Worry management factor (Items 13, 14, 16) and the Concentration ability factor (items 18, 19) and item 22. Therefore, in this study, this factor is called Anxiety and Concentration management, which consists of 6 items, where a higher score indicates a lack of ability of the athlete to regulate the degree of anxiety and worry, as well as the inability to focus and concentrate on the task ahead. The internal validity of this factor is 0.74, which indicates a satisfactory validity that does not deviate to a greater extent from the results obtained in the sample of students of sports and physical activity in South Africa, United Kingdom, and Turkey (Table 4). The second factor includes the projection of items related to the athlete's ability to set realistic goals in sports and the belief that he/she can achieve them. Factors that are in the original setting within the Mental preparation (item 5, item 8) and Self-confidence (items 9, 10, 11, 12) factors are projected on this factor. Bearing in mind that item 5 and item 8 describe the belief in the fulfillment of the set goal, their projection of the same factor related to the athlete's self-confidence represents a logical position. Therefore, this factor is called Self-confidence, and its internal validity is 0.75, which is in line with the validity achieved on various samples outside the territory of Serbia. A higher score indicates a higher level of self-confidence. The third factor consists of three items that relate to the athlete's ability to relax and maintain an optimal level of emotional arousal. The factor consists of items that refer to the ability to relax on the original factor structure of the questionnaire, whereby item 22, which refers to the pronounced degree of tension before a competition in our sample, is projected on a factor indicating the athlete's ability to cope with anxiety. Therefore, the third

TABLE 2 Principal components (H), eigenvalues (λ), and percentage of common variance explained (R2)—main components with disturbing ones removed.

Item	H1	H2	H3	H4	H5
mskill1	1.499	2.027	2.218	0.502	1.402
mskill2	1.420	1.754	2.438	−0.107	0.804
mskill4	0.553	1.891	1.932	1.679	−1.449
mskill5	2.046	1.492	−0.340	−1.641	0.141
mskill6	1.078	2.830	−1.610	0.219	0.674
mskill7	1.028	2.411	−1.480	−0.735	−1.411
mskill8	1.553	1.096	0.479	−1.664	−1.732
mskill9	3.082	−2.210	−0.064	−0.769	0.661
mskill10	4.045	−0.890	0.496	−0.432	0.190
mskill11	3.211	−2.001	−0.199	−1.081	0.966
mskill12	3.342	−0.258	−0.442	−0.312	0.637
mskill13	−6.421	0.082	−0.072	−0.262	0.100
mskill14	−5.890	0.095	1.049	0.064	0.409
mskill16	−5.684	0.160	−0.005	−0.570	−0.509
mskill18	−7.135	−1.178	−0.371	0.121	−0.043
mskill19	−7.192	−1.447	0.275	0.162	0.288
mskill21	1.757	−2.563	1.055	−0.040	−0.777
mskill22	−5.586	0.154	−1.432	0.148	0.343
mskill23	3.004	−1.979	0.269	0.519	−0.527
mskill24	2.796	−1.995	−0.071	0.971	−0.950
mskill26	2.423	−0.855	−1.251	1.363	−0.219
mskill27	3.102	0.236	−0.966	0.612	0.565
mskill28	1.968	1.146	−1.911	1.252	0.438
λ	4.20	2.50	2.25	2.36	1.92
R^2	0.32	0.19	0.17	0.18	0.15

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TABLE 3 Pattern (A) matrix and communalities (h2).

Item	A1	A2	A3	A4	A5	h^2
mskill13	0.79	0.11	−0.01	−0.02	−0.02	0.60
mskill18	**0.72**	−0.05	0.05	−0.01	−0.24	0.59
mskill14	**0.72**	0.02	0.04	−0.16	0.24	0.56
mskill19	**0.67**	−0.11	0.06	−0.15	−0.10	0.55
mskill16	**0.67**	0.34	−0.15	−0.06	−0.13	0.54
mskill11	−0.61	**0.52**	−0.12	−0.08	−0.12	0.65
mskill9	−0.52	**0.51**	0.01	−0.11	−0.16	0.59
mskill22	**0.51**	−0.09	−0.17	0.40	−0.20	0.52
mskill8	0.23	**0.67**	0.13	0.03	0.01	0.49
mskill5	0.00	**0.59**	−0.09	0.16	0.10	0.47
mskill10	−0.42	**0.52**	0.09	−0.05	0.07	0.66
mskill12	−0.36	**0.45**	−0.06	0.21	0.00	0.52
mskill24	0.03	−0.06	**0.88**	0.15	−0.09	0.76
mskill23	−0.08	0.02	**0.75**	0.04	0.01	0.65
mskill21	0.06	0.24	**0.71**	−0.27	−0.05	0.57
mskill28	−0.12	−0.06	0.02	**0.77**	0.01	0.62
mskill6	0.08	0.12	−0.13	**0.67**	0.18	0.58
mskill26	−0.17	−0.11	0.38	**0.52**	−0.10	0.51
mskill7	0.17	0.34	−0.03	**0.51**	0.00	0.46
mskill27	−0.13	0.24	0.19	**0.45**	−0.01	0.50
mskill1	−0.17	−0.07	−0.15	0.09	**0.88**	0.76
mskill2	−0.01	0.08	0.01	−0.02	**0.77**	0.65
mskill4	0.24	0.09	0.21	0.11	**0.49**	0.41

Bold values indicate the highest loading (correlation) for each variable (item).

factor is called Relaxation ability and shows a slightly lower internal validity (0.66) in relation to the obtained validity on a sample of African and English students. A higher score indicates the athlete's ability to relax and maintain an optimal level of emotional arousal. Five items are projected on the fourth factor, of which three items are from the original Motivation factor (items 26, 27, 28) and two from Mental preparation (items 6 and 7). Items 6 and 7 focus on the athlete's ability to set specific goals and analyze them after successful or unsuccessful realization, while items 26, 27, and 28 refer to the athlete's ability to get up and activate for competition, which can be seen as a form of mental preparation which is motivational in nature, while items 6 and 7 refer to pre-cognitive mental preparation. Therefore, this factor is called Mental preparation, whose internal validity is 0.68, where higher scores indicate a greater ability to mentally prepare. Three items (items 1, 2, and 4) are projected on the fifth factor, which refers to the athlete's ability to apply visualization and imagination techniques in order to improve the performance of a certain movement. Items that are projected on this factor and in the original setting make up the Imagery ability factor, so in this study, the fifth factor is called Imagery ability, whose internal validity is 0.66. A higher score indicates a higher degree of visualization and imagination.

Based on the selected factors, the differences in mental skills according to gender, playing position, and the competitive rank were examined.

Goal 2: Establishing gender differences in the mental skills of handball players

Based on Table 5, it can be seen that statistically significant differences between male and female handball players in mental skills exist only when it comes to Anxiety, Concentration management, and Relaxation ability. Female handball players score higher on Anxiety and Concentration management and lower on Relaxation ability.

Goal 3: Establishing differences in relation to the playing position in the mental skills of male and female handball players

Playing positions are grouped into goalkeepers, wing, pivotmen, center backs, and backs.

The results presented in Figure 1, obtained by applying the Kruskal–Wallis one-way analysis of variance, and Mann–Whitney's *post hoc* analysis. The results suggest that statistically significant differences in playing positions were observed between male goalkeepers and wings ($Z = 92.00$, $p = 0.020$) in the Imagery ability as well as between center backs and wings ($Z = 104.00$, $p = 0.030$). There were no statistical differences among female handball players between the playing positions.

When we look closely at achieved scores on mental skills, even though they do not statistically differ, they contribute to a better understanding of the mental skill of different playing positions. Among male handball players, center backs achieve the highest scores ($\bar{X} = 15.56 \pm 5.64$) on Anxiety and Concentration management, then wings ($\bar{X} = 14.27 \pm 6.29$), pivots ($\bar{X} = 13.59 \pm 6.59$), goalkeepers ($\bar{X} = 13.20 \pm 7.84$), and backs ($\bar{X} = 13.10 \pm 5.48$). When Self-confidence is regard, pivots achieve the highest scores ($\bar{X} = 30.12 \pm 5.37$), then goalkeepers ($\bar{X} = 29.47 \pm 5.14$), wings ($\bar{X} = 29.23 \pm 5.41$), center backs ($\bar{X} = 29.06 \pm 5.32$), and backs ($\bar{X} = 27.83 \pm 4.67$). Center backs achieve the highest average score on Relaxation ability ($\bar{X} = 13.56 \pm 1.97$), then goalkeepers ($\bar{X} = 13.27 \pm 3.51$) and backs ($\bar{X} = 13.24 \pm 3.02$), pivots ($\bar{X} = 12.76 \pm 4.38$), and wings ($\bar{X} = 11.36 \pm 3.99$). Goalkeepers ($\bar{X} = 24.29 \pm 3.91$), center backs ($\bar{X} = 24.38 \pm 3.48$), and pivots ($\bar{X} = 24.18 \pm 4.14$) achieve higher scores on Mental preparation than wings ($\bar{X} = 23.45 \pm 5.15$) and backs ($\bar{X} = 22.79 \pm 3.95$). And finally, in the factor where significant differences were found, goalkeepers ($\bar{X} = 14.40 \pm 4.19$) achieve the highest scores on Imagery ability,

TABLE 4 Result of reliability analysis (Cronbach alfa) and comparative review of obtained results in South Africa and United Kingdom (Edwards et al., 2014), Turkey (Miçooğullari et al., 2021), and Serbia.

Factor	South Africa sample (n = 211)	United Kingdom sample (n = 209)	Turkish sample (n = 294)	Serbian sample (n = 170)
Imagery ability	0.81	0.44	0.73	0.66
Mental preparation	0.72	0.69	0.52	0.68
Motivation	0.78	0.84	0.64	
Self-confidence	0.70	0.80	0.72	0.75
Anxiety and worry management	0.61	0.66	0.63	0.74
Concentration ability	0.73	0.75	0.71	
Relaxation ability	0.81	0.83	0.69	0.66

TABLE 5 Gender differences in mental skills.

Factor	Male handball players (N = 99)				Female handball players (N = 71)						
	$\bar{X} \pm$ SD	Median	IQR	KS	$\bar{X} \pm$ SD	Median	IQR	KS	U	Z	p
Anxiety and concentration management	13.86 ± 6.21	12	9–20	0.000	15.46 ± 5.60	16	11–19	0.200*	2893.5	−2.0	0.049
Self-confidence	28.98 ± 5.10	30	25–33	0.000	27.87 ± 6.06	29	25–32	0.000	3177.5	−1.1	0.286
Relaxation ability	12.80 ± 3.49	13	10–15	0.006	11.65 ± 3.46	12	9–14	0.200*	2833.0	−2.2	0.031
Mental preparation	23.65 ± 4.17	25	21–27	0.000	24.79 ± 3.93	26	23–27	0.000	2892.5	−1.9	0.061
Imagery ability	12.99 ± 3.62	14	10–16	0.004	13.75 ± 2.89	13	12–16	0.036	3197.0	−1.0	0.313

$\bar{X} \pm$ SD, Mean ± Standard Deviation; IQR, Interquartile range; KS, Kolmogorov–Smirnov test; U, Mann Whitney test; Z, Z-value; p, significance. *Statistically significant difference.

then center backs ($\bar{X}$ = 14.13 ± 2.68), pivots ($\bar{X}$ = 13.41 ± 2.72), backs ($\bar{X}$ = 12.48 ± 3.75), and wings ($\bar{X}$ = 11.55 ± 3.88) (Figure 1).

For female handball players, trends are slightly different. Wings achieve the highest score ($\bar{X}$ = 16.73 ± 6.39) on Anxiety and Concertation management, then goalkeepers ($\bar{X}$ = 16.44 ± 4.95), backs ($\bar{X}$ = 15.42 ± 5.56), center backs ($\bar{X}$ = 14.00 ± 5.69), and pivots ($\bar{X}$ = 13.50 ± 4.17). Center backs ($\bar{X}$ = 29.55 ± 5.54), pivots ($\bar{X}$ = 29.50 ± 2.99), and goalkeepers ($\bar{X}$ = 29.11 ± 4.31) achieve higher scores on Self-confidence then wings ($\bar{X}$ = 27.50 ± 5.96) and backs ($\bar{X}$ = 25.89 ± 7.96). The highest score on Relaxation Ability have center backs ($\bar{X}$ = 12.73 ± 4.34), then wings ($\bar{X}$ = 11.82 ± 3.50), pivots ($\bar{X}$ = 11.60 ± 3.24), backs ($\bar{X}$ = 11.16 ± 3.11), and goalkeepers ($\bar{X}$ = 11.00 ± 3.57). Backs ($\bar{X}$ = 25.95 ± 2.88), center backs ($\bar{X}$ = 25.64 ± 3.64), and goalkeepers ($\bar{X}$ = 25.56 ± 4.03) achieve higher scores on Mental preparation, then pivots ($\bar{X}$ = 25.00 ± 3.65) and wings ($\bar{X}$ = 22.95 ± 4.57). And, on the Imagery ability factor, the highest average score achieved pivots ($\bar{X}$ = 14.50 ± 2.12), then goalkeepers ($\bar{X}$ = 14.22 ± 2.49) and center backs ($\bar{X}$ = 14.18 ± 3.25), backs ($\bar{X}$ = 13.63 ± 2.87), and wings ($\bar{X}$ = 13.09 ± 3.25) (Figure 1).

Discussion

The first goal of the research was to examine the factor structure of the Bull's Mental Skills Questionnaire (Bull et al., 1996), which has not been tested on a sample of Serbian male and female handball players so far. Compared to the original structure of the questionnaire, which singles out seven factors of mental skills imagery ability (IA), mental preparation (MP), self-confidence (SC), anxiety and worry management (AWM), concentration ability (CA), relaxation ability (RA), and motivation (M), five factors were singled out on the sample of Serbian male and female handball players. The first factor, called Anxiety and Concentration management, consists of six items that are originally positioned on the AWM and CA factors of the original questionnaire. A higher score indicates a lack of ability of the athlete to regulate the degree of anxiety and worry, as well as the inability to focus and concentrate on the task in front of him/her. The second factor, called Self-confidence, consists of six items, which are originally positioned on the SC and MP factors of the original questionnaire. Projecting items from the MP factor to the SC factor makes sense when you take into account that items 5 and 8 refer to the athlete's belief in the fulfillment of the set goal. A higher score indicates a higher level of self-confidence. The third factor, Relaxation ability, consists of three items that relate to the athlete's ability to relax and maintain an optimal level of emotional arousal. A higher score indicates a better relaxation ability. The fourth factor, called Mental preparation, consists of five items that are originally positioned on the M and MP factors of the original questionnaire. Guided by the fact that the items relate to the athlete's ability to set specific goals and analyze them after successful or unsuccessful realization and

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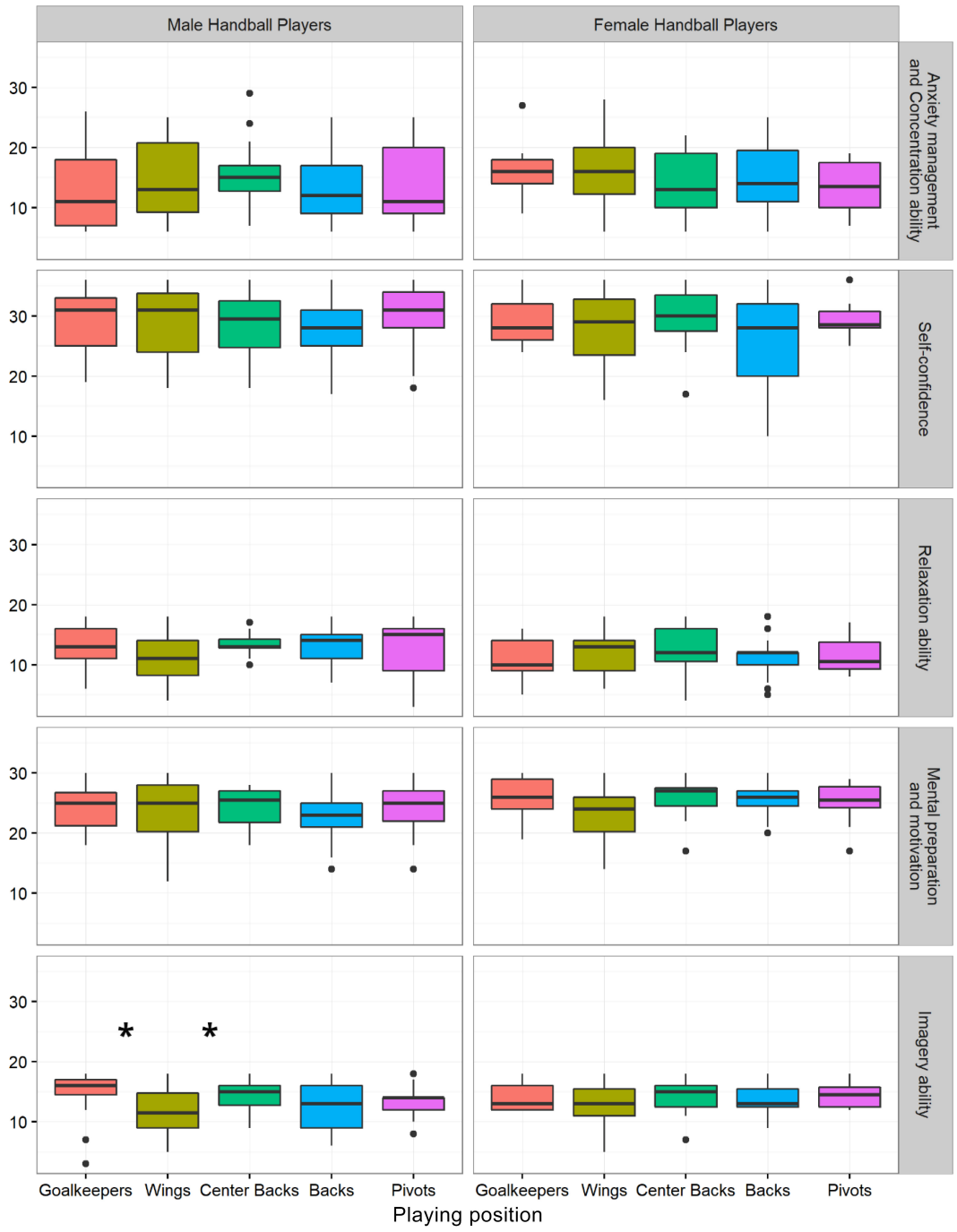

FIGURE 1
Differences in playing positions in the obtained factors. Data shows medians and interquartile ranges: *$p \leq 0.05$.

the ability to raise and activate for competition, the factor is unified by the name "mental preparation"–a type of cognitive and motivational preparation for competition. The fifth factor consists of three items that form the Imagery ability factor in Bull's questionnaire. A higher score indicates a higher degree of visualization and imagination. The internal validity of the factors proved to be satisfactory and similar to the validity obtained in the sample of English, South African, and Turkish respondents (Table 4).

Regarding gender differences in the mental skills of handball players, the obtained results indicate that female handball players show a lower degree of anxiety regulation ability than

male handball players but, on the other hand, show a higher degree of relaxation ability. The obtained results are in line with previous research, which found that female handball players have a somewhat lower ability to regulate emotions and less coping strategies compared to male handball players (Kristjánsdóttir et al., 2018; Ivaskevych et al., 2019; Ökrös et al., 2020). Although the results on gender differences in mental skills are inconsistent, what can be noticed is those female handball players have a higher degree of emotional arousal, which does not have to be a consequence of personality traits, but the situation itself, and that aspects of competitive anxiety and performance concerns are more present with them than with male handball players. The obtained results can be seen from the angle of the sport itself and the sports context. The training process, as well as the attitudes of sports workers toward women's and men's sports, can influence the development of sports settings that stimulate sports self-confidence in male handball players and a climate where female handball players lack emotional support necessary for the development of sports confidence (Trbojević et al., 2020). Handball is often seen as a men's sport, which can contribute to the development of stereotypes and prejudices faced by female handball players, which affect the image of themselves as competent sports persons (Trbojević and Petrović, 2020) and the development of greater concerns about performance. It is evident that sportswomen and sportsmen differ in morphological, motor, and anthropometric characteristics, which may be one of the reasons for the differences in the training process, but one should also keep in mind the social aspect of possible differences.

Playing positions in handball differ, as do the tasks that handball players face in these positions. Thus, a statistically significant difference was obtained in Imagery ability among male handball players, between goalkeepers and wings, and between wings and center backs (**Figure 1**). Handball players in the center position (center backs or playmakers) and goalkeepers achieve significantly higher scores on imagery ability compared to handball players in the wing position. Center backs are often the leaders of the game, and the largest number of ball exchanges takes place between them, while the wings get the opportunity to shoot in a slightly smaller percentage. This can have an effect on abilities to visual and imagine plays and tactics. Center backs are in charge of game dynamic. They have to see where each teammate and opponent are in order to successfully execute the play. The dynamic of the position of center backs, and wings, could be the reason for obtained differences. The physical position of wings is limited; they do not see the whole playing field from the center as center backs do. A significant difference in this ability was obtained between goalkeepers and wings. Like center backs, the goalkeepers have to have a good attention span and be able to predict where the ball will end up. This dynamic of the playing position can demand more abilities in visualization and imagery—as the closest skills to predicting the next move. The goalkeeper does not just "follows" the ball; he also observes the weak spots in the defense line of his teammates, which can contribute to his heightened abilities to imagine and visualize the play or movement. The position of the goalkeeper requires a high degree of concentration and predictions from which angle the shot will follow. Wings, on the other hand, in the very corner of the field and with a smaller number of ball exchanges, are more focused on the segment of the field than on the big picture, which can affect their ability to imagine.

When it comes to female handball players, significant differences in relation to the playing position were not found (**Figure 1**). But from achieved scores on five mental skills of each playing position, we can see those wings achieve the highest score on Anxiety and concentration management and the lowest scores on Imagery ability and Mental preparation. According to the obtained results, it can be noticed that the players in the wing position achieve slightly lower results when it comes to mental skills and that they can be the target group with whom it is necessary to work on mental toughness. The wing is a specific playing position that usually requires sudden and quick assessments and actions, and which again entails a smaller percentage of opportunities to shoot and exchange balls, which makes it difficult to practice and develop self-confidence and mental skills such as regulating emotions in stressful situations.

Obtained results are somewhat in line with previous research that shows that playmakers (center backs) score highest on subscales of mental skills directed toward attention and concentration process, goal-setting abilities, and mental preparation (Ökrös et al., 2020). In our sample, male center backs achieve a higher score on these subscales which is in line with Grobbelaar and Eloff (2011), who found that goal-attack players outperformed the other positional groups in team sports. However, center backs also have greater anxiety and concentration regarding their abilities, which is not in line with previous research. These results are not significantly higher for center backs in relation to other playing positions but are important to point out in order to further investigate do male center backs in Serbian handball have greater anxiety, what type is it, and is it a question of cultural and Serbian training process of center backs.

Wings, both in male and female samples of handball players, show slightly lower mental skills. Compared to previous research that found that players in these positions score higher on self-confidence and achievement motivation (Ökrös et al., 2020), the Serbian sample of wings players achieved high scores on anxiety, moderate self-confidence, and the lowest abilities of relaxation and imagination compared to other positions. It can be seen that players in the wing position would benefit most from working on mental skills, as well as players in the center back position in the form of the development of strategies to reduce competitive anxiety. These results invite sports experts to reinvestigate the game tactic and training program in Serbian handball.

Conclusion

- The internal validity of the factors of the Bull's Mental Skills Questionnaire proved to be satisfactory and similar to the validity obtained in the sample of English, South African, and Turkish respondents.
- Compared to the original structure of the questionnaire, which singles out seven factors of mental skills (imagery ability, mental preparation, self-confidence, anxiety and worry management, concentration ability, relaxation ability, and motivation), five factors were singled out in the sample of Serbian male and female handball players (anxiety and concentration management; self-confidence; relaxation ability; mental preparation, and imagery ability).
- Male and female handball players differ statistically significantly in the degree of emotional regulation, whereas male handball players show a higher degree of emotional regulation and the ability to concentrate compared to female handball players. Results regarding gender differences in sports are often non-consistent, which is why it is necessary to continue investigating and observing if those differences influence sports achievement and the wellbeing of athletes. In the Serbian sample, obtained differences may be the result of the social aspect of handball.
- Male handball players differ in Imagery ability in relation to the player's position. A significant difference was obtained between the wing players and goalkeepers and wings and center backs. Players in the wing position achieve the lowest score on Imagery ability. Significant differences in relation to playing position were not obtained in female handball players. These results indicate the need to work with players in the wing position on the development of mental skills (reduction of emotional arousal, relaxation, and imagination skills); and with players in the center backs position to develop strategies to reduce competitive anxiety. Also, the result indicates the need to work with all-female players on the development of mental skills aimed at emotional regulation, especially with female players in the wing position, in order to improve emotional regulation.
- Obtained results invite further investigation of handball players mental skills in relation to age, level of sports participation, and interaction between mental skills and other individuals (personality traits, goal orientation, motivation) and situational factors (exp. motivational climate, sport achievement, type of coaching. . .).
- In line with the understanding that mental skills can be taught, further research should focus on investigating the effects of mental training programs for handball players.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Ethical Board of the University of Novi Sad, Serbia (Ref. No. 46-06-02/2020-1). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

DJ and JT contributed to the experimental design, data collection and analysis, and drafting of the manuscript. BM contributed to the experimental design and revision of the manuscript. SM and NF contributed to the data collection and examined the study. DS, AB, and PD conceived of and examined the study and revised the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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EDITED BY
Manuel Gómez-López,
University of Murcia, Spain

REVIEWED BY
João Carlos Alchieri,
Universidade Federal do Rio Grande do Norte, Brazil
Sadeel Shanshal,
University of Mosul, Iraq
Stela Maris Aguiar Lemos,
Universidade Federal de Minas Gerais, Brazil

*CORRESPONDENCE
Isabel Vieira
isabelvieira@esdrm.ipsantarem.pt

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Quality of life of fitness professionals in Portugal: Comparative and correlation study

Isabel Vieira[1,2,3]*, Dulce Esteves[3,4], Liliana Ramos[1,2], Vera Simões[1,2] and Susana Franco[1,2]

[1]School of Sports of Rio Maior, Polytechnic Institute of Santarém, Rio Maior, Portugal, [2]Quality of Life Research Center (CIEQV), Santarém, Portugal, [3]Department of Sport Sciences, Faculty of Social and Human Sciences, University of Beira Interior, Covilhã, Portugal, [4]Research Centre in Sports Sciences, Health Sciences and Human Development (CIDESD), Vila Real, Portugal

Fitness has been revealing a positive impact on the quality of life (QoL) of practitioners and fitness professionals (FPs) represent a role model for their customers in the fitness industry, emphasizing the need to know their QoL indices. The purpose of this study is to characterize the QoL of FPs in Portugal, compare it between groups and correlate QoL with sociodemographic and work-related variables. A total of 388 FPs answered an online survey about sociodemographic and work-related variables and the Portuguese version of the World Health Organization Bref QoL Assessment. Descriptive analysis, *t*-test, ANOVA, Kruskal-Wallis, Pearson and Spearman were used for statistical analysis. The results suggest that FPs in Portugal have different levels of QoL, considering the high standard deviation, with lower average indices than other countries. The lowest scores of QoL were verified in the environment domain. The results of the comparison between groups suggest that being male, married and having a master's degree or higher were the characteristics with better indices of QoL. Age, professional experience and net salary reveal a positive relation/association with QoL. Body&mind group classes (GC) per week, maximal GC per day, paid and unpaid working hours per week and annual expenses related to the profession reveal a negative relation/association. Maximal GC per day results could be an important finding to help minimize the physical problems among FPs and body&mind GC per week results could be an indicator of the FPs adaptation that allows them to remain on the profession. Unpaid working hours per week has the highest number of significant relations/associations with QoL. These findings could be important to improve the QoL of FPs. Thus, they could result in better work capacity and, therefore, fewer professionals would abandon the profession. It would also have a positive impact on the fitness industry and on the promotion of physical activity for a healthier society. More research is needed regarding the QoL of FPs.

KEYWORDS

fitness, fitness professionals, quality of life, WHOQOL-Bref, job characteristics

Introduction

Quality of life (QoL) represents an important concept in health and medicine fields (Harper et al., 1998; Haraldstad et al., 2019). The World Health Organization (WHO) defines QoL "as individual's perception of their position in life, in the context of the culture in which they live and in relation to their goals, expectations, standards, and concerns" (Kuyken and The WHOQOL Group, 1995, p. 1405; Harper et al., 1998, p. 551). Minayo et al. (2000) add that the notion of QoL also includes the idea of sustainable development. According to a preliminary reflection on the United Nations "New Agenda" (Okado and Quinelli, 2016), the first dimension of the global megatrends 2,030 and sustainable development goals point to a new population profile, who tend to require better public policies and higher QoL from governments.

According to the Ottawa Charter (World Health Ognanization [WHO], 1986), health is an important dimension of QoL and a considerable resource for social, economic, and personal development. Since QoL is an important measure of health impact, there is a recent interest in its measurement in public policies (Campos and Neto, 2008).

Physical activity plays an important role in a healthy lifestyle and fitness has been revealing a positive impact on the QoL of the practitioners (Puciato et al., 2017; Barranco-Ruiz et al., 2020; Soares-Miranda et al., 2021). This positive relation/association has been reported in general QoL and in different domains (physical, psychological, social relations, and environment), at different ages, in healthy populations or in a population with a problem or pathology. Fitness professionals (FPs), through their intervention, contribute to the improvement of the QoL of their customers. However, few studies have been found about the QoL of these professionals.

In 2019, the global fitness industry had approximately 184 million customers and nearly 210,000 gyms/health clubs around the world (International Health Racquet & Sportsclub Association [IHRSA], 2020). In 2020, the COVID-19 pandemic led to the permanent closure of 17% of clubs in the United States and 40–50% in other countries (International Health Racquet & Sportsclub Association [IHRSA]., 2021). In the European market alone 1.4% of the clubs were closed and 15.4% of memberships were canceled (compared to 2019) (Rutgers et al., 2021). According to the Fitness Barometer 2020 (Pedragosa and Cardadeio, 2021), there was a 22.9% decrease in the average number of memberships in the fitness sector in Portugal, 27% of fitness clubs closed down and there was an 18.7% decrease in the number of fitness instructors in the industry. In Portugal's Fitness Barometer 2021 (Pedragosa et al., 2022), the decrease continues in the number of practitioners (491,355 in 2020 to 465,600 in 2021) and in the number of FPs working full-time in one gym or gym company (less 1.73% than in 2020). In 2021, there were 21,946 FPs titles in Portugal, 16,604 of which were Physical Exercise Technician (TEF) and 5,342 Technical Director (DT) (Instituto Português do Desporto e Juventude [IPDJ], 2022). Europe Active 2022 report (Rutgers et al., 2022) reveals a small recovery of the fitness industry in 2021, comparatively to 2020. However, the fitness industry is still struggling, considering the decline of 11.4% in revenues. In addition, this could also have implications on the QoL of FPs. On the other hand, QoL is associated with job satisfaction (Faragher et al., 2005; Bevilacqua et al., 2014; Neto et al., 2020), which is considered to be the most important factor that predicts turnover intention in many studies (Alam and Asim, 2019). Consequently, the information regarding the QoL of FPs could be helpful for the recovery of the fitness industry.

A pilot study conducted in Portugal (Vieira et al., 2019) reveals that FPs have positive perceptions about their QoL. The average score of Overall QoL and General Health (OQoLGH) was 79.4. The physical and social relations domains presented the highest scores (80.8 and 80.7, respectively), followed by the psychological (79.4) and the environment (73.5) domains. Despite these results, FPs are exposed to certain factors that may influence their QoL and some of them are related to the work context. According to Neto et al. (2020), QoL is associated with job satisfaction and ability to work. However, the routine of these professionals presents characteristics of an extensive workload and broad physical effort, which can interfere with their perception of QoL.

To Faragher et al. (2005), the consequences of lower levels of job satisfaction could interfere with physical and mental health, QoL, stress, self-esteem, and individual life. Marín-Farrona et al. (2021) suggest that better working conditions reduce the FPs response to stress.

A recent study on job satisfaction of FPs in Portugal (Ramos et al., 2021a) showed that lower degrees of job satisfaction were regarding salary, opportunities for promotion and stability at work. A characterization study of FPs in Portugal (Ramos et al., 2021b) reveals that 42% of FPs work 34 h per week (hours/week) or less in fitness and 37.7% reconcile the career in fitness with another job. Data from the Portuguese Fitness Barometer 2020 (Pedragosa and Cardadeio, 2021) shows that only 26% of FPs work full-time at one gym or gym company and 43% work less than 20 h/week. The number of FPs working full-time at one gym or gym company decreased from 9,822 in 2020 to 9,652 in 2021 (Pedragosa et al., 2022). In the characterization study of FPs in Portugal (Ramos et al., 2021b), it was found that most FPs are independent workers (68.1%) and the net salary received is between €631,98 and €842,63, despite that 86.2% had a bachelors' degree or higher.[1] The functions that are mostly performed are directly related to exercise. On the top of the list are the fitness group classes (GC) (82.02% of the FPs perform this function, with a weekly average of 8.66 h). This can represent a concern because

1 At the time of the questionnaire the minimum salary in Portugal was around €700.

many studies are highlighting the physical problems of FPs of GCs.

In 1988, FPs of GCs had twice the probability to be injured as the practitioners of those classes (Garrick et al., 1986). In 2001, the reported rate of injury among aerobic class FPs in Sydney (Australia) was 77% (du Toit and Smith, 2001). 15 years later, a survey of Zumba class dancers revealed that the odds of injury were seven times greater for registered instructors than for class practitioners (Domene et al., 2017). Recent research about FPs of GCs in Norway refers the need to limit the weekly number of GCs (instruction loading), especially for classes with high metabolic and/or mechanical loading (Bratland-Sanda et al., 2015). The instruction of exercise classes can be considered as an area of performance, which can be more physically and mentally demanding than participating in such classes (Bratland-Sanda et al., 2015).

There are also reports of other health problems related to this profession. The prevalence of urinary incontinence in Scottish fitness instructors was 28.2% (Stephen et al., 2018). The most frequent form of urinary incontinence in women is stress urinary incontinence (Bø, 2004) and the highest prevalence is found in sports involving high impact (Bø, 2004; Dias et al., 2017). This problem is socially embarrassing and may cause withdrawal from social situations and reduced QoL (Bø, 2004). The high impact (Weintraub, 1994; Palma et al., 2009) and the level of noise (Weintraub, 1994; Palma et al., 2009; Beach and Nie, 2014; Wolniakowska et al., 2021) have also been related/associated with hearing problems and/or hearing loss in FPs. In recent research (Overgaard et al., 2021), hearing loss appears to be closely related to poor QoL. Vocal problems have also been a concern among FPs of GCs (Rumbach, 2013; Rumbach et al., 2015; Dallaston and Rumbach, 2016; Fontan et al., 2017; Aiken and Rumbach, 2018; Estes et al., 2020; Philip et al., 2021; Venkatraman et al., 2021). Research in Australia (Rumbach et al., 2015) shows that approximately 39% of the FPs of GCs reported chronic hoarseness. According to Naqvi and Gupta (2022), partial or total loss of voice may lead to several implications on QoL, since it represents an important instrument for human communication and social interaction. In addition to all these issues, there is a need to address mental health problems among FPs. Mathisen et al. (2021) found a high frequency of sexual harassment experiences and significantly higher scores in symptoms of depression, anxiety and eating disorders among woman that reported it. The prevalence of compulsive exercise and eating disorders in FPs is higher than in the general adult population (Gjestvang et al., 2021). Fitness instructors reported that the body appearance pressure affects them negatively and this may put them at risk of impaired mental health (Mathisen et al., 2020). Most of these professionals believe that their employers give real importance to body appearance (Mathisen et al., 2020).

QoL has been a concern in many populations and FPs should be no exception. The information presented above identifies aspects that may affect the QoL of FPs. Thus, it has been a growing concern in this sector. Despite having an important role in health promotion, the growth/recovery of the fitness sector cannot be achieved in a sustainable way without considering the QoL of its professionals.

Therefore, the aim of this study is to assess the QoL of FPs in Portugal. The objectives are to analyze and compare the QoL of FPs indices concerning gender, marital status, professional title and educational qualification groups, and analyze and correlate the QoL of FPs' indices with age, number of children, professional experience (years), number of GC/week, number of cardio GC/week, number of strength GC/week, number of mixed GC/week, number of body&mind GC/week, maximal number of GCs per day (GC/day), number of paid working hours/week, number of unpaid working hours/week, monthly net salary, and annual expenses related to the profession.

Materials and methods

Participants

The inclusion criterion for this study was: working in the Portuguese fitness industry as a FP with a valid title of TEF or DT. One of the specific criterion to be able to answer the questions concerned with the fitness group class variables was to be performing the function of group class instruction. All the participants that did not complete the QoL questionnaire were excluded from the study. The sample of this study is a convenience sample since the questionnaire was not disseminated to the entire population of FPs working in the Portuguese fitness industry. Of the participants who answered the questionnaire, 388 were considered eligible for this study. Two hundred and ninety-nine individuals answered the questions related to fitness GCs. Regarding socio-demographic characteristics (**Table 1**), 51.7% of the participants are female and 48.3% are male. The average age is 30.58 ± 7.60 years and the average number of children is 0.34 ± 0.79. Concerning marital status, 66.0% of the participants are single, 16.8% are married, 13.4% are in a non-marital partnership and 3.9% are divorced. Most of the professionals have a bachelor's degree (69.6%), followed by 18.0% with a master's degree or higher and 12.4% with a high school level or lower. The participants of this study have an average of 6.96 ± 6.75 years of professional experience and include 56.2% TEFs and 43.8% DTs. The average paid working hours/week are 39.45 ± 19.67 and the unpaid working hours/week are an average of 9.12 ± 7.48. Considering the net salary, 10.3% of the participants earn less than €421,31 per month, 15.6% between €421,32 and €631,97, 25.2% between €631,98 and €842,63, 18.8% between €842,64 and €1.053,29, 12.7% between €1.053,30 and €1.263,95, 7.4%

between €1.263,96 and €1.685,27, 5.8% between €1.685,28 and €2.106,59, and 4.0% between €2.106,60 and €2.527,91. Regarding the annual expenses related to the profession, 26.3% spent less than €1.001, 25.8% between €1.001 and €2.100, 22.9% between €2.101 and €3.287, 5 and 25.0% more than €3.287, 5. Concerning the variables of fitness GCs, the average number of fitness GC/week is 9.19 ± 6.85, whereas per typology cardio GC/week is an average of 2.92 ± 4.09, strength GC/week is 2.23 ± 3.03, mixed GC/week is 2.73 ± 5.03 and body and mind GC/week is 1.31 ± 2.42. On average, the GCs FPs instruct a maximum of 3.60 ± 2.11 of GC/day.

Instruments and procedures

The Portuguese version of the WHOQOL-Bref questionnaire was used (Vaz Serra et al., 2006) to measure the QoL of FPs in Portugal. The WHOQOL-Bref arises from the need for an assessment tool that measures the QoL, which is easy to apply and quick to complete, providing a valid and reliable alternative to the large version of the WHOQoL-100 (Harper et al., 1998; Vaz Serra et al., 2006). This questionnaire consists of 26 items designed to assess four domains related to QoL, physical, psychological, social relations, and environment as well as one facet of OQoLGH (Harper et al., 1998). OQoLGH facet comprises only 2 items, the OQoLGH, and the remaining 24 items are distributed throughout the domains. The physical domain comprises 7 items: pain, energy, sleep, mobility, activities, medication, and work. The psychological domain covers 6 items: positive feelings, thinking, self-esteem, body, negative feelings, and spirituality. The social relations domain includes 3 items: relationships, support and sex. Finally, the environment domain contains the remainder 8 items: safety, home, finances, services, information, leisure, environment, and transport (Harper et al., 1998). Each item is classified by the respondents using a 5-point Likert interval scale of intensity, capacity, frequency, and evaluation (Skevington et al., 2004). The result scores for OQoLGH and the four domains were transformed into an 100-point scale. A questionnaire of sociodemographic and work-related variables of FPs intervention, developed and validated for this study, was also applied (Ramos et al., 2021b). The information was collected between November 2019 and March 2020. To avoid the data not being accurate because of the changes caused by the isolation decreed in Portugal in March, in response to the presence of coronavirus disease (COVID-19), the collection of data was finished before what was initially stipulated. The questionnaires were available on SurveyMonkey, an online platform, and disseminated through social networks, fitness sector associations, higher education institutions and training providers as well as at fitness events and conventions.

TABLE 1 Descriptive statistics of the variables.

	Frequency (%)
Gender	
Female	51.7
Male	48.3
Marital status	
Single	66.0
Married	16.8
Divorced	3.9
Non-marital partnership	13.4
Educational qualifications	
High school or level lower	12.4
Bachelor's degree	69.6
Master's degree or higher	18.0
Professional title	
TEF	56.2
DT	43.8
Net salary	
< 421,31€	10.3
421,32 to 631,97€	15.6
631,98 to 842,63€	25.2
842,64 to 1.053,29€	18.8
1.053,30 to 1.263,95€	12.7
1.263,96 to 1.685,27€	7.4
1.685,28 to 2.106,59€	5.8
> 2.106,59€	4.0
Annual expenses related to the profession	
< 1.001€	26.3
1.001 to 2.100€	25.8
2.101 to 3.287,5€	22.9
> 3.287,5€	25.0
	M* ± *SD
Age	30.58 ± 7.60
Number of children	0.34 ± 0.79
Professional experience	6.96 ± 6.75
GC/week	9.19 ± 6.85
Cardio GC/week	2.92 ± 4.09
Strength GC/week	2.23 ± 3.03
Mixed GC/week	2.73 ± 5.03
Body&Mind GC/week	1.31 ± 2.42
Maximal GC/day	3.60 ± 2.11
Paid working hours/week	39.45 ± 19.67
Unpaid working hours/week	9.12 ± 7.48

Statistical analysis

The SPSS program version 27.0.1 was used for statistical data treatment. Descriptive statistics, using central tendency (mean) and dispersion (standard deviation) measures, were applied to the OQoLGH and to all domains of QoL, previously

TABLE 2 Descriptive statistic of QoL.

	$M \pm SD$
OQoLGH	71.07 ± 16.64
Physical	74.56 ± 15.18
Psychological	72.67 ± 14.22
Social relations	72.23 ± 18.63
Environment	65.58 ± 14.63

converted to a 100-point scale. These statistical techniques were also applied to quantitative characterization variables (age, number of children, professional experience, GC/week, cardio GC/week, strength GC/week, mixed GC/week, body&mind GC/week, maximal GC/day, paid working hours/week, and unpaid working hours/week). In the descriptive analysis of the remaining characterization variables (gender, marital status, educational qualifications, professional title, net salary, and annual expenses related to the profession), a frequency analysis was used. Normal distribution was assumed for all the variables that had, at least, 30 individuals per group, based on the Central Limit Theorem (Pestana and Gageiro, 2020). Regarding group comparison, the *T*-test was applied on dichotomic variables and ANOVA was used when in the presence of more than two groups. The resource for Kruskal-Wallis non-parametric statistic test was needed for the variable with three or more groups, with less than 30 individuals, and without a normal distribution. ANOVA was complemented with Tukey's or Games-Howell *post hoc* (if the variances were found to be homogenous, or not homogenous, respectively, according to Levene's test) (Pestana and Gageiro, 2020). The Bonferroni test was the *post hoc* used with Kruskal-Wallis. The effect size was calculated for all the comparisons. To correlate QoL scores with other variables, Pearson's correlation coefficient was used for scale variables and Spearman association for ordinal variables (net salary and annual expenses related to the profession). The level of significance adopted was $p < 0.05$.

Results

The results of QoL of FPs (Table 2) reveal the highest indices in the physical domain, with a mean of 74.56 ± 15.18, followed by psychological and social relations domains (72.67 ± 14.22 and 72.23 ± 18.63, respectively). The OQoLGH had a mean of 71.07 ± 16.64 and the lower indices were verified in the environment domain (65.58 ± 14.63).

Concerning the comparison between groups (Table 3), significant differences were observed in physical, psychological, and environment domains on three different variables: gender, marital status, and educational qualifications. In gender, males have average scores higher than females in all domains, including OQoLGH. The differences in marital status were verified between married and divorced groups in the three domains identified above, between married and single groups in the psychological domain and between single and divorced groups in the environment domain. The highest mean scores in all domains, including OQoLGH, belong to the married group and the lowest to the divorced. All the significant differences reported above revealed a low effect size. When it comes to educational qualifications, there were significant differences between master's degree or higher group and bachelor's degree group regarding physical and psychological domains, and master's degree or higher group and high school level or lower group concerning the environment domain. The group with a master's degree or higher always reveals the best average scores. The significant differences in this variable have a very low effect size. No differences were found between groups according to the professional title. The DTs averages are very similar to the TEFs group, however, DTs show the greatest QoL indices average in almost all domains. The QoL average of the environment domain was the lowest in all groups, regardless of the variable (gender, marital status, educational qualifications, or professional title).

Regarding the correlation and association results (Table 4), unpaid working hours/week is the only variable that established a significant correlation with all domains, including OQoLGH. The level of correlation was considered very low with OQoLGH, physical and social relations domains, and was considered low with psychological and environment domains. This is the only variable with low effect size results. All the other significant correlations/associations that were found, indicated a very low effect size. It is important to emphasize that all correlations with this variable were negative, that is, as the number of unpaid working hours/week increases, the QoL indices decrease. This negative correlation/association trend in all domains and OQoLGH can also be observed with other variables (body&mind GC/week; maximal GC/day; paid working hours/week and annual expenses related to the profession). However, not all of them reveal the existence of a significant correlation/association. The opposite (positive correlation/association trend in all domains and OQoLGH) can be observed with age, professional experience and net salary variables.

The professional experience variable also reveals many significant correlations with the QoL of FPs. Positive correlations can be observed with OQoLGH, physical, psychological, and environment domains. Age and net salary variables reveal both significant correlations/associations, with positive correlations/associations with OQoLGH, psychological and environment domains. The number of children variable reveals a positive correlation with OQoLGH and with the psychological domain. Maximal

TABLE 3 Comparative statistics of QoL between groups.

	OQoLGH		Physical		Psychological		Social relations		Environment	
	M ± SD	*T*-TEST EFFECT SIZE	M ± SD	*T*-test Effect size	M ± SD	*T*-test Effect size	M ± SD	*T*-test Effect size	M ± SD	*T*-TEST Effect size
Gender										
Female	69.72 ± 15.71	0.119–0.160	72.63 ± 14.69	0.005*–0.289	70.25 ± 13.56	<0.001*–0.364	71.90 ± 17.57	0.651–0.046	63.74 ± 13.61	0.011*–0.262
Male	72.38 ± 17.60		76.96 ± 15.28		75.36 ± 14.54		72.76 ± 19.67		67.56 ± 15.50	
Professional title										
TEF	70.47 ± 17.11	0.442 –0.082	74.39 ± 15.50	0.809–0.025	73.03 ± 14.62	0.571 0.058	71.83 ± 19.98	0.623–0.049	65.07 ± 14.58	0.437–0.080
DT	71.84 ± 16.04		74.77 ± 14.79		72.21 ± 13.72		72.75 ± 16.78		66.23 ± 14.71	
	M ± SD	**ANOVA effect size**	**M ± SD**	**ANOVA effect size**	**M ± SD**	**ANOVA effect size**	**M ± SD**	**ANOVA effect size**	**M ± SD**	**ANOVA effect size**
Educational qualifications										
High school level or lower	67.97 ± 17.85	0.055 0.015	74.55 ± 15.57	0.033*[a] 0.18	72.74 ± 15.35	0.024*[a] 0.019	71.18 ± 22.01	0.612 0.003	61.91 ± 14.72	0.017*[b] 0.21
Bachelor's degree	70.60 ± 17.00		73.47 ± 15.48		71.59 ± 14.50		71.91 ± 18.59		65.22 ± 14.55	
Master's degree or higher	75.00 ± 13.63		78.78 ± 13.04		76.79 ± 11.52		74.17 ± 16.25		69.46 ± 14.25	
	M ± SD	**Kruskal-Wallis effect size**	**M ± SD**	**Kruskal-Wallis effect size**	**M ± SD**	**Kruskal-Wallis effect size**	**M ± SD**	**Kruskal-Wallis effect size**	**M ± SD**	**Kruskal-Wallis effect size**
Marital status										
Single	70.70 ± 16.34	0.143 0.159	74.96 ± 14.56	0.044*[c] 0.232	71.37 ± 13.99	0.003*[c,d] 0.339	72.82 ± 18.56	0.110 0.179	65.28 ± 14.81	0.002*[c,e] 0.354
Married	74.81 ± 15.86		76.37 ± 15.58		77.88 ± 13.99		75.77 ± 14.03		69.95 ± 13.39	
Divorced	64.17 ± 18.22		63.81 ± 16.74		67.22 ± 16.81		60.56 ± 23.03		55.42 ± 10.19	
Non-marital partnership	70.19 ± 18.05		73.42 ± 16.30		74.12 ± 13.34		68.27 ± 21.07		64.48 ± 14.78	

*Significant differences for $p < 0.05$.
[a]Differences between Bachelor's degree/Master's degree or higher.
[b]Differences between High school level or lower/Master's degree or higher.
[c]Differences between Married/Divorced.
[d]Differences between Single/Married.
[e]Differences between Single/Divorced.

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TABLE 4 Correlation/association statistics of QoL with the variables.

	OQoLGH		Physical		Psychological		Social relations		Environment	
	R	*p*	*R*	*p*	*R*	*p*	*R*	*p*	*R*	*p*
Age	0.113	0.026*	0.092	0.070	0.186	0.000*	0.016	0.750	0.157	0.002*
Number of children	0.104	0.041*	0.028	0.584	0.139	0.006*	−0.027	0.596	0.087	0.088
Professional Experience (years)	0.106	0.037*	0.102	0.044*	0.181	< 0.001*	0.005	0.920	0.147	0.004*
GC/week	0.016	0.779	−0.071	0.222	0.029	0.620	−0.001	0.984	−0.022	0.708
Cardio GC/week	0.029	0.621	−0.040	0.488	0.052	0.373	0.045	0.438	0.024	0.681
Strength GC/week	0.037	0.521	−0.010	0.864	0.059	0.308	−0.003	0.953	−0.046	0.432
Mixed GC/week	0.010	0.869	0.001	0.986	−0.008	0.894	0.004	0.944	0.023	0.695
Body&Mind GC/week	−0.069	0.235	−0.122	0.035*	−0.064	0.272	−0.083	0.151	−0.092	0.113
Maximal GFC/day	−0.042	0.472	−0.156	0.007*	−0.009	0.878	−0.046	0.425	−0.136	0.019*
Paid working hours/week	−0.089	0.083	−0.019	0.052	−0.069	0.176	−0.062	0.226	−0.089	0.083
Unpaid working hours/week	−0.143	0.007*	−0.180	< 0.001*	−0.203	< 0.001*	−0.106	0.044*	−0.235	< 0.001*
	| R|	*p*	| R|	*p*	| R|	*p*	| R|	*p*	| R|	*p*
Net salary	0.113	0.029*	0.087	0.093	0.145	0.005*	0.040	0.434	0.141	0.006*
Annual expenses related to profession	−0.063	0.213	−0.103	0.043*	−0.071	0.164	−0.060	0.240	−0.104	0.041*

*Significant association for $p < 0.05$. R, Pearson's correlation coefficient (r). | R|, Spearman's Rho.

GC/day and annual expenses related to the profession indicate both a negative correlation/association with physical and environment domains, and a negative correlation was also found in body&mind GC/week and the physical domain. There were not found any significant correlations between QoL and total of GC/week, cardio GC/week, strength GC/week, mixed GC/week, and paid working hours/week.

Discussion

The mean indices of QoL suggest that FPs in Portugal are not far from the maximum QoL index (100), considering the scores of OQoLGH (71.07/100), physical (74.56/100), psychological (72.67/100), and social relations (72.23/100) domains. However, taking into consideration the high standard deviation results, it can be concluded that some of the FPs in Portugal are very close to the maximum QoL index, while others are still too far away from it. The mean indices of the environment domain stand out from the results of OQoLGH, physical, psychological, and social domains by more than five points, revealing the lowest indices. The environment is the domain with mean indices results of QoL (65.58/100) farther from the maximum QoL index. The high standard deviation results of QoL in this domain could represent a concern, once these results suggest that some of the FPs in Portugal have indices of QoL in the environment domain that are too close to the middle of QoL index (50). The fact that the environment domain has the lowest QoL indices is coincident with the results of other studies of FPs (Bevilacqua et al., 2014), weight training FPs (Simões et al., 2011) and Crosstaining FPs (Neto et al., 2020) conducted in Brazil. These findings are also in line with the results of job satisfaction of FPs in Portugal (Ramos et al., 2021a), as the environment is the domain that covers the factors reported with the lowest level of satisfaction (salary and opportunities for promotion). In the Simões et al. (2011) study, the results of OQoLGH and the four domains have the same order as the results in the present study. Compared to other Studies of QoL in FPs (Simões et al., 2011; Bevilacqua et al., 2014; Neto et al., 2020), we can observe, in all of them, lower standard deviations than in the present study and higher mean indices of OQoLGH and all domains. In the OQoLGH, the differences in the mean indices are 7–17 points higher, 6/7–9/10 points higher in the physical, psychological and social relations domains and 3–10 points higher in the environment domain. According to Ferreira and Santana (2003), the Portuguese norms regarding the perception of the state of health and QoL of the working population are similar to the results of the present study but lower than the American, Italian and French norms. Monteiro (2020) affirms that the Portuguese population has shown little QoL in recent years and the results of this study, especially when compared to the results of other countries, seem to support this idea.

The indices of QoL (OQoLGH and the four domains) in this study were 5–8 points lower than the pilot study of QoL of FPs in Portugal (Vieira et al., 2019). The low percentage of individuals with a master's degree or higher and the low average of years of professional experience (both verified with

the participants in this study) are possible explanations for these results, since a higher level of education reveals better average scores in OQoLGH and in all domains, and the professional experience was positively correlated with QoL (with four significant differences in five possible). Similar results were found in other studies (although not with the same target population). Purba et al. (2021) suggest that higher education levels indicate better QoL in almost all domains (except the domain of the social relation) and according to Molsted et al. (2021), education levels reveal a positive relation with physical and mental component scales. The results of job satisfaction in FPs in Portugal (Ramos et al., 2021a) reveal slightly higher values of satisfaction in 12 of the 16 factors analyzed in the higher qualifications group. Regarding professional experience, higher levels of job satisfaction of FPs in Portugal were revealed by the group with more years of professional experience (10 or more), with significant differences in 14 of the 16 factors (Ramos et al., 2021a). Bratland-Sanda et al. (2015) found that working years as a fitness instructor were one of the factors positively associated with injury, but these findings do not appear to be significant for the perception of the QoL physical domain of FPs in Portugal.

In line with professional experience, the age variable had also revealed a positive correlation with QoL (OQoLGH and all domains), although the significant correlation occurs only with OQoLGH, psychological and environment domains. These results are also consistent with Ramos et al. (2021a) findings on FPs job satisfaction levels. In that research, older FPs (45–65-year-old group) were more satisfied in all of the 16 factors that were analyzed, being significantly higher in 10 of them. More maturity to deal with the psychological challenges of the profession could be one of the possible justifications for the positive relation of age with the psychological domain. However, studies about QoL of FPs that can support this theory were not found.

Despite these results, the positive correlations between QoL and the variables age and professional experience could be arguable. The average of these two variables is something to consider, once the participants in this study have an average of 6.69 ± 6.75 years of professional experience and 30.58 ± 7.59 years of age. According to Instituto Português do Desporto e Juventude [IPDJ] (2022), the average age of FPs with valid titles in Portugal in 2021 was 37 years, 67% being 40 years old or less and only 7% being more than 50 years old. Considering the retirement age of 66 in Portugal (Portaria n.° 307/2021), those averages correspond practically to the beginning of a career. It is also important to consider the number of FPs that have not validated their professional title in the last years. From 2010 to 2021, 33,359 professional titles were issued in Portugal (26,361 TEFs and 6,998 DTs), but only 63% of the TEFs (16,604) and 76% of the DTs (5,342) titles remained valid in 2021 (Instituto Português do Desporto e Juventude [IPDJ], 2022). Therefore, these results could be a consequence of the natural selection of the fitness industry, which clearly increases the need to understand whether the QoL of FPs improves with age and years of professional experience or if only the FPs with better levels of QoL remain in the profession.

The differences between gender found in the present research suggest that female FPs have a lower QoL than male FPs. The significant differences found in the physical, psychological, and environment domains may be related to the problems identified in some studies. Despite the lack of differences in job satisfaction between gender FPs in Portugal (Ramos et al., 2021a), a Brazilian study (Anversa et al., 2019) reveals that female FPs had lower levels of satisfaction than male FPs in some physiological needs and regarding their safety at work. Mathisen et al. (2021) found frequencies of 30% of sexual harassment among women FPs at the workplace (higher than men frequencies). Having experienced sexual harassment had significantly higher scores in symptoms of depression, anxiety and eating disorders compared to women with no such experience. Another issue reported as a common problem in the female population is urinary incontinence (Bø, 2004). Bø (2004) suggests that this is a problem that can reduce QoL because it is socially embarrassing and may cause withdrawal from social situations. In a study of QoL of young industry workers, Louzado et al. (2021) suggest double working hours for women (employment and home activities) as a possible justification for differences found between gender (lower indices of QoL for females).

Marital status seems to be an important characteristic of QoL. Being divorced was the characteristic that showed the lowest mean indices of QoL levels (OQoLGH and four domains) of all groups (considering the variables: gender, professional title, marital status, and educational qualifications) and being married showed one of the highest mean indices (once this position was shared with an educational qualification characteristic, that is having a master's degree or higher, both with very similar averages). The significant differences between these groups (married and divorced) in physical, psychological, and environment domains may be explained by the support that a partner can give in difficult situations (Molsted et al., 2021) and the possibility to share daily basis activities and worries.

Most of our respondents were single (66.0%) and with no children (once the mean and standard deviation of this variable was 0.34 ± 0.79). These characteristics seem to have a negative impact on the psychological domain of the participants in this study, since being single was significantly different (with lower indices) from being married and the number of children showed

a significant positive correlation with the psychological domain. No studies were found with FPs population that can support these results.

Concerning the professional title, no significant differences between TEFs and DTs were found. These two groups revealed different opinions on job satisfaction in the factors "opportunities for promotion" and "job stability" (Ramos et al., 2021a). Therefore, differences between these groups and QoL psychological or environment domains were expected. However, the absence of significant differences is not entirely a surprise, because the functions are not completely distinct (Lei n.° 39/2012), since DT title also covers the functions of TEF. It is also possible that some of the DTs that participated in this study do not even assume coordination functions or technical direction. On the other hand, although TEFs cannot assume the function of technical direction, they may be responsible for coordinating certain areas in the gym. Consequently, it is possible that the professional title does not correspond to a clear division of the functions performed on the field by the FPs in Portugal and this could be the reason behind the absence of differences in QoL between TEFs and DTs. The lack of results in the comparison of these two groups reinforces the need to review the existing legislation for FPs, a subject already addressed by Franco (2020).

> *"It is expected that the legislation that regulates fitness professionals will be adapted, particularly in terms of levels and extension of contexts, so that professionals can be differentiated through the specificity, complexity and depth of their skills and knowledge, in the scope of their intervention, valuing the education and regulation of the sector (. . .)"* (Franco, 2020, 7).

The biggest surprise of the results is the lack of significant relations between the number of GC/week and QoL and the same happens to cardio, strength, and mixed GC/week. Considering the number of studies that reveal the high prevalence of musculoskeletal problems in the FPs related/associated with GC (du Toit and Smith, 2001; Bø, 2004; Bratland-Sanda et al., 2015; Domene et al., 2017), significant correlation results between these variables and QoL physical domain were expected. According to Bratland-Sanda et al. (2015), the prevalence of acute, overuse and both acute and overuse injuries in FPs GCs in Norway were always higher in the group with more GC per week (GC/week). This group has an average of 7.5 h/week of GP and the results of the present study reveal an average of 9.19 ± 6.85 GC/week. A significant relation result was also expected in the social relation's domain, once the prevalence of voice (Rumbach, 2013; Rumbach et al., 2015; Dallaston and Rumbach, 2016; Fontan et al., 2017; Estes et al., 2020; Philip et al., 2021; Venkatraman et al., 2021) and hearing problems (Weintraub, 1994; Palma et al., 2009; Beach and Nie, 2014; Wolniakowska et al., 2021) was related/associated in other studies with instruction of GC and possible communication difficulties could result in limitations of QoL levels in this domain. Urinary incontinence is also a problem related/associated with impact GC. Some authors suggest that this can have a negative influence on the QoL (Bø, 2004; Stephen et al., 2018).

However, maximal GC/day variables reveal a negative correlation with QoL (OQoLGH and all domains) and this relation was significant in physical and environment domains. It seems that maximal GP/day has a bigger impact on QoL than de number of GC/week. Considering the mean of both variables (3.6 ± 2.11 maximal GP/day and 9.19 ± 6.84 GP/week) these results may increase the importance of respecting the training recovery. According to Bishop et al. (2008), different training stresses require different lengths of recovery. Therefore, the level of fatigue in the workout will change according to the recovery needs. Full training recovery is essential for athletes to achieve optimal performance and improvement (Bishop et al., 2008), and while improved performance is not a key goal for a fitness GC instructor, training volume may be similar in some cases. There is a need to understand that the training volume of a FP does not correspond to the number of classes he teaches. There may also be training for class preparation and non-occupational physical activity, which appears to improve the stress levels of fitness instructors (Marín-Farrona et al., 2021). This has been becoming very usual in instructors despite the volume of physical activity related to work.

Contrary to what was expected, body&mind GC/week was negatively related with the physical domain. Once more, the high prevalence of musculoskeletal problems in the FPs is usually related/associated with high impact, intense or repetitive movements in GC (Garrick et al., 1986; du Toit and Smith, 2001; Bø, 2004; Bratland-Sanda et al., 2015; Domene et al., 2017; Stephen et al., 2018). Although this is the only significant correlation found, this variable exposes a tendency of a negative relation with QoL (OQoLGH and all domains), which is questionable, especially concerning the psychological domain. Assuming that lower levels of QoL, especially in the physical domain, are a consequence of a higher number of body&mind GP/week could be a mistake because it is also possible that FPs with lower indices of QoL in the physical domain direct their intervention to the instruction of GC with less mechanical loading, like body&mind GC. Therefore, these results could be a sign of FPs' adaptation to the profession so that they are able to remain in the fitness industry. More research is needed to better understand these findings.

Concerning the net salary and paid working hours/week variables, similar results were expected if working more hours corresponded to earning more money, but this does

not happen with the participants in this study. The net salary has significant positive associations with OQoLGH, psychological and environment domains and paid working hours/week does not reveal any significant relation with QoL. In fact, more net salary indicates a positive association tendency with QoL (OQoLGH and four domains), whereas paid working hours/week show opposite behavior (negative correlation tendency). Unpaid working hours/week and annual expenses related to the profession also reveal a negative correlation/association tendency with QoL (OQoLGH and four domains). Unpaid working hours were the only variable that had a significant correlation with OQoLGH and all domains. Hence, 51.1% of the participants in this study receive €842, 63 or less, having an average amount of paid working hours/week of 39.45 ± 19.67 and an average of unpaid working hours/week of 9.12 ± 7.48. In addition to these results, 47.9% of the participants spent more than €2.100 per year in expenses related to the profession. These findings are in agreement with the results of lower satisfaction levels concerning salary revealed in studies that address job satisfaction of FPs (Koustelios et al., 2003; Bevilacqua et al., 2014; Bernabé et al., 2017; Ramos et al., 2021a).

A general analysis of QoL indicates that OQoLGH and psychological domain reveal a positive significant correlation with age, number of children and professional experience. A negative significant correlation was established with unpaid working hours/week. The physical domain also reveals five significant correlations/associations, being positively related to professional experience and negatively related/associated with body&mind GC/week, maximal GC/day, unpaid working hours, and annual expenses related to the profession. In the domain of social relations, the lowest number of significant correlations was found, since only unpaid working hours/week reveal a significant negative correlation. In a job satisfaction study on FPs in Portugal (Ramos et al., 2021a), the most satisfied workers also had the best results regarding their work colleagues. The largest number of significant correlations/associations were verified in the environment domain, with six correlations/associations. Age, professional experience and net salary variables indicate a positive relation/association with this domain and maximal GC/day, unpaid working hours and expenses related to the profession variables suggest a negative relation/association.

Five of the variables related to work reveal significant correlations/associations with the QoL of FPs. Despite these results exposing a very low or low effect size and bearing in mind the number of FPs that have not validated their professional title in the last few years (Instituto Português do Desporto e Juventude [IPDJ], 2022), these findings need to be considered in the fitness industry so that the working conditions of the FPs can be improved, hoping that it results in better levels of QoL, fewer FPs abandoning their careers and also leads to better work ability of the FPs.

There is clearly a lack of research on QoL of FPs and many questions remain unanswered. The struggle of the fitness industry due to the COVID-19 pandemic has affected FPs directly. It reflected itself in fewer jobs and a higher number of customers per instructor (Pedragosa and Cardadeio, 2021). Therefore, there is also a possibility that the QoL of FPs has been affected, too. Some studies refer to FPs as an important role model (Franco, 2020, Gjestvang et al., 2021; Reinboth et al., 2022), with a potentially great impact on their clients' exercise behaviors and attitudes (Reinboth et al., 2022). Considering that FPs can be one of the greatest assets in the recovery of fitness industry, their QoL levels should be crucial, as they are a part of this process and work as role models for fitness practitioners.

Conclusion

QoL mean results with a high standard deviation highlight the different levels of QoL of FPs in Portugal, with some concerning indices. Mean indices of QoL of the FPs in Portugal are lower than in other countries. The environment is the domain that revealed the lowest scores of QoL. The results reveal that being a male, married and having a master's degree or higher were the characteristics that indicated better indices of QoL. Age, professional experience and net salary indicate a positive correlation/association with QoL with a few significant results. Body&mind GP/week, maximal GP/day, paid and unpaid working hours/week, and annual expenses related to the profession reveal a negative relation/association with QoL. Paid working hours/week do not reveal any significant correlation with QoL. However, unpaid working hours/week had the highest number of significant correlations with QoL. Maximal GC/day results are a concern for the physical health of FPs, although they could also represent an important finding to help minimize the physical problems among FPs. Body&mind GC/week results could represent FPs adaptation to the job that allows them to remain in the profession. No significant relations between QoL and the number of GP/week, cardio GP/week, strength GP/week, mixed GP/week, and paid working hours/week were found. There is a possibility that the FPs with the lowest indices of QoL have abandoned the profession and the number of significant relations/correlations between QoL and variables related to work suggest the need for the fitness industry contemplate some changes in the FPs working conditions. More research is needed about the QoL of FPs, taking into consideration the remaining doubts. The important role that these professionals can represent in the recovery of

the fitness industry, the role they can play in the promotion of physical activity to give a better QoL to the practitioners and for a healthier society, the interest in improving the work conditions and the ability to work (related to QoL) and in minimizing the number of FPs abandoning the profession, represents an encouragement for the continuance of research on this topic.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the ethics and scientific board of the Polytechnic Institute of Santarém, n.° 8A-2022 ESDRM. The patients/participants provided their written informed consent to participate in this study.

Author contributions

IV wrote the sections of the manuscript. All authors have contributed to the conception and design of the study, revision of the manuscript, read, and approved the submitted version.

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Conflict of interest

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

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EDITED BY
Manuel Gómez-López,
University of Murcia, Spain

REVIEWED BY
Jana Vašíčková,
Palacký University, Czechia
Elisa Bisagno,
University of Modena and Reggio Emilia, Italy

*CORRESPONDENCE
Daphne J. Korczak
daphne.korczak@sickkids.ca

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Participating in extracurricular activities and school sports during the COVID-19 pandemic: Associations with child and youth mental health

Kaitlyn LaForge-MacKenzie[1], Katherine Tombeau Cost[1], Kimberley C. Tsujimoto[1], Jennifer Crosbie[1,2], Alice Charach[1,2], Evdokia Anagnostou[3,4], Catherine S. Birken[3,5], Suneeta Monga[1,2], Elizabeth Kelley[6,7], Christie L. Burton[1], Robert Nicolson[8], Stelios Georgiades[9] and Daphne J. Korczak[1,2]*

[1]Department of Psychiatry, Neuroscience and Mental Health, Hospital for Sick Children, Toronto, ON, Canada, [2]Department of Psychiatry, Faculty of Medicine, University of Toronto, Toronto, ON, Canada, [3]Department of Pediatrics, Faculty of Medicine, University of Toronto, Toronto, ON, Canada, [4]Holland Bloorview Research Institute, Toronto, ON, Canada, [5]Division of Paediatric Medicine, Hospital for Sick Children, Toronto, ON, Canada, [6]Department of Psychiatry, Queens University, Kingston, ON, Canada, [7]Department of Psychology, Faculty of Arts and Science, Queens University, Kingston, ON, Canada, [8]Department of Psychiatry, Schulich School of Medicine and Dentistry, Western University, London, ON, Canada, [9]Department of Psychiatry and Behavioural Neurosciences, Faculty of Health Sciences, McMaster University, Hamilton, ON, Canada

In Ontario, Canada, school extracurricular activities and sports were modified or canceled for a prolonged period due to public health restrictions resulting from the COVID-19 pandemic. The present study aims to examine the association of changes to extracurricular and sport participation and child and youth mental health. Data were collected on child and youth mental health symptoms ($n = 908$) and participation in extracurricular activities and sports in the 2019–2020 and 2020–2021 academic years. Results indicated that pre-COVID (2019–2020) participation in either extracurricular activities or sports was associated with reduced anxiety, inattention, and hyperactivity during the pandemic (β range −0.08 to −0.11, $p < 0.05$). Participation in either extracurricular activities or sports during-COVID (2020–2021) was associated with lower depressive symptoms (β range −0.09 to −0.10, $p < 0.05$). Findings suggest that participation in extracurricular activities and/or school sports both before or during the COVID-19 pandemic were associated with better mental health outcomes in children and youth. Implications of this work consider future situations where restrictions on extracurricular and sport participation are reinstated and the impact of child and youth mental health.

KEYWORDS

extracurricular activities, school sports, children and youth, mental health, COVID-19 pandemic

Introduction

Schools are places where children and youth are encouraged to learn, explore, and grow both socially and as individuals. Extracurricular activities (ECAs) and school sports offer experiential learning opportunities and help students to learn new skills, develop interests, and cultivate friendships. As part of their educational mandate, schools typically offer ECAs and sports. In the province of Ontario prior to the COVID-19 pandemic, 93.9% of elementary schools and 97.0% of secondary schools offered ECAs; 93.5% of elementary and 98.0% of secondary schools offered school sports (People for Education, 2021). However, as a result of the pandemic, ECAs and sports were either fully or partially removed from Ontario schools as part of public health safety directives (Borrelli, 2021; Fox, 2021; McKenzie-Sutter, 2021; People for Education, 2021). During the 2020-2021 academic year, 18.0% of elementary schools and 70.0% of secondary schools offered ECAs; only 5.0% of elementary and 8.0% of secondary schools offered school sports. By reducing or removing ECAs and sports from schools, the potential to benefit from these activities may have been subsequently impacted, including opportunities related to health, wellness, and development.

Participation in ECAs and sports have a positive impact on child and youth mental health and development (Eccles et al., 2003; Gilman et al., 2004; Jewett et al., 2014; Heath et al., 2018; Guilmette et al., 2019; Oberle et al., 2019a,b). Pre-COVID literature shows that students who participate in ECAs and sports experience lower levels of anxiety, depressive symptoms, and perceived stress (Jewett et al., 2014; Oberle et al., 2020) as well as higher levels of psychosocial well-being, satisfaction with life, self-esteem, self-image, and self-confidence compared with non-participating students (Harrison and Narayan, 2003; Gilman et al., 2004; Rodriguez-Ayllon et al., 2019; O'Donnell et al., 2020). Subsequently, when non-participating students become involved in ECAs and sports, they show better mental health outcomes over time facilitated by high peer belongingness; this highlights the importance of the associations between the social supports and connections afforded by ECAs and sports and improved child and youth mental health outcomes (Oberle et al., 2019a).

Considering ECAs specifically, children and youth who participate in ECAs gain positive psychosocial and emotional experiences that they can then carry into adulthood (Jewett et al., 2014; Guilmette et al., 2019). ECA participants have lower rates of substance-use compared with their peers (Harrison and Narayan, 2003) and have lower recreational screen-use after school compared to non-participants (Oberle et al., 2020). Further, different ECA activities are differentially associated with mental health. For example, children and youth who participated in arts or performance activities (i.e., music, drama, or visual arts) reported high levels of self-confidence, self-esteem, and belonging (Zarobe and Bungay, 2017) and low instances of risky behaviors such as alcohol-use (Eccles et al., 2003) while students who participated in academic clubs (i.e., debate team, chess, or tutoring) demonstrated high educational and occupational outcomes in early adulthood (Eccles et al., 2003).

With regard to school sport participation, student athletes showed lower levels of depression and psychological distress compared with their peers, and higher rates of body satisfaction, self-image, confidence, and physical, social, and emotional well-being (Harrison and Narayan, 2003; Jewett et al., 2014; Rodriguez-Ayllon et al., 2019; O'Donnell et al., 2020). The benefits of school sport participation are evident even in younger children, as elementary school students who participated in team (school) sports reported higher rates of emotional well-being compared with non-participants (Oberle et al., 2019b). In addition to the psychosocial and emotional benefits, school sports also promote physical activity and social development. Research confirmed the association of decreased physical activity and increased sedentary behavior with higher rates of depression in cross-sectional and longitudinal studies of children and adolescents (Korczak et al., 2017; Rodriguez-Ayllon et al., 2019). In addition to supporting options for physical activity, school sports provide opportunities to develop social skills and create a sense of community and belonging (O'Donnell et al., 2020). Student athletes demonstrated greater school attachment (Eccles et al., 2003), indicating that athletes were more likely to perceive supportive, meaningful relationships at school, which positively influenced their mental well-being (McLaughlin and Clarke, 2010). Student athletes also perform better academically, with sport positively impacting both memory and achievement (Lindner, 1999; Taras, 2005). Along with many of the shared benefits with ECAs, participation in school sports provide opportunities to engage in physical activity, improve social skills, and strengthen academic performance.

A key feature of schools-based ECAs and sports is that they are both accessible and affordable. Student participation in ECAs and sports is higher at schools that promoted activities regardless of ability (i.e., intramural programs), particularly for children from low-income and racialized families who may be at increased risk for negative health outcomes (Kanters et al., 2013). A recent review study on economically at-risk youth in ECA and sports programs showed that as participation rates increased for low-income students, educational, social, psychological, and behavioral outcomes improved. Increased participation resulted in greater academic (educational) and non-academic (psychosocial) outcomes in a dose-dependent fashion (Heath et al., 2018). Providing ECAs and sports in schools creates opportunities for students of all abilities and income-levels to participate, with associated improvements in mental health and academic achievement.

To our knowledge only one study has examined the impact of COVID-19 restrictions on student *sport* participation and

mental health. Student athletes who were unable to participate in sports during the initial phases of the COVID-19 pandemic experienced higher levels of depression when compared to the pre-pandemic period (McGuine et al., 2020). However, this study only included adolescents (ages 13–19 years) and did not examine the impact of loss of *ECAs* on mental health. As such, the impact of COVID-19 restrictions on ECA/sport participation and mental health of students in elementary school and students participating in non-sport ECAs is currently undetermined.

Hypothesis

The objective of the present study was to examine the associations of participating in ECAs and sports before (2019–2020) and during (2020–2021) the COVID-19 pandemic on children's mental health (MH) outcomes (depression, anxiety, hyperactivity, and inattention) during the pandemic. We explored the relationships of participating in ECAs/sports prior to and during the pandemic separately and hypothesized that participants would show fewer symptoms of depression, anxiety, hyperactivity and inattention than non-participants.

Methods

Participants

Data for these analyses were collected as part of the Ontario COVID-19 and Kids Mental Health study, a collaboration of four established research cohorts with pre-existing participant bases. Two cohorts are recruited though clinically-referred pathways (i.e., mental health and neurodevelopmental diagnoses) and two are recruited within the broader community (Korczak et al., 2022). Children and adolescents from the SickKids Psychiatry cohort are referred to an outpatient clinic for MH evaluations of disorders including but not limited to depression, anxiety, attention deficit/hyperactivity disorder (ADHD), obsessive-compulsive disorder (OCD), and disruptive behaviors (Korczak et al., 2022). Children and youth in the Province of Ontario Neurodevelopmental Disorder (POND) cohort have diagnoses of neurodevelopmental disorders (NDDs), including autism spectrum disorders (ASD), ADHD, OCD, and intellectual disabilities (About POND, 2021). Children in The Applied Research Group for Kids (TARGet Kids!) cohort are recruited from primary care practices in the Greater Toronto Area from birth to 5 years of age, and followed at their primary care visits (Carsley et al., 2015). Children and adolescents in the population-based Spit for Science cohort are recruited at an urban science museum (Spit for Science, 2021). Information including detailed descriptions of the cohorts, consent, and participation processes are described in Korczak et al. (2022).

Procedure

Questionnaires were completed by parents and children (ages 10–18 years) at two timepoints by online survey using REDCap (Research Electronic Data Capture; Harris et al., 2009, 2019). Parents reported on their children ages 6 years (Grade 1) and older (i.e., school-aged) (Korczak et al., 2022). Data on ECA and sport participation were collected in November 2020 by parent-report on child participation in ECAs/sports during in-person learning in Fall 2020 and child participation in ECAs/sports the previous academic year (2019–2020). Data on current ADHD symptoms (i.e., the previous 2 weeks) were collected in November 2020; current depression and anxiety symptoms (i.e., the past 2 weeks) were collected in February and March, 2021. The study was approved by the institutional ethics boards at all participating sites (REB # 100070222). All participants provided informed consent.

Measures

ECA and sport participation measures

Parents reported on the frequency with which their child participated in *sports or teams* or *clubs or activities* during the 2019–2020 and the 2020–2021 school year using a 5-point ordinal scale (1 = most days, 2 = a few times a week, 3 = once a week, 4 = about once a month, 5 = almost never, and not applicable [N/A]). Responses were grouped, considering limitations of ordinal scales (i.e., unequal interval measurement), such that responses of 1, 2, or 3 indicated regular participation in ECAs and sports and responses of 4, 5, and N/A indicated that their child rarely or did not participate in ECAs and sports.

Mental health measures

Revised Children's Anxiety and Depression Scale – Parent-Report (RCADS-P; Ebesutani et al., 2015). Depression was assessed using the 10-item major depressive disorder (MDD) subscale of the RCADS, rating frequency of symptoms on a 4-point scale (1 = never; 4 = always). Higher scores indicate higher levels of depressive symptoms, with borderline clinical *t*-scores ranging from 65 and 69 and clinically significant *t*-scores of 70 and above.

Screen for Child Anxiety Related Disorders (SCARED; Birmaher et al., 1997). Anxiety was assessed using the 9-item generalized anxiety disorder (GAD) subscale of the SCARED, rating items on 3-point scale (0 = not true or hardly true; 2 = very true or often true). Higher scores indicate higher levels of anxiety symptoms, with the clinical threshold for GAD subscale being a score of 9 out of a possible 18.

Strengths and Weaknesses of Attention-Deficit/Hyperactivity Disorder Symptoms and Normal Behavior Scale (SWAN; Swanson et al., 2012). Inattention and hyperactivity were assessed the 18 item SWAN instrument. The measure employs a 7-point rating scale (−3 = far below average; 3 = far above average) in which parents compare their child to other children of the same age for each item. In the original scoring, higher scores indicate lower symptoms of ADHD and as such, coding was reversed such that a higher score indicted higher levels of inattentive and hyperactivity symptoms.

Confound measures

Demographic data included both family (parent) and child information such as household annual income, child ethnicity, and child age.

Statistical analyses

In order to ensure independence of observations, one child per family was included in the analyses. Where more than one child per family participated in the study, one child was chosen based on the following algorithm: older child age, more complete data, greater ECA/sport participation (if eldest siblings were the same age), and finally, random selection (if all other conditions were equal, one sibling was chosen at random).

Four hierarchical linear regression models assessed the impact of ECA and sport participation on each mental health outcome (1) depression, (2) anxiety, (3) inattention, and (4) hyperactivity. Child age, child ethnicity, and household income were entered in the first block; pre-COVID activity participation in block two; and during-COVID activity participation in block three. Multiple imputation using logistic regression (n = 15) at the item-level was used for missing predictor and covariate data where missingness was approximately 15% (Bodner, 2008; White et al., 2011). Analyses with complete cases (listwise deletion) are available in the Supplement. Statistical analyses were conducted using both R (Team, 2015, 2018) and SPSS 27 (IBM Corp, 2020).

Results

A total of 908 children and youth were included in this study (mean age = 10.77 years [SD = 3.77]; 496 [55%] male). Nearly two-thirds of participants were of European-North American (n = 574; 65%) descent. Non-European-North American (e.g., Indigenous, Black, Latin, Caribbean, Asian, or Other; n = 155 or 18%) and multiple ethnic backgrounds (n = 155 or 18%) comprised the remainder of children's ethnicity. See Table 1 for a more detailed description of the participant characteristics and mean MH outcomes.

During the 2019–2020 academic year (hereafter referred to as "pre-COVID"), the majority of children and youth participated in ECAs, 58% (n = 513) and sports, 58% (n = 511) at least 1 day per week. In November 2020 (herein labeled "during-COVID"), participation rates decreased to 16% (n = 99) for ECAs and 27% (n = 167) for sports. During-COVID ECA participants were more often females (57% vs 48% pre-COVID), from households with annual income <$80,000 (68%), and of non-European/North-American descent (27% vs. 20% pre-COVID). During-COVID sport participants were more often non-European/North-Americans (26% vs. 21% pre-COVID). Mean MH measures for each participation group are found in Table 2. Chi-square tables showing differences in group composition are found in Supplementary Table 1 full details regarding pre-COVID and during-COVID ECA and sport participant and non-participant characteristics are found in Supplementary Table 2.

Depression

After controlling for confounders, pre-COVID ECA participation was not significantly related to levels of depression during the pandemic. However, after controlling for confounders, during-COVID ECA participation (β = −0.09, 95% CI [-10.22, −1.39], p = 0.01,) was significantly associated with decreased levels of depression in February 2021 and added significant variance to Block 3 as detailed in Table 3.

Similar to ECAs, after controlling for confounders, pre-COVID sport participation was marginally but ultimately non-significantly associated with levels of depression in February 2021 in Block 2 (p =0.07; see Table 3). During-COVID sport participation was inversely associated with child and youth depression (β = −0.10, 95% CI [−7.50, −0.11], p < 0.05) and added significant variance to Block 3. Together these findings suggest that children and youth who participated in ECAs and/or sports in November 2020 had lower levels of depressive symptoms in February 2021 than those students who did not participate in ECAs and/or sports (Figure 1; Table 3).

Anxiety

With respect to ECA participation, neither the pre-COVID ECA model nor during-COVID ECA model were significant.

Pre-COVID sport participation was significantly associated with decreased levels of anxiety in February 2021 (β = −0.12, 95% CI [−0.40, −0.10], p < 0.001,) and explained significantly more variance than confounders alone. However, the model intercept was not significant and as such, these results along with

TABLE 1 Sample characteristics and demographics and mean mental health scores of children and youth by parent-reported analyses.

Variables	Categories	Total sample $n = 908$	Elementary school $n = 662$	High school $n = 246$
Age (years)		$M = 10.77$	$M = 9.1$	$M = 15.08$
		($SD = 3.35$)	($SD = 2.06$)	($SD = 1.34$)
Sex at birth	Male	496 (55%)	374	108
	Female	410 (45%)	287	117
	Missing	2 (0%)	1	1
Ethnicity	European/North American	574 (64%)	408	153
	Non-European/North American	155 (18%)	125	27
	Multiple	155 (18%)	112	40
	Missing	24 (3%)	17	7
Household income	>$80,000	553 (71%)	402	135
	<$80,000	224 (29%)	164	56
Pre-COVID MH/NDD diagnosis	MH/NDD Diagnoses	554 (61%)	353	201
	No diagnoses	354 (39%)	309	45
Pre-COVID extracurricular participation	Yes	513 (58%)	380	133
	No	366 (42%)	258	108
	Missing	29 (3%)	24	3
During-COVID extracurricular participation	Yes	99 (16%)	65	34
	No	530 (84%)	389	141
	Missing	279 (31%)	208	71
Pre-COVID sport participation	Yes	511 (56%)	404	107
	No	369 (41%)	235	134
	Missing	28 (3%)	23	5
During-COVID sport participation	Yes	167 (27%)	153	14
	No	450 (73%)	317	133
	Missing	291 (32%)	192	99
Depression		$M = 62.29$	$M = 61.68$	$M = 64.30$
(RCADS-P t-score)		($SD = 18.42$)	($SD = 18.66$)	($SD = 17.78$)
Anxiety		$M = 7.38$	$M = 6.85$	$M = 8.89$
(SCARED score)		($SD = 5.35$)	(SD = 5.22)	(SD = 5.38)
Hyperactivity		$M = 0.10$	$M = 0.93$	$M = -2.10$
(SWAN subscale)		($SD = 11.73$)	($SD = 11.72$)	($SD = 11.61$)
Inattention		$M = 2.90$	$M = 2.79$	$M = 3.60$
(SWAN subscale)		($SD = 12.33$)	($SD = 12.12$)	($SD = 12.92$)

Household income represents annual income in Canadian dollars; MH, mental health; NDD, neurodevelopmental disorder; RCADS-P, Revised Child and Anxiety Depression Scale-Parent Version; SCARED, Screen for Child Anxiety Related Disorders; SWAN, Strengths and Weaknesses of Attention-Deficit/Hyperactivity Disorder Symptoms and Normal Behavior Scale.

those in Block 3, are not interpretable. These findings suggest that participation in either ECAs or sports in November 2020 was not associated with decreased anxiety in February 2021, although there may be a small association between lower levels of anxiety and pre-COVID sport participation (Figure 2; Table 3).

Hyperactivity

After controlling for confounders, pre-COVID ECA participation was significantly associated with decreased levels of hyperactivity in November 2020 ($\beta = -0.08$, 95% CI [−3.66, −0.37], $p = 0.02$) and added significant variance in Block 2 ($p = 0.003$). During-COVID ECA participation did not have a significant association with levels of hyperactivity. This suggests that students who participated in ECAs prior to COVID-19 during the 2019–2020 academic year had lower reported levels of hyperactivity than students who did not participate in ECAs in the 2019–2020 academic year (Figure 3; Table 3).

After controlling for confounders, neither pre-COVID nor during-COVID sport participation were associated with levels of hyperactivity despite the models having statistical significance.

TABLE 2 Mean current mental health scores by domain and measure in pre-COVID and during-COVID extracurricular activity and sport participants and non-participants.

Pre-COVID participant and non-participant mental health outcomes*				
	Pre-COVID ECA participants ($n = 513$)	**Pre-COVID ECA non-participants ($n = 366$)**	**Pre-COVID sport participants ($n = 511$)**	**Pre-COVID sport non-participants ($n = 369$)**
Depression (RCADS-P *t*-score)	$M = 61.44$ ($SD = 18.96$)	$M = 63.31$ ($SD = 17.60$)	$M = 61.02$ ($SD = 19.18$)	$M = 64.13$ ($SD = 17.38$)
Anxiety (SCARED score)	$M = 7.02$ ($SD = 5.37$)	$M = 7.89$ ($SD = 5.32$)	$M = 6.85$ ($SD = 5.26$)	$M = 8.12$ ($SD = 5.43$)
Hyperactivity (SWAN subscale)	$M = -1.03$ ($SD = 11.61$)	$M = 1.56$ ($SD = 11.64$)	$M = -0.26$ ($SD = 11.63$)	$M = 0.40$ ($SD = 11.59$)
Inattention (SWAN subscale)	M =0.95 ($SD = 12.39$)	$M = 5.49$ ($SD = 11.82$)	$M = 1.62$ ($SD = 12.47$)	$M = 4.48$ ($SD = 11.73$)
During-COVID Participant and Non-Participant Mental Health Outcomes*				
	During-COVID ECA participants ($n = 99$)	**During-COVID ECA non-participants ($n = 530$)**	**During-COVID sport participants ($n = 167$)**	**During-COVID sport non-participants ($n = 450$)**
Depression (RCADS-P t-score)	$M = 55.90$ ($SD = 18.65$)	$M = 62.81$ ($SD = 17.72$)	$M = 59.22$ ($SD = 19.27$)	$M = 63.66$ ($SD = 18.48$)
Anxiety (SCARED score)	$M = 6.98$ ($SD = 5.82$)	$M = 7.43$ ($SD = 5.35$)	$M = 5.94$ ($SD = 4.78$)	$M = 7.74$ ($SD = 5.52$)
Hyperactivity (SWAN subscale)	$M = -2.40$ ($SD = 12.32$)	$M = 0.53$ ($SD = 11.36$)	$M = 0.07$ ($SD = 11.06$)	$M = 0.70$ ($SD = 11.50$)
Inattention (SWAN subscale)	$M = -0.88$ ($SD = 12.34$)	$M = 3.49$ ($SD = 12.15$)	$M = 1.11$ ($SD = 11.17$)	$M = 3.96$ ($SD = 12.50$)

*All current mental health scores were collected from November 2020 to February 2021; RCADS-P, Revised Child and Anxiety Depression Scale-Parent Version; SCARED, Screen for Child Anxiety Related Disorders; SWAN, Strengths and Weaknesses of Attention-Deficit/Behavior Scale Hyperactivity Disorder Symptoms and Normal.

Inattention

After controlling for confounders, pre-COVID ECA participation was significantly associated with decreased levels of inattention in November 2020 ($\beta = -0.08$, 95% CI [-5.41, −1.93], $p < 0.001$,) and added significant variance in Block 2 ($p < 0.001$). Although both the overall model (p =0.007 vs. Bonferroni correction $p < 0.00625$) and during-COVID ECA participation ($p = 0.08$) approached significance, neither reached statistical significance in Block 3.

After controlling for confounders, pre-COVID sport participation was significantly associated with decreased level of inattention in November 2020 ($\beta = -0.08$, 95% CI [−3.92, −0.18], $p = 0.03$) and added significantly more variance than confounders alone in Block 2 ($p = 0.004$). During-COVID sport participation was not significantly related with November 2020 levels of attention. In addition, the overall model (Block 3) was not significant ($p = 0.02$).

These results suggest that (despite non- or marginal-significance in the overall models) children and youth who participated in ECAs and/or sports in the school year prior to COVID-19 had fewer symptoms of inattention in November 2020 than children and youth who did not participate in ECAs and/or sports pre-COVID (Figure 3; Table 3).

Discussion

The results of the present analysis indicate that participation in ECAs and school sports were associated with better child and youth MH during the first years of the COVID-19 pandemic. Students who participated in ECAs and school sports during the pandemic were reported to have lower depressive symptoms compared with non-participants. Students who participated in ECAs in the school year prior to the pandemic showed lower inattention and hyperactivity during pandemic school periods compared with pre-pandemic non-participants. Students who participated in school sports prior to the pandemic were

TABLE 3 The associations of activity participation and MH outcomes using multiple imputation hierarchical linear regression analyses.

		Depression						Anxiety						Hyperactivity						Inattention					
EA	**Variable**	***β***	**SE**	**LCI, UCI**	***p***	R^2	ΔR^2	***β***	**SE**	**LCI, UCI**	***p***	R^2	ΔR^2	***β***	**SE**	**LCI, UCI**	***p***	R^2	ΔR^2	***β***	**SE**	**LCI, UCI**	***p***	R^2	ΔR^2
	Block 1					0.01	–					0.02	–					0.01	–					0.01	–
	Intercept	–	**2.82**	**53.00, 64.05**	**<0.001***			–	**0.15**	**−0.67, −0.09**	**0.01***			–	**1.50**	**2.12, 8.00**	**<0.001***			–	1.57	−1.04, 5.13	0.19		
	Age	**0.09**	**0.22**	**0.10, 0.95**	**0.02***			**0.15**	**0.01**	**0.02, 0.07**	**<0.001***			**−0.08**	**0.12**	**−0.50, −0.05**	**0.02***			0.06	0.12	−0.01, 0.47	0.07		
	Income	−0.06	1.73	−5.97, 0.73	0.13			−0.04	0.09	−0.27, 0.07	0.26			**−0.08**	**0.91**	**−4.19, −0.64**	**0.01***			−0.05	0.93	−3.38, 0.28	0.10		
	Ethnicity	−0.01	0.82	−1.77, 1.46	0.85			−0.07	0.04	−0.17, 0.01	0.07			−0.04	0.46	−1.42, 0.36	0.25			−0.06	0.48	−1.74, 0.14	0.09		
	Block 2					0.01	0.00					0.02	0.00					**0.02**	**0.01***					**0.04**	**0.03***
	Intercept	–	**2.92**	**53.69, 64.05**	**<0.001***			–	**0.15**	**−0.60, 0.00**	**<0.05***			–	**1.55**	**3.32, 9.40**	**<0.001***			–	**1.61**	**1.17, 7.50**	**0.007***		
	Age	**0.09**	**0.22**	**0.10, 0.95**	**0.02***			**0.14**	**0.01**	**0.02, 0.07**	**<0.001***			**−0.08**	**0.12**	**−0.51, −0.06**	**0.02***			0.06	0.12	−0.02, 0.45	0.08		
	Income	−0.06	1.71	−5.82, 0.90	0.15			−0.03	0.09	−0.26, 0.09	0.33			**−0.07**	**0.91**	**−3.98, −0.43**	**0.02***			−0.05	0.92	−2.97, 0.63	0.20		
	Ethnicity	0.00	0.83	−1.72, 1.52	0.91			−0.06	0.04	−0.16, 0.01	0.09			−0.04	0.46	−1.35, 0.44	0.32			−0.05	0.47	−1.60, 0.26	0.16		
	Pre-COVID participation	−0.04	1.40	−4.35, 1.14	0.25			−0.06	0.08	−0.29, 0.01	0.07			**−0.10**	**0.80**	**−3.98, −0.84**	**0.003***			**−0.09**	**0.83**	**−5.91, −2.65**	**<0.001***		
	Block 3					**0.02**	**0.01***					0.02	0.01					0.02	0.00					0.04	0.00
	Intercept	–	**2.93**	**53.70, 65.17**	**<0.001***			–	0.15	−0.60, 0.00	0.05			–	**1.55**	**3.33, 9.45**	**<0.001***			–	1.62	1.20, 7.53	0.007		
	Age	**0.10**	**0.22**	**0.12, 0.97**	**0.01***			**0.15**	**0.01**	**0.02, 0.07**	**<0.001***			**−0.08**	**0.12**	**−0.50, −0.05**	**0.02***			0.02	0.12	−0.02, 0.46	0.07		
	Income	−0.06	1.73	−6.07, 0.76	0.13			−0.03	0.09	−0.26, 0.08	0.31			**−0.08**	**0.91**	**−4.05, −0.49**	**0.01***			−0.04	0.93	−3.07, 0.56	0.18		
	Ethnicity	0.00	0.82	−1.62, 1.60	0.99			−0.06	0.04	−0.16, 0.01	0.09			−0.04	0.46	−1.33, 0.46	0.34			−0.05	0.47	−1.57, 0.28	0.17		
	Pre-COVID participation	−0.01	1.46	−3.30, 2.43	0.79			−0.06	0.08	−0.28, 0.03	0.12			**−0.08**	**0.84**	**−3.66, −0.37**	**0.02***			**−0.08**	**0.87**	**−5.49, −2.10**	**<0.001***		
	During-COVID participation	**−0.09**	**2.24**	**−10.22, −1.39**	**0.01***			−0.03	0.12	−0.30, 0.15	0.51			−0.06	1.25	−4.52, 0.60	0.13			−0.07	1.36	−5.06 , 0.28	0.08		
Sports	**Variable**	***β***	**SE**	**LCI, UCI**	***p***	R^2	ΔR^2	***β***	**SE**	**LCI, UCI**	***p***	R^2	ΔR^2	***β***	**SE**	**LCI, UCI**	***p***	R^2	ΔR^2	***β***	**SE**	**LCI, UCI**	***p***	R^2	ΔR^2
	Block 1					0.01	–					0.02	–					0.01	–					0.01	–
	Intercept	–	**2.80**	**53.20, 64.18**	**<0.001***			–	**0.15**	**−0.65, −0.08**	**0.01***			–	**1.49**	**2.18, 8.02**	**<0.001***			–	1.58	−1.02, 2.17	0.19		
	Age	**0.09**	**0.22**	**0.10, 0.95**	**0.02***			**0.15**	**0.01**	**0.02, 0.07**	**<0.001***			**−0.08**	**0.12**	**−0.51, −0.05**	**0.02***			0.06	0.12	−0.02, 0.46	0.07		
	Income	−0.06	1.64	−6.02, 0.42	0.09			−0.05	0.09	−0.29, 0.05	0.17			**−0.09**	**0.88**	**−4.08, −0.63**	**0.01***			−0.06	0.93	−3.36, 0.30	0.10		

(Continued)

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TABLE 3 (Continued)

Sports	Variable	Depression						Anxiety						Hyperactivity						Inattention					
		β	SE	LCI, UCI	p	R^2	ΔR^2	β	SE	LCI, UCI	p	R^2	ΔR^2	β	SE	LCI, UCI	p	R^2	ΔR^2	β	SE	LCI, UCI	p	R^2	ΔR^2
	Ethnicity	−0.01	0.83	−1.79, 1.44	0.83			−0.07	0.04	−0.17, 0.00	0.06			−0.05	0.46	−1.50, 0.29	0.18			−0.06	0.48	−1.80, 0.09	0.08		
	Block 2					0.01	0.00					**0.04**	**0.02***					0.01	0.00					**0.02**	**0.01***
	Intercept	–	**2.98**	**54.72, 66.39**	**<0.001***			–	0.16	−0.48, 0.13	0.26			–	**1.60**	**2.48, 8.75**	**<0.001***			–	**1.69**	**0.57, 7.18**	**0.02***		
	Age	**0.08**	**0.22**	**0.05, 0.91**	**0.03***			**0.13**	**0.01**	**0.02, 0.06**	**<0.001***			**−0.08**	**0.12**	**−0.52, −0.06**	**0.01***			0.05	0.12	−0.07, 0.41	0.16		
	Income	−0.06	1.65	−5.91, 0.57	0.11			−0.05	0.09	−0.27, 0.07	0.23			**−0.10**	**0.88**	**−4.08, −0.63**	**0.01***			−0.05	0.93	−3.22, 0.41	0.13		
	Ethnicity	0.00	0.83	−1.65, 1.60	0.98			−0.05	0.04	−0.15, 0.02	0.12			−0.04	0.46	−1.47, 0.33	0.21			−0.05	0.48	−1.68, 0.21	0.13		
	Pre-COVID participation	−0.07	1.41	−5.34, 0.19	0.07			**−0.12**	**0.08**	**−0.40, −0.10**	**<0.001***			−0.03	0.81	−2.29, 0.87	0.38			**−0.10**	**0.85**	**−4.14, −0.81**	**0.004***		
	Block 3					**0.02**	**0.01***					0.04	0.00					0.01	0.00					0.02	0.00
	Intercept	–	**2.99**	**55.44, 67.16**	**<0.001***			–	0.16	−0.46, 0.16	0.36			–	**1.62**	**2.62, 8.95**	**<0.001***			–	1.70	0.78, 7.46	0.02		
	Age	0.07	0.22	−0.01, 0.85	0.06			**0.13**	**0.01**	**0.02, 0.06**	**<0.001***			**−0.09**	**0.12**	**−0.54, 0.07**	**0.01***			0.04	0.12	−0.09, 0.40	0.22		
	Income	−0.07	1.64	−5.94, 0.48	0.10			−0.04	0.09	−0.28, 0.06	0.22			**−0.10**	**0.88**	**−4.10, −0.65**	**0.01***			−0.05	0.93	−3.26, 0.38	0.12		
	Ethnicity	0.00	0.83	−1.59, 1.66	0.97			−0.05	0.04	−0.15, 0.02	0.13			−0.04	0.46	−1.46, 0.34	0.23			−0.05	0.48	−1.66, 0.24	0.14		
	Pre-COVID participation	−0.03	0.1.58	−4.26, 1.92	0.46			**−0.11**	**0.09**	**−0.38, −0.04**	**0.02***			−0.02	0.90	−2.18, 1.33	0.64			**−0.08**	**0.95**	**−3.92, −0.18**	**0.03***		
	During-COVID participation	**−0.10**	**1.88**	**−7.50, −0.11**	**0.04***			−0.05	0.11	−0.32, 0.09	0.28			−0.03	1.08	−2.91, 1.33	0.47			−0.03	1.18	−3.47, 1.17	0.33		

Block 2 controlled for age, income, ethnicity, with pre-COVID participation as the independent variable; **Block 3** controlled for age, income, ethnicity, pre-COVID participation with during-COVID participation as the independent variable; Age = child age in years; Income = annual household income in Canadian dollars; Depression was measured by the Revised Child and Anxiety Depression Scale-Parent Version (RCADS-P); Anxiety was measured by the Screen for Child Anxiety Related Disorders (SCARED); Hyperactivity and inattention were measured by subscales of the Strengths and Weaknesses of Attention-Deficit/Hyperactivity Disorder Symptoms and Normal Behavior Scale. Bold values indicate statistical significance $p < 0.05$. Asterisk indicates statistical significance $p < 0.05$.

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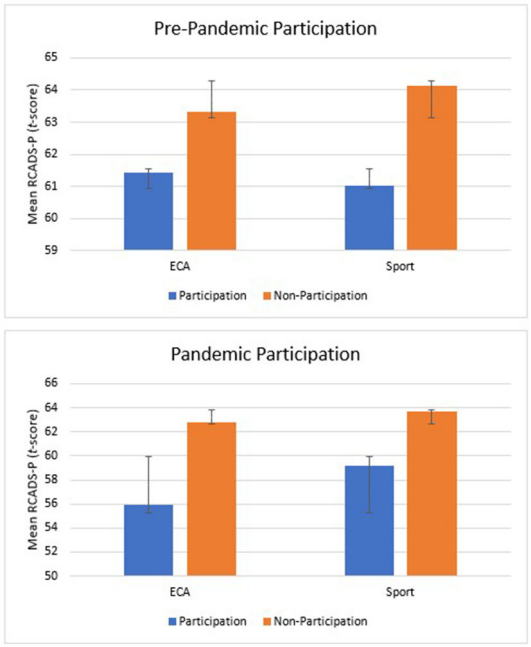

FIGURE 1
Mean depressive symptoms in extracurricular activities and sports pre-COVID and during-COVID participation. Depressive symptoms were reported by parents though the RCADS-P (Revised Child and Anxiety Depression Scale-Parent Version); Error bars represent standard error.

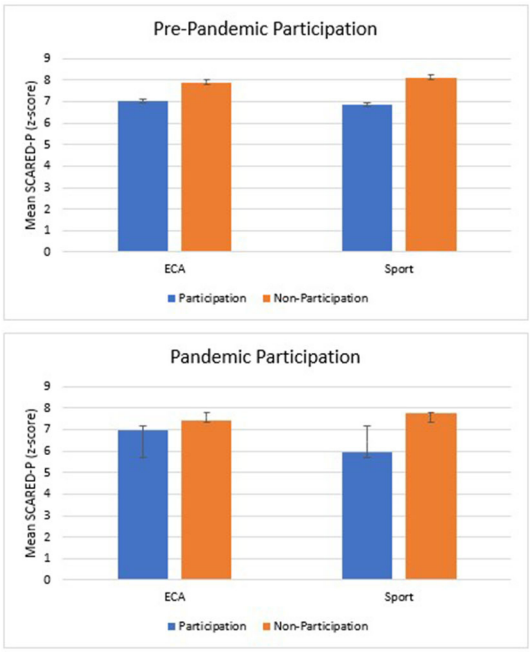

FIGURE 2
Mean anxiety symptoms in school sports comparing pre-COVID and during-COVID participation. Anxiety symptoms were reported by parents though the SCARED (Screen for Child Anxiety Related Disorders); Error bars represent standard error.

reported to have lower inattentive symptoms and marginally lower anxiety compared with pre-pandemic non-participants. We find support for our hypothesis that children and youth who participated in ECAs and school sports, whether pre-COVID, during-COVID, or both, would have better mental health outcomes during the pandemic than students who were non-participants.

Participation in ECAs and sports were associated with decrease in MH symptoms during the pandemic. Pre-COVID ECA participation was associated with decreased hyperactivity and inattention symptoms and during-COVID ECA participation was associated with decreased depressive symptoms. Additionally, pre-COVID sport participation was associated with decreased inattention symptoms and to a certain extent, anxiety, while during-COVID sport participation was associated with decreased depression symptoms. These results suggest that ECA and sport participation has the potential to attenuate some of the negative consequences of the pandemic on child and youth MH. These findings align with previous research which showed that ECA and sports participants had fewer negative MH outcomes compared to their peers (Zarrett et al., 2009; Jewett et al., 2014; White et al., 2017; Rodriguez-Ayllon et al., 2019), and that these outcomes have the potential to carry forward into the future (Jewett et al., 2014; Guilmette et al., 2019). Furthermore, the sport participation findings support recent studies that show the benefit of middle childhood participation in school sports in lessening ADHD symptoms (Pagani et al., 2020).

The availability of ECAs and sports may be particularly important to mitigate the MH impacts as the COVID-19 pandemic continues, transitions, and recovers. As ECAs and sports canceled and/or significantly altered (i.e., operating virtually or employing "cohorting" as described in the Ontario Physical Activity Safety Standards in Education, 2021), this created additional strain on top of the already deteriorating MH of children and adolescents (Racine et al., 2021; Tombeau Cost et al., 2021) and stripped them of a key protective factor. A full restart of ECAs and sports in Ontario and regularizing their administration and operation (i.e., functioning in as much normal capacity as public health regulations allow) has potential to bolster and to prevent further degradation of child and youth mental health (Kanters et al., 2013; Heath et al., 2018). Cancellation or significant alteration of ECAs and sports as part of school safety mandates should be carefully evaluated in future situations, considering their removal on the state of MH in children and adolescents.

Participating in ECAs and school sports may be associated with better MH in several respects including decreased sedentary screen time, increased physical activity, and/or increased sense

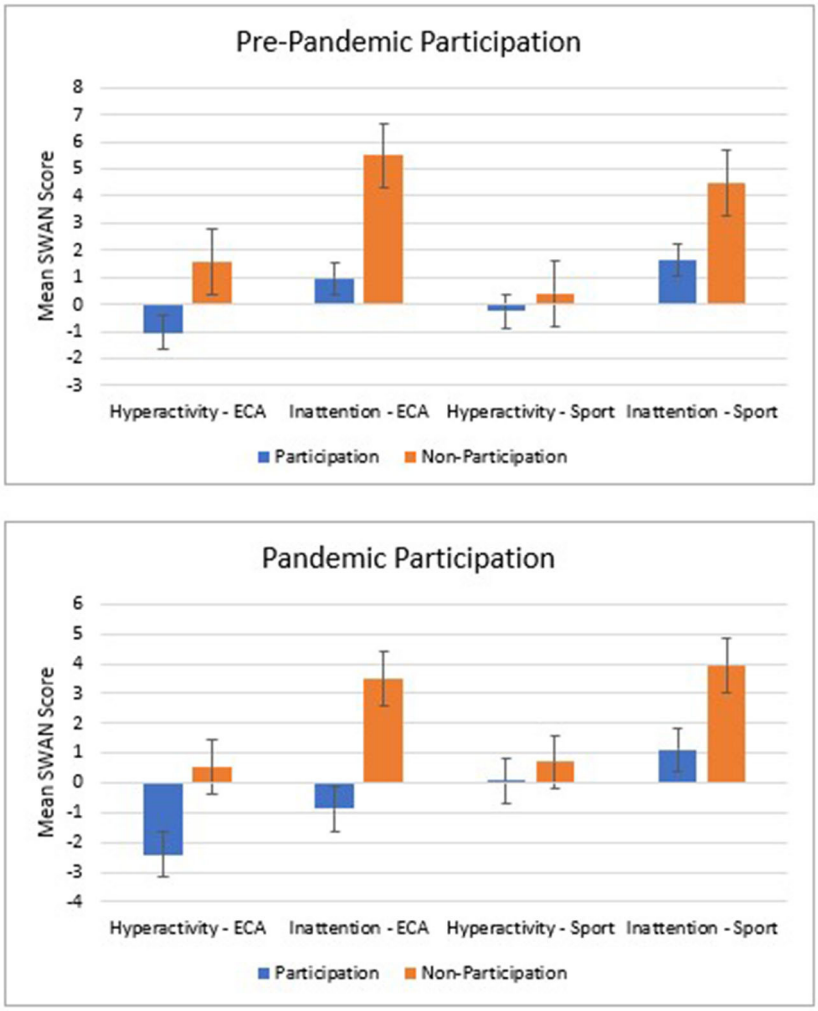

FIGURE 3
Mean hyperactivity and inattention symptoms in extracurricular activities and sports pre-COVID and during-COVID participation. ECA, extracurricular activities; Hyperactivity and inattention symptoms were reported by parents though the SWAN (Strengths and Weaknesses of ADHD symptoms) subscales; Error bars represent standard error.

of community. ECA participants engaged in less recreational screen-use following school than non-participants (Oberle et al., 2020). This is relevant given the recent research during the pandemic suggested that child and youth screen-use increased and was detrimental to MH during the first years of the COVID-19 pandemic (Li et al., 2021). Disrupting school sports may also remove the means for affordable and accessible physical activity. Prior to the pandemic, less physical activity and more sedentary behaviors were linked to greater depression in children and youth (Korczak et al., 2017; Rodriguez-Ayllon et al., 2019; Guerrero et al., 2020). With opportunities afforded for physical activity to most students regardless of ability or income (Kanters et al., 2013; Heath et al., 2018), the suspension of school sports can reinforce the connection between sedentary behaviors and greater depressive symptoms.

In addition to positive health behaviors (i.e., less screen time and more physical activity), ECAs and sports also foster a sense of community, belonging, and connectedness to school, positively influencing MH (O'Donnell et al., 2020). At times where physical and social distancing were mandated and enforced, social community and connectedness may be especially important for child and youth MH (Tombeau Cost et al., 2021). Engaging in ECAs or playing school sports during pandemic periods may heighten a sense of belonging and create a protective environment at school against negative MH outcomes, particularly depression (Bauer et al., 2018; Oberle et al., 2019a; O'Donnell et al., 2020). A recent commentary support continued ECA and sport participation in schools to provide children and youth with socialization and connectedness which have been lacking during the pandemic

(Lang, 2021). Future research can examine the mechanisms by which ECA and sport participation is associated with child and youth MH during and after the COVD-19 pandemic.

The present analysis has several strengths. The sample was drawn from both clinical and community populations for a diverse sample of children and youth and greater representation of MH in the broader population. This study is also unique in that it is a large scale, longitudinal study that includes a range of quantitative MH outcomes over the course of an international pandemic, which will allow the examination of these associations over time (Korczak et al., 2022).

The study also has several important limitations. Firstly, we did not measure the specific activities in which students were engaged and how they participated in these activities during the COVID-19 pandemic (i.e., ECAs vs. sports; in-person indoors vs.in-person outdoors vs.virtually vs. mixed). There is the potential that while ECAs and sports were offered in schools during COVID-19, participation did not have as much of a positive, MH impact due to the differences in activities and altered format of their operation. For example, participating in sports may offer different benefits than participating in ECAs. Further, participating virtually for training or working out would not have the same impact as participating with a team, in-person. This was not limited to sports. In-person meetings, band/choir practices, and performance arts also suffered if virtual participation was mandated or if they occurred at all. Children and youth continued to be physically and socially isolated from their peers. Secondly, we did not examine whether children and youth continued to participate in activities, lost activities, or never did activities; currently the groups were identified solely as "participation" and "no participation." There may be differences in MH outcomes in the "no participation" group in terms of who lost vs. who never participated in ECAs and sports, specifically in how they perceive the lack of ECAs and sports in schools. Future research should examine which activities are running and/or are canceled, how children and youth are participating in these activities, and whether losing or never having ECAs and sports results in differences in MH outcome among these groups. Lastly, as the data in this study are cross-sectional, data regarding pre-COVID sport participation are subject to retrospective reporting bias. However, parents may be just as (or more) likely to "miss" a prior activity than to over-report involvement. As such, findings of the current study may underestimate the strength of the association between participation and MH outcomes.

Conclusions

This study finds that participation in ECAs and sports are associated with better MH outcomes in children and youth. As permissions are once again afforded for ECAs and sports to operate in schools, Ontario school boards should recognize their importance to good MH in children and youth. Re-implementing and regularizing these activities in schools may offer an available, cost-effective option to support the MH for a large proportion of students. This work further points to policy implications for future situations where restriction on sports and ECAs are considered. These activities have the opportunity to foster a sense of normalcy with options to socialize, get physical activity, and reduce screen time—all of which may improve MH outcomes as the pandemic continues and transitions for Ontario children and youth.

Data availability statement

The datasets presented in this article are not readily available because the dataset contains identifiable patient health information. Requests to access the datasets should be directed to DK, daphne.korczak@sickkids.ca.

Ethics statement

The studies involving human participants were reviewed and approved by Research Ethics Board, Hospital for Sick Children. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

KL-M conceived design of the analyses, supported design of data collection instruments, and drafted initial manuscript. KL-M, KTs, KTo, and DK designed, performed, and interpreted statistical analyses. EA, CB, AC, KTo, JC, SM, and DK initiated the larger project, designed and selected data collection measures, and created data collection procedures. EK, CB, RN, and SG supported design of larger project as well as data collection measures and procedures. EA, CB, AC, KTo, JC, SM, DK, KTs, and KL-M monitored data collection. EA, CB, AC, KTo, KTs, JC, SM, DK, EK, CB, RN, SG, and KL-M revised and approved final manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fspor.2022.936041/full#supplementary-material

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EDITED BY
Manuel Gómez-López,
University of Murcia, Spain

REVIEWED BY
Vera Simões,
Polytechnic Institute of Santarém, Portugal
David Manzano Sánchez,
University of Murcia, Spain

*CORRESPONDENCE
Juan Li
47850481@qq.com

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Effect of paternalistic leadership on Chinese youth elite athletes' satisfaction: Resilience as a moderator

Pan Liu[1,2], Sitan Li[3], Qi Zhang[4], Xiumei Zhang[4], Lingling Guo[5] and Juan Li[4]*

[1]Beijing Institute of Petrochemical Technology, Beijing, China, [2]Beijing Academy of Safety Engineering and Technology, Beijing, China, [3]Moody College of Communication, The University of Texas at Austin, Austin, TX, United States, [4]School of Health Care Security, Shandong First Medical University, Shandong, China, [5]School of Physical Education, Wuhan Sports University, Wuhan, China

This study extended the research on the relationship between youth elite athletes' satisfaction and coaches' paternalistic leadership by identifying athletes' resilience as a moderator. A total of 221 youth elite football (i.e., soccer) players aged 13–19 years old who are students of a Chinese professional football boarding school participated in a questionnaire survey. The study found no correlation between the three dimensions of coaches' paternalistic leadership (authoritative leadership, benevolent leadership, and moral leadership) and the youth athletes' satisfaction. The results also showed that the interaction of resilience and moral leadership affects the youth elite athletes' satisfaction, whereas resilience does not play a moderating role in the relationship between authoritative leadership or benevolent leadership and satisfaction. As the results of the study are different from those of other scholars, they may reveal the uniqueness of youth elite football players in boarding schools. This study further analyzed the possible reasons for this result and prospected (or indicated) the theoretical and practical implications of these findings. Based on the conclusion, the study recommended that youth elite football schools should pay attention to the results of scientific research in leadership styles and apply them to practice in the future.

KEYWORDS

satisfaction, youth athletes, mental resilience, paternalistic leadership, football schools

Introduction

In China, professional football schools offer elite training programs different from campus football. In 2019, about 5,000 youth football players were studying in professional football boarding schools. These youth players are the key and core strength of the development of Chinese football and the source of Chinese football reserve talents. For example, the Shandong Luneng Taishan Football School, established in July 1999, has seen more than

230 players joining national football teams at all levels, and more than 260 players joining professional clubs in prestigious leagues such as the Chinese Super League, Chinese First League, and Chinese Second Class League (The Chinese Football Association, 2019). The school has won 70 national U13-U19 youth football matches and 8 international youth football tournaments (The Chinese Football Association, 2019).

The youth athletes studying in football boarding schools are typically 13–19 years old and are receiving unified national compulsory education. The elite athletes in these boarding schools are strictly selected and, it is the family's honor to have a child accepted to be part of a Chinese Football Boarding School. Dropping out of a school or not meeting the expectations might be considered a dishonor to the athlete as well as the family. Therefore, athletes in a Chinese Football Boarding School would be expected to accept the way the program is operated to a certain degree. For youth players attending boarding schools, the role of the parents is weakened, and their coaches and teachers are responsible for their training and other aspects of life. For the safety, learning, training, education, and growth of young athletes, each coach and teacher is responsible for managing 20–30 athletes. Therefore, it is difficult for them to observe the athletes' psychological changes and be a part of all aspects of the athletes' life. In addition, youth athletes are energetic, psychologically sensitive, and have limited emotional management capabilities (Zhang, 2019). At this time, they need to independently deal with their relationships with coaches, peers, and families, as well as manage the relationship between their life, training, and learning. Therefore, for their personal safety considerations, and also for their physical and mental health, various professional football schools have successively implemented boarding school management systems.

Although the boarding school management system in China has not been empirically researched yet, in practice, the management staff believes that introducing it as an intervention strategy (school management regulations and teaching measures) can affect youth athletes' cognition, behavior, and psychology. However, whether it affects the youth athletes' perceptions of themselves, their teams, and their coaches' leadership requires research to provide empirical evidence. Moreover, China's current sports psychology and management research related to football is concentrated on college student-athletes and campus football, and only a small portion of the literature is devoted to professional football (Gong et al., 2017; Li et al., 2018; Gu, 2019). Particularly, research on youth athletes and coaches of professional football schools remains scarce. Therefore, due to the importance of this group for the development of Chinese professional football, it deserves research attention.

Athlete satisfaction

Athlete satisfaction has been defined as "a positive affective state resulting from a complex evaluation of the structures, processes, and outcomes associated with the athletic experience" (Chelladurai and Riemer, 1997, p. 135). Due to the randomness of sports results, the satisfaction of athletes is the main outcome variable and it is considered an indicator of coaches' leadership (Chelladurai and Riemer, 1997) that can be obtained without analyzing sports performance big data. Furthermore, in sports psychology research, athlete satisfaction is also recognized as a very important variable (Burns et al., 2012).

However, the management of professional football schools and its relationship with the satisfaction of youth football players has received less attention. In the Shandong Luneng Taishan Football Schools' internal evaluation systems for players, evaluation is one-dimensional, and the combination of coaches and teachers' evaluations of youth athletes constitutes the final evaluation score. In the management routines of schools, youth athletes' satisfaction with teachers' work is also measured, but their satisfaction with self-performance and team performance is not measured (due to school regulations). To fill in this gap, this research has paid attention to the youth football players' satisfaction with self-performance and team performance.

Paternalistic leadership and athlete satisfaction

In recent years, research on paternalistic leadership has gone from theoretical (Farh and Cheng, 2000) to empirical (e.g., Cheng et al., 2002; Pellegrini and Scandura, 2006; Pellegrini et al., 2010; Fu et al., 2019). Paternalistic leadership is defined as a managerial approach that is based on strong discipline and authority combined with fatherly benevolence and moral integrity (Farh and Cheng, 2000). It can be divided into three dimensions: authoritarian, benevolent, and moral paternalistic leadership styles (Farh and Cheng, 2000). Authoritarian refers to a situation in which leaders have absolute authority and control over their subordinates, and require their subordinates to obey their actions unconditionally (Cheng et al., 2004).

Benevolence implies that leaders not only focus on the personal wellbeing of their subordinates, but also show concern for the family welfare of their subordinates (Cheng et al., 2004). Moral paternalistic leadership is considered to be a leader's behavior that demonstrates superior personal virtues, self-discipline, and selflessness (Cheng et al., 2004). Paternalistic leadership was previously found to be related to employee satisfaction (Yan et al., 2008; Pellegrini et al., 2010). Moreover, Chen and Tsai (2005) found that paternalistic leadership is related to athletes' emotional feelings and burnout. Chang et al. (2019) studied the cross-level influence of paternalistic leadership on athlete burnout. Yang's (2007) research noted the influence of coaches' paternalistic leadership on coach-athlete relationships. These studies on coaches' paternalistic leadership have drawn attention to the role of this variable in sports. Therefore, one might ask: in the context of youth sports, how does this variable affect satisfaction?

Models of athletic leadership often make use of satisfaction as an outcome variable (Riemer and Chelladurai, 1998). For example, in the study conducted by Aoyagi et al. (2008), 281 college student-athletes were surveyed using the athlete satisfaction questionnaire (ASQ)'s 6 subscales, to reveal the relationship between leadership and satisfaction in sport. Further, their research found that the coach's leadership style had a significant impact on athlete's satisfaction (Ignacio et al., 2017). Similarly, coach's paternalistic leadership was found to have a positive effect on satisfaction toward the performance of the Division I volleyball athletes (Wu, 2010). In Chinese professional football schools, the coach is the person who spends the most time with youth athletes (according to the statements provided by the school's management). The coaches not only lead in training but also live in the player's apartments. Therefore, this study aims to provide further evidence on whether the youth athletes' satisfaction is affected by the coaches' paternalistic leadership style.

Athlete resilience

Athletes' resilience is another crucial factor in the success of sports performance. Fletcher and Sarkar (2012) defined resilience as "the role of mental processes and behavior in promoting personal assets and protecting an individual from the potential negative effect of stressors" (p. 675). There is much overlap between the content reflected in this concept and the "adversity view" in traditional Chinese culture (Hu and Gan, 2008). Affected by dialectical thinking, the Chinese have an optimistic and dialectical attitude toward adversity and misfortune, considering adversity to be a test given by God (i.e., God intends to test whether you can bear adversity). Chinese culture also posits that misfortune "may be a good matter" (because it will bring good results in the future; Hu and Gan, 2008). In terms of coping with major pressure, Confucianism focuses on relying on oneself to solve difficulties, adopting the middle way in dealing with problems (i.e., "moderation is the key to a happy life"), and not expressing emotions excessively (Yan, 2005); On the other hand, Taoism—another cornerstone of Chinese culture—promotes flexibility in the face of difficulties (Young et al., 2005). Recent cross-cultural research on coping styles also indicated that there is indeed a uniqueness in the behavioral patterns of Chinese people by showing their simultaneous use of primary control (change) and secondary control (acceptance) strategies (Heppner et al., 2006), an optimistic view (Wong, 2002), and a collectivist approach (Heppner et al., 2006). These characteristics of Chinese people are likely to be reflected in the process of facing great pressure and adversity, and constitute a unique component of Chinese football school athletes' psychological resilience (Hu and Gan, 2008).

Based on the research of Olympic champions, Fletcher and Sarkar (2012) developed a grounded theory of psychological resilience and optimal sports performance. According to this theory, the influence of psychological factors should be analyzed in conjunction with the specific stressors that athletes encountered and the background of the stress incurred (Fletcher and Sarkar, 2012). The boarding life of the youth athletes may constitute the background of their stress. Youth athletes also need to participate and receive coaches' training and guidance, which may be another source of stress for them. They do everything according to this schedule, and may not have their own time or flexibility in time management, which may also cause stress. According to the aforementioned grounded theory of psychological resilience (Fletcher and Sarkar, 2012), these stressors undergo psychological transformations within the athlete's cognitive range and ultimately promote the athlete's optimal athletic performance.

In addition, scholars also highlighted that the adjustment of resilience is vital to the athlete's performance (Galli and Gonzalez, 2015). There are also studies showing that athlete resilience is pivotal in improving football performance (Chacón et al., 2016). This study replaced the youth athletes' sports performance variable with athlete satisfaction (specifically toward individual performance and team performance). Based on the above theories, previous research findings, and cultural considerations, this study

puts forward the following hypotheses. It is worth noting that the research team intentionally did not make directional predictions to reduce the researcher bias.

> Hypothesis 1: Coach's authoritarian leadership affects youth athletes' satisfaction.

> Hypothesis 2: Coach's benevolent leadership affects youth athletes' satisfaction.

> Hypothesis 3: Coach's moral leadership affects .youth athletes' satisfaction.

> Hypothesis 4: Youth athletes' resilience plays a moderating role in the relationship between authoritarian leadership and youth athletes' satisfaction.

> Hypothesis 5: Youth athletes' resilience plays a moderating role in the relationship between benevolent leadership and youth athletes' satisfaction.

> Hypothesis 6: Youth athletes' resilience plays a moderating role in the relationship between moral leadership and youth athletes' satisfaction.

The research model is depicted in **Figure 1**.

Materials and methods

Research design and statistical analysis

This research is a cross-sectional study that used, and it was approved and supported by the Academic Ethics Committee of Beijing Jiaotong University Informed consent from both the students and their parents/guardians was obtained. Participants were voluntary and not compensated for their participation. Furthermore, they were informed by the researchers of the purpose of the study, the anonymity of the questionnaire, and the voluntary nature of participating in this research. This study used Pearson's α correlation analysis for descriptive statistics (see **Supplementary Table 1**), regression analysis to test the main effect and the moderating effect (Baron and Kenny, 1986), and the Bootstrap method proposed by Preacher and Hayes (2004) and Hayes (2013) to test the moderating effect. All analyses were completed using SPSSAU, an intelligent online statistical analysis platform (The SPSSAU Project, 2020) and SPSS 25.0.

Participants

The participants were 221 youth football players (males) from Shandong Luneng Taishan Football School. The students were aged 13–19 years old (M_{age} = 15.15 ± 1.56) with the youngest students in the fifth grade of elementary school and the oldest in the third grade of high school. After excluding surveys in which all items were given the same answer, the regular answer, and blank answer, it was obtained 190 completed questionnaires (86%).

Procedure

The data was collected from September 2019 to December 2019. The researchers in this study participated in the process of distributing and collecting questionnaires. The collection time and location were not fixed, and the collection time of each questionnaire was different. The researchers spent 12 weeks collecting data. During this period, participants completed multiple scales, including a paternalistic leadership scale, resilience scale, and satisfaction scale for this study.

Measure

The revised Chinese Youth Psychological Resilience Scale (Hu and Gan, 2008) was used in this study, which is in line with the Chinese cultural characteristics. The scale includes 15 items, and five following factors: target concentration (e.g., "My life has clear goals"), emotional control (e.g., "I can adjust my emotions in a short time"), positive cognition (e.g., "I think adversity can inspire people"), family support (e.g., "My parents respect my opinion"), and interpersonal assistance (e.g., "When I am in trouble, I will take the initiative to talk to others"). Studies have shown that the reliability of the Chinese Youth Psychological Resilience Scale is satisfactory and has matched the characteristics of qualified psychological measurement. Each item in the scale is measured by a five-point Likert scale, ranging from 1 (never) to 5 (always). The reliability indexes of the five factors of the scale are: 0.654, 0.676, 0.854, 0.716, and 0.757. The overall reliability index measured in this study was 0.84.

This study adopted the two subscales of the (ASQ; Riemer and Chelladurai, 1998; Li et al., 2020) to measure the satisfaction of youth athletes. It focuses on two dimensions: individual's satisfaction with their own task performance (e.g., "The degree to which I have reached my performance goals during the season") and individual's satisfaction with the performance of

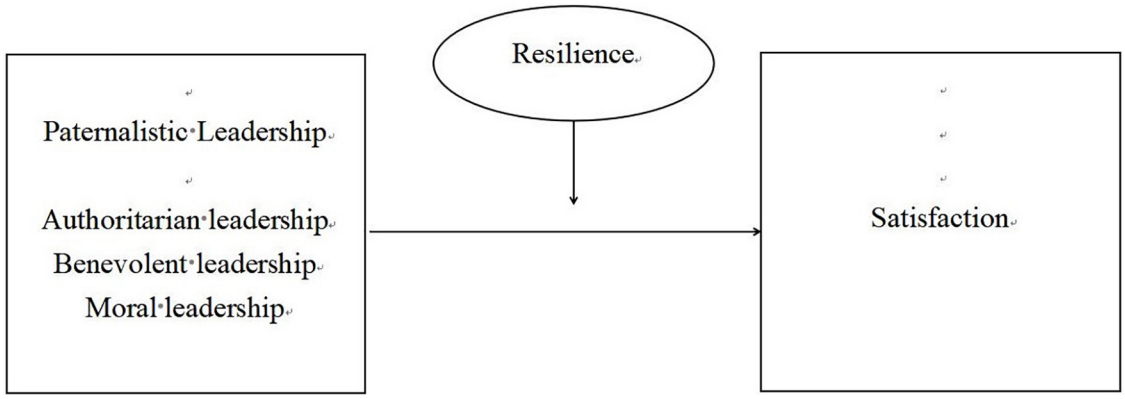

FIGURE 1
The research model.

their team's performance (e.g., "The team will break the record this season"). Each item in the scale is measured by a five-point Likert scale ranging from 1 (never) to 5 (always). Research has shown that both subscales have good psychometric reliability. The Cronbach's α measured in this study for satisfaction with own task performance was 0.81, and with team performance was 0.82.

As suggested by the original author of the paternalistic leadership scale, the study simplified and revised the scale to have a better fit with the research context. After the reliability testing and factor analysis screening, this study ended up with a total of 15 items, among which the authoritarian leadership dimension included four items (e.g., "When the coach guides my technique and concept, he adopts the tone of command"), and the benevolent leadership dimension included five items (e.g., "The coach cares about my personal life"), whereas the moral leadership dimension contained a total of six items (e.g., "The knowledge and experience of the coach is enough to guide me"). Each item was measured on a five-point Likert scale, ranging from 1 (never) to 5 (always). The Cronbach's α for each dimension were as follows: authoritarian leadership 0.725, benevolent leadership 0.689, and moral leadership 0.764.

Results

Main effect analysis

For the results of descriptive statistics (see **Table 1** and **Supplementary Table 1**). As for the main effect analysis, the study used authoritarian leadership, benevolent leadership, moral leadership, resilience as independent variables and satisfaction as the dependent variable for a linear regression analysis (Dao-de, 2000). It can be seen from **Table 1** authoritarian leadership, benevolent leadership, moral leadership, resilience explained only 2.1% change in satisfaction and the results of the F test showed that the model was not a good fit (F = 0.981, p = 0.419, n.s.). Therefore, that means, that authoritarian leadership, benevolent leadership, and moral leadership did not have a significant influence on youth athletes' satisfaction. That is, hypothesis 1, 2, 3 is not supported.

Moderating effect

It is important to note that the independent variables and moderating variables in this study were centralized. Using the analysis method of Baron and Kenny (1986), the moderating effect was divided into three models. Model 1 included independent variables (authoritarian leadership). Model 2 added a moderating variable (resilience) on the basis of Model 1, and Model 3 added an interaction (authoritarian leadership * resilience) on the basis of Model 2.

The purpose of Model 1 was to study the influence of independent variables (authoritarian leadership) on dependent variables (satisfaction) without considering the interference of moderating variables (resilience). From **Supplementary Table 2**, it can be drawn that that the independent variable (authoritarian leadership) was not significant (t = 0.614, p = 0.540, n.s.). This means that without considering the influence of moderating variables (resilience), authoritarian leadership did not have a significant influence on satisfaction.

The moderating effect can be viewed in two ways: the first is to look at the significance of the change in F value from Model 2 to Model 3; the second is to look at the significance of the interaction items in Model 3 (Hayes and Matthes, 2009; Hayes, 2013). This study analyzes the moderating effect in a second way.

In terms of Model 3, **Supplementary Table 2** shows that the interaction between authoritarian leadership and resilience

TABLE 1 Linear regression analysis results (N = 190).

	Unstandardized coefficient		Standardized coefficient	t	p	VIF	R^2	ΔR^2	F
	B	Standard error	$Beta$						
APL	0.036	0.065	0.042	0.548	0.584	1.099	0.021	0	$F(4, 185) = 0.981, p = 0.419$
BPL	0.08	0.08	0.083	0.998	0.32	1.295			
MPL	0.027	0.11	0.021	0.249	0.804	1.367			
Resilience	0.137	0.1	0.102	1.368	0.173	1.041			

APL, authoritative leadership; BPL, benevolent leadership; MPL, moral leadership; Dependent variable: satisfaction; D-W, 1.737.

was not significant (t = −0.415, p = 0.679, n.s.). And from Model 1, they can see that authoritarian leadership did not have an effect on satisfaction. Therefore, that means, that youth athletes' resilience does not play a moderating role in the relationship between authoritarian leadership and youth athletes' satisfaction. So, hypothesis 4 is not verified.

Then, the study analyzed the effect of benevolent leadership on satisfaction. Benevolent leadership as the independent variable was also analyzed, and showed no significance (t = 1.159, p = 0.248, n.s.). It can be seen from **Supplementary Table 3** that the interaction of benevolent leadership and resilience in Model 6 did not show significance (t = −1.356, p = 0.177, n.s.). And from Model 4, it can be drawn that benevolent leadership did not affect satisfaction, so there was no moderating effect. Thus, that means, that youth athletes' resilience did not play a moderating role in the relationship between benevolent leadership and youth athletes' satisfaction. So, hypothesis 5 is not verified too.

The results showed no significant moderating effect of resilience in the relationship between satisfaction and authoritative and benevolent leadership and include corresponding details as **Supplementary Tables 2**, **3**.

Next, the study verified the effect of moral leadership as the independent variable on the dependent variable (satisfaction). It can be seen from **Table 2** that moral leadership was not significant (t = 0.742, p = 0.459, n.s.). Implying no significant impact on satisfaction without considering the effect of the moderating variable (resilience). Then, the study looked at the significance of the interaction items in **Table 2**, Model 9. It can be seen that the interaction of moral leadership and resilience was significant (t = −2.241, p = 0.026, n.s.). This means that when moral leadership affects satisfaction when the moderating variable (resilience) is at different levels, the impact amplitude has a significant difference. Thus, that means, that youth athletes' resilience played a moderating role in the relationship between moral leadership and youth athletes' satisfaction. Finally, Hypothesis 6 was verified.

The simple slope graph visually shows the difference in the magnitude (slope) of the influence of the independent variable on the dependent variable when the moderating variable is at different levels. When the moderating variable takes different levels, the influence variable (slope) difference of the independent variable on the dependent variable is the specific moderating effect. In other words, when resilience is higher, moral leadership has a greater impact on satisfaction, and when resilience is lower, moral leadership has a smaller impact on satisfaction. The slope analysis is shown in **Supplementary Table 4**, and the slope comparison chart is shown in **Figure 2** depicts these results.

Then, the study used the Bootstrap method proposed by Preacher and Hayes (2004) and Hayes (2013) for verification. The analysis conclusion confirmed the above results.

Discussion

This study measured and analyzed athlete satisfaction, the youth athletes' resilience, and the coaches' paternalistic leadership based on youth football players' self-report. The results of the study showed that the coaches' paternalistic leadership (all three dimensions) is not correlated with the youth athletes' satisfaction. The results also show that the youth athletes' resilience plays a moderating role in the relationship between moral leadership and satisfaction, whereas resilience does not play a moderating role in the relationship between authoritative leadership or benevolent leadership and satisfaction.

The first reason for the discrepancy between the findings of this research (in regard to the relationship between coaches' paternalistic leadership and athlete satisfaction) and that suggested by previous literature is that other studies chose different subscales to measure this relationship (e.g., Riemer and Chelladurai, 1998; Aoyagi et al., 2008; Kao and Tsai, 2016). The second reason is the choice of the study sample, and age range. Most studies conducted their research on college athletes or adult professional elite athletes. Adolescents significantly differ from young college students or adults in terms of their physical and psychological developmental stages, and these differences might have affected the study

TABLE 2 Moral leadership moderating effect analysis results (N = 190).

	Model 7				Model 8				Model 9			
	B	Standard error	*t*	*p*	*B*	Standard error	*t*	*p*	*B*	Standard error	*t*	*p*
MPL	0.07	0.094	0.742	0.459	0.065	0.094	0.69	0.491	0.021	0.095	0.22	0.826
Resilience					0.141	0.098	1.437	0.152	0.079	0.101	0.787	0.432
MPL*Resilience									−0.303	0.135	−2.241	0.026*
R^2	0.003				0.014				0.04			
Adjusted R^2	−0.002				0.003				0.024			
F	$F(1, 188) = 0.550, p = 0.459$				$F(2, 187) = 1.309, p = 0.273$				$F(3, 186) = 2.565, p = 0.056$			
$\triangle R^2$	0.003				0.011				0.026			
$\triangle F$	$F(1, 188) = 0.550, p = 0.459$				$F(1, 187) = 2.065, p = 0.152$				$F(1, 186) = 5.020, p = 0.026$			

MPL, moral leadership; Dependent variable: satisfaction; *$p < 0.05$.

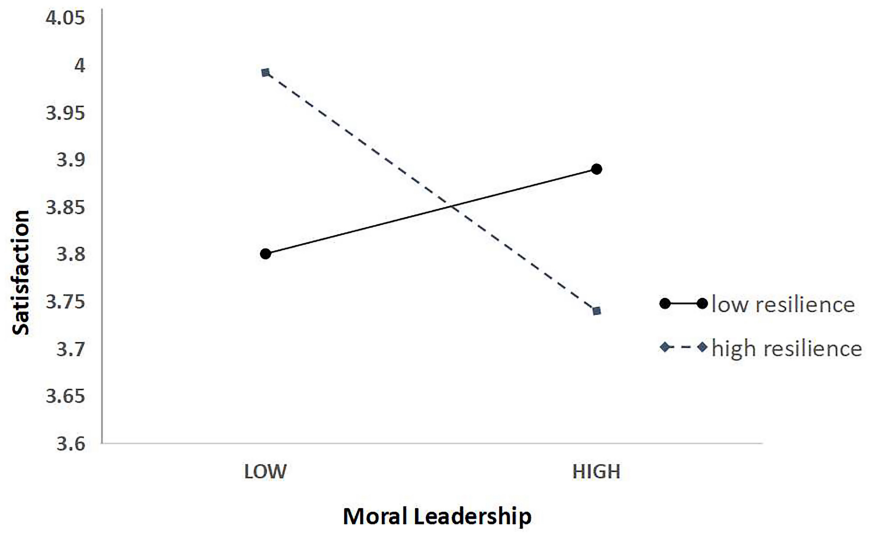

FIGURE 2
Moderating effect diagram.

results (Dorn and Biro, 2011). Therefore, it is plausible that in groups of youth athletes, findings that are different from the results based on other age groups may appear. The third reason is the particularity of the environment in which the research was conducted. In a nutshell, under the boarding school's management system, the satisfaction of youth athletes did not show a correlation with coaches' paternalistic leadership, thus other variables might be more consequential in determining satisfaction. To verify that, further research is needed.

Moreover, the study results showed that resilience plays a moderating role in the relationship between moral leadership and satisfaction. This finding is consistent with previous research that demonstrated the moderating effect of resilience in other fields of study (e.g., Zhou et al., 2017; Navarro et al., 2018; Fan and Lu, 2020; Zhang et al., 2020). However, in the present research, resilience played a moderating role only in the relationship between moral leadership and satisfaction, but not in the relationship between authoritative leadership or benevolent leadership and satisfaction. This should be viewed from the perspective of the definition of moral leadership. Moral leaders are not eager to be followed, but commit to serving subordinates, tend to help in developing subordinates' skills, and are proficient in consulting skills (Farh and Cheng, 2000). Therefore, coaches may provide heuristic guidance education (such as imagination and autonomy) to athletes during training, rather than directly touching the ball or running a position demonstration. Athletes with stronger resilience may feel and understand that most of their personal and team achievements are the result of coaches' inspiring guidance and services. Conversely, athletes with low resilience may feel that most of their athletic performance is the result of individual and team effort, and attribute the role of the coach to

secondary. The resilience of youth is different from that of adults (Debold et al., 1999; Prince-Embury and Saklofske, 2012), and can improve through school education and coaching leadership (Kazak et al., 2010; Prince-Embury and Saklofske, 2012; Collishaw et al., 2016). Therefore, there are reasons to believe that it is meaningful to conduct further sports psychology research on resilience, especially aiming to implement resilience interventions in Chinese professional football boarding schools.

As Chinese professional football boarding schools and the management system they follow are critical to the development of football in China, it is essential to study the behavior of youth athletes and the variables associated with their satisfaction. Football school administrators base the practice on their own experience or learn from other countries' management practice, but no in-depth scientific research has been conducted on the management system itself, nor has scientific research been applied to practice in this area (Yang et al., 2019). Therefore, our future research along this stream will continue to focus on coaching leadership, coach-athlete relationships, athlete satisfaction, athletes' organizational citizenship behavior, trust, psychological resilience, stress, organizational environment, and team cohesion. If professional football schools in China can attribute the same importance to scientific research as youth football training institutions in Europe, and apply scientific research to management, it can result in great improvement in the quality of Chinese football. The limitation of this article also lies in the research on one representative professional football boarding school. There were no girls in the study and, if applicable, the use of similar questionnaires in participants of very different ages. In addition, due to the limitation of the number of students enrolled in the study, the sample that was somewhat reduced could influence the results. The reliability of the resilience scale is somewhat low in two factors (>0.70 is generally accepted). In the future, the research scope should be expanded to carrying out in-depth research in other professional football boarding schools, and other studies need to be done in similar programs in other cultures. Another limitation of this article is the use of cross-sectional data, and we will continue to follow up and validate the findings of this study in subsequent follow-up studies. In addition, there may be other influencing mechanisms in the relationship between paternalistic leadership and the youth football players' satisfaction, waiting for future research to explore and verify.

Conclusion

The results of this study did not provide support for the relationship between coach paternalistic leadership and athlete satisfaction, but they indicated the moderating effect of mental resilience on the relationship between the moral leadership dimension of coaches' paternalistic leadership and athlete satisfaction. This result might have been driven by the characteristics of the present study sample and the environment, and this study provided insights into the youth athletes in Chinese professional football boarding schools, rather than adult or college student players as investigated in previous studies. This result is of great significance to the application of sports psychology and management in the field of youth football training in China. As the findings suggested, moral leadership is the best route for fostering resilience. Thus, it has important implications for future resilience interventions. To sum up, it is hoped that the contribution of this research will help deepen and further the limited understanding of athlete satisfaction, resilience, and coach leadership.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Beijing Jiaotong University. Written informed consent to participate in this study was provided by the participants or their legal guardian/next of kin.

Author contributions

JL made substantial contributions to conception of the work and wrote the manuscript. PL made contributions to the supervision and analysis of data for work. In the process of revision, SL and LG made contributions to interpretation of data. QZ and XZ revised the manuscript critically for important intellectual content.

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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.2022.1008163/full#supplementary-material

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EDITED BY
Carla Maria Chicau Costa Borrego,
Polytechnic Institute of
Santarém, Portugal

REVIEWED BY
Patrik Drid,
University of Novi Sad, Serbia
Félix Romero,
Polytechnic Institute of
Santarém, Portugal

*CORRESPONDENCE
Teresa Limpo
tlimpo@fpce.up.pt

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Examining karate and football perceptions and their links with athlete engagement and quality of life

Teresa Limpo[1]*, Gabriela Rödel[1] and Sid Tadrist[2]

[1]Faculty of Psychology and Education Sciences, University of Porto, Porto, Portugal, [2]KWF Dynamic Karate, London, United Kingdom

The importance of perceptions as determinants of people's behavior has been well-established, but little is known about athletes' perceptions of their sport and the links of these perceptions with other correlates. In this study, we compared karate (n = 51) and football (n = 49) athletes' perceived benefits and aggressiveness risks from their sports and examined whether these perceptions predicted athletes' engagement and quality of life (QoL). Participants completed perception measures of karate and football, and engagement and QoL measures. Results showed that karateka perceived more benefits and fewer risks in karate than football, but footballers generally perceived equal benefits and risks in both sports. Both athlete groups perceived similar physical and psychological benefits in their own sport, but deemed physical benefits as prominent outcomes in the other sport. Notably, karateka's perceived benefits about karate predicted engagement directly and QoL indirectly *via* vigor. Overall, karate athletes' perceptions seemed to be relevant to experiencing fulfillment in training and general well-being.

KEYWORDS

perceived benefits, aggressiveness-related risks, athlete engagement, quality of life, karate, football

Introduction

The consequences of practicing sports are becoming well-known. Research showed several physical and psychological benefits of karate (1, 2) and football (3, 4). Also, evidence on sport aggression-related risks suggested that whereas martial arts may reduce aggressive behaviors (5), football may foster them (6). Knowing sport benefits and risks is important to inform current and future athletes. Still, according to the Theory of Planned Behavior (TPB) (7, 8), people's perceptions about the consequences of an activity are powerful predictors of intended and actual behaviors. Favorable perceptions about physical activity (including sports) seem positively associated with intentions and effective participation (9, 10).

Recognizing the lack of multidimensional instruments for assessing sport perceptions, Limpo and Tadrist (11) developed a scale to measure perceived physical, emotional, cognitive, and social benefits as well as aggression-related risks in karate and football. Besides providing validity evidence on this instrument, authors reported three main findings. First, physical benefits were perceived as salient outcomes of karate and football. Second, karate was perceived to have more psychological-related benefits and less aggressiveness risks than football. Third, perceptions varied according to involvement in physical activity. This study was however limited in two ways: it neither targeted athletes nor studied the predictive role of perceptions. Here, we aimed to overcome these gaps, by examining karateka and footballers' perceptions about karate and football as well as the contribution of these perceptions to athlete engagement and quality of life (QoL).

Initially defined in work settings (12), engagement in sport refers to a mindset of fulfillment during practice, characterized by strong mental resilience and high energy levels (vigor), full concentration and focus (absorption), and a sense of significance, enthusiasm, and pride (dedication). Some studies examining the antecedents of athlete engagement targeted basic psychological needs (13–15). To date, no study tested whether sport perceived benefits/risks contribute to athlete engagement. Yet, research from other fields and/or gauging related constructs alluded to this link. For example, perceived value in academic activities predicted undergraduates' school engagement (16); perceived monetary and non-monetary work benefits contributed to employees' work engagement (17), and perceived benefits of a digital library system predicted user absorption in library resources (18). In the sport setting, perceived value in marathon running among parent-child runners predicted their intentions to participate in this activity (19), and valuing sport practice was positively associated with correlates of engagement, such as involvement and resilience (20). Perceived risks in sport or other settings has been even less researched than perceived benefits. Some studies compared athletes' perceived injury risk across sports, including karate and football [e.g., Strotmeyer and Lystad (21)], but none has related it to engagement. We located one study showing that as non-athletes perceived levels of aggression in a sport increased, their willingness to be engaged in it declined (22).

Contrasting with sparse data relating athletes' perceptions and engagement, prior research has connected perceived sport-related benefits with aspects of QoL. Among exercisers at a fitness center, perceiving exercise to be beneficial or useful was associated with better exercise-related subjective experiences (23). The more college students perceived value in elite sports, the better their subjective well-being (24). Also, perceived social benefits of university-offered sports contributed to QoL (25). However, little is known about links between perceived risks in sports and QoL, even though research in work settings suggested that this association might be negative (26).

Besides perceptions, engagement may also be a likely predictor of QoL. A handful of studies showed that athlete engagement had, respectively, positive and negative associations with flow (13) and burnout (14, 15), which are deemed indicators of well-being in sport. To the best of our knowledge, there is no evidence on the link between athlete engagement and QoL. The picture is different in work settings, where a clear link between engagement and several aspects of QoL was found (27).

Collectively, available research supports the reasonable expectation that athletes may have different perceptions about sports, which may be linked to their engagement and QoL, also likely to be inter-related. Still, there is not compelling evidence corroborating these hypotheses, which were never tested in the same study with karate and football athletes.

This study had two major goals: (a) to examine whether perceived benefits and risks varied within and between sport (karate vs. football) and type of athlete (karateka vs. footballers); and (b) to test whether athletes' perceptions predicted engagement and QoL. Respectively, our hypotheses were as follows (a) based on Limpo and Tadrist (11), we expected karateka and footballers' perceptions about karate and football to be different, and (b) based on evidence from different settings showing perceptions-engagement (16, 20), perceptions-QoL (24, 25), and engagement-QoL links (27), we hypothesized that athletes perceiving more benefits and less risks in their sport would report more engagement, and, in turn, better QoL. By focusing on two types of athletes, we were able to ascertain whether this link was sport-general or sport-specific.

Methods

Participants

Participants were 100 athletes practicing karate or football in Portugal. Sample size was defined with a priori power analysis using G*Power 3 [Version 3.1.9.6; (28)], in which we specified: power = 80%, $\alpha = 0.05$, analysis = repeated measures analysis of variance, and repeated-measures correlation = 0.40 [based on Limpo and Tadrist (11)]. A minimum of 96 participants was suggested to detect small effects ($\eta_p^2 = 0.015$), as reported by Limpo and Tadris (11). No power analysis was performed for the moderated mediation analysis as confidence intervals were built through bootstrapping (sample set to 5,000).

The karate group included 51 athletes (80% males) with a mean age of 38.55 years ($SD = 13.81$). The football group included 49 athletes (84% males) with a mean age of 21.88 years ($SD = 7.48$). Table 1 presents a characterization of both groups, which differed in terms of age, educational level, years of experience, and weekly training hours.

TABLE 1 Characterization and comparison of the karate and football groups.

	Measures	Karate athletes ($n = 51$)	Football athletes ($n = 49$)	Comparison
Age				
	Mean (*SD*)	38.55 (13.81)	21.88 (7.48)	$t = -7.55$
	Range	18–65	17–49	$p < 0.001$
Gender				
	Male (%)	41 (80%)	41 (84%)	$x^2 = 0.18$
	Female (%)	10 (20%)	8 (16%)	$p = 0.67$
Educational level				
	High school or below	26 (51%)	36 (61%)	$x^2 = 5.37$
	Graduation or above	25 (49%)	13 (39%)	$p = 0.02$
Karate graduation				
	4th kyu or below	6 (12%)	–	
	Between 3rd and 1st kyu	11 (21%)	–	
	1st dan	13 (25%)	–	
	2nd dan	10 (20%)	–	
	3rd dan	6 (12%)	–	
	4th dan or above	5 (10%)	–	
Football involvement				
	Amateur	–	27 (55%)	
	Semi-professional	–	19 (39%)	
	Professional	–	2 (4%)	
	Ex-professional	–	1 (2%)	
Instructor/coach functions				
	No	35 (67%)	39 (80%)	$x^2 = 1.56$
	Yes	16 (31%)	10 (20%)	$p = 0.21$
Years of practice				
	Mean (*SD*)	20.02 (12.68)	13.02 (7.94)	$t = -3.32$
	Range	1–47	1–40	$p < 0.001$
Weekly training hours (last 6 months)				
	Mean (*SD*)	2.37 (1.64)	6.20 (2.37)	$t = 5.19$
	Range	0–6	0–24	$p < 0.001$
Competition experience				
	None	22 (43%)	2 (4%)	$t = 1.51$
	Low (<10 times)	7 (14%)	22 (45%)	$p = 0.13$
	Moderate (between 10 and 25 times)	5 (10%)	15 (31%)	
	High (25 times or more)	17 (33%)	10 (20%)	

Measures

Perceptions about karate and football

We used the Portuguese Perceived Benefits and Aggressiveness Risks Scale (PBAR Scale), developed by Limpo and Tadrist (11). This is composed of five 3-item factors measuring perceived physical, emotional, social, and cognitive benefits along with perceived aggression-related risks in karate and football. Athletes were asked to indicate the degree to which they perceived each statement to represent outcomes of each sport, using a 5-point scale, from 1 (*totally disagree*) to 5 (*totally agree*). Cronbach's alphas for the karate/football versions were: 0.86/0.79 for physical benefits, 0.91/0.83 for emotional benefits, 0.74./0.80 for social benefits, 0.87/0.75 for cognitive benefits, and 0.76/0.79 for aggressiveness risks.

Athlete engagement

Engagement was measured with the 17-item Utrecht Work Engagement scale (29), validated to Portuguese by Simães and Gomes (30). For this study, the instrument was adapted to the sport context [for a similar procedure, see Martínez-Alvarado et al. (15) and Scotto di Luzio et al. (31)] by replacing the word "working" by "training" or "job" by "sport" (e.g., the original item "Time flies when I'm *working*" was changed to "Time flies when I'm *training*"). The instrument is composed of three engagement dimensions: vigor (6 items), absorption (6 items), and dedication (5 items). Athletes were asked to indicate how often they experienced the situations described, using a 5-point scale, from 1 (*almost never*) to 5 (*most of the time*). Cronbach's alphas were 0.80 for vigor, 81 for dedication, and 0.77 for absorption.

QoL

We used the EUROHIS-QOL-8 (32), validated to Portuguese by Pereira et al. (33). This is an 8-item unifactorial scale based on the WHOQOL-BREF (34), tapping psychological, physical, social, and environmental life domains. Athletes were asked to respond to each question using an individualized 5-point scale (e.g., ranging from "*not at all*" to "*completely*"). Cronbach's alpha was 0.80.

Procedure

The study was implemented online with the LimeSurvey software and invitations to participate were spread *via* social media and sport clubs. After reading study goals, athletes were asked to provide a consent agreement, using a click-if-you-agree system. Those who agreed to participate were given access to the survey. The study was approved by the Ethics Committee of the first author's university.

Data analysis plan

Comparison of perceptions of football and karate

First, we examined the skewness and kurtosis of all variables separately by type of athlete. Respectively, values below |3| and |10| were considered as indicative of no severe deviations from the normal distribution (35). Afterwards, we conducted a 2 (Sport targeted [karate, football]) x 2 (Athlete [karateka, footballers]) x 5 (Perceptions [physical benefits, emotional benefits, social benefits, cognitive benefits, aggressiveness risks]) analyses of variance (ANOVA) with repeated measures in the first and last factors. When the sphericity assumption was violated, we used the Greenhouse-Geisser procedure. Considering an alpha level of 0.05, significant interactions were examined with tests of simple effects, followed-up through pairwise comparisons with Bonferroni correction. Preliminary 2 x 2 x 5 ANCOVAs introducing as covariates the sociodemographic characteristics or training-related features (hereafter referred as control variables), showed no main effects or interactions involving these variables. Thus, they were not introduced in the main ANOVA.

Contribution of sport perceptions to engagement and QoL

As first preliminary step, separately for karate and football athletes, we inspected the correlations between all variables. Anticipating significant correlations involving control variables, these were accounted for in the subsequent analyses.

Second, stepwise regression analyses were used to examine the contribution of karate or football perceptions on athlete engagement and QoL, above and beyond control variables and type of athlete. For each dependent variable, we conducted two regression analyses with the same predictors on Step 1 (control variables plus type of athlete, which was dummy coded: 0 = footballers, 1 = karateka), but different predictors on Step 2. Whereas in one analysis we entered the main effects of karate perceptions and their interactions with type of athlete, in the other we added the main effects and interactions of football perceptions. To assure a participants/predictors ratio above 10 (36), we created a composite score labeled "overall benefits" by averaging athletes' perceived physical, emotional, social, and cognitive benefits in karate or football.

Finally, we used the PROCESS macro for SPSS version 3.5 (37) to test the presence of moderated mediation (38), that is, whether athlete engagement mediated the link between perceptions and QoL and whether this mediating effect was moderated by athlete type. Separate analyses were conducted to examine the contribution of perceived benefits/risks about karate/football, introducing age, education level, years of practice, and weekly training hours as covariates. The composite score combining all perceived benefits was used.

Results

Comparison of perceptions of football and karate

An inspection of skewness and kurtosis values showed no severe deviations from the normal distribution. Means and standard deviations by group are presented in Table 2. The analysis revealed main effects of sport $F_{(1,98)} = 10.29$, $p = 0.002$, $\eta^2_p = 0.10$, and perceptions, $F_{(1.79,174.99)} = 327.44$, $p < 0.001$, $\eta^2_p = 0.77$; two 2-way interactions between sport and athlete,

$F_{(1,98)} = 35.13$, $p < 0.001$, $\eta_p^2 = 0.26$, and between sport and perceptions, $F_{(1.85,181.29)} = 48.49$, $p < 0.001$, $\eta_p^2 = 0.33$; and a 3-way interaction, $F_{(1.85,181.29)} = 76.50$, $p < 0.001$, $\eta_p^2 = 0.44$, described next.

Differences between sports

Karateka perceived karate as having statistically significant more physical, emotional, social, and cognitive benefits as well as less risk than football ($Fs > 51.77$, $ps < 0.001$, $\eta_p^2 > 0.34$). Considering footballers, only one statistically significant difference was found: they perceived football to have more social benefits than karate ($F = 5.82$, $p = 0.02$, $\eta_p^2 = 0.06$).

Differences between athletes

In comparison to footballers, karateka perceived statistically significant more physical, emotional, social, and cognitive benefits ($Fs > 12.59$, $ps < 0.001$, $\eta_p^2 > 0.11$) and less risks ($F = 32.49$, $p = 0.001$, $\eta_p^2 = 0.25$) in karate. The opposite pattern was found for football, in which football athletes perceived more physical, emotional, social, and cognitive benefits ($Fs > 15.44$, $ps < 0.001$, $\eta_p^2 > 0.13$) and less risks ($F = 6.77$, $p = 0.01$, $\eta_p^2 = 0.07$) than karate athletes.

Differences between perceptions

There were statistically significant differences between perceptions across both sports and athlete types, $Fs < 19.54$, $ps < 0.001$, $\eta_p^2 > 0.45$. Karateka perceived karate to have similar physical, emotional, social, and cognitive benefits ($ts < 2.75$, $ps > 0.07$), but perceived football as having more physical (ts > 4.29, $ps < 0.001$) than all other benefits, with no statistically significant differences between them ($ts < 1.24$, $ps = 1.00$). Footballers perceived football to have similar physical, emotional, and social benefits ($ts < 0.91$, $ps = 1.00$) and less cognitive benefit ($ts > 3.54$, $ps > 0.001$), but perceived karate to have statistically significant more physical than emotional and social benefits, which were deemed significantly higher than cognitive ones (ts > 3.21, $ps < 0.02$). Consistently across athletes and sports, emotional and social benefits was perceived to be similar, and all benefits were deemed higher than risks ($ts > 9.14$, $ps < 0.001$).

Contribution of sport perceptions to engagement and QoL

Table 3 presents correlations between all variables, conducted as a preliminary step before the regression analyses. Karateka's age was linked to karate perceived benefits and engagement ($0.30 < rs < 0.51$), and their years of experience were negatively associated football perceived benefits ($-0.35 < rs < -0.58$). For footballers, there were correlations between age and vigor ($r = -0.29$), weekly training hours and QoL ($r = 0.29$), and some control variables and perceptions ($-0.28 < rs < -0.34$). In general, athletes' perceived benefits in their own sport were correlated with each other ($0.34 < rs < 0.72$) and with engagement ($0.28 < rs < 0.70$), which was related to QoL ($0.34 < rs < 0.44$).

Predictive role of control variables and type of athlete

Step 1 of the regression analyses proved significant for vigor, absorption, and dedication, but not QoL (Table 4). Age ($bs > 0.38$) and educational level ($bs > -0.21$) predicted all engagement variables; years of experience predicted dedication ($b = 0.25$); and footballers reported more absorption than karateka ($b = -0.30$).

Predictive role of karate perceptions

When we added the main effects of karate perceptions and their interactions with type of athlete, there was a significant increase in the amount of variance explained in vigor, absorption, and dedication, but not in QoL (Table 4). The full model explained 28, 36, and 38% of the variance in vigor, absorption, and dedication, respectively. Significant predictors of vigor were educational level ($b = -0.26$), perceived benefits ($b = 0.74$), and the Athlete x Benefits interaction ($b = 0.65$). Significant predictors of absorption were educational level ($b = -0.22$), athlete type ($b = -0.60$), perceived benefits ($b = 0.90$), and the Athlete x Benefits interaction ($b = 0.76$). Significant predictors of dedication were age ($b = 0.30$), athlete type ($b = -0.41$), perceived benefits ($b = 0.88$), and the Athlete x Benefits interaction ($b = 0.69$). Athlete x Benefits interactions mean that greater perceived benefits about karate were associated with more vigor, absorption, and dedication only among karateka.

Predictive role of football perceptions

The inclusion of football perceptions and their interactions with type of athlete, led to no increase in the amount of variance explained in any outcome (Table 4).

Moderated mediation analyses

We found a single effect of moderated mediation involving vigor. For karateka (but not footballers) the perception of more benefits in karate was associated with better QoL through higher vigor, estimate = 0.48, bootstrap standard error = 0.16, 95% CI [0.18; 0.81]. No moderated mediation effects were found for football perceptions.

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TABLE 2 Means and standard deviations for perceptions, engagement, and quality of life for karate and football athletes.

Measures	Karate athletes ($n = 51$)		Football athletes ($n = 49$)	
	M	*SD*	*M*	*SD*
Perceptions about karate				
Physical benefits	4.85	0.23	4.37	0.93
Emotional benefits	4.78	0.38	4.20	1.02
Social benefits	4.75	0.41	4.09	1.06
Cognitive benefits	4.66	0.48	3.86	1.02
Aggressiveness risks	1.34	0.63	2.27	0.96
Perceptions about football				
Physical benefits	3.91	0.84	4.52	0.49
Emotional benefits	3.50	0.87	4.47	0.50
Social benefits	3.40	0.79	4.44	0.61
Cognitive benefits	3.50	0.83	4.10	0.70
Aggressiveness risks	2.76	1.10	2.24	0.88
Athlete engagement				
Vigor	4.36	0.56	4.19	0.51
Absorption	4.43	0.59	4.52	0.42
Dedication	4.64	0.51	4.57	0.44
Quality of Life	4.17	0.43	4.02	0.45

Discussion

Comparison of perceptions of football and karate

There were four main findings concerning karate and football athletes' perceptions. It is worth keeping in mind that, despite group differences in sociodemographic and training-related features, preliminary ANCOVAs showed that perceptions did not vary as a function of these variables.

First, between-group athlete comparisons showed that karateka (vs. footballers) perceived karate to bring them more benefits, whereas footballers (vs. karateka) perceived football to bring them more benefits. Though these findings may suggest endogroup favoritism (39), within-group comparisons advise caution in assuming that. Though karateka clearly perceived more benefits in karate than football, footballers only perceived football to have more social benefits than karate. Also, due to the few studies comparing actual karate and football benefits, it is difficult to infer whether athletes were overestimating the benefits of their own sport or not.

Second, karateka and footballers tended to perceive as much physical as psychological benefits in their own sport. Given available evidence showing that those are real benefits of karate and football (1–3), these athletes seem to have a richer knowledge about the benefits of their sport than other sports. This result extends prior findings with non-athletes, who perceived physical benefits as the most salient outcomes of karate and football, likely due to their limited knowledge about these sports (11). The same was observed here, when athletes judged the non-practiced sport. It seems that for people not practicing a specific sport, the physical dimension is deemed its core feature. Also, there was a tendency to devalue the cognitive benefits of karate and football, particularly evident among footballers. This finding matches those of Limpo and Tadrist (11), who noted that this devaluing contrasts with evidence-based cognitive gains of these sports (4, 40). Overall, there seems to be a need to raise people's awareness about the psychological (mainly cognitive) benefits of sports, in which they do not partake in.

Third, regardless of athlete type, social and emotional benefits were perceived to the same extent in both sports. Though this finding may question PBAR scale's discriminant validity, we believe it would be premature to conclude that. First, the connection between social and emotional aspects is well recognized (47), including in the study of perceived benefits of physical activity (41). Second, Limpo and Tadrist (11) showed clear differences between social and emotional benefits. Finally, in the present study, footballers did discriminate between these aspects, by deeming social (but not emotional) benefits in football to outweigh those in karate. Still, future studies may explore the comparative merits of studying perceived emotional and social benefits as separate or joint constructs.

Fourth, our results involving aggressiveness-related risks revealed that: (a) both sports were deemed to have larger benefits than risks; (b) karateka perceived more risks in football than

TABLE 3 Bivariate correlations for karate athletes (above the diagonal) and football athletes (below the diagonal).

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Control Variables		**0.39**	**0.5**	0.14	**0.44**	**0.40**	**0.42**	**0.37**	**0.30**	0.06	−0.26	−0.24	−0.24	−0.27	−0.17	0.18	**0.35**	**0.46**	**0.51**	0.19
1. Age																				
2. Educational level	**0.53**		0.18	−0.03	0.14	0.02	0.20	0.04	0.18	0.16	−0.03	0.05	−0.08	−0.02	−0.04	0.13	−0.13	−0.05	−0.06	0.04
3. Years of experience	**0.86**	**0.39**		**0.28**	0.16	0.19	0.13	0.05	0.19	0.20	**−0.54**	**−0.58**	**−0.51**	**−0.46**	**−0.35**	0.24	0.16	0.23	0.17	0.08
4. Weekly training hours	**−0.40**	−0.22	−0.26		0.09	0.20	0.06	−0.03	0.12	−0.11	−0.24	−0.16	−0.15	**−0.29**	−0.24	0.17	0.16	0.14	0.19	0.003
Karate perceptions	0.09	0.13	−0.07	−0.26		**0.82**	**0.85**	**0.78**	**0.88**	< 0.001	0.03	0.01	−0.03	−0.03	0.19	0.08	**0.57**	**0.66**	**0.69**	0.22
5. Benefits (overall)																				
6. Physical benefits	0.12	0.07	−0.02	−0.14	**0.94**		**0.64**	**0.61**	**0.62**	−0.01	−0.01	−0.03	−0.09	−0.15	0.21	0.12	**0.53**	**0.67**	**0.70**	0.15
7. Emotional benefits	0.05	0.08	−0.12	−0.20	**0.96**	**0.90**		**0.49**	**0.72**	0.01	0.01	0.01	0.004	−0.05	0.08	0.13	**0.38**	**0.48**	**0.57**	0.02
8. Social benefits	0.09	0.16	−0.05	**−0.34**	**0.95**	**0.85**	**0.89**		**0.51**	−0.14	−0.05	−0.12	−0.12	−0.02	0.09	−0.06	**0.62**	**0.64**	**0.67**	0.25
9. Cognitive benefits	0.09	0.18	−0.06	**−0.28**	**0.93**	**0.82**	**0.85**	**0.86**		0.12	0.12	0.11	0.05	0.05	0.20	0.08	**0.42**	**0.47**	**0.46**	0.27
10. Aggressiveness risks	−0.02	−0.02	0.21	< 0.001	0.12	0.19	0.10	0.09	0.09		0.15	0.14	0.05	0.11	0.25	0.19	−0.17	−0.18	−0.15	−0.14
Football perceptions	−0.20	−0.16	−0.27	0.14	0.22	0.15	0.17	0.23	0.26	**−0.37**		**0.87**	**0.91**	**0.89**	**0.85**	**−0.36**	−0.21	−0.19	−0.20	0.13
11. Benefits (overall)																				
12. Physical benefits	−0.15	**−0.30**	−0.08	0.27	0.05	0.13	0.04	−0.02	0.06	−0.13	**0.71**		**0.74**	**0.65**	**0.66**	−0.21	−0.26	−0.24	−0.22	0.18
13. Emotional benefits	−0.21	−0.17	**−0.32**	−0.003	0.25	0.18	**0.28**	0.26	0.23	−0.21	**0.68**	**0.34**		**0.82**	**0.65**	**−0.28**	−0.18	−0.19	−0.19	0.04
14. Social benefits	−0.19	−0.03	−0.24	0.08	0.06	−0.01	0.04	0.15	0.02	**−0.33**	**0.78**	**0.47**	**0.41**		**0.69**	**−0.57**	−0.23	−0.24	**−0.28**	0.08
15. Cognitive benefits	−0.06	−0.04	−0.17	0.09	0.26	0.15	0.15	0.26	**0.41**	**−0.39**	**0.77**	**0.37**	**0.36**	**0.42**		−0.24	−0.09	−0.01	−0.03	0.16
16. Aggressiveness risks	−0.05	−0.08	0.16	0.14	**−0.30**	−0.15	**−0.31**	**−0.36**	**−0.32**	**0.46**	**−0.48**	−0.11	**−0.52**	**−0.42**	**−0.36**		0.02	0.09	0.15	−0.23
Athlete engagement	**−0.29**	−0.25	−0.16	0.06	−0.04	−0.09	−0.08	−0.05	0.08	−0.09	0.25	**0.28**	0.14	0.13	0.20	−0.27		**0.84**	**0.81**	**0.39**
17. Vigor																				
18. Absorption	−0.23	−0.17	−0.15	−0.03	0.07	0.03	0.05	0.05	0.13	−0.07	**0.31**	**0.32**	**0.32**	0.15	0.18	−0.22	**0.76**		**0.87**	**0.34**
19. Dedication	−0.27	−0.09	**−0.30**	0.11	0.09	0.003	0.06	0.08	0.17	−0.24	**0.40**	0.23	**0.30**	**0.30**	**0.33**	**−0.44**	**0.76**	**0.68**		0.13
20. Quality of Life	−0.22	−0.12	−0.10	**0.29**	−0.09	−0.12	−0.06	−0.11	−0.06	−0.05	0.12	0.09	0.27	0.04	−0.002	−0.27	**0.41**	**0.28**	**0.44**	

Correlations equal to or above |0.28| are significant at an alpha level of 0.05 and are signaled in bold.

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TABLE 4 Complete results of all regression models tested.

Predictors	Vigor				Absorption				Dedication				Quality of Life			
	b	*t*	*p*	part corr	*b*	*t*	*p*	part corr	*b*	*t*	*p*	part corr	*b*	*t*	*p*	part corr
Step 1	$R^2 = 0.12, p = 0.03$				$R^2 = 0.14, p = 0.02$				$R^2 = 0.17, p = 0.003$				$R^2 = 0.08, p = 0.19$			
Age	0.38	2.35	0.02	0.23	0.53	3.33	0.001	0.32	0.64	4.08	< 0.001	0.38	0.14	0.82	0.42	0.08
Educational level	−0.29	−2.65	0.01	−0.26	−0.26	−2.38	0.02	−0.23	−0.21	−2.01	0.05	−0.19	−0.05	−0.40	0.69	−0.04
Years of experience	−0.06	−0.49	0.63	−0.05	−0.08	−0.65	0.52	−0.06	−0.25	−2.01	0.05	−0.19	−0.04	−0.27	0.79	−0.03
Weely training hours	0.09	0.78	0.44	0.08	0.04	0.40	0.69	0.04	0.16	1.52	0.13	0.14	0.23	2.00	0.05	0.20
Athlete (0 = footballer, 1 = karateka)	0.06	0.45	0.65	0.04	−0.30	−2.33	0.02	−0.22	−0.11	−0.87	0.38	−0.08	0.22	1.68	0.10	0.17
Step 2—Perceptions about karate	$\Delta R^2 = 0.16, p = 0.001$				$\Delta R^2 = 0.22, p < 0.001$				$\Delta R^2 = 0.21, p < 0.001$				$\Delta R^2 = 0.02, p = 0.66$			
Age	0.09	0.53	0.60	0.05	0.18	1.17	0.25	0.10	0.30	1.99	0.05	0.17	0.03	0.15	0.89	0.02
Educational level	−0.26	−2.48	0.02	−0.22	−0.22	−2.24	0.03	−0.19	−0.19	−1.94	0.06	−0.16	−0.03	−0.23	0.82	−0.02
Years of experience	0.04	0.34	0.74	0.03	0.04	0.39	0.70	0.03	−0.12	−1.03	0.31	−0.09	0.01	0.10	0.92	0.01
Weekly training hours	0.05	0.43	0.67	0.04	0.01	0.07	0.95	0.01	0.14	1.45	0.15	0.12	0.21	1.75	0.08	0.18
Athlete (0 = footballer, 1 = karateka)	−0.19	−1.36	0.18	−0.12	−0.60	−4.56	< 0.001	−0.38	−0.41	−3.14	0.002	−0.26	0.11	0.70	0.49	0.07
Overall benefits	0.74	4.07	< 0.001	0.37	0.90	5.32	< 0.001	0.45	0.88	5.23	< 0.001	0.43	0.24	1.17	0.25	0.12
Aggressiveness risks	−0.15	−1.32	0.19	−0.12	−0.18	−1.66	0.10	−0.14	−0.19	−1.76	0.08	−0.15	−0.12	−0.92	0.36	−0.09
Athlete x Overall benefits	0.65	3.97	< 0.001	0.36	0.76	4.90	< 0.001	0.41	0.69	4.51	< 0.001	0.37	0.23	1.24	0.22	0.12
Athlete x Aggressiveness risks	−0.06	−0.56	0.58	−0.05	−0.09	−0.96	0.34	−0.08	0.02	0.23	0.82	0.02	−0.06	−0.52	0.61	−0.05
Step 2—Perceptions about football	$\Delta R^2 = 0.05, p = 0.25$				$\Delta R^2 = 0.05, p = 0.24$				$\Delta R^2 = 0.08, p = 0.06$				$\Delta R^2 = 0.09, p = 0.06$			
Age	0.38	2.36	0.02	0.23	0.53	3.32	0.001	0.32	0.64	4.15	< 0.001	0.38	0.13	0.82	0.42	0.08
Educational level	−0.26	−2.37	0.02	−0.23	−0.23	−2.08	0.04	−0.20	−0.18	−1.74	0.09	−0.16	−0.04	−0.38	0.71	−0.04
Years of experience	−0.10	−0.73	0.47	−0.07	−0.11	−0.77	0.44	−0.07	−0.30	−2.22	0.03	−0.20	0.07	0.52	0.61	0.05
Weekly training hours	0.07	0.65	0.52	0.06	0.01	0.07	0.94	0.01	0.13	1.22	0.23	0.11	0.28	2.45	0.02	0.24
Athlete (0 = footballer, 1 = karateka)	0.07	0.43	0.67	0.04	−0.29	−1.85	0.07	−0.18	−0.02	−0.12	0.90	−0.01	0.27	1.66	0.10	0.16
Overall benefits	0.03	0.19	0.85	0.02	0.17	1.02	0.31	0.10	0.11	0.72	0.48	0.07	0.07	0.42	0.67	0.04
Aggressiveess risks	−0.13	−1.16	0.25	−0.11	−0.02	−0.20	0.84	−0.02	−0.08	−0.74	0.46	−0.07	−0.29	−2.59	0.01	−0.25
Athlete x Overall benefits	−0.22	−1.83	0.07	−0.18	−0.27	−2.27	0.03	−0.22	−0.31	−2.71	0.01	−0.25	0.05	0.38	0.70	0.04
Athlete x Aggressiveess risks	−0.07	−0.54	0.59	−0.05	−0.13	−0.98	0.33	−0.09	0.01	0.06	0.95	0.01	−0.09	−0.67	0.51	−0.06

part corr, part correlation.

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karate, but footballers perceived equal risks between them; and (c) karateka perceived less risks in karate than footballers, while footballers perceived less risks in football than karateka. These findings partially align with Limpo and Tadrist (11), who found that perceived benefits of karate surpassed its risks, and that perceived karate risks were lower than perceived football risks. The different results mainly involve football and may be explained by the samples: athletes vs. non-athletes. Athletes may have underestimated the risks in their own sport, as it happened with Muay Thai fighters, concerning injury risks (21). Future research may examine the degree to which perceived risks in different sports match actual risks.

Contribution of sport perceptions to engagement and QoL

After controlling for participants' age, education level, years of practice, and weekly training hours, we found that karateka's perceptions about karate predicted their engagement. The more benefits karateka perceived in their own sport, the more they reported high levels of vigor, absorption, and dedication. Specifically, they reported to have more energy and mental resilience while training, to be fully focused and happily engrossed in karate, and to feel strongly identified and enthusiastic about it. Karateka's perceptions about football did not predict their sport engagement, confirming the specificity of this perception-engagement link. Though past evidence hinted at this link (17), this study provides its first empirical demonstration. Determining the correlates of engagement is relevant because engagement is seen as a form of optimal functioning, associated with positive cognitive and emotional experiences (13, 14) and performance (42).

Although karate and football athletes' perceptions did not predict QoL directly, karateka's perceived benefits in karate did predict QoL indirectly through vigor. The more karateka perceived benefits in karate, the more energy they spent in this sport, and the better they felt about their lives. This is the first study linking core dimensions of athletes' lives in a mediating chain from perceptions to QoL *via* engagement, specifically, vigor. The prominent role of vigor in sport studies was also reported by Stolarski et al. (42), who found that this was the unique engagement dimension with a clear and positive relationship with running performance. The noticeable association of vigor with physical strength (43) may explain its central role in sport-related models and athlete samples, as those tested here and in the study conducted by Stolarskli et al. (42).

Two additional remarks are worth mentioning. First, karateka's perceived aggression risks in karate were not associated with either engagement or QoL. Likely, the perception of few risks in their sport diminished the relevance of this variable in relation to sport- and life-related outcomes. More research is needed to elucidate the potential role of perceived risks in sports, which may act as a more relevant predictor of intentions to become an athlete (22) rather than of engagement while being one. Second, the perception-engagement-QoL link was not observed among football players, indicating that this may be a sport-specific link. Its occurrence in karate but not in football may be related to the nature of these sports. Though both karate and football have a strong focus on physical skills (e.g., strength, speed), karate has an additional focus on the mind and the spirit (44). The degree to which these features relate to current findings is however open to inquiry. Future studies testing the perception-engagement-QoL in other sports seem warranted.

Limitations and future research directions

Interpretations of these findings should consider four limitations. First, our data were obtained at a single time point and this study was correlational in nature. Thus, causality inferences should be avoided. More research is needed to replicate our results, through experimental and longitudinal tests of the mechanisms through which athletes' perceptions influence engagement and QoL. Second, we used a single-indicator approach, which did not model measurement error. Despite the validity and reliability of the instruments we used, it is advisable to cross-validate these findings with a multiple-indicator approach. Third, the groups of karate and football athletes differed in some characteristics. Though we statistically assured that our findings were not associated with these differences, future studies should aim for matched groups of athletes. Finally, because data was collected during the COVID-19 (January-February 2021), we cannot know whether results were influenced by the pandemic and will be replicated once it is over. However, the pattern of these findings aligned with pre-pandemic studies, and there is indication that the pandemic does not greatly threaten studies' external validity (45).

Conclusion

A clear-cut message of this study is that athletes' perceptions matter in karate, but not in football. As shown here, karateka's perceived benefits about karate predicted vigor, which, in turn, predicted QoL. Still, footballers' perceptions played not predictive role either on engagement or QoL. These findings have a twofold implication. From a research viewpoint, a future avenue of inquiry shall aim not only to replicate these findings but also to gather evidence-based explanations. For example, which characteristics of karate and football are likely to explain the differential role of athlete's perceptions

on engagement and QoL? From an applied viewpoint, sport psychologists should aim to gauge athletes' perceived benefits and risks about karate, and implement psycho-educational workshops highlighting its multiple benefits. By nurturing positive perceptions about karate, sport psychologists may be also boosting athletes' engagement and well-being. Given the pandemic's detrimental effects on athletes professional and personal lives (46), this seems particularly relevant in present times.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Faculty of Psychology and Education Sciences of the University of Porto. The patients/participants provided their written informed consent to participate in this study.

Author contributions

TL designed the study, oversaw the data collection and coding, analyzed and interpreted the data, and wrote the first version of the manuscript. GR helped in the preparation and implementation of the study. ST contributed to the design of the study and interpretation of the data. All authors reviewed the article and approved the submitted version.

Conflict of interest

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

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EDITED BY
Manuel Gómez-López,
University of Murcia,
Spain

REVIEWED BY
David Manzano Sánchez,
University of Murcia,
Spain
Jesús-Nicasio García-Sánchez,
Universidad de León,
Spain

*CORRESPONDENCE
Nieves Gutiérrez Ángel
nga212@ual.es
Nieves Fátima Oropesa Ruiz
foropesa@ual.es

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Emotional intelligence as a predictor of identified regulation, introjected regulation, and external regulation in athletes

Isabel Mercader-Rubio[1], Nieves Gutiérrez Ángel[1]*, Nieves Fátima Oropesa Ruiz[1]* and José Juan Carrión-Martínez[2]

[1]Department of Psychology, Universidad de Almería, Almería, Spain, [2]Department of Education, Universidad de Almería, Almería, Spain

Self-determination theory (SDT) considers motivation as a multidimensional phenomenon, with different levels of intensity, purposes, intentions, wills and autonomies. It distinguishes between intrinsic motivation (IM), extrinsic motivation (EM) and amotivation (AM). In this paper, we are going to focus on extrinsic motivation, which is related to those tasks that the subject performs without having a purpose in themselves, and which is composed of identified regulation, introjected regulation and external regulation. The aim of this research is to analyse the relationship between them and emotional intelligence in 165 students with university degrees related to Physical Activity and Sport Sciences. The main findings of this work lie mainly in the demonstration of the fact that emotional intelligence is a predictor of identified regulation, introjected regulation and external regulation.

KEYWORDS

motivation, emotional intelligence, athletes, regulation, students

Introduction

The purpose of sport is to show or improve physical and psychological condition, to develop social relations and to obtain better results (Unisport, 1992). Therefore, it is a widely recognised field of research to investigate different variables such as the influence of motivation (León et al., 2017). Motivation has important implications for athletes (Irwin and Feltz, 2016), as it is considered an essential component for obtaining commitment and adherence to sports practice, consolidating itself as the most important and immediate psychological determinant in the behaviour of the subject (Iso-Ahola and Clair, 2000).

In line with these ideas, when we talk about motivation, in general, we refer to the predisposition of a subject to perform a task with a certain intention (Palmero, 2005; Vallejo-Reyes et al., 2018). The study of motivation and behaviour in physical activity has been approached from two theoretical frameworks: achievement goal theory (Nicholls, 1989) and self-determination theory (Deci and Ryan, 1985; Ryan and Deci, 2000). In the

scientific literature, several review papers on achievement goal theory (Braithwaite et al., 2011) and self-determination theory (Curran and Standage, 2017; Sun et al., 2017; Van den Berghe, et al., 2014) can be found.

In this sense, one of the main psychological theories on this construct is Self-Determination Theory (SDT). This theory considers self-determination as a multidimensional phenomenon, with different levels of intensity, purposes, intentions, wills and autonomies (Deci and Ryan, 1985). Therefore, this theory distinguishes between intrinsic motivation (IM), extrinsic motivation (EM) and amotivation (AM).

There are several investigations carried out in the field of sport under the prism of this theory (Li and Harmer, 1996; Martens and Weber, 2002; Guzmán et al., 2006; Balaguer et al., 2007; Mallett et al., 2007; Martin-Albó et al., 2007; López, 2010; Pelletier et al., 2013; Guevara et al., 2015; León et al., 2017; Muñoz, 2021; Vallejo-Reyes et al., 2018) which aim to inquire about the motives that lead the athlete to both initiate and maintain a behaviour (Trigueros-Ramos, et al., 2019; Navarro-Patón et al., 2020; Mercader-Rubio et al., 2022; Mossman et al., 2022).

However, in this paper, we are going to focus on extrinsic motivation, which is related to those tasks that the subject performs without possessing a purpose in themselves (Vallejo-Reyes et al., 2018). Therefore, taken to the field of sport, we speak of that type of motivation that leads the athlete to the task that is a means to other ends, where the locus of causality becomes external (Balaguer et al., 2007).

In addition, within extrinsic motivation, we find four levels, which correspond to different types of regulation (Deci and Ryan, 1985; Vallejo-Reyes et al., 2018). Integrated Regulation (INTEG): It corresponds to the highest level of self-determination and occurs when the cognition of motivation is related and in accordance with the subject's own self-concept and values (Vallerand and Bissonnete, 1992). It represents the highest level of self-determination. Identified Regulation (IDR): It corresponds to the fact that the cognition of motivation is considered relevant, despite the fact that the task is exercised largely for extrinsic reasons. In this case, we therefore refer to an internally regulated behaviour. And it corresponds to medium levels of self-determination. Introjected Regulation (INTY): It corresponds to the mental image of external contingencies. In this type, we find that the subject either possesses the behaviours fully internalised, but tends to exercise them by imposition or guilt. It corresponds to low levels of self-determination. External Regulation (EXT): It corresponds to those actions that are directly controlled by external stimuli and corresponds to low levels of self-determination.

However, the creators of the SMS/EMD instrument developed and validated an instrument in which there are some modifications to the different types of motivation proposed in the self-determination theory (Balaguer et al., 2007), in which extrinsic motivation is composed of three types: identified regulation, introjected regulation and external regulation. These are the ones that have been taken in this work.

In short, in the field of sport, motivation is one of the most studied variables as it is closely related to those motives that lead the athlete to start, maintain and abandon sport practice (Guillén, 2007; Muñoz, 2021).

Another of the constructs that has been widely studied in sport psychology is emotional intelligence (Ribeiro et al., 2018; Cowden, 2020). A large number of studies on this construct have selected athletes as a sample in order to clarify the relevance and importance of emotional intelligence in the field of sport. The results provided by them indicate that those athletes who obtain higher scores in the levels of emotional intelligence have greater effectiveness at the competitive level (Lott and Truner, 2018), or in the different dimensions of self-concept (Vaughan and Laborde, 2017). And several studies have shown a direct and positive correlation between emotional intelligence and motivation in the field of sport (Castro-Sánchez et al., 2018, 2019; Gallegos and López, 2020; Méndez-Giménez et al., 2021; Mercader-Rubio et al., 2022), although there is not much agreement on the differences established between sexes in this regard (Luna et al., 2019; Sánchez et al., 2021; Tinkler et al., 2021).

When talking about emotional intelligence, therefore, we have to highlight the fact that two models coexist to express and understand the concept of emotional intelligence: mixed models and ability models. However, this research specifically focuses on ability models (Mayer and Salovey, 1997), which are composed of sections or branches: Emotional perception: refers to the ability to match and examine one's own and others' feelings. This involves, therefore, attention to and recognition of the expression of different symbols, emotions and clarity of feeling. Emotional understanding: this involves recognising, cataloguing and exploring emotions in retrospect, both one's own and those of others. Emotional regulation: this is about apprehending, comparing and deliberating about emotions, both interpersonally and intrapersonally.

Thus, the results show that high levels of emotional intelligence correlate directly and positively with motivation (Castro-Sánchez et al., 2019; Gallegos and López, 2020; Méndez-Giménez et al., 2021; Mercader-Rubio et al., 2022). This leads us to create the main research question for this work, what type of relationship exists between emotional intelligence and each of its dimensions and identified regulation (FD), introjected regulation (FT) and external regulation (FC)?

Therefore, this research aims to analyse the Self-Determination Theory (SDT), specifically in extrinsic motivation (EM) and specifically in identified regulation, introjected regulation and external regulation, and their relationship with emotional intelligence.

Under the formulation of the following hypotheses:

> *H1.* There is a direct and positive relationship between emotional attention and identified regulation, introjected regulation, and external regulation.

H2. H1: There is a direct and positive relationship between emotional clarity and identified regulation, introjected regulation, and external regulation.

H3. H1: There is a direct and positive relationship between emotional regulation and identified regulation, introjected regulation, and external regulation.

Materials and methods

The methodology used corresponds to an *ex post facto*, retrospective and comparative design, since the dimensions of emotional intelligence are compared with other types of variables, in this case with identified regulation, introjected regulation and external regulation.

Participants

The total sample consisted of 165 undergraduate and master's degree students related to Physical Activity and Sport Sciences. Their mean age was 20.33 years, with a standard deviation SD = 3.44. With regard to sex, 70.9% ($n = 117$) were men and 27.9% ($n = 46$) were women. The sample size was determined by the number of students who, with prior information and consent, decided to participate in the study. All participants completed an official informed consent form from the University of Almeria (Spain) and were informed of the data protection protocol (Table 1).

Inclusion criteria took into account that each participant was an official student of the course in which the questionnaires were administered, that they signed the informed consent form (official model of the University of Almeria) and that they were of legal age.

As exclusion criteria, we eliminated those questionnaires that were not 100% completed, or that lacked socio-demographic information. In addition, the questionnaires were collected on paper, so another exclusion criterion was to check that there was no randomness in the answers or that the answers formed drawings.

The type of sampling used was simple random, as the questionnaire was given to all the students who attended class that day, with the prior agreement and permission of the teacher responsible for the subject.

The sample size was determined according to the number of students who, with prior information and consent, decided to participate in the study. The questionnaire was administered to all four undergraduate courses in physical activity and sport sciences. The questionnaire was administered to students of the master's degree in teaching (specialisation in physical education) and the master's degree in sport science research (Figure 1).

TABLE 1 Description of the sample according to age and sex.

	Females	Males	Total	Menos de 25	Mayores de 25
First course	18 (39.1)	68 (58.1)	86	86 (97.8%)	2 (2.2%)
Second course	16(34.8)	23 (19,7)	39	38 (97.4)	1 (2.6%)
Third year	6 (13%)	14 (12%)	20	20 (100%)	0
Total	40	105	145		
Master's degree	6 (13%)	12(10.3)	18	4 (22.3%)	17 (77.7%)
Total	46	117	163		

Instruments

Two instruments were used in this work:

The TMMS-24 (Fernández-Berrocal et al., 2004). It corresponds to a self-report that measures self-perceived emotional intelligence, i.e., the subject's knowledge of his or her own emotional capacities: attention to feelings, emotional clarity and emotion regulation, using a Likert-type scale (1–5). A Cronbach's alpha = 0.84 was obtained for this work. In addition, it shows high reliability (Cronbach's alpha) for each dimension (perception, $\alpha = 0.90$; clarity, $\alpha = 0.90$; regulation $\alpha = 0.86$) and adequate test–retest reliability: perception = 0.60; understanding = 0.70 and regulation = 0.83.

And, the Sport Motivation Scale (SMS/EMD; Pelletier et al., 1995; Balaguer et al., 2007). It is a Likert-type scale (1–7) that measures motivation through seven subscales: (1) intrinsic motivation to experience stimulation; (2) intrinsic motivation to achieve things; (3) intrinsic motivation towards knowledge; (4) identified regulation; (5) introjected regulation; (6) external regulation and (7) amotivation. In this research, we only took data from subscales 4-5-6. For this work, we obtained a Cronbach's alpha = 0.73. In addition, it shows high reliability (Cronbach's alpha) for each subscale (identified regulation, $\alpha = 0.74$; introjected regulation, $\alpha = 0.73$ and external regulation $\alpha = 0.79$).

To calculate the variance in the total scores, the hierarchical omega (ωH; Zinbarg et al., 2006) was computed. Magnitudes $\geq$ 0.70 indicate the presence of a unidimensional structure (Reise et al., 2013). In addition, the hierarchical omega (ωHs; Zinbarg et al., 2006) was calculated to estimate the reliability of the scores. Where ωHs values $\geq$0.30 are considered as significant (Smits et al., 2020). The common variance explained (ECV; Stucky and Edelen, 2015) was also calculated. Values below 0.70 indicate multidimensionality, whereas values above 0.85 are considered unidimensional.

The percentage of untainted correlations (PUC) score was also taken into account. If ECV and PUC are >0.70, or if PUC has a high coefficient (>0.80), and ECV and ωH magnitudes of >0.60 and $\geq$0.70, respectively, these are favourable indications of unidimensionality.

At the item level, the ECV-I (Stucky and Edelen, 2015) was calculated, which indicates the percentage of the variance of each

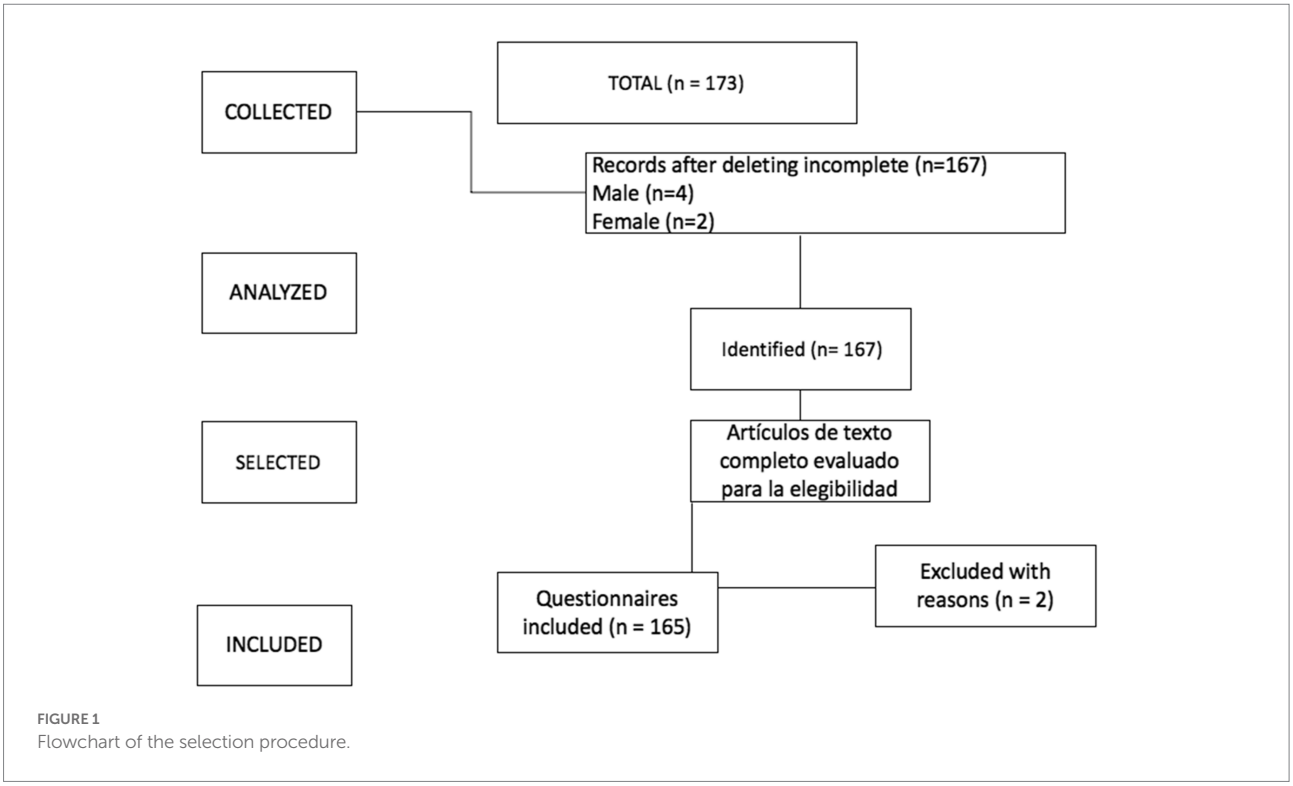

FIGURE 1
Flowchart of the selection procedure.

TABLE 2 Preliminary analyses.

	1	2	3	4	5	6
1. FACTOR 2		0.639**	0.328	0.257**	0.222**	0.215**
2. FACTOR 3			0.481**	0.264**	0.115	0.081
3. FACTOR 4				0.178*	0.–007	0.138
4. AE					0.127	0.263**
5. CE						0.508**
6. RE						

*$p < 0.05$; **$p < 0.01$.

item explained by the FG. Values ≥ 0.80 indicate a significant influence of the FG (Stucky and Edelen, 2015).

On the other hand, reliability was estimated using the omega coefficient (ω; McDonald, 1999), which measures how a latent variable is represented by a set of items. Values > 0.70 suggest a latent variable adequately defined by its indicators (Hancock and Mueller, 2005).

Data analysis

The data analyses used in this study were descriptive statistics (mean, standard deviation and bivariate correlations), reliability analysis and structural equation modelling (SEM) to test the relationships established in the hypothesised model.

Specifically, we applied Joreskog's test for the analysis of covariance structure (Jöreskog, 1970, 1973) to a multiple cause indicator (MIMIC). The rationale for using this test is that we are dealing with a situation where the latent variable is defined as a composite of a set of measures, i.e. the measures produce the constructs. This is called formative indicators. Structural equation systems such as MIMIC solve this.

To accept or reject the proposed model, a set of suitable indices were taken into account (Hu and Bentler, 1999): TLI (Tucker—Lewis index), SRMR (standardised root mean square residual) and RMSEA (root mean square error of approximation). Thus, the appropriate indices are as follows: TLI values above 0.95; SRMR values below 0.06 and RMSEA values below 0.08. These analyses were carried out with SPSS software (version 26) and R statistical analysis programme (version 2015) and the analysis modules belonging to the "lavaan" package.

Results

The data analysis shows the following bivariate correlations where the relationships between each of the dimensions of emotional intelligence (AE/CE/RE) and their relationship with identified regulation (FD), introjected regulation (FT) and external regulation (FC) are shown in Table 2, where the correlations between the positive and reciprocal study variables are evident.

On the other hand, as for the structural equation models (SEM) to test the relationships established in the hypothetical model, the hypothetical model of predictive relationships (Figure 2) has shown that the overall fit indices (evaluating the

model in general) were adequate: $p < 0.001$, RMSEA = 0.038 and GFI = 0.971.

As well as the incremental or comparative fit indices (comparing the proposed model with the model of independence or absence of relationship between the variables) were NNFI = 0.917; TLI = 0.963; CFI = 0.982 and IFI = 0.983.

And the parsimony indices (assessing the quality of the model fit in terms of the number of coefficients estimated to achieve this level of fit) were AGFI = 0.900.In addition, two further indicators were calculated: Composite Reliability (CR), which indicates acceptable reliability (Heinzl et al., 2011), and the AVE (Average Variance Extracted) index, which measures the variance captured by a construct relative to the other constructs in the model (Fornell and Larcker, 1981).

The relationships established in the structural equation model are specified below and their relationship with identified regulation (FD), introjected regulation (FT) and external regulation (FC).

1. Emotional intelligence and factor two: Identified regulation was positively correlated (=0.13, $p < 0.001$). This explains that, in this case, emotional intelligence is a predictor of introjected regulation; therefore, the presence of this variable explains the existence of the other variable.

2. Emotional intelligence and factor three: Introjected regulation was positively related (=0.16, $p < 0.001$). The results show that emotional intelligence also predicts introjected regulation in an explanatory way.

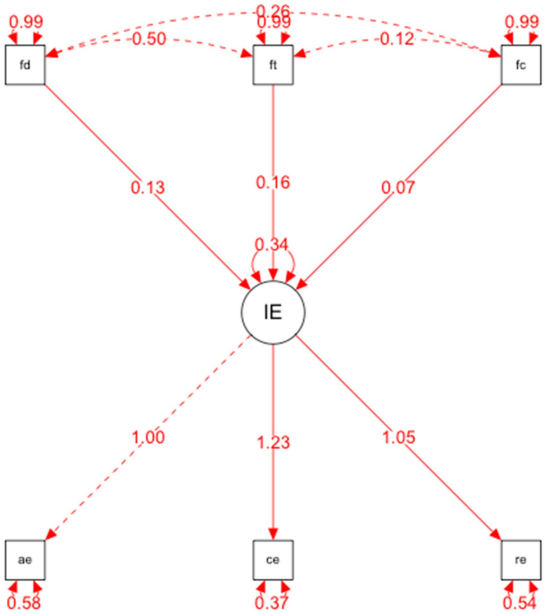

FIGURE 2
Structural equational modelling.

3. Emotional intelligence and factor four: External regulation was positively correlated (=0.07, $p < 0.001$). This explains that, in this case, emotional intelligence is a predictor of external regulation; therefore, the presence of this variable explains the existence of the other variable.

Therefore, based on these results, we can affirm that emotional intelligence is a predictor of extrinsic motivation.

Discussion and conclusion

The aim of this research has been to analyse from the Self-Determination Theory (SDT), specifically in extrinsic motivation (EM), and specifically in identified regulation, introjected regulation and external regulation, and its relationship with emotional intelligence: attention, clarity and emotional regulation. Therefore, the research question is, what kind of relationship exists between emotional intelligence and each of its dimensions and identified regulation (FD), introjected regulation (FT) and external regulation (FC)? This is answered with the results provided by this work. Therefore, hypotheses 1, 2, and 3 are fulfilled.

The main findings of this work lie mainly in the demonstration of the fact that emotional intelligence is a predictor of identified regulation, introjected regulation and external regulation, from which we deduce the direct and positive correlation between levels of emotional intelligence and levels of self-determination (Méndez-Giménez et al., 2017, 2020, 2021).

Furthermore, this work demonstrates the close relationship between motivation and emotional intelligence in the field of sport, as previous research has already done (Castro-Sánchez et al., 2018, 2019; Gallegos and López, 2020; Méndez-Giménez et al., 2021; Mercader-Rubio et al., 2022).

In such a way, taking these results as an axis, within the sports field, they serve as reference data to take into account and understand the pre-eminence of an intervention that is not only cognitive, but also psychological and emotional, in relation to the competencies of the athlete in the context in which he or she performs (Calero and González, 2014). This will allow full decision-making when implementing different actions that effectively implement the results (Iglesias et al., 2012) through the management of different psychological variables considered key in this area (Calero et al., 2008).

In this sense, it is worth highlighting the relevance of the presence of the sports psychologist and emotional training, since it has been demonstrated that working on and improving emotional intelligence has an impact on the athlete with greater efficiency at a competitive level (Lott and Truner, 2018), or even on their own self-concept (Vaughan and Laborde, 2017).

The main conclusions of this study lead us to stress the idea of the importance of the sports psychologist and the study of those psychological variables that allow the athlete to obtain a greater and better performance. In this particular case, this work shows

how emotional training is a good tool for improving the athlete's abilities and motivation.

We must not forget to be cautious with these results due to the size of the sample. Therefore, we believe that it would be useful to replicate this research with larger samples in order to be able to contrast these observations, as this is one of the current limitations of the work.

Future lines of research will aim to analyse whether there are discrepancies according to the type of sport practised. Thus, future studies will try to find out the contrasts according to the degree of professionalisation of each sport practised by the future participants.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by UALBIO2022/035. The patients/participants provided their written informed consent to participate in this study.

Author contributions

IM-R, JC-M, and NÁ: conceptualization. NÁ: methodology. JC-M: software. IM-R, NR, NÁ, and JC-M: research analysis. NR: data curation. NÁ and NR: original drafting—drafting. NÁ and JC-M: drafting—revising and editing. IM-R: supervision. All authors contributed to the article and approved the submitted version.

Conflict of interest

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

Publisher's note

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EDITED BY
Marianna Alesi,
University of Palermo, Italy

REVIEWED BY
Danilo Reis Coimbra,
Juiz de Fora Federal University, Brazil
Nuno Pedro Couto,
Polytechnic of Santarém
(ESDRM-IPSantarém), Portugal

*CORRESPONDENCE
Jinxiu Sun
jinxiu_sun@126.com

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The strategies of exercise intervention for adolescent depression: A meta-analysis of randomized controlled trials

Chang Sheng Zhang[1], Liang Cheng[2], Xiaoan Chen[3], Yi Wang[3], Shuguang Wei[4] and Jinxiu Sun[3]*

[1]School of Physical Education, Chengdu Sport University, Chengdu, China, [2]School of Sports Medicine and Health, Chengdu Sport University, Chengdu, China, [3]School of Sports Science, Jishou University, Jishou, Hunan, China, [4]Department of Psychology, College of Education, Hebei Normal University, Hebei, China

Purpose: This study aimed to investigate the effect of exercise intervention, and analyze exercise intervention strategies for adolescent depression through a meta-analysis of RCTs.

Methods: Accordance to PRISMA guidelines, PubMed, Medline, EBSCO, Web of Science, SPORTDiscus, PsycINFO, ProQuest, and CNKI were searched for eligible records. Peer-reviewed studies were included if they met the following criteria: population (mean age of 10–18 years), intervention (physical activity, sport, or exercise), and outcomes (depression, adherence, ITT, dropout, adverse events, follow-up report). The protocol of this systematic review was registered in PROSPERO (CRD42022321683). Effect sizes calculations and methodological quality of exercise intervention (TESTEX scale) were carried out. The certainty of evidence was assessed by GRADE framework.

Results: Thirteen randomized controlled trials were eligible for this review, which comprised a total of 433 adolescents. Compared with the control treatment, the effect of exercise on adolescent depression was moderate (SMD = −0.65, 95%CI: −1.03 to −0.27, $p < 0.01$). Heterogeneity was substantial ($T^2 = 0.30$, $I^2 = 67\%$, $p < 0.01$). The moderating effect analysis showed that exercise intervention characteristics (organization form, exercise frequency, exercise intensity, exercise type, and single exercise session duration) of included studies varied greatly revealing multiple factors that may impact the antidepressant effect of exercise on adolescent depression ($I^2 > 50\%$, $p < 0.05$). Three studies show that the positive effect of exercise on reducing depression in adolescents remained 40 weeks after the intervention. Moreover, owing to the included studies contained methodological limitations, the certainty of evidence was reduced to moderate level.

Conclusion: This study shows that exercise intervention has a moderate and sustained positive effect on adolescent depression. Our results recommended that adolescents with depression undertake moderate to high intensity group

mixed exercise for more than 12 weeks, 20 to 60 min/time, more than 3 times/week. Additionally, our study also shows that the antidepressant effects remained for a long time after the end of exercise interventions. However, following the GRADE framework, we rated the certainty of evidence the primary meta-analysis as moderate evidence due to some limitations of included studies. Therefore, rigorous studies are still needed to verify the results.

Systematic review registration: [https://www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=321683], identifier [CRD42022321683].

KEYWORDS

adolescent, depression, exercise intervention, exercise strategies, meta-analysis

Introduction

Depressive symptoms and depressive disorders are a common threat to the mental health of adolescents (World Health Organization, 2020). Depressive disorder is diagnosed when depressive symptoms are present for most days over at least 1 year (Thapar et al., 2012). According to the Centers for Disease Control and Prevention, an estimated 4.4 million adolescents in the United States had been diagnosed with depression as of 2016 (Centers for Disease Control and Prevention of American, 2018). According to the latest Chinese official data, the overall prevalence of depression among Chinese teenagers is 15.4% (Huang et al., 2019). However, it should be noted that the official or relevant statistical data are only obtained through clinical diagnosis or self-rating depression scale screening. In reality, there are still a considerable number of children and adolescents with depression due to the sense of medical fraud (Dunn et al., 2005), concealment of disease (Costello et al., 2006), and other factors are not detected. This situation means that a significant number of adolescents with depression do not receive timely intervention. What is more important is that the negative effects of depression can extend to the employment and social status of teenagers, and even lead to self-harm or suicide in serious cases (Clayborne et al., 2019). Depression of adolescent imposes a heavy burden of disease on countries, societies and individuals (Kessler and Bromet, 2013; Sagatun et al., 2016). Therefore, this study will focus on the active prevention and treatment of depression and depressive symptoms in adolescents.

At present, the treatment of adolescent depression mainly includes drug therapy and psychological therapy (Weisz et al., 2017). In drug therapy, clinical guidelines recommend tricyclic antidepressants (TCA), selective serotonin reuptake inhibitors (SSRIs) and fluoxetine. But relevant studies show that drug therapy is not ideal (Cox et al., 2012). There is no targeted antidepressant drug for all patients, and drug therapy costs are high and relapse rate is high (Weisz et al., 2017). Some drugs also have side effects such as weight gain, increased blood pressure and impaired sexual function (Pinna, 2015; Cipriani et al., 2016). Fluoxetine has been associated with suicide and high-risk ideational behavior in adolescents (Hammad et al., 2006; Bridge et al., 2007). Cognitive behavioral therapy (CBT) has been confirmed to have moderate to large effect sizes in the treatment of adolescent depression (Klein et al., 2007; Cuijpers et al., 2011). But CBT takes a relatively long time and is expensive (Asarnow et al., 2009). Therefore, it has become the focus of clinicians and researchers to explore the treatment of adolescent depression with convenient operation, low cost and good efficacy.

In recent years, exercise intervention has been recognized as a potentially valuable alternative or adjunct to adolescent depression (Oberste et al., 2018). At present, some meta-analysis has proved that exercise intervention can achieve moderate to large effect size in the treatment of depression (Hu et al., 2020). However, there are many problems with the study results of exercise intervention in adolescent depression. First of all, existing meta-analyses on the efficacy of exercise intervention in the treatment of adolescent depression are controversial. Meta-analysis of Wunram et al. (2018) showed that exercise intervention had a moderate effect size on the treatment of adolescent depression. However, a meta-analysis conducted by Radovic et al. (2017) revealed that exercise intervention had only a small effect size on the treatment of adolescent depression. The controversy of meta-analysis results has brought some confusion to researchers and clinicians, and affected the practical application of exercise intervention in the treatment of adolescent depression. Therefore, it is urgent to review high-quality RCTs to determine the efficacy of exercise on adolescent depression. In the second place, the existing meta-analysis of potential regulatory variables affecting exercise intervention in adolescent depression is not sufficient. And there is debate about the characteristics of the exercise intervention strategies for adolescent depression. Meta-analysis of Wegner et al. (2020) investigated the moderating effects of intervention duration, frequency and type on exercise treatment of adolescent

depression. However, the moderating effects of such variables as organization form, single session duration and intensity were not further explored. In addition, there is a lack of retrospective analysis of the sustainability of effects after exercise intervention for adolescent depression.

Therefore, the purpose of this systematic review and meta-analysis is going to investigate the effect size of exercise intervention, and to analyze different exercise intervention strategies for adolescent depression through a meta-analysis of Randomized Controlled Trials. Additionally, we also are going to investigate the sustainability of effects after exercise intervention for adolescent depression, and examine the certainty of evidence in this meta-analysis by using the GRADE framework.

Methods

The specific operation and writing process of this study followed the PRISMA 2020 guidelines and statement (Page et al., 2021; **Supplementary Table 1**). The protocol of this systematic review was registered in PROSPERO (CRD42022321683).

Eligibility criteria

The eligibility criteria of this article were followed the PICOS framework (Liberati et al., 2009). Only the study that conform to the PICOS framework were considered for inclusion. In addition, included studies must be published in English or Chinese in peer-reviewed journals. The eligibility criteria of this review was set before performing a literature search. The eligibility criteria were determined on 1 March 2022, and the last search date was 30 April 2022.

Population

Studies were eligible for this review if the participants with a mean age of 10 to 18 years. Furthermore, it is required that the baseline level of depression of the included participants must reach the minimum threshold of depression prescribed by clinical diagnosis or self-rating scale, without other comorbidities (e.g., obesity, cancer, and diabetes).

Intervention

Studies were eligible for this review if the treatment meets the American Academy of Sports Medicine's definition of physical activity. The American Academy of Sports Medicine defines "physical activity" as: "[. . .] any bodily movement produced by the skeletal muscles that results in energy expenditure above resting levels" (American College of Sports Medicine, 2017). Physical activity, just like The American College of Sports Medicine definition, is an umbrella term that includes subcategories such as sports, leisure activities, and exercise. Exercise, in this article, is defined as a training physical activity intervention that is planned and structured, repetitive and purposeful, leading to a change in fitness (Wegner et al., 2020). Therefore, physical activity includes exercise, but not all physical activity is exercise. Nevertheless, we included physical activity to our search in order to avoid missing some research on exercise.

Comparison

Trials were eligible for this review if they compared the effects of exercise and the control group treatment. The control group included in the study requires no additional any exercise or physical activity, which can be educational interventions, recreational games, waiting lists, no interventions, normal medication, etc.

Outcome

Included studies were required to report participants' depressive symptom severity or depression rating Scale scores before and after the trial. Studies use a variety of depression scales like, for example: Depressed Adjective Checklist (DACL), 90-item Self-Rating Depression Scale (SCL-90-R), Achenbach Child Behavior Scale (CBCL), Reynolds Adolescent Depression Scale (RADS), Hamilton self-rating depression scale (Ham-D), Baker self-rating depression scale (BDI, BDI-2).

Study design

Only Randomized Controlled Trials were eligible for this article. Additionally, included studies were required there was no significant difference in baseline of all indexes between the experimental group and the control group before the test.

Search strategy

The electronic search strategy for this study was carried out under the guidance of a research librarian with expertise in systematic reviews. The following databases were searched: PubMed, Medline, EBSCO, Web of Science, SPORTDiscus, PsycINFO, ProQuest, CNKI. The filter of electronic database was used. The search was last conducted 30 April 2022.

Two independent members of the review team (CZ and LC) searched using the operators "AND," "OR" as well as "*" according to the designed retrieval strategy. Search strategies were modified for each database, and MeSH terms were used when applicable. A variety of search terms were as follows: "Depress*," "affective symptom," "affective disorder," "mood disorder," "child*," "adolesc*," "pubert*," "girl*," "boy*," "youth*," "teen*," "exercis*," "sport*," "physical activity," "physical exertion," "physical training," "physical education," "running," "jogging," "walking," "bicycling," "swimming," "strength training." In addition, Meta analyses related to this research topic were searched in each database to supplement the missing literature. The detailed search strategy of this meta-analysis is provided in **Supplementary Table 2**.

Data extraction

ENDNOTE X9.0 software was used to remove the repeated processing of literature retrieval. Two researchers (CZ and LC) independently completed literature screening and data extraction according to the above reference inclusion and exclusion criteria. Data extraction included reference information (author, publication year, country), Study design, population information (sample size, age range, sex ratio, description), exercise intervention information (type, Organizational form, frequency, duration, intensity), control intervention information, outcome measure and results (depression, adherence, ITT, dropout, adverse events, follow-up report). For those studies that do not meet the inclusion criteria, review, duplicate publication, irrelevant to the research topic, and have low quality evaluation in the retrieval results, it is eliminated. In addition, the full text of the study was not obtained, and the study whose contact author failed to obtain data was also excluded. Cross-check the results of literature screening and data extraction of two researchers. Any differences between the two searchers (CZ and LC) were resolved in consultation with the third author (JS).

Methodological quality of studies

Two researchers (CZ and LC) independently used The Assessment of Study Quality and Reporting in Exercise (TESTEX) scale to assess the quality and reporting of the include studies. The TESTEX scale is a specifically tool, designed specifically for use in exercise training studies (Smart et al., 2015). The TESTEX scale consists of 12 criterions, with 15 items (each of which is assigned 1 point), for a maximum score of 15 points. There are 5 criterions of the TESTEX scale for study quality: (1) eligibility criteria specified, (2) randomization specified, (3) allocation concealment of all patients at the time of randomization, (4) groups similar at baseline, (5) blinding of assessor (for at least one key outcome). There are 10 criterions of the TESTEX scale for study reporting: (6) outcome measures assessed in 85% of patients (study withdrawals reported, adverse events reported, session attendance reported), (7) intention-to-treat analysis, (8) reporting of between-group statistical comparisons (primary outcome reported, secondary outcome(s) reported), (9) point measures and measures of variability for all reported outcome measures, (10) activity monitoring in control groups, (11) relative exercise intensity remained constant, (12) exercise volume and energy expenditure. Higher scores on the TESTEX scale reflect better research quality and reporting (Smart et al., 2015). Any differences between the two searchers (CZ and LC) were resolved in consultation with the third author (JS).

Evaluation of the certainty of evidence

Two researchers (CZ and LC) independently used the GRADE framework to evaluate the certainty of evidence of this study. The GRADE framework consists of the following 4 categories: high level of certainty, moderate level of certainty, low level of certainty, very low level of certainty. The shortcomings that downgrade the certainty of evidence are as follows: limitations in study design, inconsistency, indirectness, imprecision, publication bias. In general, the presence of any of the above shortcomings can downgrade the certainty of evidence by one level, and the presence of all the above shortcoming can downgrade the certainty of evidence by up to three levels. The certainty of evidence is upgraded if one or more of the following factors are present: a large effect, potential bias that reduces the intervention effect, a dose-effect gradient (Schünemann et al., 2013). Any differences between the two searchers (CZ and LC) were resolved in consultation with the third author (JS).

Statistical analyses

RevMan 5.4 software was used for statistical analysis. In all meta-analyses included, this study used the standardized mean difference (SMD = $M_1 - M_{2/}SD_{pooled}$) to analysis effect size, and the 95% CI to show the 95% confidence interval. Statistical significance of this study was set at $p \leq 0.05$. The SMD were interpreted with threshold values as follow: 0.2, 0.5 and 0.8 were interpreted as small, medium and large effect sizes, respectively (Cohen, 2013; Oberste et al., 2020). I^2 was used to test the heterogeneity of the included studies, in which 25, 50 and 75% of the I^2 value were the judgment thresholds of low, medium and high heterogeneity, respectively (Higgins et al., 2003). The random effects model was used for all analyses in this study to reduce the bias stemming from the potential heterogeneity between studies (Carter et al., 2016). Based on subgroups analyses, we also examined the moderating potential of antidepressant variables (e.g., organization form, exercise frequency, exercise intensity, exercise type, exercise duration and single exercise session duration) in exercise interventions.

I^2 and p-value was used to test the moderating effect (Oberste et al., 2020). Furthermore, if a study included more than one intervention sector, it was analyzed separately in the analysis.

Results

Selected studies

In this study, 1,795 studies were preliminarily retrieved from various electronic databases (1,335 in English databases, 444 in

Chinese databases, and 16 obtained from other sources) through the designed retrieval strategy. A total of 117 studies were excluded because they were duplicated. Then, 1,326 unrelated studies were further excluded by reading the title and abstract of the article. After that, on the basis of obtaining, reading and evaluating the full papers, 343 trials were further excluded. In the end, nine studies were included in this systematic review and meta-analysis. **Figure 1** shows the more information on the selection process.

Study characteristics

Table 1 presents the general characteristics information of the studies that were extracted by two reviewers (CZ and LC) using a data extraction form and were summarized.

Nine included studies, all RCTs, published between 1984 and 2018. Only two of the nine studies were reported in the Chinese language (Lu et al., 2017; Liu, 2018), and seven other studies were reported in the English language (Burrus, 1984; Kanner, 1990; Beffert, 1993; Jeong et al., 2005; Dabidy Roshan et al., 2011; Hughes et al., 2013; Carter et al., 2015).

A total of 433 adolescents with depression were included from 9 studies. The sample sizes included in the study ranged from 24 to 91. Only two of the nine studies recruited only female participants (Jeong et al., 2005; Dabidy Roshan et al., 2011), and seven other studies involved both male and females (Burrus, 1984; Kanner, 1990; Beffert, 1993; Hughes et al., 2013; Carter et al., 2015; Lu et al., 2017; Liu, 2018). In addition, the average age of the study participants ranged from 10 to 18 years old. In four of the nine studies, participants were derived from clinical patients who received psychotherapy or medication or control in addition to exercise (Kanner, 1990; Beffert, 1993; Hughes et al., 2013; Carter et al., 2015). In the remaining five studies, participants were in a school setting and received physical activity to treat their depression (Burrus, 1984; Jeong et al., 2005; Dabidy Roshan et al., 2011; Lu et al., 2017; Liu, 2018).

The composition of exercise interventions varies widely across studies. On the type of exercise intervention, six studies used aerobic exercise (Burrus, 1984; Kanner, 1990; Beffert, 1993; Jeong et al., 2005; Dabidy Roshan et al., 2011; Lu et al., 2017), and four studies used mixed exercise (Burrus, 1984;

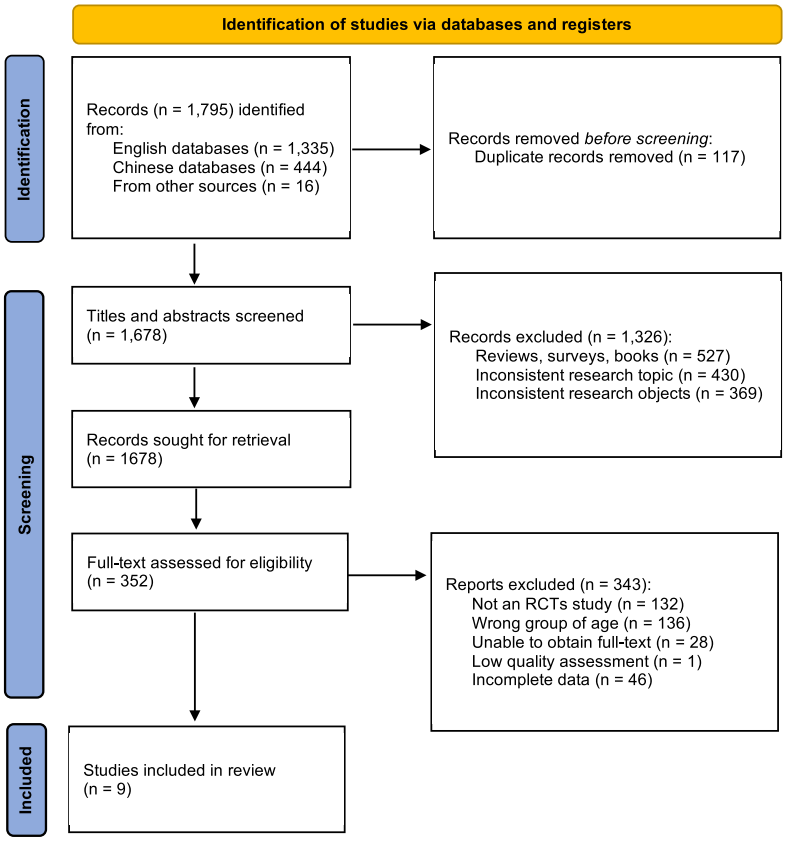

FIGURE 1
Flow chart of the selection process.

TABLE 1 Characteristics of trials included in the qualitative synthesis of this review.

References & and Country	Study design	Population	Exercise treatment	Comparison intervention	Outcome measure & and results
		1. # of subjects: enrolled (*N*), exercise group (N_E), & and comparison group (*N*c) 2. Age range 3.% of males 4. Description	**1. Type of exercise 2. Organizational form 3. Frequency & and duration 4. Intervention intensity**		**1. Depression 2. Adherence 3. ITT 4. Dropout 5. Adverse events 6. Follow-up report**
Burrus (1984)	RCTs	1. *N* = =45, N_E = =30, *N*c = =15	T1 group:	Education intervention	1. Self-rating scale: DACL
USA		2. 15—18 years-old 3. 60% 4. Student	1. Mixed exercise 2. Group training 3. 45 min/time, 2 times/week, 9 weeks 4. Moderate T2 group: 1. Aerobic exercise 2. Individual exercise 3. 45 min/time, 2 times/week, 9 weeks 4. Moderate		2. 100% 3. NR 4. None out of 45 5. NR 6. NR
Kanner (1990)	RCTs	1. *N* = =45, N_E = =37, *N*c = =16	T1 group:	Board games and pool while supervised	1. Clinical interviews: CDI-2
USA		2. 11—16 years-old 3. 62% 4. Clinical patients	1. Aerobic exercise 2. Individual exercise 3. 60 min/time, 2 times/week, 6 weeks 4. Moderate T2 group: 1. Aerobic exercise 2. Individual exercise 3. 60 min/time, 2 times/week, 6 weeks 4. Low		2. 27% 3. NR 4. 12 out of 45 5. NR 6. NR
Beffert (1993)	RCTs	1. *N* = =26, N_E = =15, *N*c = =11	1. Aerobic exercise	Waiting list	1. Clinical interviews: RADS
USA		2. 12—15 years-old 3. 77% 4. Clinical patients	2. Individual exercise 3. 20 min/time, 2 times/week, 6 weeks 4. Moderate		2. 100% 3. NR 4. None out of 26 5. NR 6. 2 months Follow-up
Jeong et al. (2005)	RCTs	1. *N* = =40, N_E = =20, *N*c = =20	1. Aerobic exercise	No treatment	1. Self-rating scale: SCL-90-R
South Korea		2. 14—18 years-old 3. 100% 4. Student	2. Group training 3. 45 min/time, 3 times/week, 12 weeks 4. Low		2. 100% 3. Yes 4. None out of 40 5. Yes 6. NR
Dabidy Roshan et al. (2011)	RCTs	1. *N* = =24, N_E = =12, *N*c = =12	1. Mixed exercise e	No treatment	1. Observer-rating scale: Ham-D
Iran		2. 15—18 years-old 3. 100% 4. Student	2. Group training 3. 50 min/time, 3 times/week, 6 weeks 4. Moderate		2. 100% 3. NR 4. None out of 24 5. NR 6. NR
Hughes et al. (2013)	RCTs	1. *N* = =26, N_E = =14, *N*c = =12	1. Mixed exercise	No treatment	1. Clinical interviews: CDI-2
USA		2. 14—18 years-old 3. 58% 4. Clinical patients	2. Individual exercise 3. 35 min/time, 3 times/week, 12 weeks 4. Moderate		2. 87% 3. NR 4. 4 out of 30 5. Yes 6. 6—12 months Follow-up

(Continued)

TABLE 1 (Continued)

References & and Country	Study design	Population	Exercise treatment	Comparison intervention	Outcome measure & and results
		1. # of subjects: enrolled (*N*), exercise group (N_E), & and comparison group (*Nc*) 2. Age range 3.% of males 4. Description	**1. Type of exercise 2. Organizational form 3. Frequency & and duration 4. Intervention intensity**		**1. Depression 2. Adherence 3. ITT 4. Dropout 5. Adverse events 6. Follow-up report**
Carter et al. (2015) Britain	RCTs	1. N = =64, N_E = =36, Nc = =28 2. 13—17 years-old 3. 78% 4. Clinical patients	1. Mixed exercise 2. Individual exercise 3. 60 min/time, 2 times/week, 6 weeks 4. Low	Drug treatment	1. Clinical interviews: CDI-2 2. 75% 3. NR 4. 22 out of 87 5. Yes 6. 6 months Follow-up
Liu (2018) China	RCTs	1. N = =64, N_E = =48, Nc = =16 2. 10—13 years-old 3. 52% 4. Student	T1 group: 1. Mixed exercise 2. Group training 3. 30 min/time, 2 times/week, 18 weeks 4. Low T2 group: 1. Mixed exercise 2. Group training 3. 45 min/time, 3 times/week, 18 weeks 4. Moderate T3 group: 1. Mixed exercise 2. Group training 3. 55 min/time, 3 times/week, 18 weeks 4. Vigorous	No treatment	1. Clinical interviews: CDI-2 2. 100% 3. NR 4. NR 5. NR 6. NR
Lu et al. (2017) China	RCTs	1. N = =91, N_E = =46, Nc = =45 2. 10—13 years-old 3. 47% 4. Student	1. Aerobic exercise 2. Group training 3. 60 min/time, 4 times/week, 8 weeks 4. Low	No treatment	1. Self-rating scale: CBCL 2. 100% 3. NR 4. NR 5. NR 6. NR

RCTs, randomized controlled trial; T1 group, the experimental group T1 in the study; T2 group, the experimental group T2 in the study; T3 group, the experimental group T3 in the study; DACL, Depression Adjective Checklist; CDI-2, Children's Depression Inventory, Second Edition; RADS, Reynolds Adolescent Depression Scale; SCL-90-R, Depression scale of the Symptom Checklist-90-Revised; Ham-D, Hamilton Rating Scale for Depression; CBCL, Child Behavior Checklist: CDI, Children's Depression Inventory.

Hughes et al., 2013; Liu, 2018). Mixed exercise, the concept in this study, is defined as regular sessions of two or more types of exercise including aerobic, strengthening, or flexibility exercise (Bidonde et al., 2019).

In terms of organizational form, there were five studies on group training (Burrus, 1984; Jeong et al., 2005; Dabidy Roshan et al., 2011; Lu et al., 2017; Liu, 2018), and five studies on individual sports (Burrus, 1984; Kanner, 1990; Beffert, 1993; Hughes et al., 2013; Carter et al., 2015). The range of exercise length and frequency was included in nine studies were as follows: between 20 and 70 min per session; two to four sessions per week; from 6 to 18 weeks. In terms of exercise intensity, only one study involved high-intensity exercise (Liu, 2018), while the other eight studies were low-intensity or moderate-intensity.

Methodological quality of included studies

The results of assessment of the two researchers (CZ and LC) were in good agreement (Kappa = 0.87, 95% CI: 0.69 to 0.94, $p < 0.01$). According to the TESTEX criteria, the total TESTEX score, study quality score, and study reporting score of the included studies were 10.00 ± 1.91 (range: 9 to 14, median = 9), 2.62 ± 0.87 (range: 2 to 4, median = 2), 7.46 ± 1.13 (range: 6 to 10, median = 7), respectively. In terms of study

quality, the most common concerns were the lack of blinding of assessor (100% of 13 RCTs), the lack of randomization specified (69%), and the lack of allocation concealment of all patients at the time of randomization (69%). In terms of study reporting, the most common concerns were the lack of activity monitoring in control groups (85%), the lack of intention-to-treat analysis (85%), and the lack of adverse events reported (69%). All the included studies for this study obtained a score ≥9 points, so no studies were excluded based on the quality of the study methodology (Thapa et al., 2021). **Supplementary Table 3** shows the detail of the TESTEX scores for included studies in this study.

Results of primary meta-analysis

Figure 2 shows the heterogeneity test results of thirteen RCTs included in nine studies. The random effects model was used for to calculate the effect sizes in this study. Three of the nine included studies utilized Multiple arm test. When the study had one or more common intervention groups, in order to avoid the analysis unit error, we divided the common group into two or more sample groups and included two or more (reasonably independent) comparisons (Higgins and Green, 2011). After pooling effect size estimates, the overall combined effect size was SMD = −0.65, 95% CI: −1.03 to −0.27. The result was statistical significance ($p < 0.01$). This study Heterogeneity was substantial ($T^2 = 0.30$, $I^2 = 67\%$, $p < 0.01$). The result indicate that exercise intervention has a therapeutic effect on adolescent depression, reaching a moderate-to-large effect size.

Moderator analysis

This study Heterogeneity was substantial ($T^2 = 0.30$, $I^2 = 67\%$, $p < 0.01$). The moderating effects were described by subgroup analysis of the exercise variables and methodological features of included studies. A summary of our moderator analysis is presented in **Table 2**.

Variables of exercise intervention

Type of exercise

Subgroup analysis revealed that there were significant differences in the therapeutic effect of different exercise types on adolescent depression ($\chi^2 = 2.31$, $p < 0.05$, $I^2 = 76.1\%$). The data indicate that exercise type influences the relationship between exercise intervention and treatment for depression in adolescents. Mixed exercise had a large effect size (SMD = −1.14, 95% CI: −1.88 to −0.40, $p < 0.01$), and aerobic exercise had a medium effect size (SMD = −0.32, 95% CI: −0.59 to −0.05, $p < 0.05$).

Organizational form

Subgroup analysis showed that there were significant differences in the therapeutic effect of different tissue forms on adolescent depression ($\chi^2 = 3.33$, $p < 0.05$, $I^2 = 72.4\%$). The data suggest that organizational form influences the relationship between exercise intervention and treatment for adolescent depression. Group training had a large effect size (SMD = −1.06, 95% CI: −1.77 to −0.35, $p < 0.01$) on the treatment of adolescent depression, while individual exercise had a medium effect size (SMD = −0.32, 95% CI: −0.61 to −0.02, $p < 0.05$).

Intervention duration

Subgroup analysis revealed a small-to-moderate effect size when intervention duration was less than 8 weeks (SMD = −0.50, 95% CI: −0.90 to −0.04, $p < 0.05$). When the intervention lasted 8 to 12 weeks, a small-to-moderate effect size was achieved (SMD = −0.39, 95% CI: −0.73 to −0.04, $p < 0.05$). When the intervention lasted more than 12 weeks, the large effect size was achieved (SMD = −1.30, 95% CI: −2.42 to −0.18, $p < 0.05$). However, the difference between the effect sizes

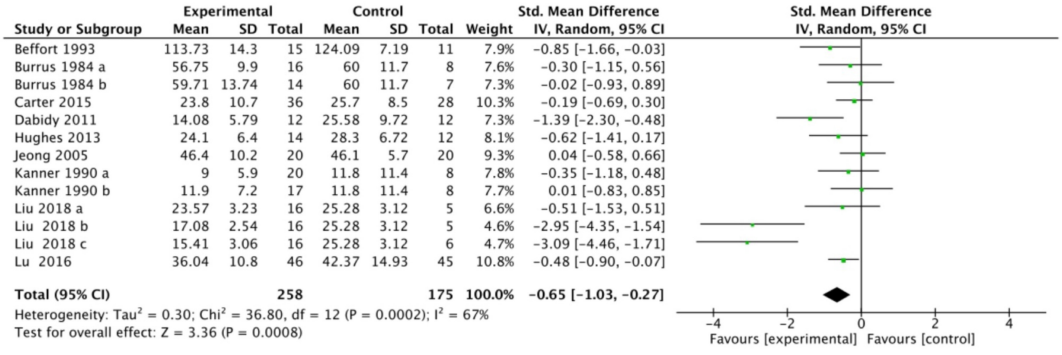

FIGURE 2
Forest plot of studies included in the primary meta-analysis.

TABLE 2 Moderator analysis of this review.

Variable	Subgroups	*K*	*n*	SMD value (95% CI)	Two-sided Hypotheses		Heterogeneity test between groups		
					Z	*p*	χ^2	*p*	I^2 (%)
Exercise type	Aerobic exercise	6	231	−0.32 (−0.59, −0.05)	2.35	<0.05	2.31	<0.05	76.1%
	Mixed exercise	7	202	−1.14 (−1.88, −0.40)	3.03	<0.01			
Organizational form	individual exercise	6	190	−0.32 (−0.61, −0.02)	2.08	<0.05	3.33	<0.05	72.4%
	Group training	7	243	−1.06 (−1.77, 0.35)	2.87	<0.01			
Intervention duration	<8 weeks	5	167	−0.50 (−0.95, −0.04)	2.15	<0.05	2.34	0.31	14.7%
	8∼12 weeks	3	136	−0.39 (−0.73, −0.04)	2.18	<0.05			
	>12 weeks	5	130	−1.30 (−2.42, −0.18)	2.27	<0.05			
Single session duration	20 to 60 min/time	9	225	−0.94 (−1.55, −0.33)	3.01	<0.01	3.27	<0.05	69.4%
	≥60 min/time	4	208	−0.32 (−0.60, −0.04)	2.23	<0.05			
Intervention frequency	1∼2 times/week	7	209	−0.29 (−0.58, −0.03)	1.96	<0.05	4.64	<0.05	78.5%
	≥3 times/week	6	224	−1.22 (−2.01, −0.42)	3.01	<0.01			
Intervention intensity	Low	5	241	−0.27 (−0.53, −0.01)	2.01	<0.05	4.92	<0.05	79.7%
	Moderate to vigorous	8	192	−1.06 (−1.71, −0.41)	3.19	<0.01			
Context of participant	School students	9	290	−0.89 (−1.45, −0.33)	3.13	<0.01	3.53	<0.05	71.7%
	Clinical patients	4	143	−0.27 (−0.61, −0.13)	2.21	<0.05			

k, number of effect size estimates; N, number of participants; SMD, standardized mean different; CI, confidence interval.

of subgroups did not reach statistical significance (χ^2 = 2.34, p = 0.31, I^2 = 14.7%).

Single session duration

Subgroup analysis revealed that there were significant differences in the therapeutic effect of different single session duration on adolescent depression (χ^2 = 3.27, $p < 0.05$, I^2 = 69.4%). The data suggest that the single session duration affects the relationship between exercise intervention and treatment for depression in adolescents. When single session duration was 20 to 60 min/time, a moderate-to-large effect size was achieved (SMD = −0.94, 95% CI: −1.55 to −0.33, $p < 0.01$). When the single session duration greater than or equal to 60 min/time, a small-to-moderate effect size was achieved (SMD = −0.32, 95% CI: −0.60 to −0.04, $p < 0.05$).

Intervention frequency

Subgroup analysis revealed that there were significant differences in the therapeutic effect of different intervention frequency on adolescent depression (χ^2 = 4.64, $p < 0.05$, I^2 = 78.5%). The data suggest that the intervention frequency affects the relationship between exercise intervention and treatment for depression in adolescents. When the intervention frequency was 1 to 2 times/week, a small-to-moderate effect size was achieved (SMD = −0.29, 95% CI: −0.58 to −0.03, $p < 0.05$). When the intervention frequency was 3 times/week or more, the effect size was large (SMD = −1.22, 95% CI: −2.20 to −0.42, $p < 0.01$).

Intervention intensity

Subgroup analysis revealed that there were significant differences in the therapeutic effects of different intervention intensities on adolescent depression (χ^2 = 4.92, $p < 0.05$, I^2 = 79.7%). The results showed that intervention intensity had an effect on the relationship between exercise intervention and treatment of adolescent depression. Low intensity exercise had a small-to-moderate effect size on the treatment of depression in adolescents (SMD = −0.27, 95% CI: −0.53 to −0.01, $p < 0.05$). Moderate to high intensity exercise achieved large effect size (SMD = −1.06, 95% CI: −1.71 to −0.41, $p < 0.01$).

Methodological features of included studies

We compared the antidepressant effects of exercise on adolescent depression in different contexts of participant. Subgroup analysis revealed that there were significant differences in the therapeutic effects of different contexts on adolescent depression (χ^2 = 3.52, $p < 0.05$, I^2 = 71.7%). The results showed that intervention intensity had an effect on the relationship between exercise intervention and treatment of adolescent depression. Exercise intervention has a moderate-to-large effect size on school students (SMD = −0.89, 95% CI: −1.45 to −0.33, $p < 0.01$). Exercise intervention has a small to moderate effect size on clinical patients (SMD = −0.27, 95% CI: −0.61 to −0.13, $p < 0.01$).

Analysis of the sustainability of the effects after exercise intervention termination

Table 3 shows follow-up data from the three included studies that reported the sustainability of effects after exercise treatment termination. We chose to describe the results of the three studies that reported the follow-up data due to too low statistical test power. Two of there studies reported specific data of sustained relief of depressive symptoms after the exercise intervention (Beffert, 1993; Carter et al., 2015). One study reported the remission rate of depressive symptoms after the exercise intervention (Hughes et al., 2013), Beffert (1993) reported that the antidepressant effects of exercise intervention still remained 5 months after the exercise intervention ended (SMD = −0.94, 95% CI: −1.78 to −0.11). In the study by Carter et al. (2015), at 6 months after the end of exercise intervention, the antidepressant effects of exercise intervention approached almost a moderate level (SMD = 0.39, 95% CI = −1.00 to 0.22). At post-intervention, Hughes et al. (2013) reported that the remission for all exercise group participant remained stable until 40 weeks after the end of exercise intervention.

Publication bias analysis

Figure 3 shows the publication bias risk test of the paper included in this study. The risk of publication bias can be tested by funnel plots (Rothstein et al., 2005). The results showed that the included studies were evenly distributed around the combined effect size SMD, and the left and right sides were basically symmetrical. There were two studies with some degree of deviation. It can be seen that there may be some publication bias in the 13 RCTs trials, but it is not very serious. Within the acceptable range, the stability of the results of this meta-analysis will not be seriously affected.

TABLE 3 Follow-up reports included in the reference.

References	Follow-up report		
	The immediate effect of the end of the exercise intervention	Length of follow-up	Subsequent effect changes
Beffert, 1993	SMD = −0.85, 95% CI: −1.66∼−0.03	2 months	SMD = −0.94, 95% CI: −1.78∼ −0.11
Carter et al., 2015	SMD = −0.19, 95% CI: −0.69∼ 0.30	6 months	SMD = −0.39, 95% CI: −1.00∼ 0.22
Hughes et al., 2013	SMD = −0.62, 95% CI: −1.41∼ 0.17	6–12 months	1. After 14 weeks, 86% of the trial group no longer had clinical symptoms of depression. 2. After 40 weeks, no clinical symptoms of depression were found in all subjects.

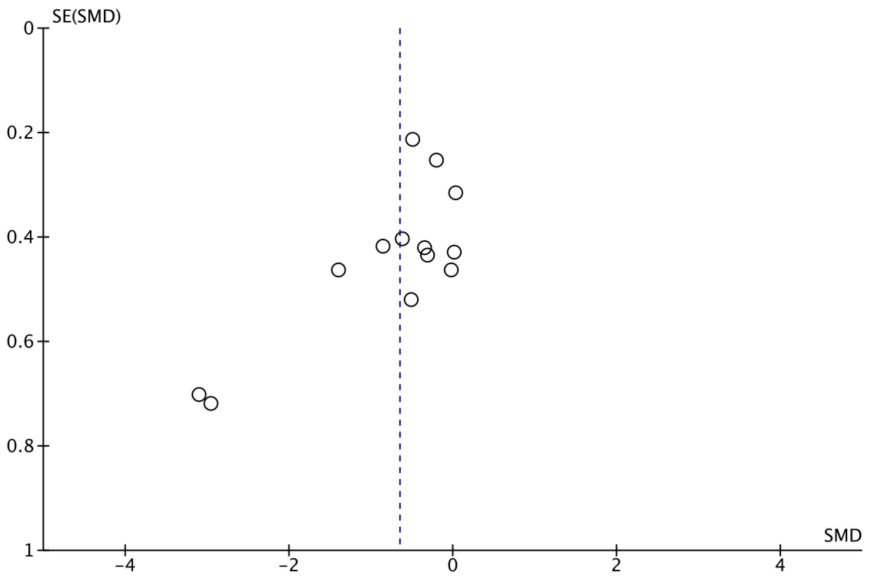

FIGURE 3
Results of publication bias analysis.

Certainty of evidence

We used the GRADE framework to evaluate the certainty of evidence of this study. Following the GRADE framework, owing to the included studies contained some methodological limitations, we rated the certainty of evidence the primary meta-analysis as moderate evidence. In terms of "study design," we identified some limitations, and downgraded one level the certainty of evidence. In terms of "inconsistency," "indirectness," "imprecision" or "publication bias," we did not downgrade the certainty of evidence. **Supplementary Tables 4, 5** shows the more information of the GRADE rating.

Discussion

Effect of exercise on the treatment of adolescent depression

This study conducted a meta-analysis of thirteen RCTs trials in nine studies, which comprised a total of 433 adolescents. The results showed that the effect of exercise on the treatment of adolescent depression in comparison to control treatments reached moderate pooled effects, with a confidence interval that ranged from a medium to a large effect (SMD = −0.65, 95% CI: −1.03 to −0.27, $p < 0.01$). Our results are consistent with the results of some previous meta-analyses (Brynhildur et al., 2020; Oberste et al., 2020). Moreover, the finding of the antidepressant effect size in our study, is slightly higher than the effect size recommended by clinical guidelines for drug treatment of adolescent depression (SMD = −0.48) (Zhou et al., 2015). It is worth affirming that there were no reports of adverse events caused by exercise intervention in the included studies.

We found that compared with clinically confirmed patients (confirmed by structured clinical interview), exercise intervention had a greater therapeutic effect on school students (identified by the Self-Rating Scale). This result may be related to the bias in the screening process of some subjects and the inclusion of some false positive samples. As we all know, clinical interview is the gold standard for the diagnosis of adolescent depression (Haugen et al., 2016), while but the sensitivity of most self-rating scales for adolescent depression is less than 75% at present (Salle et al., 2012). The difference in sensitivity between the two diagnostic methods means that a higher percentage of false positive samples will be screened out by the self-rating Depression Scale compared to structured clinical interviews. Such misdiagnosis may influence trial results and thus interfere with researchers' judgment of the anti-depressive effect of exercise intervention (Bailey et al., 2018). Therefore, it is suggested to set up structured clinical interviews for blind diagnosis by clinical experts in future studies to test whether the subjects are eligible for inclusion.

However, owing to the included studies contained some methodological limitations (according to the TESTEX criteria), we rated the certainty of evidence the primary meta-analysis as moderate evidence. Thus, we have a moderate degree of confidence in the estimate of the effect, and the true value is likely to be close to the estimate, but there are still different possibilities. More rigorous studies are still needed to verify the antidepressant effect size on adolescent depression.

Exercise intervention strategies for adolescent depression

We found that mixed exercise had a large effect size on the treatment of depression in adolescents, and its effect was significantly better than the moderate effect of aerobic exercise. Aerobic exercise is the most commonly used type of exercise clinically recommended for the treatment of depression (Morres et al., 2019), but mixed exercise has significant advantages over aerobic exercise alone (Hishikawa et al., 2019). Some studies have found that when the exercise intervention program is aerobic, anaerobic, resistance, competition and sports games and other mixed exercise, patients with depression symptoms are not only effectively treated, but also have multiple benefits such as physical function improvement, emotional regulation and improvement, and quality of life improvement (Ranjbar et al., 2015). Moreover, the compliance rate of subjects was over 80% (Korman et al., 2020). For adolescents with depression who prefer different forms of stimulation, mixed exercise can stimulate their enthusiasm for exercise participation and treatment compliance rate more than single exercise to some extent.

As for the organizational form, we found that group form exercise achieved a large effect size in the treatment of adolescent depression, and its treatment effect was significantly better than the medium effect size of individual form exercise. Previous studies have shown that compared with the boring individual form of exercise (e.g., running or walking), interpersonal interaction, social support and sports professional guidance in group form of exercise can help patients with depression to relieve depressive symptoms more quickly (Carter et al., 2016; Meyer et al., 2016). Loss of interest in social activities is one of the most important symptoms in depressed individuals (Sani et al., 2014). Group form of exercise can provide adolescents with depression the opportunity to express their thoughts, memories and emotions (Harris and Orth, 2020), promote communication with others, and promote later social integration (Dupuis et al., 2011).

As for the intervention duration, we found that exercise intervention had the best effect on adolescent depression when the intervention was more than 12 weeks, followed by less than 8 weeks, and finally 8 to 12 weeks. Although there was small statistical test power might explain the lack of statistical significance between the effects of the three subgroups, but the result suggested that the therapeutic effect of exercise on adolescent depression may fluctuate to some

extent. Previous studies have found that the therapeutic effect of exercise intervention on depression will lag about 3–4 weeks in time (Michele and Giosuè, 2010), and significant improvement can be achieved only after lasting at least 9 weeks (Stanton and Reaburn, 2014). This may be related to such factors as depression patients' doubt about treatment methods, delay in self-feeling improvement and resistance to receiving improvement effects (Mota-Pereira et al., 2011). Other studies have found that the effect of exercise antidepressant therapy will be flat, that is, with the increase of intervention duration, the effect value will decrease to a certain extent (Schuch et al., 2016). But more research is still needed to confirm this fluctuation phenomenon of exercise treatment effect on adolescent depression.

As for the single session duration, we found that the single session duration of 20 to 60 min/time was significantly better than a single duration of more than 60 min/time. Previous meta-analyses at different periods have also shown that different exercise duration (range: 20 to 60 min/time) has a significant positive effect on the treatment of depression (Martinsen, 2008; Stanton and Reaburn, 2014). Other studies suggest that the antidepressant effect of exercise needs to reach a certain time transition point, among which at least 30 min/time is the general view of exercise antidepressant (Meyer et al., 2016). This phenomenon may be related to the time-dependent response of human neurophysiological processes to exercise (Duclos and Tabarin, 2016). Maladjusted levels of norepinephrine, brain-derived neurotrophic factor (BDNF), and 5-hydroxytryptamine (5-HT) have been shown to be potentially underlying causes of depression (Carek et al., 2011; Xie et al., 2021). Studies have shown that exercise can affect the production of norepinephrine, brain-derived neurotrophic factor (BDNF) and serotonin (5-HT), with concentrations of these neurotransmitters varying at different points in time (Medina et al., 2015; Kandola et al., 2019). However, it is not clear which single exercise duration has the optimal effect on the relevant neurotransmitters.

As for the exercise frequencies, we found that more than 3 times/week is significantly better than 1 to 2 times/week in the treatment of adolescent depression. For the antidepressant effects of different exercise frequencies, previous studies have suggested that high frequency exercise (3 to 5 times/week) is more effective than low frequency exercise (1 time/week) (Legrand and Heuze, 2007). Some studies have suggested that exercise intervention prescription for depression can be limited to 4 to 5 times/week, and for large intensity exercise program, it can be one time/week or 2 to 3 times/week, but the maximum interval between two events should not exceed 3 days, and it is difficult to achieve the ideal effect after the interval exceeds 3 days (Medina et al., 2015).

As for exercise intensity, we found that moderate to vigorous intensity exercise had a large effect on the treatment of adolescent depression, and the treatment effect was significantly better than low intensity exercise. Short-term intermittent aerobic exercise that reaches 80% of maximum heart rate has been shown to effectively reduce depressive symptoms (Herring et al., 2017), and long-term aerobic exercise that reaches 70% to 80% of maximum heart rate has almost the same improvement effect on depression as antidepressants (Shimoda et al., 2017). Some studies have found that low-intensity, medium-intensity and high-intensity exercise both can improve depressive symptoms (Meyer et al., 2016), but in comparison, moderate to vigorous intensity exercise has better antidepressant effects than low intensity exercise (Silveira et al., 2013).

The sustainability of the effects after exercise intervention termination

We found a follow-up effect of the exercise intervention, which further improved the treatment of adolescent depression after the exercise was stopped. The follow-up report of Beffert (1993) showed that the therapeutic effect of exercise intervention on adolescent depression increased slightly 2 months after the end of exercise, with SMD = −0.85 (95% CI: −1.66 to −0.03) rising to SMD = −0.94 (95% CI: −1.78 to −0.11). The follow-up report of Carter et al. (2015) showed that the therapeutic effect of exercise intervention on adolescent depression increased from small effect size (SMD = −0.19, 95% CI: −0.69 to 0.30) to medium effect size (SMD = −0.39, 95% CI: −1.00 to 0.22). In the follow-up report of Hughes et al. (2013) showed that 86% of the test group no longer showed clinical symptoms of depression 14 weeks after the exercise intervention, and 40 weeks after the end of exercise therapy, the clinical symptoms of depression were effectively alleviated in almost all subjects in the experimental group. However, the duration and internal mechanism of the follow-up effect of exercise intervention on depression remain unclear. Some studies speculated that the continuation of the antidepressant effect of exercise intervention might be related to the change of subjects' living habits (Hoffman et al., 2011; Helgadottir et al., 2017). Adolescent depression patients had a high compliance with exercise intervention, and the shedding rate of test group and control group was much lower than the data reported by previous psychotherapy (De-Haan et al., 2013) and related medication (Hetrick et al., 2012). To a certain extent, the exercise habits formed by the exercise intervention are beneficial to the maintenance of exercise habits after the exercise intervention, thus reducing their depression state. However, we need to treat this conclusion with caution for the sustainability of effects after exercise treatment termination. High-quality RCTs research, Significantly, is needed to confirm this conclusion.

Limitations of this meta-analysis

In this systematic review and meta-analysis, we included only articles published in English or Chinese. Therefore, studies

in other languages and unpublished have not been included. There may be language bias and scattered bias to some extent. In addition, the strength of our conclusions is limited by the small number of included studies and lack of large-sample and high-quality RCT studies on exercise intervention in the treatment of adolescent depression.

General practice implications

Currently, exercise is considered by clinicians and the general public as an effective way to prevent or treat depression in adolescents, and this is supported by numerous studies (Carek et al., 2011; Medina et al., 2015; Xie et al., 2021). We suggest that the following points should be considered in the future research or clinical practice of exercise intervention in adolescent depression: First, when exercise is used as monotherapy, adjuvant therapy or combination therapy, the degree of depressive symptoms of participants should be considered. It is worth noting that future studies should consider establishing structured clinical interviews and expert blind diagnosis to reduce false positive samples. Secondly, the exercise plan should be personalized and interesting. In other words, the exercise plan should be negotiated by professionals according to the participants' own factors (e.g., age, gender, athletic ability, economic ability, time, personal preference). Third, exercise programs should be conducted under the supervision or guidance of a physical therapist, personal trainer or other professional, with follow-up records and feedback.

Conclusion

This systematic review and meta-analysis systematically reviewed studies that look at exercise intervention with adolescent depression. Our review indicated that exercise intervention can effectively treat adolescent depression with a moderate effect size. Our results recommended that adolescents with depression undertake moderate to high intensity group mixed exercise for more than 12 weeks, 20 to 60 min/time, more than 3 times/week. Additionally, our study also shows that the antidepressant effects remained for a long time after the end of exercise interventions. However, following the GRADE framework, we rated the certainty of evidence the primary meta-analysis as moderate evidence due to some methodological limitations of included studies. Thus, we have a moderate degree of confidence in the estimate of the effect, and the true value is likely to be close to the estimate, but there are still different possibilities. Therefore, more rigorous studies are still needed to verify the antidepressant effect size on adolescent depression.

Data availability statement

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

Author contributions

CZ and JS conceptualized and designed the idea of the study. CZ, JS, and LC designed the data collection instruments, collected the data, carried out the initial analyses. CZ and LC drafted the initial manuscript and reviewed and revised the manuscript. XC, YW, and SW reviewed and revised the manuscript. All authors have read and approved the final version of the manuscript and agreed with the order of presentation of the authors.

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Conflict of interest

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

Publisher's note

Supplementary material

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Carla Maria Chicau Costa Borrego,
Polytechnic Institute of Santarém,
Portugal

REVIEWED BY
Diogo Teixeira,
Universidade Lusófona, Portugal
Teresa Limpo,
University of Porto, Portugal

*CORRESPONDENCE
Paul R. Appleton
p.appleton@mmu.ac.uk

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Measurement invariance of the empowering and disempowering motivational climate questionnaire-coach in youth sport

Paul R. Appleton[1,2]*, Carme Viladrich[3], Eleanor Quested[4,5], Lorena González-García[6], Athanasios Papaioannou[7], Howard K. Hall[8], Isabel Balaguer[6], Yago Ramis[9], Philippe Sarrazin[10], Jean-Philippe Heuzé[10], Yngvar Ommundsen[11], Bente Wold[12], Oddrun Samdal[12] and Joan L. Duda[13]

[1]Department of Sport and Exercise Sciences, Musculoskeletal Science and Sports Medicine Research Centre, Faculty of Science and Engineering, Manchester Metropolitan University, Manchester, United Kingdom, [2]Institute of Sport, Manchester Metropolitan University, Manchester, United Kingdom, [3]Department of Psychobiology and Methodology of Health Sciences, Faculty of Psychology, Autonomous University of Barcelona, Barcelona, Spain, [4]Curtin School of Population Health, Curtin University, Perth, WA, Australia, [5]Physical Activity and Well-Being Research Group, enAble Institute, Curtin University, Perth, WA, Australia, [6]Department of Social Psychology, Faculty of Psychology, University of Valencia, Valencia, Spain, [7]Department of Physical Education and Sport Science, University of Thessaly, Trikala, Greece, [8]Retired, Sutton on the Forest, York, United Kingdom, [9]Department of Basic, Developmental and Educational Psychology, Faculty of Psychology, Autonomous University of Barcelona, Barcelona, Spain, [10]Univ. Grenoble-Alpes, SENS, Grenoble, France, [11]Department of Sport and Social Sciences, Norwegian School of Sport Sciences, Oslo, Norway, [12]Department of Health Promotion and Development, Faculty of Psychology, University of Bergen, Bergen, Norway, [13]School of Sport, Exercise and Rehabilitation Sciences, College of Life and Environmental Sciences, University of Birmingham, Birmingham, United Kingdom

The purpose of this study was to test the measurement invariance (across five languages, two time points, and two experimental conditions) of the empowering and disempowering motivational climate questionnaire-coach (EDMCQ-C; Appleton et al., 2016) when completed by 9256 young sport participants (*M* age = 11.53 years, *SD* = 1.39 years; 13.5% female). Exploratory Structural Equation Modeling was used to test the validity of a 2-factor (empowering and disempowering) model running a multiple group analysis without any equality constraint (configural invariance) followed by measurement invariance of factor loadings and thresholds (scalar invariance). Findings provided support for partial invariance across languages and scalar invariance across time and experimental groups. The factors were interpretable across the analyses, and items loaded as intended by theory except for item 15. This study provides further evidence regarding the psychometric properties of the EDMCQ-C and suggests this scale (minus item 15) can be used to provide meaningful latent mean

comparisons (Marsh et al., 2013) of empowering and disempowering coach-created climates across athletes speaking the five targeted languages, across time, and across experimental groups.

KEYWORDS

AGT, SDT, sport, youth, ESEM, invariance

Introduction

For several decades, the coach-created motivational climate has been one of the most studied topics within sport psychology (see Duda et al., 2018). The motivational climate captures the social psychological environment that is created by significant others in sport, including coaches, and is relevant to variability in athletes' cognitions, affect and behavior. This motivational environment concerns what the coach does, says and how he/she structures the environment in training and competitions (Duda, 2001).

Much of the work conducted on the coach-created motivational climate has been guided by achievement goal theory (AGT; Ames, 1992; Nicholls, 1989) and self-determination theory (SDT; Deci and Ryan, 1985, 2000). AGT and SDT identify specific facets of the motivational climate that have implications for athletes in and outside of sport. Whereas AGT places emphasis on task- and ego-involving climates, SDT recognizes dimensions of the climate that supports (e.g., autonomy-supportive, socially-supportive) or frustrates (e.g., controlling) an athlete's psychological needs. Recently, Duda (2013) and Duda and Appleton (2016) proposed a multidimensional conceptualization of the coach-created motivational climate that integrates the social environmental dimensions forwarded by AGT and SDT. Duda's framework considers that the coach-created motivational climate can be more or less 'empowering' and 'disempowering' in nature. Empowering climates are task-involving, autonomy-supportive and socially-supportive in nature and are theorized to be adaptive. Conversely, disempowering climates are ego-involving and controlling and have negative implications for athletes.

Within Duda's conceptualization, empowering climates reflect adaptive coaching strategies emphasized by AGT and SDT. According to AGT, a task-involving climate is characterized by athletes perceiving that trying hard, skill development and cooperative learning between teammates are valued by the coach (Newton et al., 2000). Within SDT, an autonomy-supportive climate includes athletes' preferences being recognized and their perspectives considered, their feelings are acknowledged, they are provided with meaningful choices, their input into decision-making (when and where possible) is welcomed, and a rationale is provided when they are asked to do something by the coach (Mageau and Vallerand, 2003). In a socially-supportive environment, every athlete feels cared for and is empathized with, and is valued as an athlete and as a person (Mageau and Vallerand, 2003; Reinboth et al., 2004).

In contrast, disempowering climates are marked by the negative and debilitating coaching strategies recognized in AGT and SDT. An ego-involving climate, for example, is characterized by athletes perceiving that mistakes result in punishment, the coach providing differential treatment based on the ability level of athletes, and that intra-team member rivalry is encouraged on the team (Newton et al., 2000). Relatedly, a controlling climate is evident when coaches pressure, coerce and intimidate their athletes (Bartholomew et al., 2010).

To enable researchers to measure empowering and disempowering motivational climates, Appleton et al. (2016) developed the 34-item Empowering and Disempowering Motivational Climate Questionnaire-Coach (EDMCQ-C) using data from samples of young British sport participants. The theoretical model proposed by Duda (2013; Duda and Appleton, 2016) that informed the development of the EDMCQ-C includes five lower order factors (task- and ego-involving, autonomy- and social-supportive, and controlling) and two higher-order dimensions (empowering and disempowering). Moreover, although it is possible to capture data on the motivational climate using a range of distinct albeit related sources (e.g., coach self-report; objective observations), the EDMCQ was originally developed by Appleton et al. to measure athletes' perceptions of their coaches' empowering and disempowering strategies in training and competition. Capturing athletes' views of empowering and disempowering features of the coach-created motivational climate is important given they are the most proximal predictor to variability in athletes' cognitions, affect and behaviors. Furthermore, compared to coaches' self-reports of their motivational climate, athletes' own reports tend to be closer to reality (i.e., what coaches are actually doing; Smith et al., 2016).

The 34 items included in the EDMCQ-C were identified from a pool of 67 statements from established measures of the five lower order climate factors using confirmatory factor analyses. Appleton et al. (2016) subsequently tested a series of factor structures using exploratory structural equation models (ESEM). ESEM integrates the principles of Exploratory Factor Analysis (i.e., items permitted to load on intended factor and

crossload on non-intended factors) within the SEM framework (i.e., fit indices to assess model fit) (Asparouhov and Muthén, 2009). The first ESEM model tested by Appleton et al. was a lower-order five factor (task, autonomy-supportive, socially-supportive, controlling, ego) model. The second model tested the proposed hierarchical structure of the EDMCQ-C using Hierarchical ESEM (HESEM) in which the aforementioned lower-order dimensions were modeled onto their respective higher order factor (i.e., task, autonomy-supportive, socially-supportive loaded on an empowering higher-order dimension; control and ego loaded on a disempowering higher-order dimension). Finally, Appleton et al. also tested a bi-factor ESEM (BESEM) which is represented by two higher-order (or "general") factors (e.g., empowering and disempowering climates), five lower-order (or "group") factors (e.g., task- and ego-involving climates, autonomy- and social-supportive climates, and controlling climates), and a pattern matrix in which items loads onto the general and group factors.

All ESEM models resulted in acceptable model fit (e.g., CFI $>$ 0.94; TFI $>$ 0.91; RMSEA $\leq$ 0.30), with the better fit achieved *via* the BESEM model. However, across all ESEM models, inspection of the standardized factor loadings revealed that the majority of autonomy-supportive and some controlling and socially-supportive items failed to load significantly on their intended factor and demonstrated elevated and significant factor loadings on their non-intended climate dimension. More specifically, autonomy- and socially-supportive items loaded onto the task-involving dimension and controlling items loaded significantly onto the ego-involving factor.

In sum, the findings reported by Appleton et al. (2016) do not lend support for the multidimensional, hierarchical structure proposed to underpin the EDMCQ-C. Rather than abandon the scale, however, researchers have proposed that the scale's structure may be best represented by two main climate factors (empowering and disempowering). This is evident in the Appleton et al. (2016) study where many of the items from the empowering lower-order dimensions (task, autonomy-supportive, socially-supportive) loaded significantly onto one factor, and many items from the disempowering lower-order dimensions (control, ego) loaded onto a second factor. This two-factor model has also been tested using ESEM (in which the 34-items are permitted to load on both factors) in subsequent research (Milton et al., 2018; Solstad et al., 2020; Sukys et al., 2020).

Although adopting a two-factor model prevents researchers from using the scale to examine the multidimensional and hierarchical structure of the climate as emphasized in Duda's framework, adopting a two-factor approach to modeling the EDMCQ-C would still permit researchers the opportunity to examine empowering and disempowering coach-created motivational climates and examine their association with athletes' cognitions, affect and behavior (e.g., Appleton and Duda, 2016; Smith et al., 2016; Fenton et al., 2017). In addition, this simpler two-factor model (in comparison to the HESEM and BESEM models tested by Appleton et al., 2016) would reduce the complexities associated with establishing the psychometric properties (e.g., invariance) of the scale (Milton et al., 2018; Solstad et al., 2020).

Adopting the two-factor structure supported in previous research, the main purpose of this study was to further contribute to evidence regarding the psychometric properties of the EDMCQ. This was achieved by using ESEM to test measurement invariance using data from young football players from five European countries (i.e., France, Greece, Norway, Spain, and England) who spoke the main language in each country (e.g., English in England; Spanish in Spain etc.), across time (start and end of season), and between experimental conditions (intervention and control groups).

Materials and methods

Participants

The data come from the large European-wide PAPA project (see Duda et al., 2013) that sought to promote healthy and sustained physical activity in children and adolescents *via* participation in grassroots football. Player questionnaire data from the PAPA project on the motivational climate has been used in other studies, albeit limited to Time 1 data in England (Appleton et al., 2016) or one facet of the climate (i.e., autonomy-support) in five countries (Quested et al., 2013). 9256 football players (13.5% female) aged between 9 and 15 years (mean = 11.53, SD = 1.39) from five European countries (France = 1426, Greece = 1707, Norway = 1998, Spain = 2335, and the England = 1790) participated in this study. The participants played for 638 teams at the grassroots level, reported to have been playing for their teams between the present season and the last 10 seasons (median = 3 seasons, interquartile range = 4), and trained between 0.5 and 10 h a week (median = 4, interquartilerange = 2). 61.4% of the participants were from the intervention group in the PAPA project. The intervention (*Empowering Coaching*^{TM}; see Duda, 2013) involved the participants' coaches attending a 6-hour education workshop concerning the creation of empowering (and less disempowering) motivational climates in training and matches. The coaches of the participants in the control condition engaged in their normal coaching practices. See **Table 1** for an overview of participants' demographic information by country.

Procedures

The protocol outlining the procedures associated with data collection in the PAPA project were described in Duda et al. (2013) and employed in previous studies (e.g.,

TABLE 1 Participants' demographic information by country.

	England	France	Spain	Norway	Greece
Gender					
Boy	1553	1390	2117	1254	1649
Girl	237	36	213	744	22
Condition					
Experimental	1019	895	1235	1452	1082
Control	771	531	1100	546	625
Age					
9–12 years	1019	859	1684	940	1000
13–15 years	343	353	544	431	462
Number of seasons on team (*M*, *SD*)	2.5 (1.9)	3.3 (2.4)	3.2 (2.2)	4.4 (2.2)	3.1 (2)
Number of hours per week playing with team (*M*, *SD*)	2.8 (1.1)	4.7 (1.1)	4.7 (1.2)	3.5 (1.7)	4.8 (1.7)
Number of hours per week spent with coach (*M*, *SD*)	2.9 (1.1)	4.7 (1.1)	4.7 (1.3)	N/A	4.9 (1.7)

N/A, not applicable.

Quested et al., 2013). Ethical approval was granted by the Universities of each team of researchers working on the PAPA project. Prior to collecting data, parents had the opportunity to opt out their son and/or daughter from the project. Participants were fully informed about the study before it took place, and a parental written opt out form was used in accordance with national legislation and the institutional requirements.

The EDMCQ-C was one of a number of scales included in the overall player questionnaire employed in the PAPA project. Time 1 data was collected at the start of the competitive football season (spring 2011 in Norway and between autumn and winter 2011/2012 in the other countries). Time 2 data was collected at the end of the same season, approximately 20–28 weeks after Time 1 (in late summer 2011 in Norway, and spring 2012 in the other countries). Data was collected by trained research assistants working on the PAPA project. Each participants completed the questionnaire individually albeit were grouped with their teammates typically during a training session. The overall questionnaire took between 20–40 min to complete, and the EDMCQ-C took between 5–10 min (see Duda et al., 2013 for further details).

Measure

All text in the questionnaire was initially drafted in English, translated into Spanish, Norwegian, Greek, and French by a native speaker, and then back-translated into English by a second dual-language speaker. The translation-back translation procedure was based on the recommendations from mainstream (Harkness, 1999; Hambleton, 2005) and sport psychology literature (Duda and Hayashi, 1998).

The EDMCQ-C (Appleton et al., 2016) includes 17 empowering items measuring task-involving (e.g., "My coach encouraged athletes to try new skills"), autonomy-supportive (e.g., "My coach gave athletes choices and options") and socially-supportive (e.g., "My coach really appreciated athletes as people, not just as a sport participants") coaching. 17 disempowering items are also included measuring ego-involving (e.g., "My coach yelled at athletes for messing up") and controlling (e.g., "My coach paid less attention to athletes if they displeased him or her") climate dimensions. Participants were instructed to "think about what it has usually been like on *this* team/club *during the last 3–4 weeks*" when providing their responses, which were measured on a 5-point scale (i.e., 1 = *strongly disagree*, 5 = *strongly agree*).

Data management and analysis

The data were validated and screened for patterns of missing values prior to the creation of an international file for main analysis. Although the majority of the sample (9194 cases) responded to the EDMCQ-C at Time 1 and/or Time 2, only 35% of the sample had complete data for all items and both time points. To detect any bias attributable to data missingness, we analyzed the data twice: first using the whole sample and second with the subsample that provided complete data. As the results of both analyses were similar, only the results obtained using the whole sample are presented.

To test for measurement invariance, target rotation (Asparouhov and Muthén, 2009; Marsh et al., 2013) in the ESEMs conducted in Mplus (Muthén and Muthén, 1998–2015) were employed. A target rotation consists of defining which factor loadings will be freely estimated (those for items on their intended factor) and which factor loadings will be restricted to values as close as possible to zero (those for items on their non-intended factor/s; Muthén, and Muthén, 1998-2017). In our study, task-involving, autonomy-supportive and socially-supportive items were freely estimated on an empowering factor and permitted to cross-load on the disempowering factor but with factor loadings restricted to values close as possible to zero. Controlling and ego involving items were freely estimated on the disempowering factor and permitted to cross-load on the empowering factor but with factor loadings restricted to values close as possible to zero. We followed the recommendations

proposed by Millsap and Yun-Tein (2004) for categorical variables, and Marsh et al. (2013) and Marsh et al. (2020) for ESEMs. First, we tested the validity of a 2-factor model in each country using ESEM running a multiple group analysis without any equality constraint (configural invariance). We then tested measurement invariance of factor loadings and thresholds (scalar invariance; Muthén and Muthén, 1998–2015; Wang and Su, 2013) across countries, time, and experimental condition in separate steps. Total or partial scalar invariance of items ensures meaningful latent mean comparisons across groups and over time (e.g., Marsh et al., 2013).

Due to the complexity of the analyses (5 countries * 2 conditions * 2 waves), we did not employ the "interactional" tests of invariance outlined in Grouzet et al. (2006). Moreover, we did not have reason to test invariance in any specific order (Wang and Su, 2013). For the test of invariance across time, we correlated the error terms from the same items on different occasions to account for within subjects' data (Marsh and Hau, 1996). In all analyses, factor loadings and thresholds were constrained to be equal in tandem as it is recommended for categorical-ordered indicators (Muthén and Muthén, 1998–2015).

Due to the categorical nature of the data and the presence of missing values (see Results section), the weighted least-squares mean and variance-adjusted estimator was used with pairwise deletion for missing values, both of them being the Mplus defaults for categorical data. The Goodness-of-fit Indices were $\chi 2$, Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), and root mean square error of approximation (RMSEA). In an independent clusters confirmatory factor analysis model with quantitative indicators, CFI and TLI values >0.95 and RMSEA <0.06 are considered as indicators of excellent fit (Hu and Bentler, 1995), and CFI and TLI values >0.90 and RMSEA <0.08 are considered as indicators of acceptable fit (Marsh et al., 2004). Little simulation data are available on the behavior of these cut-off values in categorical data ESEM analysis, but Yu (2002) suggested using a CFI >0.96 for categorical data and most papers using ESEM, including categorical data ESEM (Myers et al., 2011), rely on them with some caution (but see Maydeu-Olivares et al., 2017). Standard errors and fit indices were calculated taking into account that players' responses were clustered within their teams.

In order to compare nested models, we employed *ad hoc* guidelines to evaluate differences in fit, including the difference in CFI (ΔCFI) and RMSEA (ΔRMSEA). As a cut-off value, a ΔCFI < 0.01 (Cheung and Rensvold, 2002) and changes in RMSEA <0.015 (Chen, 2007) are considered as evidence for the more parsimonious model. Marsh (2007) also proposed that the more parsimonious models is supported if the TLI and RMSEA are as good as or better than that for the more complex model. However, Marsh also proposed that these above proposals for assessing invariance should be considered as rough guidelines rather than golden rules. All these recommendations were considered in this paper.

Regarding reliability, we followed the advice of Viladrich et al. (2017) regarding the coefficient H, also known as maximal reliability (Raykov, 2012), that should be used to get an adequate reliability estimate when the intended measures are factors instead of unweighted composite measures. As H is strongly related to the size of factor loadings but not directly applicable to ordinal data, we used the size of the factor loadings to gauge the reliability of the EMP and DISEMP factor scores.

Results

Responses to the questionnaire showed sizeable floor (disempowering items) or ceiling (empowering items) effects (see **Table 2**), confirming the decision to treat the data as categorical using the WLSMV estimator in MPlus. As reported in **Table 2**, the most frequent response in each country was "agree" (16–52% of responses) and "strongly agree" (17–72% of responses) for the majority of the empowering items at both time points, with fewer participants responding "strongly disagree" (1–12% of responses) or "disagree" (1–13% of responses). One exception was empowering item three "My coach offers choices and options", where the proportion of the French sample was similar across the five response categories. For the disempowering items, the proportion of the sample was higher for the "strongly disagree" (10–57% of responses), "disagree" (11–39% of responses) and "neutral" (13–38% of responses) responses across the countries and at each time point with fewer participants responding "strongly agree" (1–7% of responses) or "agree" (5–33% of responses), albeit there were some exceptions. For example, for disempowering item 15 "My coach only allowed something we like to do at the end of training if players had done well during the session," there was a larger proportion of the sample who responded "agree" and fewer who responded "strongly disagree" compared to the other disempowering items.

Language invariance

At Time 1, indexes of fit for configural invariance across languages were: $\chi^2(2470) = 5932.68$, CFI = 0.952, TLI = 0.945, RMSEA = 0.030 (CI 95% = 0.029–0.031) and scalar invariance $\chi^2(3126) = 10644.48$, CFI = 0.895, TLI = 0.906, RMSEA = 0.039 (CI 95% = 0.039–0.042). Results were similar for Time 2: indexes of fit for configural invariance were: $\chi^2(2470) = 5908.73$, CFI = 0.953, TLI = 0.946, RMSEA = 0.034 (CI95% = 0.032–0.035) and scalar invariance $\chi^2(3126) = 9362.04$, CFI = 0.914, TLI = 0.923, RMSEA = 0.040 (CI95% = 0.039–0.041). Although ΔRMSEA met the adopted criteria of <0.015 (Chen, 2007), ΔCFIs were > 0.01 and TLI

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TABLE 2 Percentage of responses to each category by time and language.

Time1	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Items					
E1	1/2/2/1/8	2/3/3/3/10	12/17/16/15/24	52/39/48/51/30	33/39/31/31/28
E4	1/2/2/2/3	1/2/3/2/4	7/6/13/13/13	35/20/40/42/27	56/72/42/42/53
E11	1/2/2/2/3	2/3/3/4/3	10/12/15/20/14	44/31/35/42/30	43/53/45/33/50
E13	2/3/10/3/6	2/2/11/4/7	16/8/29/9/24	43/27/29/36/30	37/61/20/48/33
E18	2/2/1/2/5	2/4/3/4/4	20/23/20/26/19	49/30/48/46/34	27/41/29/22/38
E23	2/4/1/2/3	3/4/3/3/5	13/16/18/14/15	44/27/48/42/31	39/49/29/39/46
E28	2/3/1/2/5	2/4/2/3/5	14/15/13/15/23	39/24/33/38/29	43/55/51/42/38
E30	2/3/1/2/4	3/4/3/4/4	16/14/17/16/14	43/25/44/39/32	36/54/35/39/45
E34	1/2/1/2/3	2/2/1/2/3	11/7/8/7/10	28/16/32/27/28	58/72/59/61/57
E3	2/5/4/4/22	4/4/10/7/16	18/21/32/20/28	50/35/36/43/22	26/35/18/26/12
E6	2/4/1/2/5	3/3/2/5/5	22/14/13/16/11	44/25/34/37/22	30/55/50/41/57
E16	1/4/1/2/3	4/4/4/4/6	23/13/26/12/20	42/28/43/39/32	31/51/26/43/39
E22	2/2/2/2/3	4/3/4/4/5	26/15/26/13/17	45/26/41/42/33	24/54/27/40/42
E32	2/2/2/3/8	3/3/3/5/6	18/12/14/19/17	38/19/35/40/24	39/63/47/34/45
E8	2/2/2/3/4	3/3/4/5/4	23/9/19/19/20	40/20/39/40/32	32/67/37/33/40
E14	2/4/2/3/5	3/4/3/5/5	19/19/25/17/30	43/25/37/37/28	0.33/49/34/38/33
E27	9/10/2/7/9	9/9/3/10/9	24/28/26/31/36	33/21/40/30/22	25/32/30/22/23
D5	33/29/45/22/31	35/18/27/27/17	20/28/21/29/23	9/13/5/14/16	3/12/3/8/13
D9	38/51/26/39/43	35/19/28/32/24	17/16/29/16/17	7/8/12/8/8	4/6/6/6/8
D10	36/40/52/9/28	27/20/25/17/17	23/21/17/31/22	10/9/4/28/20	5/10/2/15/13
D19	31/31/27/30/45	27/16/24/25/19	24/27/27/27/20	11/12/14/12/7	7/14/8/6/9
D21	18/32/37/22/36	31/18/31/29/22	30/22/22/29/19	15/14/7/15/13	7/14/3/5/11
D25	37/50/24/43/53	30/18/20/29/16	19/18/25/16/16	9/6/19/8/9	4/1/12/5/6
D33	34/41/28/30/36	27/19/23/30/20	24/21/29/25/23	11/10/13/11/11	5/9/8/4/10
D2	21/40/28/24/42	30/20/30/32/20	26/24/29/25/21	17/0.10/10/15/11	5/6/4/5/8
D7	24/39/33/29/42	33/19/26/31/19	28/23/28/21/21	11/11/10/15/9	4/9/4/5/8
D12	26/39/32/29/43	36/24/28/34/25	27/24/30/23/28	8/8/8/10/7	3/5/3/4/6
D15	6/16/7/17/33	10/11/9/25/12	36/29/31/30/25	29/19/34/18/24	19/25/21/11/23
D17	23/36/40/24/26	31/21/34/37/22	33/27/20/28/28	10/10/5/8/14	3/6/2/3/11
D20	23/55/7/48/56	22/15/11/26/20	31/16/36/16/13	15/7/31/6/6	10/7/15/4/5
D24	25/23/40/23/24	27/15/26/25/15	28/25/2/27/25	14/18/10/17/20	6/19/3/9/16
D26	47/37/53/31/30	22/15/24/22/14	16/20/14/22/20	11/14/7/17/18	4/15/3/8/17
D29	12/36/27/33/29	19/14/32/26/17	38/23/30/23/29	19/14/7/13/13	13/13/4/6/11
D31	35/57/35/21/37	23/15/33/21/16	26/16/25/32/27	10/6/5/18/11	6/6/2/9/9
Time 2					
Items					
E1	2/3/2/2/11	3/4/3/3/13	13/17/18/14/28	49/35/45/49/30	33/42/33/32/17
E4	1/2/1/1/5	2/3/4/3/5	7/8/13/18/16	33/24/43/42/34	56/63/40/37/40
E11	1/3/2/2/4	2/4/2/5/6	11/17/12/20/17	46/32/40/46/34	40/45/44/27/39
E13	12/3/10/2/5	3/5/11/3/7	18/14/28/12/24	44/31/29/42/35	34/48/23/40/29
E18	1/3/1/1/6	4/5/3/5/6	21/27/16/26/21	47/30/51/45/36	27/35/30/23/31
E23	2/3/1/10/5	4/8/3/5/5	21/17/18/17/19	41/30/47/44/35	32/42/31/34/37
E28	2/3/1/1/5	4/5/3/4/6	20/19/14/15/25	35/27/34/40/33	39/45/48/39/31
E30	2/4/1/2/6	5/7/3/5/4	21/17/17/18/22	40/28/45/40/37	32/45/34/36/31
E34	1/2/0/1/4	1/4/2/2/4	11/11/9/12/15	35/23/33/34/34	52/61/57/52/44
E3	2/4/3/4/29	5/6/8/6/21	18/25/31/22/26	50/35/38/45/17	25/30/20/22/7
E6	1/4/2/1/4	3/4/1/4/4	25/17/13/18/12	42/26/32/43/27	28/50/52/33/52
E16	2/3/1/2/4	5/7/5/3/6	24/17/24/15/21	43/30/47/43/37	27/44/24/38/32
E22	2/3/2/1/4	6/5/1/5/8	3/19/13/16/21	41/30/32/46/37	22/43/52/32/31

(Continued)

and RMSEA values were not as good or better for scalar invariance compared to configural invariance (see Table 3). Inspection of the modification indices revealed non-invariant thresholds for a number of items. We therefore freed the thresholds of these items in partially invariant models. At Time 1, indexes of fit for partial invariant model were $\chi^2(3086) = 8950.36$, CFI = 0.918, TLI = 0.926, RMSEA = 0.035 (CI95% = 0.034–0.036) and Time 2 $\chi^2(3086) = 7966.11$,

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TABLE 2 (Continued)

Time1	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
E32	1/3/1/2/7	4./5/2/4/7	18/15/14/19/18	40/27/33/39/37	38/52/50/37/39
E8	2/2/2/3/6	4/5/3/6/7	22/13/19/23/24	38/24/41/37/32	33/55/36/31/31
E14	1/4/2/2/5	4/6/3/5/7	18/23/21/19/33	42/27/37/36/31	40/40/37/38/25
E27	7/9/2/7/6	11/11/4/10/7	29/28/25/29/26	31/24/40/33/33	22/28/30/22/28
D5	33/21/41/23/26	32/22/28/27/19	23/31/22/31/27	7/15/6/13/18	5/11/3/7/11
D9	35/41/22/34/40	37/21/26/33/25	16/18/30/19/20	8/12/14/10/8	4/8/8/4/7
D10	32/33/49/10/22	31/24/26/19/20	23/23/19/33/24	10/10/4/29/21	4/9/2/10/13
D19	31/28/25/25/45	26/18/21/25/20	27/27/29/29/17	10/13/15/14/8	7/14/11/7/10
D21	20/28/35/23/30	27/20/29/29/22	31/25/23/30/24	17/16/9/13/14	6/12/5/5/10
D25	32/40/19/41/46	29/21/19/29/18	26/22/24/17/18	09/10/22/9/11	4/7/15/4/07
D33	31/31/24/27/32	30/22/21/30/21	23/22/29/23/23	11/14/16/14/14	5/11/11/7/11
D2	26/38/29/28/40	27/23/28/34/24	28/24/29/25/21	14/9/10/11/9	5/6/5/3/6
D7	25/33/33/27/37	32/22/26/31/24	28/25/26/27/24	12/12/11/13/8	4/8/5/2/7
D12	27/33/31/24/31	39/27/30/39/26	25/24/27/24/30	7/10/9/10/8	4/6/3/3/5
D15	5/3/6/16/15	12/11/9/27/14	36/28/29/33/31	30/23/35/17/25	17/24/24/7/16
D17	21/31/39/27/22	33/22/33/34/25	34/29/22/28/29	9/11/4/9/16	3/7/2/2/8
D20	24/52/6/45/49	27/16/11/25/21	29/17/33/18/18	14/10/33/7/7	6/6/17/5/5
D24	27/20/39/23/21	25/18/26/23/20	28/28/20/32/28	14/19/11/15/17	5/14/5/7/15
D26	40/33/53/30/28	24/17/21/22/16	20/23/13/24/21	11/14/9/18/20	5/13/4/7/16
D29	14/28/27/31/27	20/18/32/30/19	41/28/30/23/33	17/15/9/11/12	8/11/4/5/10
D31	34/45/36/20/31	23/18/34/21/21	28/20/23/35/28	10/9/5/16/12	5/9/3/8/8

NBE, Empowering item; D, Disempowering item; English/Spanish/Norwegian/Greek/French.

TABLE 3 Model fit of the approximate invariance test across language, time and condition.

Model	χ2	df	CFI	TLI	RMSEA	RMSEA 90% CI
Language Time 1						
Configural invariance	5932.68	2470	0.952	0.945	0.030	0.029–0.031
Scalar invariance	10644.48	3126	0.895	0.906	0.039	0.039–0.042
Partial invariance	8950.36	3086	0.918	0.926	0.035	0.034–0.036
Language Time 2						
Configural invariance	5908.73	2470	0.953	0.946	0.034	0.032–0.035
Scalar invariance	9362.04	3126	0.914	0.923	0.040	0.039–0.041
Partial invariance	7966.11	3086	0.933	0.939	0.036	0.035–0.037
Time						
Configural invariance	8982.89	2106	0.937	0.931	0.019	0.018–0.019
Scalar invariance	10229.91	2307	0.927	0.928	0.019	0.019–0.020
Condition Time 1						
Configural invariance	5497.15*	988	0.925	0.915	0.034	0.033–0.035
Scalar invariance	4465.67*	1152	0.945	0.947	0.027	0.026–0.028
Condition Time 2						
Configural invariance	5656.37*	988	0.924	0.913	0.039	0.038–0.040
Scalar invariance	4195.22*	1152	0.950	0.952	0.029	0.028–0.030

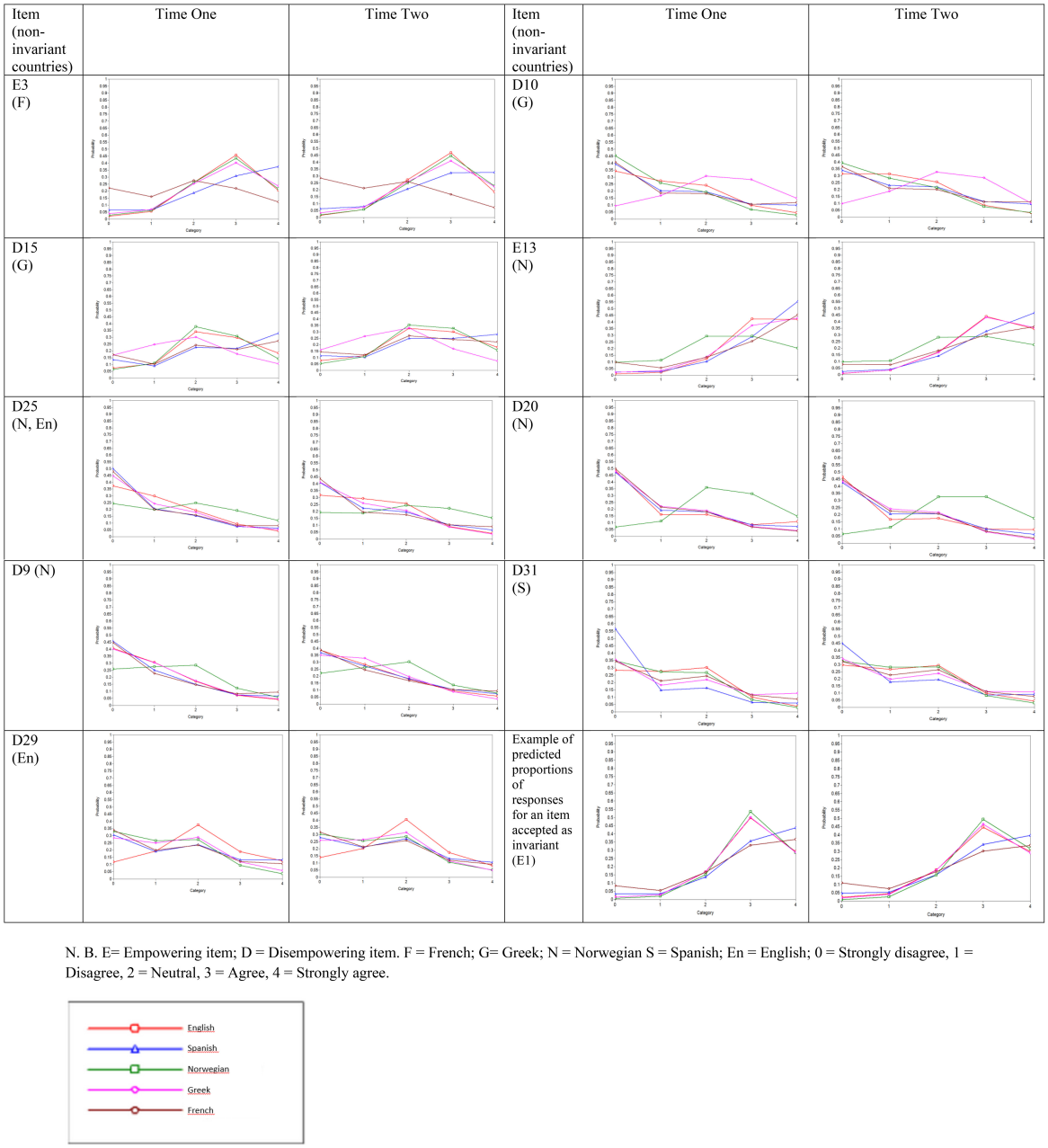
df, degrees of freedom; CFI, comparative fit index; TLI, Tucker–Lewis index; RMSEA, root mean square error of approximation; CI, confidence interval.

CFI = 0.933, TLI = 0.939, RMSEA = 0.036 (CI95% = 0.035–0.037) (see Table 3).

Non-invariant thresholds emerged for nine items (see Figure 1). Empowering item three was non-invariant in French with predicted proportions of responses more uniformly distributed across all categories compared to the other countries with distributions relatively skewed towards agreeing with this item. Disempowering items 10 and 15 were both more

uniformly distributed for Greek than for the other countries. Empowering item 13 and disempowering items nine, 20 and 25 were more uniformly distributed in Norwegian. Disempowering items 25 and 29 were relatively more uniformly distributed in English. As an exception, item 31 in Spanish was non-invariant due to a predicted distribution of responses more skewed toward strongly disagree responses compared to the other languages.

Non-standardized factor loadings were statistically invariant across languages, thus only factor loadings for the reference language (i.e., English) are reported (see **Table 4**) in a standardized form. They revealed all empowering and disempowering items loaded positively and more strongly on their intended factor than on the non-intended factor at times 1 and 2 except for disempowering item 15 ("My coach only allowed something we like to do at the end of training



N. B. E= Empowering item; D = Disempowering item. F = French; G= Greek; N = Norwegian S = Spanish; En = English; 0 = Strongly disagree, 1 = Disagree, 2 = Neutral, 3 = Agree, 4 = Strongly agree.

FIGURE 1
Predicted proportions of responses for non-invariant items from the empowering and disempowering motivational climate questionnaire-coach (EDMCQ-C). NBE, empowering item; D, disempowering item. F, French; G, Greek; N, Norwegian; S, Spanish; En, English; 0, strongly disagree; 1, disagree; 2, neutral; 3, agree; 4, strongly agree.

if players had done well during the session") which loaded more strongly onto the empowering factor in all countries. For the non-reference languages (i.e., Spanish, Norwegian, Greek, French), standardized factor loadings showed no major discrepancies (around 0.10) in each factor loading, except for autonomy-supportive item one ("My coach gave players choices and options") in French with standardized factor loadings of 0.15 at Time 1 and 0.10 at Time 2. Both values were lower than those of the other countries which ranged from 0.40 to 0.57 at Time 1 and from 0.46 to 0.61 at Time 2. Overall, the majority of factor loadings were high (>0.50) suggesting indirect evidence for internal consistency (reliability) for the empowering and disempowering latent variables across the five countries.

Finally, the correlation between the empowering and disempowering factor at Time 1 was −0.48 ($p < 0.001$) in English, −0.67 ($p < 0.001$) in Spanish, −0.68 ($p < 0.001$) in Norwegian, −0.28 ($p < 0.001$) in Greek, and −0.36 ($p < 0.001$) in French. At Time 2, the correlation was −0.58 ($p < 0.001$) in English, −0.82 ($p < 0.001$) in Spanish, −0.66 ($p < 0.001$) in Norwegian, −0.48 ($p < 0.001$) in Greek, and −0.67 ($p < 0.001$) in French.

Time invariance

Indexes of fit for configural invariance were $\chi^2(2106) = 8982.89$, CFI = 0.937, TLI = 0.931, RMSEA = 0.019 (CI95% = 0.018–0.019) and scalar invariance $\chi^2(2307) = 10229.91$, CFI = 0.927, TLI = 0.928, RMSEA = 0.019 (CI95% = 0.019–0.020). ΔCFI = 0.01, ΔRMSEA <0.015 and TLI and RMSEA values were as good for scalar invariance compared to configural invariance, offering support for scalar invariance (see Table 3).

Non-standardized factor loadings were statistically invariant across time, thus only factor loadings for Time 1 are reported in standardized form. Inspection of the factor structure revealed that empowering and disempowering factors were clearly distinguishable, with 33 items loading ranging from 0.35 to 0.67 ($p < 0.001$) on the intended factor (see Table 4). Standardized factor loadings of the non-intended factor ranged from −0.14 to 0.38. As per the language analyses, item 15 loaded more strongly on the empowering factor (0.383) than disempowering factor (0.206). However, as the majority of factor loadings were high (>0.50) for items on their intended factor, there is indirect evidence for internal consistency (reliability) for the empowering and disempowering latent variables across time. The correlations between the error terms from the same items on different occasions ranged from 0.04 to 0.38.

The correlation between the empowering climate factors at Time 1 and Time 2 was 0.52 ($p < 0.001$), and between disempowering climate factors at Time 1 and Time 2,0.55 ($p < 0.001$). The correlation between the empowering and disempowering factors was −0.51 ($p < 0.001$) at Time 1 and −0.55 ($p < 0.001$) at Time 2. The correlation between empowering factor at Time 1 and disempowering factor at Time 2 was −0.30 ($p < 0.001$). Finally, the correlation between the disempowering factor at Time 1 and the empowering factor at Time 2 was −0.34 ($p < 0.001$).

Condition invariance

Indexes of fit for configural invariance across condition at Time 1 one were $\chi^2(988) = 5997.15$, CFI = 0.925, TLI = 0.915, RMSEA = 0.034 (CI95% = 0.033–0.035) and scalar invariance $\chi^2(1152) = 4465.67$, CFI = 0.945, TLI = 0.947, RMSEA = 0.027 (CI95% = 0.026–0.028). ΔCFI = 0.02, ΔRMSEA < 0.015 and TLI and RMSEA values were as good for scalar invariance compared to configural invariance, offering support for scalar invariance. Likewise, indexes of fit for configural invariance at Time 2 were $\chi^2(988) = 5656.37$, CFI = 0.924, TLI = 0.913, RMSEA = 0.039 (CI95% = 0.038–0.040) and scalar invariance were $\chi^2(1152) = 4195.22$ CFI = 0.950, TLI = 0.952, RMSEA = 0.029 (CI95% = 0.028–0.030). ΔCFI = 0.026, ΔRMSEA < 0.015 and TLI and RMSEA values were as good for scalar invariance compared to configural invariance, offering support for scalar invariance (see Table 3).

Non-standardized factor loadings were statistically invariant across the condition groups, thus only standardized factor loadings for the control group are reported. Standardized factor loadings (see Table 4) revealed all empowering and disempowering items for the control group loaded positively and strongly on their intended factor. Standardized factor loadings for empowering items ranged from 0.41 to 0.65 ($p < 0.001$) (Time 1) and 0.53 to 0.70 ($p < 0.001$) (Time 2) on the empowering factor (see Table 4) and −0.12 to 0.21 (Time 1) and −0.13 to 0.19 (Time 2) on the non-intended disempowering factor. The standardized factor loadings for the disempowering items ranged from 0.18 to 0.63 ($p < 0.001$) (Time 1) and 0.20 to 0.73 ($p < 0.001$) (Time 2) on the disempowering factor and −0.16 to 0.35 (Time 1) and −0.11 to 0.40 ($p < 0.001$) (Time 2) on the non-intended empowering factor. Item 15 loaded positively and more strongly onto the empowering compared to the disempowering factor.

For the non-reference (intervention) group, standardized factor loadings for empowering items ranged from 0.41 to 0.65 ($p < 0.001$) (Time 1) and 0.53 to 0.65 ($p < 0.001$) (Time 2) on the empowering factor and −0.14 to 0.20 (Time 1 and 2) on the disempowering factor. The standardized factor loadings for the disempowering items ranged from 0.20 to 0.61 ($p < 0.001$) (Time 1) and 0.21 to 0.71 ($p < 0.001$) (Time 2) on the disempowering factor and −0.14 to 0.34 (Time 1) and −0.10 to 0.37 (Time 2) on the empowering factor. Again, item 15 loaded positively and more strongly onto the empowering compared to the disempowering factor. As the majority of factor loadings for items on their intended factor were above 0.50, indirect support for the internal consistency of the empowering and disempowering latent variables across conditions is provided.

TABLE 4 Standardized factor loadings for the 34 items from the empowering and disempowering motivational climate questionnaire-coach (EDMCQ-C) across language, time, and condition.

	Language invariance[a]				Time invariance[b]		Condition invariance[c]			
Items	**EmT1**	**DisT1**	**EmT2**	**DisT2**	**Em**	**Dis**	**EmT1**	**DisT1**	**EmT2**	**DisT2**
E1	**0.54**	− 0.03	**0.59**	− 0.05	0.56	− 0.01	**0.51**	− 0.02	**0.63**	0.00
E4	**0.64**	− 0.07	**0.65**	− 0.10	**0.64**	− 0.05	**0.62**	− 0.05	**0.65**	− 0.06
E11	**0.70**	0.00	**0.72**	0.00	**0.63**	0.02	**0.62**	0.01	**0.66**	0.00
E13	**0.67**	0.21	**0.76**	0.27	**0.56**	0.23	**0.59**	0.21	**0.61**	0.19
E18	**0.66**	0.00	**0.70**	0.00	**0.63**	0.02	**0.61**	0.00	**0.68**	0.01
E23	**0.70**	− 0.03	**0.69**	− 0.05	**0.66**	− 0.03	**0.65**	− 0.03	**0.69**	− 0.04
E28	**0.66**	− 0.08	**0.67**	− 0.07	**0.64**	− 0.07	**0.64**	− 0.09	**0.68**	− 0.05
E30	**0.70**	− 0.03	**0.70**	− 0.02	**0.66**	− 0.02	**0.65**	− 0.03	**0.67**	− 0.03
E34	**0.64**	− 0.07	**0.69**	− 0.04	**0.67**	− 0.04	**0.63**	− 0.06	**0.70**	− 0.02
E3	**0.54**	0.08	**0.61**	0.03	**0.47**	0.09	**0.44**	0.06	**0.53**	0.08
E6	**0.54**	0.01	**0.52**	− 0.03	**0.51**	0.00	**0.50**	0.02	**0.55**	− 0.04
E16	**0.64**	− 0.07	**0.66**	− 0.03	**0.60**	− 0.05	**0.56**	− 0.06	**0.62**	− 0.05
E22	**0.63**	0.05	**0.65**	0.06	**0.65**	0.05	**0.62**	0.04	**0.67**	0.04
E32	**0.65**	0.00	**0.63**	− 0.03	**0.63**	0.00	**0.65**	0.00	**0.67**	− 0.03
E8	**0.57**	− 0.13	**0.61**	− 0.14	**0.61**	− 0.12	**0.57**	− 0.12	**0.64**	− 0.13
E14	**0.64**	− 0.05	**0.67**	− 0.03	**0.58**	− 0.02	**0.57**	− 0.03	**0.63**	− 0.03
E27	**0.37**	− 0.02	**0.47**	− 0.02	**0.46**	− 0.03	**0.41**	− 0.03	**0.53**	− 0.02
D5	0.07	**0.48**	0.02	**0.58**	0.08	**0.55**	0.10	**0.48**	0.02	**0.53**
D9	− 0.10	**0.65**	− 0.09	**0.67**	− 0.10	**0.63**	− 0.12	**0.58**	− 0.09	**0.65**
D10	0.02	**0.67**	− 0.04	**0.69**	0.00	**0.60**	0.03	**0.57**	− 0.07	**0.56**
D19	0.00	**0.64**	0.02	**0.73**	0.04	**0.64**	0.01	**0.59**	0.05	**0.70**
D21	0.00	**0.58**	0.00	**0.61**	0.04	**0.58**	0.03	**0.48**	0.02	**0.58**
D25	− 0.13	**0.60**	− 0.04	**0.66**	− 0.10	**0.56**	− 0.16	**0.53**	− 0.04	**0.62**
D33	− 0.11	**0.67**	− 0.03	**0.72**	− 0.09	**0.67**	− 0.12	**0.63**	− 0.07	**0.73**
D2	− 0.01	**0.57**	− 0.03	**0.55**	− 0.01	**0.51**	0.00	**0.44**	− 0.03	**0.53**
D7	− 0.04	**0.54**	− 0.08	**0.60**	− 0.02	**0.55**	− 0.01	**0.49**	− 0.06	**0.58**
D12	.-09	**0.58**	− 0.10	**0.68**	− 0.09	**0.58**	− 0.01	**0.55**	− 0.11	**0.60**
D15	0.41	**0.20**	0.39	**0.18**	0.36	**0.20**	0.35	**0.18**	0.40	**0.20**
D17	− 0.08	**0.62**	− 0.07	**0.69**	− 0.06	**0.61**	− 0.06	**0.58**	− 0.07	**0.61**
D20	0.08	**0.35**	0.04	**0.39**	0.06	**0.35**	0.06	**0.35**	0.08	**0.39**
D24	0.08	**0.69**	0.11	**0.76**	0.14	**0.63**	0.12	**0.55**	0.09	**0.58**
D26	0.00	**0.63**	0.05	**0.65**	0.05	**0.53**	0.03	**0.48**	0.04	**0.52**
D29	0.23	**0.38**	0.08	**0.18**	0.18	**0.35**	0.19	**0.33**	0.16	**0.33**
D31	− 0.02	**0.40**	− 0.01	**0.36**	− 0.05	**0.35**	− 0.07	**0.36**	− 0.04	**0.36**

Em, empowering climate; Dis, disempowering climate; T, time; [a]standardized factor loadings of reference group (England); [b]standardized factor loadings of time one; [c]standardized factor loadings of reference group (control). The bold values indicate the items that are expected to load on the specified factor.

Finally, the correlation between the empowering and disempowering factor was –0.48 ($p < 0.001$) in the control condition and –0.40 ($p < 0.001$) in the experimental condition at Time 1. At Time 2, the correlation was –0.58 ($p < 0.001$) in the control condition and –0.53 ($p < 0.001$) in the experimental condition.

Discussion

The purpose of this study was to further contribute to the development and validation process of the EDMCQ-C (Appleton et al., 2016) by exploring measurement invariance of a two-factor model across five languages, longitudinally, and across intervention groups in a multi-national sample of young footballer players.

In testing for invariance, total or partial scalar invariance is required to ensure future comparisons of latent mean scores (across the groups and over time) are meaningful. ESEM analyses indicated that the two-factor model tested in this study showed partial invariance across language and full scalar invariance across time and experimental condition groups. Moreover, the analyses confirmed that the majority (33 of 34) of items from the EDMCQ-C loaded positively onto their intended factor (with lower scores on the non-intended factor). Taken together, the invariance findings and factor loadings reported in this study provide additional evidence that the EDMCQ-C provides a sound measure of the array of coaching strategies central to Duda (2013) theory-informed model of the motivational climate. The questionnaire can also be used with confidence to provide meaningful comparisons of latent mean empowering and disempowering climate values in the sample of junior participants recruited in the PAPA project.

Item 15 ("My coach only allowed something we like to do at the end of training if players had done well during the session") was the only item that failed to load as hypothesized across all tests of invariance in this study. Item 15 attempts to capture a controlling reward that coaches may employ during training, and loaded most strongly on the empowering factor across all analyses. This finding is consistent with the ESEM findings reported by Appleton et al. (2016) and Milton et al. (2018). Thus, it seems that junior athletes in the PAPA project may not interpret this particular coaching strategy as disempowering as intended by the scale's authors. Rather, the young footballers seem to perceive that being allowed to do a favorite activity at the end of a training session on those occasions when they had done well in the session is an empowering coaching strategy.

There are a number of reasons that item 15 may load most strongly onto the empowering factor in this study. First, doing something "we like to do at the end of training" is most likely an activity (or activities) that the players enjoy, and thus creates the perception of a positive coaching strategy. Second, empowering coaching strategies are considered key predictors of the satisfaction of athletes' basic psychological needs (Duda, 2013), including feelings of competence. It may be that the young footballers perceive the reward emphasized by item 15 as recognition for demonstrating sufficient level of performance (i.e., doing well), which may subsequently contribute to them feeling more competent. Finally, the "done well during the session" aspect of the item may have been interpreted by the athletes in a task-involving manner, reflecting their personal development, skill mastery and application of effort. Based on the findings reported here (as well as Appleton et al., 2016), we recommend that additional studies utilizing the data from the PAPA project proceed without the inclusion of item 15 from the EDMCQ-C. We also recommend that future research employing the EDMCQ should examine whether item15 cross-loads (more strongly) onto the empowering (compared to the disempowering) factor using data provided by junior sport participants from alternative (non-PAPA) samples and countries.

Although we found partial scalar invariance across languages, there were also non-invariant thresholds of nine items in this particular analyses. As highlighted above, non-invariant thresholds do not prevent a researcher from making meaningful comparisons of latent mean scores. However, a closer inspection of the results for eight of the nine items with non-invariant thresholds revealed differences in the proportion of athletes from each country for the less extreme responses (i.e., "disagree," "neutral," and "agree"). For example, regarding item three ("My coach gave players choices and options"), the analyses revealed that a larger proportion of the athletes in France responded "strongly disagree" and "disagree," compared to athletes speaking the four other languages. This particular finding suggests that French speaking young footballers are given (or perceived to be given) fewer choices and options by their coaches during training and competition. Other studies (e.g., Tessier et al., 2013; Smith et al., 2016) assessing empowering and disempowering coach-created motivational climates have also revealed that French-speaking coaches provide lower levels of autonomy-supportive coaching compared to English, Greek and Spanish speaking athletes. The current study helps clarify the findings reported by Tessier et al. (2013) and Smith et al. (2016) by suggesting the differences in autonomy-support may lie in the lower choice and options provided by French speaking coaches. Conversations between the researchers and the participants during the data collection in the PAPA project provide an anecdotal explanation for this finding. Specifically, some of the French-speaking coaches perceived that giving their players choices and options was a sign of weakness and lack of authority, and the players reported that they did not understand choices their coaches could offer. Given that offering meaningful choices and attractive options is a key facet of an empowering climate, future intervention work with French-speaking coaches may wish to target this particular empowering strategy.

Regarding item 31 ("My coach tried to interfere in aspect of players' lives outside of football"), the analyses revealed that Spanish speaking players' responses were more optimistic (i.e., more players responding "strongly disagree") compared to players from the other countries (albeit more athletes from the other countries disagreed than agreed with this statement). Why more Spanish speaking players responded strongly disagreed is not clear in the current study. It would be interesting to determine in future research whether this particular finding emerges when examining language invariance of the EDMCQ-C with athletes from other sports and competitive levels. Consistent support for this finding across other sports would suggest coaches in Spain are less disempowering with respect to interfering in their athletes' lives outside of sport compared to coaches in other countries.

While the findings of this study are informative regarding the psychometric properties of the EDMCQ-C, we also recognize some limitations. For example, we were unable to test for gender invariance due to a gender imbalance in the sample and because in some cases, boys and girls were nested within the same team (i.e., they played for the same team). Future research may wish to test the gender invariance of the EDMCQ when completed by young athletes, and well as replicating the analyses reported in this study with a more diverse sample of athletes (e.g., older athletes, range of sports, more diverse range of languages). Consistent with recommendations (Muthén and Muthén, 1998–2015) for categorical-ordered data, we made the decision to constrain the factor loadings and thresholds in tandem, freeing the latter when testing partial (language) invariance. As a result, we did not test for factor loading

invariance. We made this decision, as per previous studies (e.g., Myers et al., 2011; Viladrich et al., 2013), due to the complexities associated with managing factor loading non-invariance attributable to one language on one item in an ESEM. Moreover, with categorical data, the factor loadings and thresholds are not independent as both contribute to the item characteristic function. Based on the difficulties reported by Appleton et al. (2016) in modeling the hierarchical structure of the EDMCQ-C, we also decided to limit our analyses to a two-factor model that reflected the overall empowering and disempowering features of the coach-created motivational climate. However, if advances are made in refining the content of the EDMCQ-C to enable the successful modeling of the scale's hierarchical nature, future research will be needed to re-examine the scale's invariance. Finally, future research may wish to include interactional invariance tests (e.g., across countries, experimental conditions, time points, gender), which was not possible in this study due to the complexity of the analyses and the nature of our data (missing data, sample size and skewness).

Conclusion

Collectively, the results from this study provide further evidence on the psychometric properties of the EDMCQ-C as a measure of the empowering and disempowering features of the coach-created motivational climate in youth sport. Overall, the findings suggest the scale (minus item 15) may be used to provide meaningful latent mean comparisons (Marsh et al., 2013) across the five targeted languages, time, and experimental groups when utilizing the data from the PAPA project. This is especially important given the PAPA project attempted to help coaches create empowering (and reduced disempowering) motivational climates in youth sport. The findings reported in this study should also increase researchers' confidence in using the EDMCQ-C as a measure of athletes' perceptions of empowering and disempowering coach-created motivational climate in future research. Such research could use the EDMCQ-C to test theory-informed process models (see Duda and Appleton, 2016; Duda et al., 2018) that include the two climate factors proposed in this study, and such research would also contribute to the nomological validity of the EDMCQ-C.

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 granted by the Universities of each team of researchers working on the PAPA project. Prior to collecting data, parents had the opportunity to opt-out their son and/or daughter from the project. Participants were fully informed about the study prior to it taking place and a parental written opt-out form was used in accordance with national legislation and the institutional requirements.

Author contributions

PA and JD: conceived the study. PA, EQ, and JD: designed the original questionnaire. IB and LG-G: designed the Spanish version of the questionnaire. PS and J-PH: designed the French version of the questionnaire. AP: designed the Greek version of the questionnaire. YO: designed the Norwegian version of the questionnaire. JD, IB, AP, HH, PS, J-PH, YO, BW, and OS: funding acquisition. JD: supervised the manuscript. PA, EQ, LG-G, AP, HH, IB, YR, PS, J-PH, YO, BW, OS, and JD: collected the data. PA and CV: analyzed the data. PA, CV, and JD: interpreted the results of the research. CV: designed the figures and tables. PA and CV: wrote and edited the manuscript. All authors provided critical revisions and the formal analysis on the successive drafts and approved the manuscript in its final form.

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Conflict of interest

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

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EDITED BY
Manuel Gómez-López,
University of Murcia, Spain

REVIEWED BY
Nieves Gutiérrez Angel,
University of Almeria, Spain
Mohamed Jarraya,
University of Sfax, Tunisia
David Manzano Sánchez,
University of Extremadura, Spain

*CORRESPONDENCE
Nicola Luigi Bragazzi
✉ bragazzi@yorku.ca

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The problem-solving method: Efficacy for learning and motivation in the field of physical education

Ghaith Ezeddine[1], Nafaa Souissi[1,2], Liwa Masmoudi[1,3], Khaled Trabelsi[1,3], Luca Puce[4], Cain C. T. Clark[5], Nicola Luigi Bragazzi[4,6]* and Maher Mrayah[2,7]

[1]High Institute of Sport and Physical Education of Sfax, University of Sfax, Sfax, Tunisia, [2]Research Unit of the National Sports Observatory (ONS), Tunis, Tunisia, [3]Research Laboratory: Education, Motricity, Sport and Health, EM2S, LR19JS01, University of Sfax, Sfax, Tunisia, [4]Department of Neuroscience, Rehabilitation, Ophthalmology, Genetics, Maternal and Child Health (DINOGMI), University of Genoa, Genoa, Italy, [5]Centre for Intelligent Healthcare, Coventry University, Coventry, United Kingdom, [6]Laboratory for Industrial and Applied Mathematics, Department of Mathematics and Statistics, York University, Toronto, ON, Canada, [7]High Institute of Sport and Physical Education of Ksar Saîd, University Manouba, UMA, Manouba, Tunisia

Background: In pursuit of quality teaching and learning, teachers seek the best method to provide their students with a positive educational atmosphere and the most appropriate learning conditions.

Objectives: The purpose of this study is to compare the effects of the problem-solving method vs. the traditional method on motivation and learning during physical education courses.

Methods: Fifty-three students (M^{age} 15 ± 0.1 years), in their 1st year of the Tunisian secondary education system, voluntarily participated in this study, and randomly assigned to a control or experimental group. Participants in the control group were taught using the traditional methods, whereas participants in the experimental group were taught using the problem-solving method. Both groups took part in a 10-hour experiment over 5 weeks. To measure students' situational motivation, a questionnaire was used to evaluate intrinsic motivation, identified regulation, external regulation, and amotivation during the first (T0) and the last sessions (T2). Additionally, the degree of students' learning was determined *via* video analyses, recorded at T0, the fifth (T1), and T2.

Results: Motivational dimensions, including identified regulation and intrinsic motivation, were significantly greater (all $p < 0.001$) in the experimental vs. the control group. The students' motor engagement in learning situations, during which the learner, despite a degree of difficulty performs the motor activity with sufficient success, increased only in the experimental group ($p < 0.001$). The waiting time in the experimental group decreased significantly at T1 and T2 vs. T0 (all $p < 0.001$), with lower values recorded in the experimental vs. the control group at the three-time points (all $p < 0.001$).

Conclusions: The problem-solving method is an efficient strategy for motor skills and performance enhancement, as well as motivation development during physical education courses.

KEYWORDS

problem-solving method, traditional method, motivation, learning, students

1. Introduction

The education of children is a sensitive and poignant subject, where the wellbeing of the child in the school environment is a key issue (Ergül and Kargin, 2014). For this, numerous research has sought to find solutions to the problems of the traditional method, which focuses on the teacher as an instructor, giver of knowledge, arbiter of truth, and ultimate evaluator of learning (Ergül and Kargin, 2014; Cunningham and Sood, 2018). From this perspective, a teachers' job is to present students with a designated body of knowledge in a predetermined order (Arvind and Kusum, 2017). For them, learners are seen as people with "knowledge gaps" that need to be filled with information. In this method, teaching is conceived as the act of transmitting knowledge from point A (responsible for the teacher) to point B (responsible for the students; Arvind and Kusum, 2017). According to Novak (2010), in the traditional method, the teacher is the one who provokes the learning.

The traditional method focuses on lecture-based teaching as the center of instruction, emphasizing delivery of program and concept (Johnson, 2010; Ilkiw et al., 2017; Dickinson et al., 2018). The student listens and takes notes, passively accepts and receives from the teacher undifferentiated and identical knowledge (Bi et al., 2019). Course content and delivery are considered most important, and learners acquire knowledge through exercise and practice (Johnson et al., 1998). In the traditional method, academic achievement is seen as the ability of students to demonstrate, replicate, or convey this designated body of knowledge to the teacher. It is based on a transmissive model, the teacher contenting themselves with exchanging and transmitting information to the learner. Here, only the "knowledge" and "teacher" poles of the pedagogical triangle are solicited. The teacher teaches the students, who play the role of the spectator. They receive information without participating in its creation (Perrenoud, 2003). For this, researchers invented a new student-centered method with effects on improving students' graphic interpretation skills and conceptual understanding of kinematic motion represent an area of contemporary interest (Tebabal and Kahssay, 2011). Indeed, in order to facilitate the process of knowledge transfer, teachers should use appropriate methods targeted to specific objectives of the school curricula.

For instance, it has been emphasized that the effectiveness of any educational process as a whole relies on the crucial role of using a well-designed pedagogical (teaching and/or learning) strategy (Kolesnikova, 2016).

Alternate to a traditional method of teaching, Ergül and Kargin (2014), proposed the problem-solving method, which represents one of the most common student-centered learning strategies. Indeed, this method allows students to participate in the learning environment, giving them the responsibility for their own acquisition of knowledge, as well as the opportunity for the understanding and structuring of diverse information.

For Cunningham and Sood (2018), the problem-solving method may be considered a fundamental tool for the acquisition of new knowledge, notably learning transfer. Moreover, the problem-solving method is purportedly efficient for the development of manual skills and experiential learning (Ergül and Kargin, 2014), as well as the optimization of thinking ability. Additionally, the problem-solving method allows learners to participate in the learning environment, while giving them responsibility for their learning and making them understand and structure the information (Pohan et al., 2020). In this context, Ali (2019) reported that, when faced with an obstacle, the student will have to invoke his/her knowledge and use his/her abilities to "break the deadlock." He/she will therefore make the most of his/her potential, but also share and exchange with his/her colleagues (Ali, 2019). Throughout the process, the student will learn new concepts and skills. The role of the teacher is paramount at the beginning of the activity, since activities will be created based on problematic situations according to the subject and the program. However, on the day of the activity, it does not have the main role, and the teacher will guide learners in difficulty and will allow them to manage themselves most of the time (Ali, 2019).

The problem-solving method encourages group discussion and teamwork (Fidan and Tuncel, 2019). Additionally, in this pedagogical approach, the role of the teacher is a facilitator of learning, and they take on a much more interactive and less rebarbative role (Garrett, 2008).

For the teaching method to be effective, teaching should consist of an ongoing process of making desirable changes among learners using appropriate methods (Ayeni, 2011; Norboev, 2021). To bring about positive changes in students, the methods used by teachers should be the best for the subject to be taught (Adunola et al., 2012). Further, suggests that teaching methods work effectively, especially if they meet the needs of learners since each learner interprets and answers questions in a unique way. Improving problem-solving skills is a primary educational goal, as is the ability to use reasoning. To acquire this skill, students must solve problems to learn mathematics and problem-solving (Hu, 2010); this encourages the students to actively participate and contribute to the activities suggested by the teacher. Without sufficient motivation, learning goals can no longer be optimally achieved, although learners may have exceptional abilities. The method of teaching employed by the teachers is decisive to achieve motivational consequences in physical education students (Leo et al., 2022). Pérez-Jorge et al. (2021) posited that given we now live in a technological society in which children are used to receiving a large amount of stimuli, gaining and maintaining their attention and keeping them motivated at school becomes a challenge for teachers.

Fenouillet (2012) stated that academic motivation is linked to resources and methods that improve attention for school learning. Furthermore, Rolland (2009) and Bessa et al. (2021) reported a link between a learner's motivational dynamics and classroom activities. The models of learning situations, where the student is the main actor, directly refers to active teaching methods, and that there is a strong link between motivation and active teaching (Rossa et al., 2021). In the same context, previous reports assert that the motivation of students in physical education is an important factor since the intra-individual motivation toward this discipline is recognized as a major determinant of physical activity for students (Standage et al., 2012; Luo, 2019; Leo et al., 2022). Further, extensive research on the effectiveness of teaching methods shows that the quality of teaching often influences the performance of learners (Norboev, 2021). Ayeni (2011) reported that education is a process that allows students to make changes desirable to achieve specific results. Thus, the consistency of teaching methods with student needs and learning influences student achievement. This has led several

researchers to explore the impact of different teaching strategies, ranging from traditional methods to active learning techniques that can be used such as the problem-solving method (Skinner, 1985; Darling-Hammond et al., 2020).

In the context of innovation, Blázquez (2016) emphasizes the importance of adopting active methods and implementing them as the main element promoting the development of skills, motivation and active participation. Pedagogical models are part of the active methods which, together with model-based practice, replace traditional teaching (Hastie and Casey, 2014; Casey et al., 2021). Thus, many studies have identified pedagogical models as the most effective way to place students at the center of the teaching-learning process (Metzler, 2017), making it possible to assess the impact of physical education on learning students (Casey, 2014; Rivera-Pérez et al., 2020; Manninen and Campbell, 2021). Since each model is designed to focus on a specific program objective, each model has limitations when implemented in isolation (Bunker and Thorpe, 1982; Rivera-Pérez et al., 2020). Therefore, focusing on developing students' social and emotional skills and capacities could help them avoid failure in physical education (Ang and Penney, 2013). Thus, the current emergence of new pedagogical models goes with their hybridization with different methods, which is a wave of combinations proposed today as an innovative pedagogical strategy. The incorporation of this type of method in the current education system is becoming increasingly important because it gives students a greater role, participation, autonomy and self-regulation, and above all it improves their motivation (Puigarnau et al., 2016). The teaching model of personal and social responsibility, for example, is closely related to the sports education model because both share certain approaches to responsibility (Siedentop et al., 2011). One of the first studies to use these two models together was Rugby (Gordon and Doyle, 2015), which found significant improvements in student behavior. Also, the recent study by Menendez and Fernandez-Rio (2017) on educational kickboxing.

Previous studies have indicated that hybridization can increase play, problem solving performance and motor skills (Menendez and Fernandez-Rio, 2017; Ward et al., 2021) and generate positive psychosocial consequences, such as pleasure, intention to be physically active and responsibility (Dyson and Grineski, 2001; Menendez and Fernandez-Rio, 2017).

But despite all these research results, the picture remains unclear, and it remains unknown which method is more effective in improving students' learning and motivation. Given the lack of published evidence on this topic, the aim of this study was to compare the effects of problem-solving vs. the traditional method on students' motivation and learning.

We hypothesized would that the problem-solving method would be more effective in improving students' motivation and learning better than the traditional method.

2. Materials and method

2.1. Participants

Fifty-three students, aged 15–16 (M^{age} 15 $\pm$ 0.1 years), in their 1st year of the Tunisian secondary education system, voluntarily participated in this study. All participants were randomly chosen. Repeating students, those who practice handball activity in civil/competitive/amateur clubs or in the high school sports association, and students who were absent, even for one session, were excluded. The first class consisted of 30 students (16 boys and 14 girls), who represented the experimental group and followed basic courses on a learning method by solving problems. The second class consisted of 23 students (10 boys and 13 girls), who represented the control group and followed the traditional teaching method. The total duration was spread over 5 weeks, or two sessions per week and each session lasted 50 min.

University research ethics board approval (CPPSUD: 0295/2021) was obtained before recruiting participants who were subsequently informed of the nature, objective, methodology, and constraints. Teacher, school director, parental/guardian, and child informed consent was obtained prior to participation in the study.

2.2. Procedure

Before the start of the experiment, the participants were familiarized with the equipment and the experimental protocol in order to ensure a good learning climate. For this and to mitigate the impact of the observer and the cameras on the students, the two researchers were involved prior to the data collection in a week of familiarization by making test recordings with the classes concerned.

An approach of a teaching cycle consisting of 10 sessions spread over 5 weeks, amounting to two sessions per week. Physical education classes were held in the morning from 8 a.m. to 9 a.m., with a single goal for each session that lasted 50 min. The cyclic programs were produced by the teacher responsible for carrying out the experiment with 18 years of service. To do this, the students had the same lessons with the same objectives, only pedagogy that differs: the experimental group worked using problem-solving pedagogy, while the control group was confronted with traditional pedagogy. The sessions took place in a handball field 40 m long and 20 m wide. Examples of training sessions using the problem-solving pedagogy and the traditional pedagogy are presented in Table 1. In addition, a motivation questionnaire, the Situational Motivation Scale (SIMS; Guay et al., 2000), was administered to learners at the end of the session (i.e., in the beginning, and end of the cycle). Each student answered the questions alone and according to their own ideas. This questionnaire was taken in a classroom to prevent students from acting abnormally during the study. It lasted for a maximum of 10 min.

Two diametrically opposed cameras were installed so to film all the movements and behaviors of each student and teacher during the three sessions [(i) test at the start of the cycle (T0), (ii) in the middle of the cycle (T1), and (iii) test at the end of the cycle (T2)]. These sessions had the same content and each consisted of four phases: the getting started, the warm-up, the work up (which consisted of three situations: first, the work was goes up the ball to two to score in the goal following a shot. Second, the same principle as the previous situation but in the presence of a defender. Finally, third, a match 7 $\neq$ 7), and the cooling down These recordings were analyzed using a Learning Time Analysis System grid (LTAS;

TABLE 1 Example of activities for the different sessions.

Problem-solving method	Traditional method
T0	**T0**
Evaluation test at the beginning of the cycle	Evaluation of the beginning of the cycle
The class will be divided into two groups: the first group will play a game of dodgeball. The second will perform the test through a two-man ball climb to the halfway line and then return to the goal by dribbling to attempt a shot. Then, learners change roles. The first group will do the test and the second group will play dodgeball.	The court is divided into three parts across the width. The students in turn are divided into teams of three and will play 3#3 on a third of the field. The winners will play among themselves.
T1	**T1**
Situation 1 The court is divided into three parts along the length. The students carry out a two-man ball lift in the presence of an active defender.	**Situation 1** The work is done along the length of the court. The students perform a three-way ball run.
Situation 2 The court is divided into two parts along the length. The students carry out a three-way ball attack in the presence of two active defenders.	**Situation 2** The same exercise, but students play crisscross.
Situation 3 Progress toward the opposing camp in crisscross and attempt a shot.	**Situation 3** The work is done on a half court, students are divided in three groups on the 9 m line, they passes a ball and follows to finally shoot toward the cage.
Situation 4 The students perform a four-man high ball in the presence of three active defenders.	
T2	**T2**
Evaluation of the end of the cycle	**Evaluation of the end of the cycle**
Divide the students into two groups: the first group is in turn divided into two teams, each starting from the sideline. At the signal, the student starts to dribble, goes around a cone and moves toward the cage to attempt a shot. The second group is divided into four teams to play 4#4 on a quarter of the court. Then, they will switch roles.	**Situation 1** The work is done on half court. These students who are going to do a two-man ball climb then one will dribble in slalom to shoot toward the cage and the second will become a goalkeeper then they will change roles.
	Situation 2
	The students perform a half match of 4#4.

Brunelle et al., 1988). This made it possible to measure individual learning by coding observable variables of the behavior of learners in a learning situation.

2.3. Data collection and analysis

2.3.1. The motivation questionnaire

In this study, in order to measure the situational motivation of students, the situational motivation scale (SIMS; Guay et al., 2000), which used. This questionnaire assesses intrinsic motivation, identified regulation, external regulation and amotivation. SIMS has demonstrated good reliability and factor validity in the context of physical education in adolescents (Lonsdale et al., 2011). The participants received exact instructions from the researchers in accordance with written instructions on how to conduct the data collection. Participants completed the SIMS anonymously at the start of a physical education class. All students had the opportunity to write down their answers without being observed and to ask questions if anything was unclear. To minimize the tendency to give socially desirable answers, they were asked to answer as honestly as possible, with the confidence that the teacher would not be able to read their answers and that their grades would not be affected by how they responded. The SIMS questionnaire was filled at T0 and T2. This scale is made up of 16 items divided into four dimensions: intrinsic motivation, identified regulation, external regulation and amotivation. Each item is rated on a 7-point Likert scale ranging from 1 (which is the weakest factor) "not at all" to 7 (which is the strongest factor) "exactly matches."

In order to assess the internal consistency of the scales, a Cronbach alpha test was conducted (Cronbach, 1951). The internal consistency of the scales was acceptable with reliability coefficients ranging from 0.719 to 0.87. The coefficient of reliability was 0.8.

In the present study, Cronbach's alphas were: intrinsic motivation = 0.790; regulation identified = 0.870; external regulation = 0.749; and amotivation = 0.719.

2.3.2. Camcorders

The audio-visual data collection was conducted using two Sony camcorders (Model; Handcam 4K) with a wireless microphone with a DJ transmitter-receiver (VHF 10HL F4 Micro HF) with a range of 80 m (Maddeh et al., 2020). The collection took place over a period of 5 weeks, with three captures for each class (three sessions of 50 min for each at T0, T1, and T2). Two researchers were trained in the procedures and video capture techniques. The cameras were positioned diagonally, in order to film all the behavior of the students and teacher on the set.

2.3.3. The Learning Time Analysis System (LTAS)

To measure the degree of student learning, the analysis of videos recorded using the LTAS grid by Brunelle et al. (1988) was used, at T0, T1, and T2. This observation system with predetermined categories uses the technique of observation by small intervals (i.e., 6 s) and allows to measure individual learning by coding observable variables of their behaviors when they have been in a learning situation. This grid also permits the specification of the quantity and quality with which the participants engaged in the requested work and was graded, broadly, on two characteristics: the type of situation offered to the group by the teacher and the behavior of the target participant. The situation offered to the group was subdivided into three parts: preparatory situations; knowledge development situations, and motor development situations.

The observations and coding of behaviors are carried out "at intervals." This technique is used extensively in research on behavior analysis. The coder observes the teaching situation and a particular student during each interval (Brunelle et al., 1988). It then makes a decision concerning the characteristic of the observed behavior. The 6-s observation interval is followed by a coding interval of 6 s too. A cassette tape recorder is used to regulate the observation and recording intervals. It is recorded for this purpose with the indices "observe" and "code" at the start of each 6-s period. During each coding unit, the observer answered the following questions: What is the type of situation in which the class group finds itself? If the class group is in a learning situation proper, in what form of commitment does the observed student find himself? The abbreviations representing the various categories of behavior have been entered in the spaces which correspond to them. The coder was asked to enter a hyphen instead of the abbreviation when the same categories of behavior follow one another in consecutive intervals (Brunelle et al., 1988).

During the preparatory period, the following behaviors were identified and analyzed:

- Deviant behavior: The student adopts a behavior incompatible with a listening attitude or with the smooth running of the preparatory situations.
- Waiting time: The student is waiting without listening or observing.
- Organized during: The student is involved in a complementary activity that does not represent a contribution to learning (e.g., regaining his place in a line, fetching a ball that has just left the field, replacing a piece of equipment).

During the motor development situations, the following behaviors were identified and analyzed:

- Motor engagement 1: The participant performs the motor activity with such easy that it can be inferred that their actions have little chance to engage in a learning process.
- Motor engagement 2: The participant-despite a certain degree of difficulty, performs the motor activity with sufficient success, which makes it possible to infer that they are in the process of learning.
- Motor engagement 3: The participant performs the motor activity with such difficulty that their efforts have very little chance of being part of a learning process.

2.4. Statistical analysis

Statistical tests were performed using statistical software 26.0 for windows (SPSS, Inc, Chicago, IL, USA). Data are presented in text and tables as means ± standard deviations and in figures as means and standard errors. Once the normal distribution of data was confirmed by the Shapiro-Wilk W-test, parametric tests were performed. Analysis of the results was performed using a mixed 2-way analysis of variance (ANOVA): Groups × Time with repeated measures.

For the learning parameters, the ANOVA took the following form: 2 Groups (Control Group vs. Experimental Group) × 3 Times (T0, T1, and T2).

For the dimensions of motivation, the ANOVA took the following form: 2 Groups (Control Group vs. Experimental Group) × 2 Time (T0 vs. T2).

In instances where the ANOVA showed a significant effect, a Bonferroni *post-hoc* test was applied in order to compare the experimental data in pairs, otherwise by an independent or paired Student's T-test. Effect sizes were calculated as partial eta-squared ηp^2 to estimate the meaningfulness of significant findings, where ηp^2 values of 0.01, 0.06, and 0.13 represent small, moderate, and large effect sizes, respectively (Lakens, 2013). All observed differences were considered statistically significant for a probability threshold lower than $p < 0.05$.

3. Results

Table 2 shows the results of learning variables during the preparatory and the development learning periods at T0, T1, and T2, in the control group and the experimental group.

The analysis of variance of two factors with repeated measures showed a significant effect of group, learning, and group learning interaction for the deviant behavior. The *post-hoc* test revealed significantly less frequent deviant behaviors in the experimental than in the control group at T0, T1, and T2 (all $p < 0.001$). Additionally, the deviant behavior decreased significantly at T1 and T2 compared to T0 for both groups (all $p < 0.001$).

For appropriate engagement, there were no significant group effect, a significant learning effect, and a significant group learning interaction effect. The *post-hoc* test revealed that compared to T0, Appropriate engagement recorded at T1 and T2 increased significantly ($p = 0.032$; $p = 0.031$, respectively) in the experimental group, whilst it decreased significantly in the control group ($p < 0.001$). Additionally, Appropriate engagement was higher in the experimental vs. control group at T1 and T2 (all $p < 0.001$).

For waiting time, a significant interaction in terms of group effect, learning, and group learning was found. The *post-hoc* test revealed that waiting time was higher at T1 and T2 vs. T0 (all $p < 0.001$) in the control group. In addition, waiting time in the experimental group decreased significantly at T1 and T2 vs. T0 (all $p < 0.001$), with higher values recorded at T2 vs. T1 ($p = 0.025$). Additionally, lower values were recorded in the experimental group vs. the control group at the three-time points (all $p < 0.001$).

For Motor engagement 2, a significant group, learning, and group-learning interaction effect was noted. The *post-hoc* test revealed that Motor engagement 2 increased significantly in both

TABLE 2 Comparison of learning variables using two teaching methods in physical education.

Variables		Groups	Means ± SD			Groups effect			Learning effect			Groups × learning interaction		
			T0	T1	T2	$F_{(1, 51)}$	*p*-value	η_p^2	$F_{(2, 102)}$	*p*-value	η_p^2	$F_{(2, 102)}$	*p*-value	η_p^2
Preparatory period	Deviant behavior	Control group	40.7 ± 15	38.9 ± 11	30.3 ± 11.5$^{\#\$}$	90.524	0.000	0.640	61.332	0.000	0.546	5.070	0.008	0.090
		Experimental group	26.1 ± 6.2∗	19.3 ± 5.7$^{*\#}$	7.2 ± 3.4$^{*\#\$}$									
	Appropriate engagement	Control group	68 ± 10.9	64.3 ± 10	57.5 ± 5.4$^{\#\$}$	0.661	0.420	0.013	4.219	0.017	0.076	62.812	0.000	0.552
		Experimental group	56.5 ± 3.3∗	64 ± 2.4$^{\#}$	65.9 ± 1.7$^{*\#}$									
	Waiting time	Control group	82.9 ± 2.9	87.9 ± 3$^{\#}$	97 ± 3.5$^{\#\$}$	2,902.065	0.000	0.983	56.068	0.000	0.524	683.062	0.000	0.931
		Experimental group	70.6 ± 2.9∗	67.3 ± 3.1$^{*\#}$	47.8 ± 1.4$^{*\#\$}$									
Motor development	Motor engagement 2	Control group	14.2 ± 25.7	20.9 ± 19	61.1 ± 33.8$^{\#\$}$	34.126	0.000	0.401	80.626	0.000	0.613	8.553	0.000	0.144
		Experimental group	38.4 ± 51.7	55.3 ± 42.6∗	131.8 ± 28.6$^{*\#\$}$									
	Motor engagement 3	Control group	45.9 ± 25.4	40.2 ± 18.9	18 ± 31.8$^{\#}$	1.683	0.200	0.032	31.219	0.000	0.380	3.984	0.022	0.072
		Experimental group	68.9 ± 51.3	54.1 ± 41.5	9.3 ± 27.9$^{\#\$}$									
	Organized during	Control group	13.1 ± 2.3	12.5 ± 1.3	11 ± 4.2$^{\#}$	29.983	0.000	0.370	16.687	0.000	0.247	1.075	0.345	0.021
		Experimental group	14.6 ± 1.1	15 ± 0.6∗	12.9 ± 0.4$^{*\#\$}$									

*Significantly different from control group at $p < 0.05$.

$^{\#}$Significantly different from T0 at $p < 0.05$.

$^{\$}$Significantly different from T1 at $p < 0.05$.

For motor engagement 1 (ME1), the time devoted to this variable is equal zero for the three measurement times (T0, T1, and T2).

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groups at T1 ($p < 0.0001$) and T2 ($p < 0.0001$) vs. T0 ($p = 0.045$), with significantly higher values recorded in the experimental group at T1 and T2.

Regarding Motor engagement 3, a non-significant group effect was reported. Contrariwise, a significant learning effect and group learning interaction was reported (Table 1). The *post-hoc* test revealed a significant decrease in the control group and the experimental group at T1 ($p = 0.294$) at T2 ($p = 0.294$) vs. T0 ($p = 0.0543$). In addition, a non-significant difference between the two groups was found.

A significant group and learning effect was noted for the organized during, and a non-significant group learning interaction. For organized during, the paired Student *T*-test showed a significant decrease in the control group and the experimental group (all $p < 0.001$). The independent Student *T*-test revealed a non-significant difference between groups at the three-time points.

Results of the motivational dimensions in the control group and the experimental group recorded at T0 and T2 are presented in Table 3.

For intrinsic motivation, a significant group effect and group learning interaction and also a non-significant learning effect was found. The *post-hoc* test indicated that the intrinsic motivation decreased significantly in the control group ($p = 0.029$), whilst it increased in the experimental group ($p = 0.04$). Additionally, the intrinsic motivation of the experimental group was higher at T0 ($p = 0.026$) and T2 ($p < 0.001$) compared to that of the control group.

For the identified regulation, a significant group effect, a non-significant learning effect and group learning interaction were reported. The paired Student's *T*-test revealed that from T0 to T1, the identified motivation increased significantly only in the experimental group ($p = 0.022$), while it remained unchanged in the control group. The independent Student's *T*-test revealed that the identified regulation recorded in the experimental group at T0 ($p = 0.012$) and T2 ($p < 0.001$) was higher compared to that of the control group.

The external regulation presents a significant group effect. In addition, a non-significant learning effect and group learning interaction were reported. The paired Student's *T*-test showed that the external regulation decreased significantly in the experimental group ($p = 0.038$), whereas it remained unchanged in the control group. Further, the independent Student's *T*-test revealed that the external regulation recorded at T2 was higher in the control group vs. the experimental group ($p < 0.001$).

Relating to amotivation, results showed a significant group effect. Furthermore, a non-significant learning effect and group learning interaction were reported. The paired Student's *T*-test showed that, from T0 to T2, amotivation decreased significantly in the experimental group ($p = 0.011$) and did not change in the control group. The independent Student *T*-test revealed that amotivation recorded at T2 was lower in the experimental compared to the control group ($p = 0.002$).

TABLE 3 Comparison of the four motivational dimensions in two teaching methods in physical education.

Dimensions		Means ± SD		Group effect			Learning effect			Group × learning interaction		
		T0	T2	$F_{(1, 51)}$	*p*-value	η_p^2	$F_{(2, 102)}$	*p*-value	η_p^2	$F_{(2, 102)}$	*p*-value	η_p^2
Intrinsic motivation	Control group	4.4 ± 2.1	3.3 ± 1.3#	35.859	<0.001	0.413	0.692	0.409	0.013	17.206	<0.001	0.252
	Experimental group	5.5 ± 1.4*	6.2 ± 0.8*#									
Identified regulation	Control group	4.2 ± 1.8	4.4 ± 1.1	17.682	<0.001	0.257	1.341	0.252	0.026	0.236	0.629	0.005
	Experimental group	5.4 ± 1.5*	5.8 ± 1.2*#									
External regulation	Control group	4.3 ± 1.4	4.2 ± 1	11.892	0.001	0.189	3.726	0.059	0.068	1.821	0.183	0.034
	Experimental group	3.7 ± 1.1	3 ± 1.2*#									
Amotivation	Control group	3.5 ± 1.3	3.9 ± 1.1	7.828	0.007	0.133	0.023	0.881	0.000	3.145	0.082	0.058
	Experimental group	3.2 ± 1.1	2.9 ± 1.1*#									

*Significantly different from control group at $p < 0.05$.
#Significantly different from T0 at $p < 0.05$.

4. Discussion

The main purpose of this study was to compare the effects of the problem-solving vs. traditional method on motivation and

learning during physical education courses. The results revealed that the problem-solving method is more effective than the traditional method in increasing students' motivation and improving their learning. Moreover, the results showed that mean wait times and deviant behaviors decreased using the problem-solving method. Interestingly, the average time spent on appropriate engagement increased using the problem-solving method compared to the traditional method. When using the traditional method, the average wait times increased and, as a result, the time spent on appropriate engagement decreased. Then, following the decrease in deviant behaviors and waiting times, an increase in the time spent warming up was evident (i.e., appropriate engagement). Indeed, there was an improvement in engagement time using the problem-solving method and a decrease using the traditional method. On the other hand, there was a decrease in motor engagement 3 in favor of motor engagement 2. Indeed, it has been shown that the problem-solving method has been used in the learning process and allows for its improvement (Docktor et al., 2015). In addition, it could also produce better quality solutions and has higher scores on conceptual and problem-solving measures. It is also a good method for the learning process to enhance students' academic performance (Docktor et al., 2015; Ali, 2019). In contrast, the traditional method limits the ability of teachers to reach and engage all students (Cook and Artino, 2016). Furthermore, it produces passive learning with an understanding of basic knowledge which is characterized by its weakness (Goldstein, 2016). Taken together, it appears that the problem-solving method promotes and improves learning more than the traditional method.

It should be acknowledged that other factors, such as motivation, could influence learning. In this context, our results showed that the method of problem-solving could improve the motivation of the learners. This motivation includes several variables that change depending on the situation, namely the intrinsic motivation that pushes the learner to engage in an activity for the interest and pleasure linked to the practice of the latter (Komarraju et al., 2009; Guiffrida et al., 2013; Chedru, 2015). The student, therefore, likes to learn through problem-solving and neglects that of the traditional method. These results are concordant with others (Deci and Ryan, 1985; Chedru, 2015; Ryan and Deci, 2020). Regarding the three forms of extrinsic motivation: first, extrinsic motivation by an identified regulation which manifests itself in a high degree of self-determination where the learner engages in the activity because it is important for him (Deci and Ryan, 1985; Chedru, 2015). This explains the significant difference between the two groups. Then, the motivation by external regulation which is characterized by a low degree of self-determination such as the behavior of the learner is manipulated by external circumstances such as obtaining rewards or the removal of sanctions (Deci and Ryan, 1985; Chedru, 2015). For this, the means of this variable decreased for the experimental group which is intrinsically motivated. He does not need any reward to work and is not afraid of punishment because he is self-confident. Third, amotivation is at the opposite end of the self-determination continuum. Unmotivated students are the most likely to feel negative emotions (Ratelle et al., 2007; David, 2010), to have low self-esteem (Deci and Ryan, 1995), and who attempts to abandon their studies (Vallerand et al., 1997; Blanchard et al., 2005). So, more students are motivated by external regulation or demotivated, less interest they show and less effort they make, and more likely they are to fail (Grolnick et al., 1991; Miserandino, 1996; Guay et al., 2000; Blanchard et al., 2005).

It is worth noting that there is a close link between motivation and learning (Bessa et al., 2021; Rossa et al., 2021). Indeed, when the learner's motivation is high, so will his learning. However, all this depends on the method used (Norboev, 2021). For example, the method of problem-solving increase motivation more than the traditional method, as evidenced by several researchers (Parish and Treasure, 2003; Artino and Stephens, 2009; Kim and Frick, 2011; Lemos and Veríssimo, 2014).

Given the effectiveness of the problem-solving method in improving students' learning and motivation, it should be used during physical education teaching. This could be achieved through the organization of comprehensive training programs, seminars, and workshops for teachers so to master and subsequently be able to use the problem-solving method during physical education lessons.

Despite its novelty, the present study suffers from a few limitations that should be acknowledged. First, a future study, consisting of a group taught using the mixed method would preferable so to better elucidate the true impact of this teaching and learning method. Second, no gender and/or age group comparisons were performed. This issue should be addressed in future investigations. Finally, the number of participants is limited. This may be due to working in a secondary school where the number of students in a class is limited to 30 students. Additionally, the number of participants fell to 53 after excluding certain students (exempted, absent for a session, exercising in civil clubs or member of the school association). Therefore, to account for classes of finite size, a cluster-based trial would be beneficial in the future. Moreover, future studies investigating the effect of the active method in reducing some behaviors (e.g., disruptive behaviors) and for the improvement of pupils' attention are warranted.

5. Conclusion

There was an improvement in student learning in favor of the problem-solving method. Additionally, we found that the motivation of learners who were taught using the problem-solving method was better than that of learners who were educated by the traditional method.

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

University Research Ethics Board approval was obtained before recruiting participants who were subsequently informed of the nature, objective, methodology, and constraints. Teacher, school director, parental/guardian, and child informed consent

was obtained prior to participation in the study. In addition, exclusion criteria included; the practice of handball activity in civil/competitive/amateur clubs or in the high school sports association. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

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

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Conflict of interest

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

The reviewer MJ declared a shared affiliation, with no collaboration, with the authors GE, NS, LM, and KT to the handling editor at the time of review.

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EDITED BY
Manuel Gómez-López,
University of Murcia,
Spain

REVIEWED BY
Miguel Pic,
South Ural State University,
Russia
Pedro Gaspar,
University of Coimbra,
Portugal

*CORRESPONDENCE
Ashley Flemington
✉ flemin41@uwindsor.ca
Todd M. Loughead
✉ loughead@uwindsor.ca

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Assessing athlete leadership and cohesion using a social network analysis approach

Ashley Flemington*, Todd M. Loughead* and Marie Desrosiers

Department of Kinesiology, Sport Psychology and Physical Activity Research Collaborative (SPPARC), University of Windsor, Windsor, ON, Canada

The study of athlete leadership has gained momentum over the past 15 years and is recognized as a vital component of team performance. Specifically, athlete leadership has been most studied with regards to its impact on the outcome of cohesion. As a result, a current gap in this area of research is the analysis of attribute data, such as tenure and self-reported athlete leadership, and how this attribute data is related to outcomes, such as cohesion. However, much of current research examining this relationship has utilized traditional statistical methods, limiting interpretation of data because team members are inherently interdependent. One approach that considers the interdependence of team members is social network analysis (SNA). SNA facilitates the study of social structures within networks of people, such as a sports team, as well as individual attributes influencing or being influenced by the network. The present study used SNA to examine athlete leadership and cohesion within a sports team of 22 female professional hockey players. Participants self-reported tenure, completed a self-rated athlete leadership questionnaire, and rated each of their team members on network variables of athlete leadership and cohesion. The results showed that high network density and low degree centralization was found for both athlete leadership and cohesion networks, with high indegree centralities for each team member. Further, a strong correlation was found between the athlete leadership and cohesion networks ($p<0.001$), indicating a positive relationship between the athlete leadership ties and the cohesion ties. Lastly, significant correlations were found between self-rated athlete leadership and the networks of athlete leadership and cohesion. Together these data suggest that a cohesive team shares leadership responsibilities with many ties between teammates.

KEYWORDS

athlete leadership, cohesion, group dynamics, social network analsysis, sport

1. Introduction

Athlete leadership is defined as "an athlete occupying a formal or informal role within a team who influences a group of team members to achieve a common goal" (Loughead et al., 2006, p. 144). This definition suggests that any athlete on a team can take on a leadership role. Thus, a team is not limited to a single athlete leader, but rather the leadership process is shared amongst several athletes depending on their leadership role. As noted in the above definition, athletes can occupy either a formal or informal leadership role. Athletes who occupy a formal leadership role are those that have been prescribed or selected into that position and are commonly known as captains, co-captains, or assistant captains (Loughead et al., 2006). In contrast, athletes who occupy an informal leadership role are those that ascend to their

leadership role by being held in high esteem by their teammates despite not being formally recognized as a leader (Loughead et al., 2006). Having both formal and informal athlete leadership roles on a team enables several athletes to provide leadership to their teammates in a process known as shared leadership. As such, Loughead et al. (2021) advanced another definition to account for the shared nature of athlete leadership, describing it as "a shared dynamic team process composed of mutual influence and shared responsibility among team members, who lead each other toward the achievement of a common goal" (p. 161).

One reason athlete leadership is shared amongst numerous athletes is that there are multiple leadership behaviours to be performed thus, different team members can fulfil different behavioural roles. One set of leadership behaviours that athletes perform are transformational leadership behaviours. Within the context of athlete leadership, transformational leadership behaviours are those that consider the interest of teammates, assist teammates in being more aware of the importance of shared goals, and allow teammates to move beyond their own interests (Price and Weiss, 2013). The most utilized inventory to measure transformational leadership within athlete leadership research is the Differentiated Transformational Leadership Inventory (DTLI; Callow et al., 2009), which consist of six transformational leadership behaviours. The six dimensions include individualized consideration, inspirational motivation, intellectual stimulation, fostering the acceptance of group goals, high performance expectations, and appropriate role model. Individualized consideration assesses the leader's personal attention to the follower and considers the follower's individual needs. Inspirational motivation refers to a leader articulating a positive vision of the future and inspiring followers that they can achieve that vision. Intellectual stimulation is displayed when a leader challenges their followers to demonstrate creativity. Fostering acceptance of group goals refers to a leader promoting cohesion and cooperation by getting group members involved and committed to the group's goals. High performance expectations occurs when a leader places high demands on the follower, expecting a high quality of work. Lastly, appropriate role model is displayed when a leader acts in ways that sets an example for followers.

While much of the research on leadership in the sport context focuses on coaches, the changing emphasis to athlete leaders has gained momentum as researchers have found that coaches and athletes exhibit different leadership behaviours (Loughead and Hardy, 2005). In their study, Loughead and Hardy (2005) found that coaches were perceived to exhibit more training and instruction, and autocratic decision-making behaviours. In contrast, athlete leaders were found to exhibit more social support, positive feedback, and democratic decision-making behaviours. As such, it is important to further our understanding of the role athlete leadership plays in team functioning and outcomes.

The current literature on athlete leadership has highlighted its importance as an integral component of successful team functioning (Loughead, 2017) with positive relationships being found between athlete leadership and athlete satisfaction (Paradis and Loughead, 2012), collective efficacy (Price and Weiss, 2011), and cohesion (Callow et al., 2009; Vincer and Loughead, 2010). As one of the most studied team outcomes, cohesion has been of particular interest as it relates to athlete leadership. More specifically, cohesion has historically been viewed as *the* most important small group variable (Lott and Lott, 1965; Carron et al., 1998), and as such is a construct that athlete leaders would want to foster on their teams since it is related to enhanced performance (Carron et al., 2002). For example, Vincer and Loughead (2010) conducted a study assessing athlete leadership and cohesion in varsity and club level athletes. Participants completed questionnaires assessing athlete leadership behaviours and cohesion on their team with the results showing that all four dimensions of cohesion were positively and strongly associated with each of the athlete leadership behaviours measured. The results from Vincer and Loughead assessed athlete leaders as a whole; meaning they did not discern between formal and informal athlete leaders. To address this limitation, Burkett et al. (2014) surveyed NCAA Division III basketball players regarding the formal and informal athlete leadership behaviours and cohesion on their team. The results of this study also found positive correlations between athlete leadership behaviours demonstrated by both formal and informal athlete leaders and dimensions of cohesion.

Researchers examining athlete leadership and cohesion often collect attribute data regarding characteristics such as tenure on the team; that is the amount of time the athlete has been a member of a particular team. This information is generally only used to describe the sample as a demographic variable, typically reported in terms of an average along with its standard deviation with the analysis not extending beyond this level. However, collecting these types of attribute data provides the opportunity to assess how factors such as tenure may impact the nature of athlete leadership and/or cohesion within teams. For instance, Fransen et al. (2015) used the demographic variables of competitive level and gender of the team to assess differences in perceived athlete leadership quality. In this study, no significant differences were found regarding athlete leadership quality based on team level (high vs. low), or gender. However, Duguay et al. (2019) also analyzed demographic data using SNA regression techniques (i.e., multiple regression quadratic assignment procedures), assessing relationships between leadership network and demographic data including age, playing position, leadership status, and nominations for the most skilled player on the team. It was found that skill nomination was a significant predictor of athlete leadership nomination for all teams, and being a formal leader (e.g., captain) was a significant predictor on two of the four teams sampled. Taken together, these studies provide evidence that the relationships between athlete leadership networks and demographic information is important to assess to better understand how these variables are related in various contexts.

In addition, relationships between attribute data of self-rated athlete leadership behaviour and network athlete leadership, as nominated by one's teammates has not been previously examined. While researchers have explored the associations between different athlete leadership networks such as different athlete leadership roles (task, motivation, social, and external; Fransen et al., 2015), and dimensions of identity leadership (prototypicality, advancement, entrepreneurship, and impresarioship; Bruner et al., 2022), no current research has simultaneously examined self-reported athlete leadership and peer reported network athlete leadership. Assessing the difference between self-reported (attribute) and other-reported (network) leadership is of interest because previous literature has found discrepancies between these two types of information (e.g., Branson and Cornell, 2009; Yeatman and Trinitapoli, 2011), which may be due to factors such as social desirability bias (Gould, 1969) leading to

over-estimating one's own characteristics (An, 2022). Thus, discrepancies in research findings may become apparent as we transition from self-reported data to other-reported data when using Social Network Analysis (SNA). To address this shortcoming, the present study aims to assess relationships between self-rated leadership behaviours and other-rated network leadership using a SNA approach. This method is used to look at the interplay between attribute (self-rated) leadership of individual team members and the leadership relations between teammates that has been previously studied separately (e.g., Callow et al., 2009; Loughead et al., 2016). To further extend this area within athlete leadership research, using both self-rated and other-rated leadership allows both of these measures to be assessed with network cohesion, providing a more in-depth investigation into the athlete leadership – cohesion relationship.

Although the majority of research supports a positive relationship between athlete leadership and cohesion, much of this research has been done using traditional statistical techniques. While this is common practice, and necessary for certain research questions, traditional statistics such as null hypothesis significance testing like t-tests, ANOVAs, and regressions, have a limitation when it comes to research on social groups, such as sport teams (e.g., Prell, 2012; Borgatti et al., 2013; Duguay et al., 2020). The use of null hypothesis significance testing requires that certain assumptions about the data are met for the test to be reliable. For example, these types of tests require the data to be independent, meaning each rating is not related or correlated to another rating. In research on social groups, we know this assumption is impossible to satisfy since members of social groups are inherently interdependent, thus the data collected on the social relationship between members is inherently interdependent as well. SNA techniques are a way to overcome this issue of data dependency. SNA is a group of methodologies and statistical techniques used for the study of social groups by assessing social structures within a network of people (Borgatti et al., 2013). These techniques allow for the assessment of relational ties between members of a social group, as well as examining how individual attributes of the members influence, or are influenced by, the network as a whole. While SNA originated from fields such as sociology and social psychology, SNA is useful in sport psychology as the inherent dependency of data within a team analysis is overcome. Significance testing with SNA techniques uses permutation tests in which data are reordered and reanalyzed many times creating a distribution of potential outcomes for the given data. This distribution, created through many permutation tests, is then used to compare the data for determining the significance levels of the results (Prell, 2012).

Given the advantage of overcoming the issue of data dependency, it is not surprising that there has been an increasing prevalence of SNA techniques to examine team-based relationships and outcomes in sport psychology (e.g., Fransen et al., 2015; Duguay et al., 2019). While research in this area is still in its infancy and there is not a wide breath of literature on many team outcomes, cohesion is one team outcome that has garnered some research attention. For example, Loughead et al. (2016) used SNA techniques to examine the relationship between athlete leadership quality and cohesion, finding a positive correlation between these two networks. Loughead et al. (2016) also examined the association between four athlete leadership roles and cohesion, also finding positive correlations between these networks.

Within SNA research there are multiple design types, two of the most relevant for studying sports teams are whole networks and multiple networks (Robins, 2015). A whole network design consists of a full set of actors within a well-defined network boundary, for example all (or most) of the athletes (i.e., actors) of a single sport team (e.g., Passos et al., 2011). In contrast, the multiple network design consists of more than one whole network, for example members coming from two or more teams (e.g., Fransen et al., 2017) where the teams' data are generally aggregated for analyses. The networks (e.g., sport teams) in a multiple network design need to be different from one another such that there is not social overlap between the networks. Consequently, this assumption can be challenging to achieve within a multiple network design (Robins, 2015). Further, while multiple network designs allow for a greater generalization, detail and specificity within a team is lost, limiting the specific conclusions that can be drawn. With whole network designs a high response rate is needed from all (or most) group members (e.g., athletes from one team), as it allows conclusions to be drawn about the entire social system of a given network (e.g., one sport team).

Taken together, the purpose of the current study was to advance our understanding of tenure and self-rated leadership and how they relate to cohesion and athlete leadership using a whole network design. To achieve our objectives, we assessed the network density and centralization as well as degree centrality for both the cohesion and athlete leadership networks. As well, associations between the athlete leadership and cohesion networks were assessed, and finally associations between attribute data (tenure, and self-rated leadership) and both networks were assessed using data from one sport team.

2. Method

2.1. Participants

Participants included members of one professional female ice hockey team from a North American league. Of the 22 members who were rostered on the team, 19 of them agreed to participate in the current study. The athletes ranged in age from 22 to 30 years old ($M = 24.63 \pm 2.48$) with team members having played on this team between 1 to 5 years ($M = 2.32 \pm 1.49$).

2.2. Measures

2.2.1. Demographics

Demographic information collected included age, tenure on the team, and playing position (right wing, center, left wing, right defence, left defence, or goalie).

2.2.2. Self-rated leadership

In order to assess self-rated leadership, each participant completed 23 items from the Differentiated Transformational Leadership Inventory (DTLI; Callow et al., 2009) that is scored on a 5-point Likert scale from 1 (*not at all*) to 5 (*all of the time*) to measure six dimensions of transformational leadership. These dimensions include individual consideration, inspirational motivation, intellectual stimulation, fostering acceptance of group goals and promoting teamwork, high performance expectations, and appropriate role model. An overall transformational leadership score was calculated for each participant by summing the scores of the six dimensions.

2.2.3. Network athlete leadership

To measure athlete leadership at the network level, athletes were asked to rate the leadership effectiveness for each of their teammates. A one item statement was used for each of the six dimensions of the DTLI and were scored on a scale from 1 (*very poorly*) to 5 (*very well*). These one-item statements were derived from the definitions of each of the DTLI dimensions. For inspirational motivation, participants were asked "How well does each member of your team energize you by presenting an optimistic view of the future concerning the team's goals?." For appropriate role model, participants were asked "How well does each member of your team serve as a role model for you?." For fostering acceptance of group goals, participants were asked "How well does each member of you team cooperate with you in working towards the team's goals?." For high performance expectations, participants were asked "How well does each member of your team stress the importance of striving for excellence by having high personal performance standards?" For intellectual stimulation, participants were asked "How well does each member of your team challenge you to view problems from different perspectives." For individualized consideration, participants were asked "How well does each member of your team show an interest in your own development as a player on this team?" An overall score for network athlete leadership for each participant was calculated by calculating the sum of these six dimensions.

2.2.4. Network cohesion

To measure cohesion at the network level, athletes were asked to rate how cohesive they felt with each of their teammates. Items were based on Carron et al. (1985)'s framework distinguishing between task and social components. One item was used to assess the social component of cohesion, referring to the development and maintenance of social relationships, asking participants to "Please indicate the extent to which you feel united with each of your teammates in order to maintain good social relationships within the team." One item was also used to assess the task component of cohesion, referring to the achievement of group goals and objectives (Carron et al., 1985) asking participants to "Please indicate the extent to which you feel united with each of your teammates in order to achieve the team's goals and objectives." Athletes rated these items on a scale from 1 (*Not united at all*) to 5 (*Extremely united*). These one-item statements were derived from the definitions of each form of cohesion.

2.3. Procedure

Following ethics clearance from the university's Research Ethics Board, four female professional hockey teams from a North American league were contacted through email regarding their interest to participate in the study. We received a response from one general manager indicating a desire to participate in the study. Consequently, a second email was sent to the general manager who then forwarded it to the athletes on the team that provided a description of the study. Those athletes interested in participating were instructed to email the researcher, who then sent an email containing a link to the study's survey. Upon opening the study's survey link, participants were first asked to provide informed consent and once this was completed, they were directed to the survey. The survey took approximately 30 min to complete.

2.4. Data analysis

All analyses on the social network data were conducted using version 6 of the UCINET software (Borgatti, 2002) and visualizations utilized the NetDraw tool within this software program (Borgatti et al., 2002). At the network level of analysis, density and degree centralization were calculated for the athlete leadership network and both task and social cohesion networks. First, density measures the proportion of possible ties in a given network that are present in the whole network. We calculated valued (data with more numerical value options than one and two) and directional data (data values that go from one athlete to another, and the reciprocal data does not need to match) for this analysis. For the present study, the density for any given network can range from 1 (low density) to 5 (very high density). Second, degree centralization assesses the extent to which any one athlete receives all of the ties within the network. Thus, a high degree of centralization would indicate that the network density is focused on a single athlete. For the present study normalized degree centralization scores were used such that scores could range between 0 (no centralization) to 1 (completely centralized on a single athlete). At the individual athlete level of analysis, indegree centrality was calculated for the athlete leadership and cohesion networks. This assesses the number of ties received by an athlete from their teammates indicating their involvement in the network (Prell, 2012), thus a high indegree centrality for a given athlete suggests many teammates nominate them. Data were dichotomized for this analysis, providing a binary and directional network, thus scores could range from 0 to 1.

Lastly, permutation tests were used to assess correlations between the athlete leadership and cohesion networks, as well as between attribute data and each of the networks. To assess the relationship between the athlete leadership and each of the two cohesion networks a Quadratic Assignment Procedure (QAP) correlation was computed. This provides a Pearson's r correlation between the two networks, determining if the presence of a tie between members in one network corresponds to a tie between those same members in the another network. Further, to assess the relationship between attribute data (tenure, and self-rated athlete leadership) and each of the networks (i.e., athlete leadership, task cohesion, social cohesion), Moran's autocorrelation techniques were used. This technique allows for discrete or continuous variables, such as attribute data, to be correlated with the network data. Interpreted similarly to a Pearson's r, a larger positive Moran's I is indicative of a greater positive autocorrelation (Borgatti et al., 2002). QAP correlations and autocorrelations are most appropriate for these data, as they are non-parametric tests using permutations to determine significance, thus they are more robust to violations of the assumption of independence (Krackhardt, 1988) compared to traditional significance testing techniques.

3. Results

Density for the athlete leadership network was found to be high at 3.98 ± 0.80, out of a possible 5 (Figure 1). The density for both the task (4.15 ± 0.89) and social (4.11 ± 0.92) cohesion networks were also high, and relatively higher than the athlete leadership network for this team (Figures 2, 3, respectively). These findings suggests that there are many connections between teammates regarding athlete leadership, social cohesion, and task cohesion.

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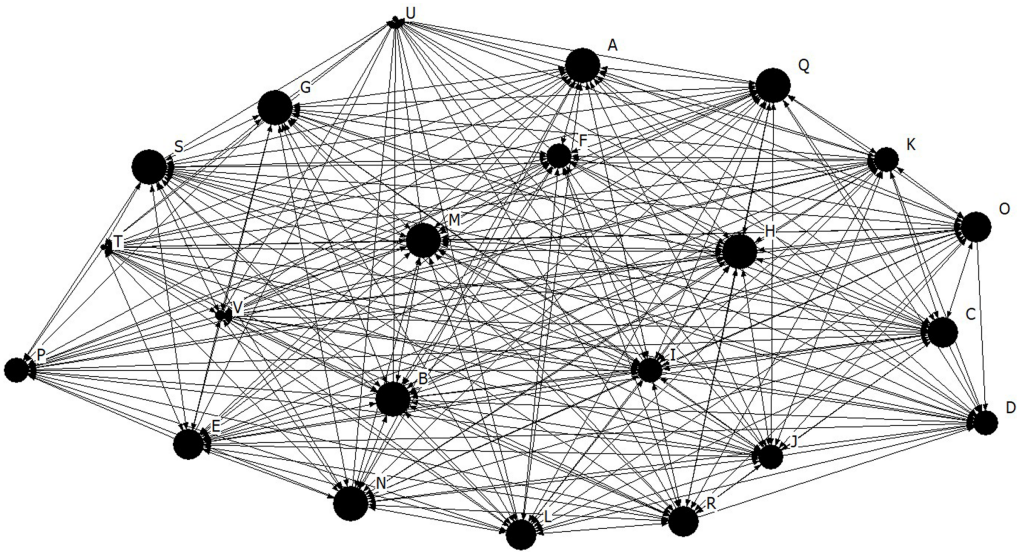

FIGURE 1
Network diagram for athlete leadership. Dots indicate each team member, Size of dot indicates relative indegree centrality for athlete leadership.

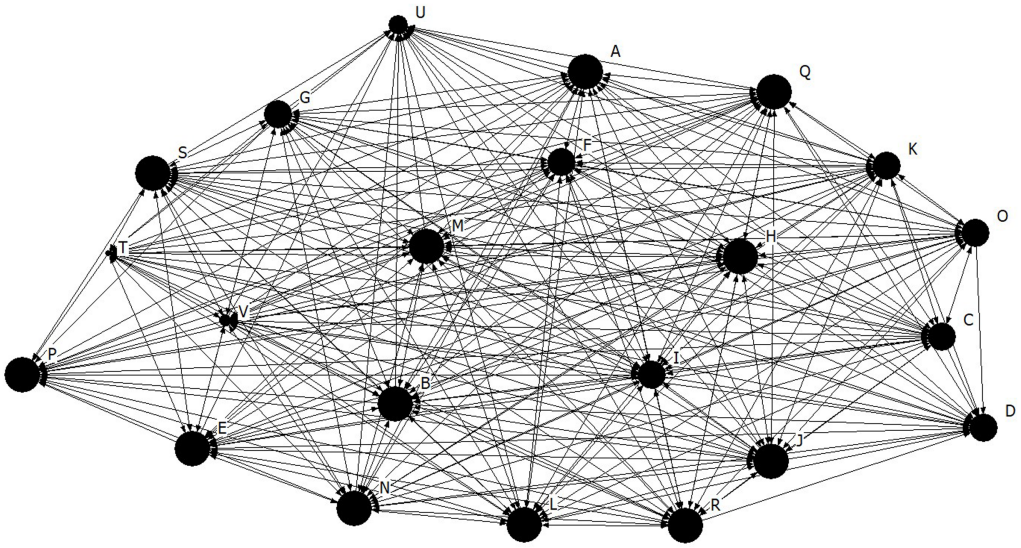

FIGURE 2
Network diagram for task cohesion. Dots indicate each team member, Size of dot indicates relative indegree centrality for task cohesion.

Centralization for the team was found to be low, with a normalized indegree centralization of 0.08 for the AL network and 0.04 for both the task and social cohesion networks. With the network level indegree centralization being low, these results suggests that a single athlete is not receiving all of the connections, rather these relationships are shared among many of the athletes. The indegree centralities of individual athletes for all networks were found to be high and are reported in Table 1, indicating that many athletes are perceived to be providing these leadership and cohesion relationships to their teammates.

The results also showed a large and significant positive correlation between the athlete leadership and task cohesion networks ($r = 0.71$, $p < 0.001$) as well as between the athlete leadership and social cohesion networks ($r = 0.57$, $p < 0.001$). These findings indicate that there is a strong positive relationship between these networks, highlighting that when a relationship exists in one network (i.e., leadership), it is most likely to exist in another network (i.e., social cohesion).

Correlations between attribute data and each of the networks were also computed. For the athlete leadership network non-significant relationships were found for tenure ($I = -0.53$, $p = 0.29$), suggesting number of years on this team is not indicative of being perceived as a leader. Importantly, a significant and positive correlation was found between the athlete leadership network and self-reported athlete leadership behaviours ($I = 0.003$, $p < 0.001$), meaning those athletes

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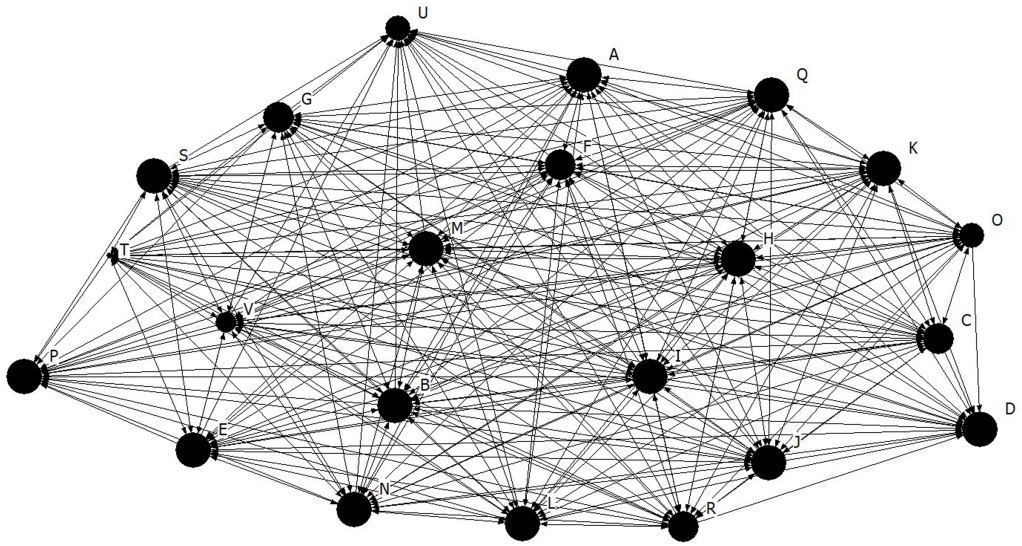

FIGURE 3
Network diagram for social cohesion. Dots indicate each team member, Size of dot indicates relative indegree centrality for social cohesion.

TABLE 1 Normalized indegree centrality for Athlete Leadership and Cohesion networks.

Athlete	Athlete leadership	Task cohesion	Social cohesion
A	0.86	0.86	0.86
B	0.86	0.86	0.86
C	0.81	0.81	0.81
D	0.76	0.81	0.86
E	0.81	0.86	0.86
F	0.76	0.81	0.81
G	0.86	0.81	0.81
H	0.86	0.86	0.86
I	0.76	0.81	0.86
J	0.76	0.86	0.86
K	0.76	0.81	0.86
L	0.81	0.86	0.86
M	0.86	0.86	0.86
N	0.86	0.86	0.86
O	0.81	0.81	0.76
P	0.76	0.86	0.86
Q	0.86	0.86	0.86
R	0.81	0.86	0.81
S	0.86	0.86	0.86
T	0.57	0.67	0.57
U	0.57	0.76	0.76
V	0.62	0.71	0.71

who rated themselves as leaders, were also viewed as leaders by their teammates.

For the cohesion networks, non-significant relationships were also found for tenure (task: $I = -0.05$, $p = 0.33$; social: $I = -0.05$, $p = 0.38$), again indicating that number of years on the team is not associated with perceptions of cohesion. Interestingly, a significant and negative correlation was found between the cohesion network and self-reported athlete leadership behaviours (task: $I = -0.001$, $p < 0.001$; social: $I = -0.005$, $p < 0.001$), which indicates that those who rated themselves as leaders were perceived as being less cohesive by their teammates.

4. Discussion

The purpose of the present study was to investigate cohesion and athlete leadership using SNA, and to further our understanding of how tenure and self-rated leadership are related to these networks. First, high density and individual centralities coupled with low centralization suggests that the team from the present study had many well dispersed connections for both their athlete leadership and cohesion relationships. According to Prell (2012) high density alone is not enough to indicate a well-connected group because those connections could be occurring through a single or small group of key members. Thus, the high density found within the current team is best interpreted along side the low centralization score, which supports the idea that connections are not concentrated on a few team members, rather they are spread well throughout the team. Many well dispersed athlete leadership connections suggests that leadership responsibilities were shared amongst a large portion of the team. These results mirror those of Duguay et al. (2019) who also found that all soccer players were nominated by at least one teammate as being a leader, therefore demonstrating the presence of shared athlete leadership. Similarly, many well dispersed cohesion connections suggest that all members of the team get along well with each other, feeling connected and united toward team goals. This overall pattern of results, where a sports team has a high density coupled with a low centralization, has

been seen in previous literature matching the visual interpretation of the networks sociogram supporting a shared nature of athlete leadership (Duguay et al., 2020). Importantly, this pattern of results further supports the notion that a formal leadership role occupied by a single athlete, such as a captain, does not fulfill the entire athlete leadership role within a team (Fransen et al., 2014). The results of the present study are substantiated by Fransen et al. (2014) who found that 43.6% of participants did not report their captain as their strongest leader. Taken together, the results of previous studies along with the findings of the present study, provide empirical support of shared athlete leadership as many athletes on a team take part in a process of mutual influence and shared responsibilities (Loughead et al., 2021).

Further, the associations between network athlete leadership and each of the cohesion networks were also assessed and found to be positive. This means there was a high degree of agreement between the networks, when a connection existed in the athlete leadership network, it was also highly likely to exist in the cohesion networks. Practically speaking, athletes that were rated highly on their leadership relationships were also rated highly on their cohesion relationships. As previously mentioned, this relationship is well established in previous literature using traditional statistical methods (e.g., Callow et al., 2009; Vincer and Loughead, 2010) with a similar pattern emerging when using social network analysis techniques. The only other study to our knowledge to assess athlete leadership and cohesion using SNA is Loughead et al. (2016), who found that, for most teams in their study, both social and task cohesion were positively and significantly correlated to four leadership dimensions (task, motivational, social, and external). Thus, the present study provides further support for the importance of the athlete leadership – cohesion relationship using SNA and expands upon this by utilizing the six dimensions of the DTLI for assessing leadership behaviour. This provides support for the association existing not only with the four types of leadership, but also six transformational leadership behaviours, which highlights the complexity of this relationship whereby numerous athlete leadership behaviours are related to task and social cohesion.

The relationship between athlete leadership and cohesion is important for sport teams because both athlete leadership and cohesion are positively associated with performance (Carron et al., 2002; Fransen et al., 2017). The direction of these relationships are reciprocal, such that cohesion improves performance and good performance improves cohesion (Carron et al., 2002). This is also the case for the relationship between leadership and performance, as indicated by the Multidimensional Model of Leadership (Chelladurai, 2007), where leadership characteristics positively impact leadership behaviour which in turn improves performance, and improved performance enhances positive leadership behaviours. Taken together, there are many positive relationships between leadership, cohesion, and performance, and thus are important for improving team effectiveness.

Lastly, the present study assessed relationships between attribute data (tenure and self-reported leadership) and each of the networks (cohesion and athlete leadership). Tenure was not found to be associated with any of the networks, suggesting that regardless of how long a team member has played for the team they provided and received leadership, and experienced similar feelings of cohesion with their teammates. This was an interesting finding as it suggests strong intra-team relationships, however it contradicts some previous research findings that suggests higher tenured athletes are perceived as providing more leadership. For example, Loughead et al. (2006) found that between 70 and 88% of intercollegiate athletes classified as a leader were in their third or fourth year on the team. Similarly, Duguay et al. (2018) found that intercollegiate athletes placed greater importance on higher tenured teammates (years four and five on the team) to show leadership compared to lower tenured teammates (years two and three on the team). Similarly, greater importance for showing leadership was placed on those athletes in their second and third year, compared to those in their first year on the team. There are a few different explanations for these differing findings. First, the present study may show a different relationship due to how highly dense and cohesive this particular team was; thus, the density of the team may act as a moderating factor for the relationship between an athlete leadership or cohesion network and athlete tenure. Second, the current study sampled athletes playing at a professional level compared to studies (Loughead et al., 2006; Duguay et al., 2018) where the athletes were competing at an intercollegiate level. At the intercollegiate level, coaches place a major emphasis on developing their athlete leaders gradually over the course of their five-year career (Duguay et al., 2020). In contrast, it may be the case that athletes at the professional level are expected to provide leadership as soon as they join the team. Future research should examine whether and what are the different expectations for leadership based on playing level.

Interestingly, while self-reported athlete leadership was positively associated with the athlete leadership network, it was negatively associated with both cohesion networks. Meaning that individuals that rate themselves highly as leaders, are also perceived highly as leaders within the team, however these individuals tend to be rated lower on being cohesive with their teammates. This is an unexpected finding since typically athlete leadership and cohesion are highly correlated, however this is the first study to assess both self-rated athlete leadership and network athlete leadership simultaneously. These results suggest that some differences may exist between one's self-perception of leadership and teammates perception of their leadership as it relates to cohesion between members, and further investigation into this discrepancy is warranted.

Along with the many strengths and insights of this study, there remains limitations to be considered during interpretation of the results and for future research in this area. Firstly, looking at a single team strengthens our ability to assess and understand that team but limits the generalizability to any other context. As such future research should conduct multiple whole network analyses without aggregating the data, where several teams of equal sizes are analyzed independently but also allowing for comparisons between teams broadening the scope of the research. To expand further on this area of research, it will also be important to examine teams with various amounts of athlete leadership density, including densities lower than the team in the present study. Assessing this diversity may provide insight into how variations in athlete leadership relationships and the sharedness of athlete leadership influences associations with cohesion and attribute data. Secondly, the present study was a cross sectional design, as such changes in the teams' relationships across the season as well as potential casual relationships are not captured in the present data. Moving forward, research should aim to collect data from teams across multiple time points of a season, to better capture the changes and development of team relationships. Lastly, due to the nature of data collection for SNA studies and participant burden, the full DTLI could not be used for network athlete leadership. As such each

dimension of the DTLI was collapsed into a single representative item, reducing the items to six as opposed to the original 23. As a result, these specific six items have not been previously validated. Bruner et al. (2022) recommended this approach when conducting SNA.

The present study used both visual and quantitative SNA techniques to assess the team's athlete leadership and cohesion relationships as well as the relationships between attribute data and the networks. Overall, the present study found a highly cohesive team that shares leadership responsibilities across many members, regardless of one's tenure on the team.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Research Ethics Board, University of Windsor. The patients/participants provided their written informed consent to participate in this study.

Author contributions

MD completed participant recruitment and data collection and aided in the study conceptualization. TL aided in the study conceptualization and development, as well as writing the manuscript. AF completed the data cleaning and analysis and was the primary author of the manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

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

Publisher's note

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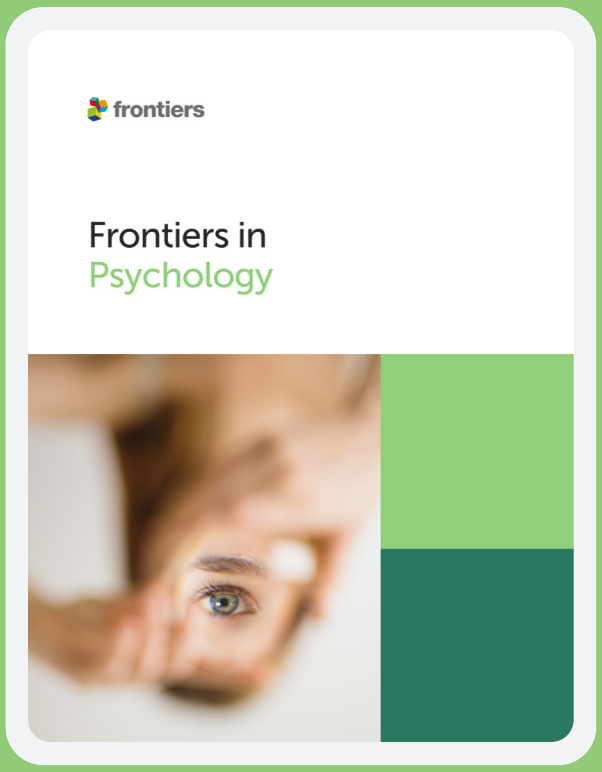

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