INTERACTIONS BETWEEN EDUCATION, PRACTICE OF PHYSICAL ACTIVITY AND PSYCHOLOGICAL WELL-BEING

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INTERACTIONS BETWEEN EDUCATION, PRACTICE OF PHYSICAL ACTIVITY AND PSYCHOLOGICAL WELL-BEING

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EDITORIAL
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Editorial: Interactions Between Education, Practice of Physical Activity and Psychological Well-Being

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Keywords: physical activity, exercise psychology, psychological factors, cognition, physical education

Editorial on the Research Topic

Interactions Between Education, Practice of Physical Activity and Psychological Well-Being

Physical activity is scientifically recognized as a modifiable habit lifestyle with a wide array of benefits for a human being. Thus, there is strong evidence that performing human movement has a positive impact on the lives of people. Traditionally, these implications have been associated only on a physical dimension, but in recent times there is much evidence on mental or brain level, specifically on certain aspects of human behavior and personality traits. Additionally, the interest between this modifiable factor (physical activity) and the educational field is being the target of recent investigations. This Research Topic aims to update the scientific knowledge within this triangle built up around physical activity, psychological well-being, and education. Specifically, it yielded 16 articles, which are the result of a process of free sending, peer reviewing and modification of the manuscripts, embedded in three strands of research. Firstly, three articles focused on the role of physical activity in different population contexts. Secondly, six articles examined the effects of physical activity, sport, and exercise on psychological variables. Thirdly, seven articles examined the implications of physical activity in a variety of educational contexts. These three research strands are presented below.

Worldwide insufficient physical activity is worrisome (Guthold et al., 2018). In this scenario, the use of electronic media has been noted as an important risk factor for a sedentary lifestyle. Zagalaz-Sánchez et al. analyze the possible relation between the misuse of smartphones and the reduction in the practice of physical activity. Although they found scarce scientific evidence, it seems that improper use of this technology might be linked with lower levels of physical activity. In addition to these intriguing facts, the situation is even more alarming in the female gender, being much less physically active (Serra et al., 2018). Thus, Serra et al. focused the research on determining factors affecting interest in pursuing a degree in Physical Activity and Sport Science (PASS) among teenage students. They found a lack of interest by young women in studying a degree in PASS in comparison with boys, which was partially explained by perceived social supports and positive conceptions of outcome expectations. Likewise, physical activity could also play an important role from an early age, thereby, Palou et al. suggested that parent's reports of their children's physical activity levels were associated with relevant health markers (physical fitness and body composition indicators) in preschool children.

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The second strand of our Research Topic has attempted to advance knowledge in sports psychology by investigating relationships across some psychological factors in a diverse context. Sports performance is a subsequent result of multiples factors, among them psychological variables play an important role, such as competitive anxiety or flow disposition (Swann et al., 2018; Rice et al., 2019). Thus, as far as we know, Ponseti et al. have been the first ones in demonstrating by means of a Bayesian network two probability trees that have extrinsic motivation and motivation at the top, while the anxiety/activation due to worries about the performance was found clearly at the bottom of the probabilities. In addition, Fernando Garcia et al. found a positive link between dispositional flow and performance in ironman athletes and Ribeiro Contreira et al. demonstrated that young athletes' and coaches' sport satisfaction is strongly influenced by the satisfaction of their basic psychological needs. Our Research Topic also explores some psychological variables in relation to physical activity and exercise in a non-sport population. For instance, Castro-Sánchez et al. developed an explicative model suggesting that practicing physical activity in a natural environment is a key to acquire healthy patterns and diminish the consumption of harmful substances. However, as evidenced by Chacón-Cuberos et al. the practice of physical activity seems to be not only beneficial for a physical health dimension, as well as, for its role to develop a better resilience capacity, tolerance to adversity and the positive acceptance of changes. In a further step, Aguirre-Loaiza et al. have demonstrated the effects on executive functions, and mainly, in the emotional contextual recognition with a single bout of moderate-high intensity exercise.

Within the scope of this Research Topic, the third strand was centered in an education context. A group of researchers examined theoretical approaches to understand the relation of self-concept and physical activity on students. Fernández-Bustos et al. observed that physical activity had a positive and indirect effect on self-concept and direct effects on body dissatisfaction and physical self-concept. Onetti-Onetti et al. confirmed this positive relationship between physical activity self-concept, however, they also found a negative relationship between the self-concept dimensions and the amount of time the adolescent spends sitting. These results reflect the usefulness of promoting physical activity to achieve a positive self-concept and promote psychological well-being in both adolescents and university students.

An innovative methodological approach was conducted by Florese et al. whose results showed that the majority of scientific interest in Sport and Exercise Psychology is developed by Exercise and Sport Science programs rather than Psychology in Brazil universities, data that perhaps may drive us to have some reflection about the strength and power of the paradigm in which we are currently working. In this field, and for the first time in the scientific literature, Gavala-González et al. described the perception of the dual career in both professional and semi-professional under-23 canoeists. They encountered that athletes have specific problems that make it difficult to efficiently combine their athletic and academic careers. Certainly, both studies might serve as a precedent to intervene in the university to counteract the limitations of this field.

In a school context, one of the most intriguing debate is around the most suitable pedagogical model for a successful in physical education (Casey and MacPhail, 2018; González-Víllora et al., 2019). This issue is also addressed in this topic, specifically, Sierra-Díaz et al. tried in their systematic review to find implications of a model-based practice or instructional models on student's self-determined motivation and basic psychological needs. They concluded that model-based practice is an ideal pedagogical framework to produce significant increases in sport competence and self-determined motivation. More specifically, Gil-Madrona et al. studied the effects of an intervention based on a personal and social responsibility model. In brief, the intervention was effective to generate positive changes in children's attitudes and social skills. Lastly, Malkin et al. corroborate the importance of the physical activity to interfere in psychological factors, such as hardiness. These researchers found higher levels of hardiness in those students who engaged regularly in sports activities in comparison with those who did not. These studies enrich our understanding of physical activity and education binomial and offer new insights for developing interventions in physical education classes.

Collectively, this Research Topic has embraced a large spectrum of scientific concerns. Mostly, the publications of this Research Topic cover how psychological factors are influenced by physical activity, exercise and/or sport through a compendium of cross-sectional and systematic reviews studies. These works contributed toward the understanding of the impact of human movement on the physiological well-being, and also may show how the different fields placed under the umbrella of Sport Sciences interacted among them to produce and disseminate new knowledge both in theoretical and applied ways.

AUTHOR CONTRIBUTIONS

AM-M wrote the initial draft. AM-M, PP, PA, and AG-M review critically the final version of the manuscript.

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Finally, during the elaboration of this Research Topic, our dear colleague Valerii Malkin from the Federal University of the Urals (Russia) passed away. We hope that this work constitutes some kind of homage to his person and academic figure, very relevant in the complex effort to make visible the Russian Psychology of Sport, of such a long and fruitful tradition in past years. AM-M was a recipient of a José Castillejo Fellowship from the Spanish Ministry of Science, Innovation, and Universities (CAS19/00265).

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ORIGINAL RESEARCH
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Physical Activity in Natural Environments Is Associated With Motivational Climate and the Prevention of Harmful Habits: Structural Equation Analysis

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Background: Practicing physical activity in a natural environment has various benefits that make it an ideal setting to develop healthy behaviors and thereby diminish unhealthy habits. The objective of this study was to develop and verify an explicative model for motivational climate in sport, considering its potential influence on alcohol and tobacco consumption.

Methods: The study included 2273 adolescents from Granada (Spain), analyzing motivational climate (PMCSQ-2), alcohol consumption (AUDIT) and tobacco consumption (FTND). Multi-group structural equation modeling was conducted, yielding an excellent fit ($\chi 2 = 168.170$; gl = 32; $p = 0.00$; CFI = 0.972; NFI = 0.966; IFI = 0.972; RMSEA = 0.045).

Results: The main findings were: a negative relationship between task climate and alcohol consumption among students practicing physical activities in a natural environment; a positive relationship between ego climate and alcohol consumption among those practicing other types of physical activity; and a positive and direct relationship between alcohol and tobacco consumption, which was stronger among those who did not practice physical activity in a natural environment.

Conclusion: We conclude that physical-sport activity practiced in nature is a key to acquiring healthy patterns characterized by intrinsic motivations in sport and lower consumption of harmful substances.

Keywords: motivation, physical activity, natural environment, alcohol, tobacco

INTRODUCTION

Adolescence represents a key stage in the development and acquisition of healthy and/or harmful habits that will endure throughout adulthood (Urrutia-Pereira et al., 2017). According to Lindgren et al. (2017) it is crucial to understand why tobacco and alcohol consumption begins during adolescence and to determine motivating factors, with the aim of avoiding the emergence of these behaviors and encouraging young people to acquire healthy life habits that persist during adulthood (Taylor et al., 2017).

Most of the research proposes the practice of healthy physical activity as a main alternative to these harmful habits (Barrett et al., 2017). In fact, it has been found a negative relationship between the levels of physical activity and the consumption of alcohol and tobacco, showing benefits at a physical, psychological and social level (Donoghue et al., 2017; Lewis et al., 2017). For these reasons, it is necessary to promote habits related to the practice of physical activity in children and adolescents towards in order to create healthy patterns that could be repeated in adulthood and avoid the development of maladaptative behaviors (Hatano et al., 2017; Montero-Duarte et al., 2019). There is a need to involve the peer group, educational institutions and family in the control of the multiple risk factors for this consumption in adolescents (Lebron et al., 2017).

Various researchers have proposed physical and sports activities as an alternative to these damaging behaviors and as a means of distancing young people from harmful substances (Cerkez et al., 2015). Ayán et al. (2017) reported that tobacco/alcohol consumption was inversely related to sports practice, which provides multiple psychological, physical and social benefits (Kose et al., 2015).

Physical activities in a natural environment have major hedonistic effects and involve interaction with nature in novel surrounds, while they are characterized by less strict rules in comparison to more competitive sports (Lawton et al., 2017). They may therefore be an ideal means for adolescents to acquire healthy habits, improving the physical condition of their whole body (Pretty et al., 2017; World Health Organization, 2017) and enhancing their psychological development in previously unknown settings that promote wellbeing and autonomy. Moreover, the socializing component of this type of activity fosters a feeling of belonging to the group and often requires collaboration to achieve its objectives (Sims-Gould et al., 2017).

Therefore, activities in natural environments appear to be an ideal way to get to know and enjoy the environment while performing motor activities that generate physical, cognitive and social benefits. This is because the natural environment has characteristics that make it conducive to fun, enhancing the sport's hedonistic component (Lorenz et al., 2017). This type of physical activity has a strong motivational component, which is key to modifying the intensity and direction of behavior, because the activities carried out in the natural environment focus on fun and pleasure, eliminating the negative connotations of excessive competitiveness that is sometimes present in sports (Calogiuri and Elliott, 2017). Psychologists consider motivation as one of the most influential factors to explain human behaviors (Gutiérrez and López, 2012).

Various studies identified the benefits derived from the practice of physical activity in nature, classified as follows: a decrease in cardiovascular diseases, a decrease in the rates of overweight and obesity, preventive effect against type 2 diabetes, various psychosocial benefits such as reduced levels of anxiety, depression, stress and emotional distress (Casper and Pfahl, 2015; Moreno et al., 2015; Cox et al., 2017; Gómez et al., 2018).

The practice of physical activity carried out in the natural environment in a non-competitive way, in which the subject focuses on the achievement of intrinsic goals, orienting itself more towards intrinsic motivations, constitutes a factor of prevention against the consumption of alcohol and tobacco. Nevertheless, physical activity focused on the achievement of extrinsic goals, in which a motivational orientation towards the ego is adopted, may represent a risk for the consumption of these substances (Bengoechea et al., 2017).

The importance of motivation in people's daily lives lies in their influence to perform certain behaviors or not, providing a theoretical basis to understand human behavior (Ryan and Deci, 2017). In the case of physical activity and sports, it will be valid to understand a multitude of psychological and behavioral factors related to their practice (Dweck, 1986). This study is focused on the motivational climate in sport, based on the Achievement Goal Theory (Nicholls, 1989) derived from the Self-determination Theory of Deci and Ryan (2008). According to this model, physical activities can be either ego-oriented, focused on demonstrating skills, competing with group members and defeating rivals, or task-oriented, centring on personal effort and self-improvement with greater self-determined motivation and enjoyment of the activity, enhancing adherence to physical activity practice (Newton et al., 2000; Palmer et al., 2017).

After reviewing the existing literature, the existence of an association between motivational climates and the development of healthy or maladaptive behaviors related to the consumption of harmful substances is observed. Therefore, it is important to analyze the possible relationship between the motivational climate in sports and the consumption of alcohol and tobacco, as well as to analyze the differences according to whether physical activity practice is performed in a standard way or in the natural environment because this can be constituted as a protective factor against this type of unhealthy habits. For these reasons, the objective of this study was to develop an explicative model for motivational climate in sport, considering its potential influence on alcohol and tobacco consumption. We performed multi-group structural equation modeling (SEM) as a function of the type of physical activity practiced by adolescents, comparing between activities in a natural environment and those in other settings.

MATERIALS AND METHODS

Subjects and Design

A quantitative, descriptive and cross-sectional study was undertaken, followed by a relational study developed using Structural Equation Modeling to analyze the degree of dependence among the different study variables.

Participants were selected from among the 11030 secondary school students in the city of Granada in southern Spain (data provided by the Education Ministry of the Junta de Andalucía). A representative sample (0.02 error; 95.5% CI) was selected by stratification, proportionality and randomization techniques, considering sex (male-female) and cycle (first-second). The inclusion criteria were: a) that the adolescents attended Compulsory Secondary Education in the city of Granada; b) not have any type of pathology that prevents them from participating in the research: c) have the informed consent of the parents or legal guardians to participate in the study. The final sample included 2273 adolescents, aged between 13 and 17 years (M = 14.94 years; SD = 1.25). The study was approved by the Research Ethics Committee of the University of Granada (641/CEIH/2018) and followed the principles of the 1975 Helsinki Declaration. Informed consent was obtained from all participants and their guardians. The anonymity of the participants was preserved at all times.

Measures

The perceived motivational climate in sport was evaluated with the 33-item Perceived Motivational Climate in Sport Questionnaire (PMCSQ-2), alongside the Spanish validation form González-Cutre et al. (2008). Participants responded to each item on a five-point scale from 1 (strongly disagree) to 5 (strongly agree). The questionnaire comprised two higher-order scales, each containing three subscales (task: cooperative learning [CL], effort/improvement [EI] and important role [IR]; ego: member rivalry [MR], unequal recognition [UR] and punishment for mistakes [PM]). Internal consistency of the data was assessed using Cronbach's alpha and was acceptable for both perceived task-involved climate (TC) and perceived ego-involved climate (EC) subscales ($\alpha = 0.860$ and $\alpha = 0.810$, respectively).

Alcohol consumption was assessed using the Spanish adaptation by Rubio (1998) of the Alcohol Use Disorders Identification Test (AUDIT) (Saunders et al., 1993). AUDIT comprises ten items, the first eight are evaluated on a five-point Likert scale (0 = Never; 4 = Daily) and the last two items on a three-point Likert scale, yielding a score of 0, 2, or 4 points. The first three items of the AUDIT describe the frequency of consumption, the next three describe the level of dependence and the remaining four items are related to harmful consumption. Item scores are added together to produce an overall score for each dimension. Cronbach's alpha for the data was $\alpha = 0.832$.

Tobacco consumption was assessed using the Spanish adaptation by Villareal-González (2009) of the Fagerström Test for Nicotine Dependence (FTND) (Heatherton et al., 1991). This instrument evaluates the number or amount of cigarettes,

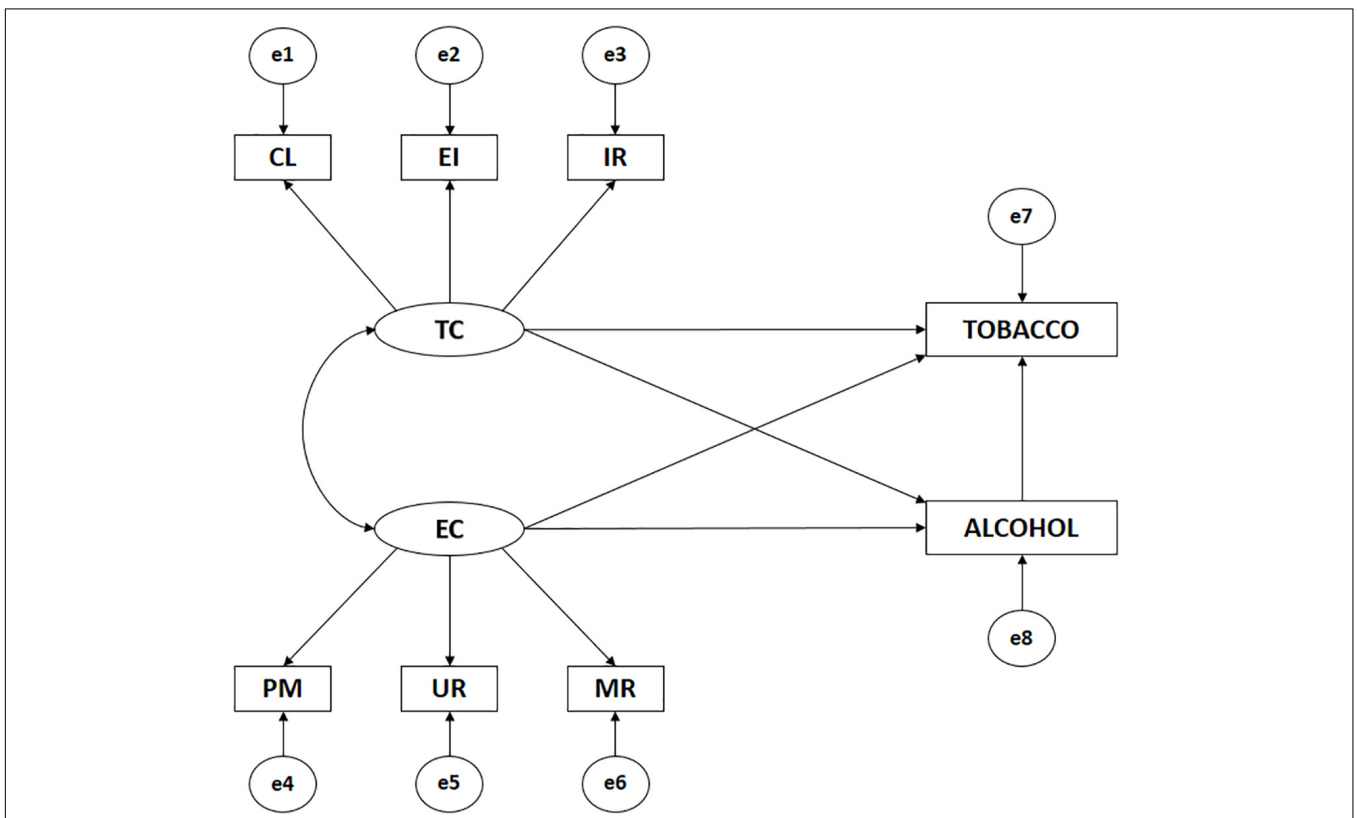

FIGURE 1 | Model theories: Task climate, ego climate, alcohol consumption and tobacco consumption. TC, Climate-Task; CL, Climate-Task Cooperative Learning; EI, Climate-Task Effort/Improvement; IR, Climate-Task Important Role; EC, Climate-Ego; MR, Climate-ego Intra-team Member rivalry; UR, Climate-ego Unequal Recognition; PM, Climate-ego Punishment for Mistakes; TOBACCO, Tobacco Consumption; ALCOHOL, Alcohol Consumption.

impulse to smoke and nicotine dependency. It includes six questions, the first four are dichotomous (0 = No and 1 = Yes), and the other two follow a four-option Likert-type scale (0 = Never and 3 = Always). The sum of items ranges between 0 and 10, establishing four categories (0 = Non-smoker, 1–4 = Low dependency, 5–6 = Moderate dependency and >6 = High dependency). The reliability determined for this investigation was $\alpha = 0.956$.

Procedure

Permission was obtained from the Education Office of the Junta de Andalucía for the participation of secondary schools in the city of Granada, selected according to convenience sampling of the study categories. The management of each educational centre was informed about the nature of the research and the need for the collaboration of students. Authorisation forms were provided to obtain the informed consent of legal guardians.

Participants were guaranteed the anonymity of the information gathered, clarifying that it would only be used for scientific purposes. Interviewers were present during data gathering to solve any possible doubts, and no problems were reported. Teachers, counselors and other collaborators were thanked and promised a report on the data obtained, respecting confidentiality.

Statistical Analysis

SPSS® version 22.0 (IBM Corp, Armonk, NY, United States) was used for data analyses. Descriptive analysis was performed, determining frequencies and mean values. Associative analysis was conducted using Pearson's chi-square test. The significance level was set at 0.05. AMOS version 23.0 was used to create statistical models with instructive equations at the latent variable level. SEM was used to analyze the relationships between perceived motivational climate in sport, alcohol consumption and tobacco consumption (**Figure 1**). After developing the theoretical model, path analysis was conducted, considering the relationships of the matrix based on a multi-group analysis classifying participants in terms of the type of physical activity practiced as grouping variable (Marsh, 2007). Thus, two different structural models were configured to verify whether relationships among study variables varied as a function of the type of physical activity practiced: "physical activity in a natural environment" and "other type of physical activity."

The SEM for these data is characterized by eight observed variables and two latent variables. This model provides causal explanations for the latent variables from the relationships observed between indicators. Squares represent the observed variables, circles the error terms, and ovals the latent variables. The exogenous latent variables, TC and EC, were each inferred

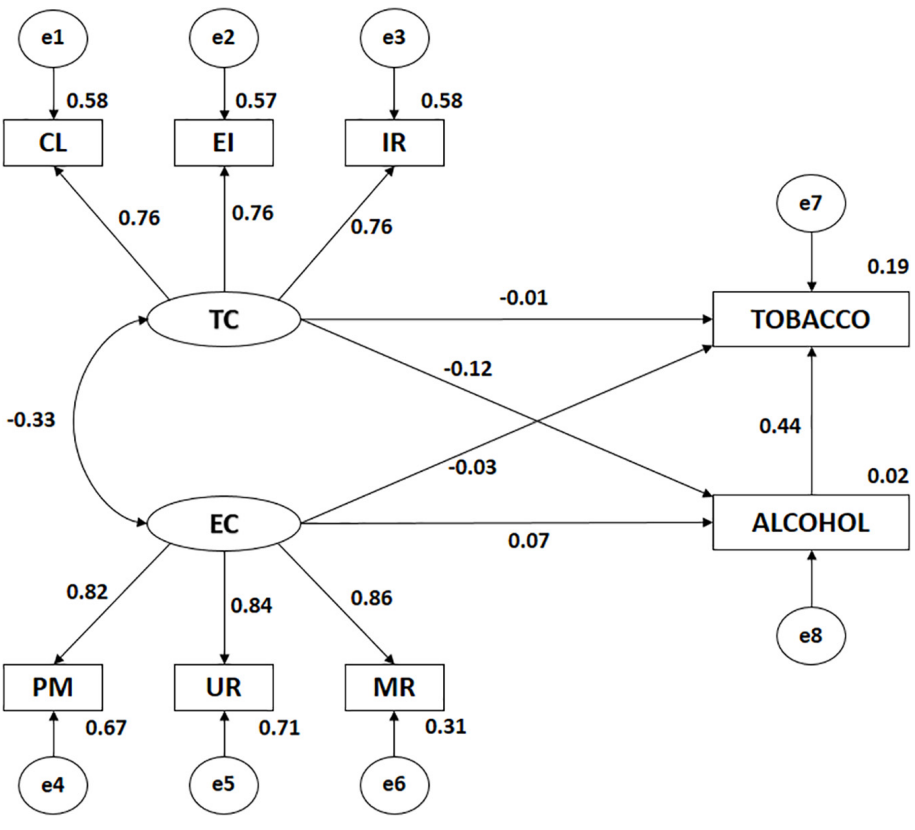

FIGURE 2 | Structural equation model in those who practice physical activity in a natural environment. TC, Climate-Task; CL, Climate-Task Cooperative Learning; EI, Climate-Task Effort/Improvement; IR, Climate-Task Important Role; EC, Climate-Ego; MR, Climate-ego Intra-team Member rivalry; UR, Climate-ego Unequal Recognition; PM, Climate-ego Punishment for Mistakes; TOBACCO, Tobacco Consumption; ALCOHOL, Alcohol Consumption.

using three indicators; for TC: CL, EI and IR; and for EC: MR, UR and PM. Alcohol consumption (ALCOHOL) and tobacco consumption (TOBACCO) were observed endogenous variables.

The bi-directional arrow (covariance) relates exogenous variables, while the unidirectional arrows are lines of influence between the latent and observable indicators, and are interpreted as multivariate regression coefficients. In addition, error prediction terms are associated with endogenous variables. The maximum likelihood (ML) method was used to estimate relationships between variables. We chose this method because it is consistent, unbiased and invariant to types of scale for variables with normal distribution.

Model fit was examined to verify the compatibility of the proposed model and the empirical information gathered. Goodness of fit was tested using a number of indexes briefly described here Chacón et al. (2018). Chi-square analysis was conducted when non-significant *p*-values indicated a good model fit. Comparative fit index (CFI), normalized fit index (NFI) and increase fit index (IFI) values >0.90 indicate acceptable model fit while values >0.95 indicate excellent model fit. Root mean square error of approximation (RMSEA) values <0.08 indicate acceptable model fit while values <0.05 indicate excellent model fit (Marsh, 2007).

RESULTS

Almost all model fit indexes indicated an excellent fit. A significant chi-square value was obtained ($\chi 2 = 168.170$; gl = 32; $p < 0.001$); however, given that this index has no upper limit and may also be sensitive to sample size, we also considered other standardized indexes less sensitive to sample size (Jöreskog, 1997). The NFI was 0.96, indicating an acceptable model fit. The CFI and the IFI yielded a value of 0.97 for both, indicating an excellent model fit. The RMSEA value was 0.45, indicating excellent fit (Browne and Cudeck, 1993). In summary, the data suggest that the model fits the empirical data well.

Figure 2 and **Table 1** exhibit the estimated values of the structural model parameters for students who practiced physical activity in a natural environment. They should present adequate magnitude, and the effects should significantly differ from zero. Likewise, improper estimations should not be obtained, such as negative variances. Statistically significant positive and direct relationships ($p < 0.005$) were observed among all categories of motivational climate and its dimensions. There was a significant ($p < 0.005$) negative indirect relationship between TC and EC ($r = -0.331$).

Analysis of the influence of indicators on each latent variable showed statistical significance in all cases ($p < 0.005$), with all relationships being positive and direct. In the case of TC, the highest correlation coefficient was obtained with IR ($r = 0.763$), followed by CL ($r = 0.760$) and EI ($r = 0.756$). In the case of EC, the highest correlation was with UR ($r = 0.842$), followed by PM ($r = 0.819$) and MR ($r = 0.556$).

A significant negative and direct association ($p < 0.005$) was observed between TC and alcohol consumption ($r = -0.121$), which was not associated with EC. No association was found between EC or TC and tobacco consumption. A statistically significant ($p < 0.005$) positive and direct association was found between tobacco and alcohol consumption ($r = 0.441$).

TABLE 1 | Weights and standardized regression weights of those who practice physical activity in a natural environment.

Relationship between variables	RW				SRW
	Estimations	SE	CR	*P*	Estimations
ALCOHOL ← EC	0.736	0.334	2.206	0.027	0.069
ALCOHOL ← TC	−1.008	0.264	−3.811	***	−0.121
CL ← TC	1.000	–	–	***	0.760
EI ← TC	0.845	0.035	24.109	***	0.756
IR ← TC	0.953	0.039	24.174	***	0.763
MR ← EC	1.000	–	–	***	0.556
UR ← EC	1.560	0.080	19.387	***	0.842
PM ← EC	1.396	0.071	19.537	***	0.819
TOBACCO ← TC	−0.058	0.120	−0.485	0.627	−0.014
TOBACCO ← ALCOHOL	0.220	0.012	18.289	***	0.441
TOBACCO ← EC	−0.153	0.151	−1.011	0.312	−0.029
EC ↔ TC	−0.102	0.011	−8.893	***	−0.331

*RW, Regression Weights; SRW, Standardized Regression Weights; SE, Estimation of Error; CR, Critical Ratio. TC, Task-involved Climate; EC, Ego-involved Climate; CL, Cooperative Learning; EI, Effort/Improvement; IR, Important Role; PM, Punishment for Mistakes; UR, Unequal Recognition; MR, Member Rivalry. *p < 0.05; **p < 0.01; ***p < 0.001.*

Figure 3 and **Table 2** exhibit the estimated values of structural model parameters for students who practice another type of physical activity. They should present an adequate magnitude, thee effects should significantly differ from zero and improper estimations should not be obtained, including negative variances. Statistically significant ($p < 0.005$) positive and direct relationships were observed between both TC and EC and their dimensions. There was a significant ($p < 0.005$) negative and indirect relationship between TC and EC ($r = -0.325$).

Analysis of the influence of indicators on each latent variable found statistically significant ($p < 0.005$) positive and direct relationships in all cases. In the case of TC, IR showed the highest correlation coefficient ($r = 0.790$), followed by CL ($r = 0.753$) and EI ($r = 0.750$), while EC showed the highest association with UR ($r = 0.860$), followed by PM ($r = 0.809$) and MR ($r = 0.524$), as in the model for physical activity in a natural environment.

A significant ($p < 0.005$) positive and direct association was found between EC and alcohol consumption ($r = 0.196$), which showed no association with TC. As in the model for physical activity in a natural environment, no association was found between EC or TC and tobacco consumption.

A statistically significant ($p < 0.005$) positive and direct relationship was observed between tobacco consumption and alcohol consumption ($r = 0.497$). The relationship was stronger in the case of those practicing activities in a natural environment.

DISCUSSION

The SEM developed in this study reveals an excellent fit in all evaluation indexes, as a function of the number

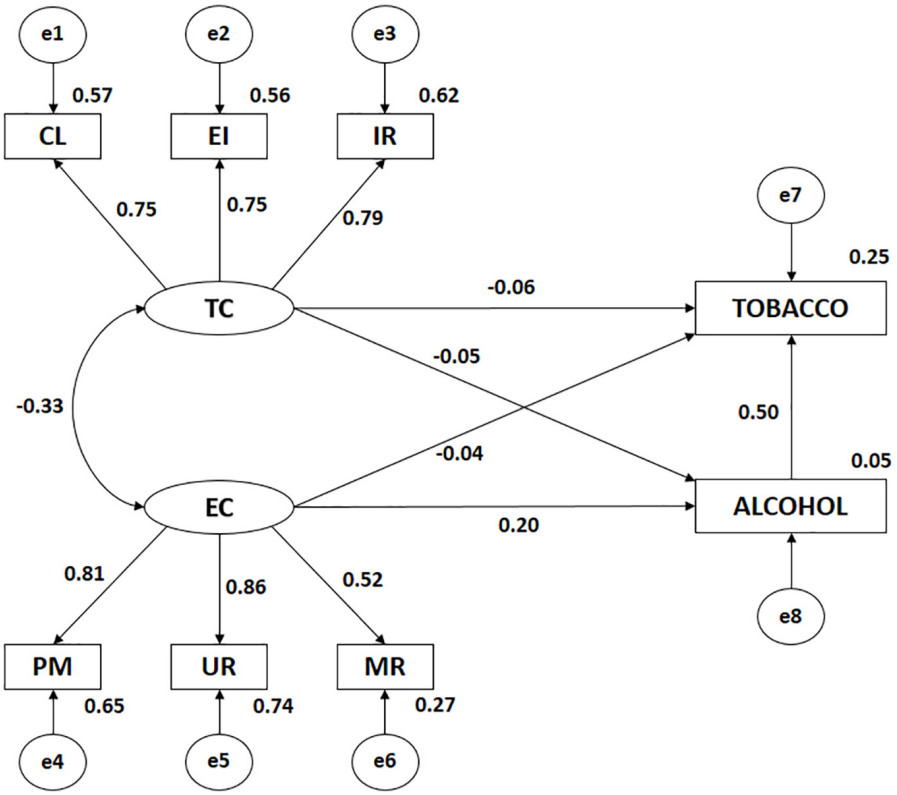

FIGURE 3 | Structural equation model in those practicing another type of physical activity. TC, Climate-Task; CL, Climate-Task Cooperative Learning; EI, Climate-Task Effort/Improvement; IR, Climate-Task Important Role; EC, Climate-Ego; MR, Climate-ego Intra-team Member rivalry; UR, Climate-ego Unequal Recognition; PM, Climate-ego Punishment for Mistakes; TOBACCO, Tobacco Consumption; ALCOHOL, Alcohol Consumption.

of participants, and significance was reached. A multigroup analysis of structural equations was conducted to compare the associations between sport-related motivational climate and harmful substance consumption according to the type of physical activity (in natural environments or otherwise). The path model developed achieved excellent fit indexes and represents a valid explicative model to elucidate the relationships between motivational factors and alcohol and tobacco consumption in Spanish secondary school students, in line with various national and international studies (Jaakkola et al., 2016; Lee and Chelladurai, 2016; Stenling et al., 2017; Chacón et al., 2018; Chacón-Cuberos et al., 2018).

Analyzing motivational climate, the proposed structural model revealed a significant inverse relationship between TC and EC among students practicing physical exercise either in a natural environment or in other settings, observing a stronger and more differentiated association among the former. Thus, individuals who practice physical-sports activities in a natural environment perceive a high climate of involvement with the task and a low climate of involvement with the ego, the opposite of the perceptions of those practicing activities in other settings (Navarro-Patón et al., 2018; Ring and Kavussanu, 2018). It appears that students adopt a predominant orientation, either towards the task, rewarding effort and self-improvement, or towards the ego, fomenting rivalry among group members and the pure demonstration of skills (Gano-Overway et al., 2017; Erturan-Ilker et al., 2018). In the case of those practicing sport in a natural environment, this inverse relationship is stronger, explained by the greater group cohesion and the ludic component of physical activities in this environment, promoting cooperation among group members. In contrast, physical activities in other environments place a higher value on the defeat of rivals and the exhibition of their skills (Arslanoglu, 2016; Amaro et al., 2017; Castro-Sánchez et al., 2019).

The most influential category for the TC dimension was IR, while the most influential indicator for EC was UR, especially in the case of students who did not practice physical activity in a natural environment. Harwood et al. (2015), reported that students who assign greater importance in their physical activity practices to social relationships, characteristic of activities developed in a natural environment, show a higher task orientation, prioritizing the ludic component of this type of activity. In activities developed in natural environments, the competitive desire to stand out in the group is attenuated in favor of a greater enjoyment of the activity, focusing on the fun and play it offers, dissociated from the competitive component characteristic of sports (Gerdin and Pringle, 2017).

Adolescents who practice physical activity in nature show a lower tendency to consume harmful substances (alcohol and tobacco) than adolescents who do physical activity in

TABLE 2 | Weights and standardized regression weights of those who practice another type of physical activity.

Relationship between variables	RW				SRW
	Estimations	SE	CR	*P*	Estimations
ALCOHOL ← EC	2.327	0.541	4.304	***	0.196
ALCOHOL ← TC	−0.418	0.387	−1.080	0.280	−0.048
CL ← TC	1.000	–	–	***	0.753
EI ← TC	0.839	0.049	17.076	***	0.750
IR ← TC	1.001	0.058	17.323	***	0.790
MR ← EC	1.000	–	–	***	0.524
UR ← EC	1.618	0.127	12.771	***	0.860
PM ← EC	1.469	0.113	12.984	***	0.809
TOBACCO ← TC	−0.311	0.189	−1.642	0.101	−0.065
TOBACCO ← ALCOHOL	0.274	0.019	14.760	***	0.497
TOBACCO ← EC	−0.273	0.259	−1.053	0.292	−0.042
EC ↔ TC	−0.099	0.016	−6.092	***	−0.325

*RW, Regression Weights; SRW, Standardized Regression Weights; SE, Estimation of Error; CR, Critical Ratio. TC, Task-involved Climate; EC, Ego-involved Climate; CL, Cooperative Learning; EI, Effort/Improvement; IR, Important Role; PM, Punishment for Mistakes; UR, Unequal Recognition; MR, Member Rivalry. *p < 0.05; **p < 0.01; ***p < 0.001.*

other environments. This association is fulfilled with alcohol, but not with the consumption of tobacco. In terms of the relationship between motivational climate and alcohol consumption, a negative and direct association was observed between TC and alcohol consumption in students practicing sport in a natural environment, while a positive relationship between EC and alcohol consumption was found in students practicing other types of physical activity. Accordingly, physical activity in natural environments is related to lower alcohol consumption, associated with task orientation, while activities in other settings is related to higher alcohol consumption, associated with ego orientation. It is considered that the practice of physical activity in natural environments is a protective factor against the consumption of harmful substances, including alcohol and tobacco (Dodge et al., 2017). This is explained by the generally hedonistic aim of physical activity in a natural environment, geared to enjoyment, contrasting with the performance-oriented objective of other physical-sport activities, leading to possible frustrations when the individual fails, favoring the consumption of alcohol and tobacco, among other harmful behaviors.

The relationship between tobacco and alcohol consumption was positive and direct but was stronger and more differentiated among students practicing physical activity in settings other than nature. This is consistent with the aforementioned proposition that physical-sport activities not developed in natural environments may pose a risk of alcohol consumption due to its higher competitive component (Cronholm et al., 2017). In addition, the state of euphoria generated by the positive results in sports competition causes some young people consume alcohol in order to celebrate the achievements. The natural environment enhances the enjoyment and involvement of adolescents in their activities, hence prioritizing task orientation and favoring lower levels of alcohol consumption (Nooijen et al., 2017) and higher adherence to physical activity during adulthood (Mäkelä et al., 2017).

This investigation permitted analysis and verification of the relationships between motivational factors and harmful substance consumption. However, it was not possible to infer cause-effect relationships due to its cross-sectional design, and longitudinal interventional studies are warranted based on programs of physical activity in a natural environment. It would be interesting for future studies that use the mixed methods study designs would be interesting to address this topic, qualitative research design is needed.

The main conclusion of this study is that physical activity in nature has a ludic component that favors a more self-determined motivation that may be related to lower alcohol consumption. Enjoyment and group cohesion prevail in this environment, whereas there is a greater motivational ego orientation in other settings, which may be related to higher alcohol consumption. The task motivational climate, both in sporting contexts and those linked to the practice of healthy physical activity in nature, constitutes a protective factor against the development of harmful behaviors such as the consumption of harmful substances, the development of sedentary habits or poor diet. Therefore, physical-sport activities in a natural environment are considered important to acquire healthy behaviors associated with adherence to physical activity practice and a lower consumption of harmful substances.

We propose the incorporation of activities in natural environments in school programs with the aim of reducing harmful behaviors and improving the health of adolescents through enjoyment-centered physical activities. In addition, it is necessary to promote task-oriented motivational climates in the adolescent stage, both in the context of the practice of daily physical activity and in competitive sport. This is because it relates to healthier behaviors and greater adhesion to the practice of physical activity that will last over time. To achieve this, teamwork should be encouraged, rewarding the effort to learn and personal improvement. On the contrary, excessive competitiveness must be suppressed, linking sports achievement to progress and not results. In this sense, the playful component of physical activity should be given special importance.

DATA AVAILABILITY

All datasets generated for this study are included in the manuscript and/or the supplementary files.

ETHICS STATEMENT

The research Ethics Committee of the University of Granada approved this study with code 641/CEIH/2018. Written informed consent was obtained from the parents/legal guardians of all participants.

AUTHOR CONTRIBUTIONS

RC-C, FZ-O, JP-T, and MC-S conceived the hypothesis of this study. FZ-O, MC-S, and CC-B participated in data collection. RC-C, MC-S, and CS-L analyzed the data. RC-C, JC-Z, and JP-T wrote the manuscript with significant input from MC-S. All authors contributed to data interpretation of the statistical analysis, and read and approved the final manuscript.

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MINI REVIEW
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Mini Review of the Use of the Mobile Phone and Its Repercussion in the Deficit of Physical Activity

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Background: Current technology has the ability to distract and evade its users, this resulting in an addiction or "escape" from the real world. The excessive use of smartphones can cause a decrease in physical activity (PA) for many people prefer to use these devices rather than do the recommended physical exercise.

Objective: The objective of this paper is to analyze the possible relation between the use of smartphones and the reduction in the practice of PA that is reflected in scientific articles.

Methods: The PRISMA statement has been followed for systematic reviews and meta-analyses in order to achieve a correct organization and integrity of the work. Our search for bibliography has been carried out in the WOS and Scopus databases, together with the research domains "Social Sciences Other Topics," "Education Educational Research," and "Sport Sciences." After applying the inclusion criteria, a total of 14 articles were obtained, these forming the base body of this research.

Results: Nine of the fourteen articles show that there is a negative relationship between the smartphone and PA practice. The age groups most studied in relation to this topic range from 13 to 18 and from 19 to 25.

Conclusion: It is our conclusion that the inappropriate use of these mobile devices is associated with low levels of motivation and practice of PA in their users. Similarly, we have emphasized the lack of scientific work dealing with this issue.

Keywords: physical activity, smartphone, addiction, sedentariness, technology

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INTRODUCTION

The concern about the possible effects of Information and Communication Technologies (ICTs) is no longer new. Current studies allude to the problems caused by the excessive use of small screens, especially smartphones and, therefore, the Internet, as well as addictions to video games..., and also in relation to the dependence they create on users. Since the internet exists, problems related to its use have continuously appeared (Domínguez et al., 2012). Nowadays technology has the ability to distract and evade people from their problems, but it can also result in addictions or become an unhealthy escape from the real world (Sánchez-Zafra et al., 2019).

The speed at which technology advances makes the functionality of smartphones change continuously. Each time, they offer more applications, better camera, more power and memory.

They grant a large number of services related to leisure, such as watching television, listening to music or enjoying multiple games. In the same way, they provide current information and allow socializing with other people through social networks (Aranda et al., 2017). This makes them increasingly attractive to children, young and adults, causing certain problems and situations when there is excessive and continuous dependence on these devices (Echeburúa and de Corral, 2010; Alfaro et al., 2015; Rozgonjuk et al., 2018). Over time, smartphones users are normalizing their use, leaving aside the playful part they offer to give them a more professional and personal use. This also occurs in the educational context (Ramírez et al., 2018), where there are more than 80.000 educational Apps.

However, its problematic use can affect various factors in our daily life, causing, for instance, a lack of practice of physical activity (PA) (Sung et al., 2016; Elhai et al., 2017; Ramírez-Granizo et al., 2018). Actions such as sending messages, phoning or surfing the internet are considered sedentary and this can lead to health problems since insufficient levels of moderate and vigorous physical exercise are associated with the increase of obesity. The regular practice of pa is associated with benefits similar to those of some medical treatments. This is why it is an essential activity in our lives (Perea et al., 2015). An addictive use of smartphones is also related to a higher body mass index and a deterioration of physical health, such as loss of vision and musculoskeletal problems (Bell et al., 2014; Kim et al., 2015; Sook and Chun, 2017), in addition to loss of attention and lack of sleep, not to mention -specially among young people- the risk of using it while driving. One of the main factors associated with overuse of smartphones is age. It is the university students, along with the younger ones, who have more normalized its use in their routine (Jasso et al., 2017).

It is scientifically proven that a regular practice of PA is associated with health benefits and that a sedentary lifestyle slows them down, having negative consequences even in active people (Barkley et al., 2016). The first studies focused on the sedentary lifestyle of schoolchildren related it exclusively to the hours they spent watching television but over time it has been also applied to the rest of electronic devices with a screen (Sandercock et al., 2016). As the use of smartphones increases, the practice of PA decreases (Joshi et al., 2016) to such an extent that the fight against sedentary lifestyle and obesity necessarily includes the analysis and harm of the abusive use of smartphones. Venkatesh et al. (2017) confirm that adults addicted to these devices do less physical exercise if compared to those who are not, and Samaha and Hawi (2017) obtain the same results in a population of children. Sedentary lifestyles, motivated among other reasons by the excessive use of smartphones, are becoming one of the main concerns of society (Glynn et al., 2013).

Despite these disadvantages, the use of smartphones does not necessarily lead to sedentary actions. In fact, there are many applications in the market helping us in our practice of physical activity. Some remind users of the moment when they have to do exercise or what kind of activity they have to do that day (Patel et al., 2018). Likewise, the research by Shen et al. (2018) states that the people who practice PA most are those who most consult their smartphones for health-related issues.

Our main objective is to conduct a systematic review of scientific literature focused on the use of the smartphone and its relationship with the practice of PA in populations of different ages without diseases.

METHODOLOGY

The PRISMA statement has been followed for systematic reviews and meta-analyses (Hutton et al., 2016) in order to achieve a correct organization and integrity of the work.

Procedure and Literature Search Strategy

The literature review of the articles was carried out in November and December of 2018, paying special attention to those relating the excessive use of the smartphone with the amount of PA in the last decade.

The Web of Science (WOS) and Scopus databases have been used to search for the articles. The articles were searched using the following keywords: "mobile phone," "physical activity" and "the Boolean operator." Subsequently, the search was refined taking into account only the articles published in the research areas "Social Sciences Other Topics," "Education Educational Research," and "Sport Sciences," leaving a total of 271 documents.

Inclusion Criteria

The inclusion criteria were established: (1) articles that relate the use of smartphones to the practice of PA, (2) use that is given to mobile phones, and (3) whether the research is cross-sectional or longitudinal.

Study Selection and Data Collection Process

The first part of the search initially obtaining an amount of 1.908 articles. For the application of the first inclusion criteria, a first reading of the title and summary of the 271 selected papers was made. In a following stage, a second deeper reading was necessary to apply the rest of the inclusion criteria. After the application of these criteria, a total of 257 articles were eliminated.

Population and Scientific Literature Sample

The population of this study is set at 271 articles extracted from the WOS and Scopus databases. After applying the inclusion criteria, the study sample is refined to 14 scientific publications.

RESULTS

Evolution of the Scientific Production

Considering the selected research areas and the inclusion criteria, 271 articles related to the subject under discussion have been published in the last decade. 14 works have been selected to constitute the body of the investigation.

TABLE 1 | Basis of the study.

Authors and year	Country	Kind of investigation	Age of the Sample	Instrument*	Relation PA-smartphone
Arora et al. (2013)	United Kingdom	Cross	11–18 years old	Stadiometer Scales *Ad hoc* TUQ	Positive
Barkley and Lepp (2016)	United States	Cross	18–34 years old	GLTEQ *Ad hoc* *Ad hoc*	Negative
Beltrán-Carrillo et al. (2016)	Spain	Cross	15–16 years old	*Ad hoc*	Positive
Delfino et al. (2018)	Brazil	Cross	10–17 years old	*Ad hoc*	Negative
Haug et al. (2015)	Switzerland	Cross	15-older than 21	*Ad hoc* SAS-SV *Ad hoc*	Negative
Kim et al. (2015)	Korea	Cross	19–25 years old	SAPS Pedometer 320 Body Composition Analyzer Anthropometer	Negative
Lane et al. (2014)	Ireland	Longitudinal	9 years old	*Ad hoc*	Negative
Lepp et al. (2013)	United States	Cross	University students	SESEB *Ad hoc* *Ad hoc*	Negative
Mojica et al. (2014)	United States	Cross	11–14 years old	YRBSS *Ad hoc*	Positive
Morita et al. (2016)	Japan	Cross	12–13 years old	PA *Ad hoc*	Negative
Sevil et al. (2018)	Spain	Cross	Average age: 13 years old	*Ad hoc*	Negative
Shen et al. (2018)	Hong Kong	Cross	18-older than 65	HIE HB	Positive/Negative
Silva et al. (2017)	Portugal	Cross	13–19 years old	*Ad hoc* *Ad hoc*	Negative
Zach et al. (2016)	Israel	Longitudinal	16–18 years old	*Ad hoc* *Ad hoc*	Positive

**TUQ, technology use questionnaire; GLTEQ, godin leisure-time exercise questionnaire; SAS-SV, smartphone addiction scale short version; SAPS, smartphone addiction proneness scale; SESEB, self-efficacy survey for exercise behaviors; YRBSS, youth risk behavioral surveillance system; HIE, health information exposure; HB, health behaviors.*

Data From the Studies Selected for the Systematic Review

For the selection of the articles and their coding (**Table 1**), the following data have been taken into account: (1) authors and year of publication, (2) country where the work has been carried out, (3) type of research carried out, (4) size of the sample, (5) sample age, (6) instruments, (7) variables that have been measured, and (8) relation between PA and the use of smartphones, understanding that the latter is positive when there is an active use of these devices whereas it is negative when it is a passive or sedentary one.

The reviewed articles are spread across countries all over the world without being concentrated in any particular geographical area. The majority of the works belong to a cross sectional paradigm. With respect to the instruments, as highlighted, there is no validated universal questionnaire that measures the relation between the use of smartphones and their relationship with the practice of PA, since our approach reveals that each author has chosen a different questionnaire for their research, many of them being of own elaboration. Regarding the relationship between PA and the use of smartphones, most of the works speak of a negative, passive use, in which the time of physical exercise is considerably reduced. Others point out a positive use, focusing on applications or ways to encourage the practice of PA thanks to smartphones.

Figure 1 shows the distribution of the articles that make up the sample according to the age of the participants. Some of the studies are framed in more than one age group because they used participants of different ages. It can be seen that most of the articles focus on an age range between 13 and 18 years old (N = 8), followed by 19 to 25 years old (N = 5). The least studied ages are those under 12 (N = 2) and those above 26 (N = 2).

DISCUSSION

Most of the papers presented in the Results section share the view that there is nowadays an excessive use of smartphones among children, adolescents and adults. It is the youngest who spend

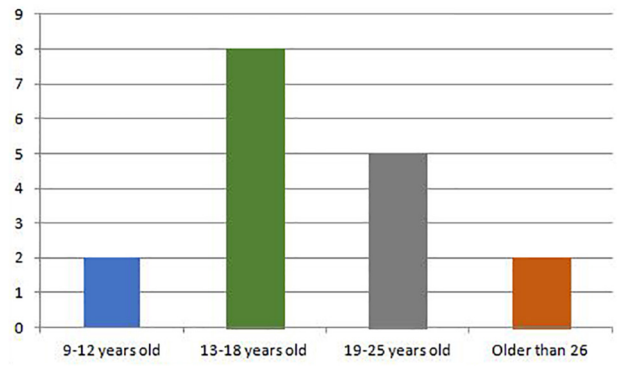

FIGURE 1 | Distribution of selected articles according to age.

more hours in front of the screens and those who have more problems and addictions (Haug et al., 2015).

In the study by Lane et al. (2014), there arises the discussion on the recommendation made by the American Academy of Pediatrics (2001) about not using smartphones for more than 2 h a day. This recommendation is not met by the sample of the articles studied, according to which children between 6 and 12 spend an average of 40 h a week talking, writing text messages, listening to music and surfing the Internet. Most of them can send text messages through the internet thanks to the data plans they have (Mojica et al., 2014). According to Sudan et al. (2016) children born in the last 20 years have been exposed to these devices since birth and, therefore, their relationship with them is different and cannot be compared with that of adults. Children are continually watching videos, playing games or talking on WhatsApp. They live attached to the smartphone.

Sevil et al. (2018) show that adolescents spend an average of 407 min a day (6.7 h) with different technological devices, smartphones being the second most used to communicate with others, for example, through WhatsApp. As with children, these adolescent users have in many cases flat data rates, which allow them to use smartphones anywhere and anytime, progressively increasing the time spent on them (De-Sola et al., 2016). Preadolescents and adolescents spend more time with smartphones, and therefore have a more sedentary behavior than younger children (Joshi et al., 2016).

Likewise, the research carried out by Lepp et al. (2013) and Barkley and Lepp (2016) show that the average number of minutes per day spent by university users is 300 and 380, respectively. Horwood and Anglim's (2018) survey showed that 54% of adults used smartphones when they should be doing other things and that 34% lost sleep hours when using them. 65% of respondents confirm that they have used smartphones for a longer time than they had originally planned. In university classes it is normal to see students using the smartphone instead of attending to the teacher. Even so, older people use less smartphones than younger ones (Barkley and Lepp, 2016).

The majority of studies imply that there are no significant differences in the use of the smartphone as far as gender is concerned, but Beltrán-Carrillo et al. (2016) state women use these devices more frequently, coinciding with other studies such as Joshi et al. (2016) or Pedrero-Pérez et al. (2018), who explain that women use instant messages and social networks more, men preferring the internet and video games.

As confirmed by most studies, the time users spend with smartphones is associated with sitting. Those who use the smartphone less spend less time sitting than those who have a more continuous use of it (Barkley and Lepp, 2016). The muscle mass of people with addiction to smartphones was much lower than that of the more moderate users. The opposite occurs with fat mass, since the more a smartphone is used, the more fat mass users have (Kim et al., 2015). Furthermore, the misuse of smartphones is associated with a greater proclivity to suffer body aches in the back, neck (today's boys are known as the generation of crouched heads), wrists, hips and knees (Silva et al., 2017).

The relation between the misuse of smartphones and the practice of PA is obvious. There are authors who speak of a negative relation, arguing that the excessive use of smartphones produces a sedentary lifestyle and inactivity, leading to a reduction in the time devoted to physical exercise. Nowadays, the majority of the population prefers to use the smartphone instead of going for a walk or doing some kind of physical exercise. The first thing young people do when they leave class and adults do when they leave work is to take the smartphone. Delfino et al. (2018) observed that users who spent more than 2 h using smartphones were physically less active than others. These researchers suggest that the practice of low intensity PA can help to reduce the time spent on these devices. Additionally, sedentary behaviors should be discouraged and foster a change from moderate physical exercises to vigorous ones (Morita et al., 2016).

The same users are aware, in many cases, that smartphones can interfere with their PA and many of them say they leave their smartphone off in order to be more active and reduce sedentary behavior (Lepp et al., 2013). On the other hand, it is found that those people who do more moderate and vigorous PA are the ones who use the smartphone most to consult health issues (Shen et al., 2018).

Conversely, smartphones can also be used to reduce sedentary levels and increase PA. It should not be forgotten that they are small devices that can be carried anywhere and used in movement (Arora et al., 2013). It is important to widespread the use of ICTs in PA classes in order to promote knowledge and increase healthy lifestyles in terms of physical exercise (Zach et al., 2016). There are a multitude of games and applications that can be used to encourage PA practice. It is important for children to know them.

Similarly, there are several studies that show that the use of messages through the smartphone aimed at enhancing the levels of PA in users is effective, since sedentary lifestyles can be reduced through reminders on the smartphone to get up when the user has been sitting for a long time, to go for a walk or do any simple exercise (McCoy et al., 2017; Dunning et al., 2018). Through virtual reality, some aspects related to PA can be improved more effectively, such as spatial orientation (Gómez-García et al., 2018).

CONCLUSION

Our analysis reveals that the number of studies that address the issue of the influence of smartphones in the practice of PA is scarce and that, in spite of having considered a whole decade in our approach, they were all published only in the last 5 years. This question has been raised globally, finding that the investigations have been carried out in different countries, inferring that it is a subject of special relevance and international significance. At the same time, we have highlighted that most of them are cross-sectional studies.

All the stages have been considered, from children to adults, and each of them shows that the inappropriate use of smartphones reduces the practice of PA, since these devices are preferred. On the other hand, some works claim that a suitable use of smartphones can foster the recommended daily exercise, for example, through applications or messages that remind and encourage the activities to be carried out.

Regarding the limitations of our study, we have only covered a decade and, consequently, this research is likely to be developed and extended to see if more articles investigating this topic have been published since the appearance of smartphones.

AUTHOR CONTRIBUTIONS

MZ-S, JC-Z, MS-Z, and AL-S contributed to the conception and design of the revision. All authors wrote some part of the manuscript and all reviewed the manuscript.

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Self-Concept and Physical Activity: Differences Between High School and University Students in Spain and Portugal

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The period of adolescence stands out as a critical and decisive phase, first because it leaves its mark on personality development, which is affected by psychosocial factors, and second because the healthy lifestyle habits acquired during this stage form a foundation for adulthood. The objective of the present study was first to evaluate the levels of participation in physical activities (PA) and of self-concept in high school and university students, and second to find relationships between these psycho-physical variables. Four hundred and forty adolescents ranging in age from 16 to 20 years, from Spain and Portugal, participated in this study (cross-sectional design). The IPAQ and Self-Concept Form-5 questionnaires were used. The results demonstrated some differences; the Portuguese university students had lower scores in the academic, emotional and physical dimensions and vigorous PA but higher sitting time, walking and moderate PA compared to Portuguese high school students. In addition, Spanish university students had lower self-concept scores although higher practice of PA and lower sitting time than Spanish high school students ($p < 0.05$). On the other hand, a positive relationship was found between different dimensions of self-concept and levels of PA, while the relationship between these dimensions and the time the adolescent spent sitting was negative. In conclusion, the university students have lower scores of self-concept dimensions (in general), and the practice of PA is higher in Spanish university students, confirming the clear presence of differences between both educational stages. The relationship between the dimensions of self-concept in general and the level of PA was positive (following the contributions of Marsh).

Keywords: physical activity, self-concept, adolescents, educational stage, IPAQ

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INTRODUCTION

The scientific literature has demonstrated that regular practice of moderate (MPA) and vigorous (VPA) physical activities (PA) provides health benefits for different ages (Reiner et al., 2013). Accordingly, the World Health Organization has recommended that adolescents between 15 and 17 years old should practice at least 60 min of MPA and VPA daily, and at later ages,

at least 150 min of MPA or 75 min of VPA weekly (World Health Organization, 2010). These ages, which include adolescence as well as the start of adulthood, are particularly important due to their propensity for forming healthy lifestyle habits. For this reason, Hills et al. (2015) recommend programs to create such habits and to reduce physical inactivity, as the latter could lead to the onset of certain health risk factors such as overweight and obesity (Du et al., 2014).

More specifically, adhering to a practice of PA is considered one of the principal solutions to avoid these risk factors and cardiovascular diseases, thereby fostering good health and quality of life (Myers et al., 2002; Blair et al., 2012; Kokkinos, 2012). Nevertheless, adolescents do not regularly practice PA, neither in high school (Olds et al., 2009) nor in university (Pengpid et al., 2015). This lack of practice has become one of the major problems of today's society in general (World Health Organization, 2010; Kohl et al., 2012), as there exist a significant number of persons who are sedentary as compared to those who are physically active (Expósito et al., 2012).

The beginnings of unhealthy lifestyles seem to appear, predominantly, in the period of adolescence which coincides with the transition from high school to university, where these young adults are subjected to multiple changes because of their psychological instability (Smetana et al., 2006). The transition to university is seen as an exciting period for many students in their first year as it involves new challenges in their lives (Rach and Heinze, 2017) and also greater responsibility, which consequently poses risks for their self-concept (Salinas-Miranda et al., 2015). The changes in healthy lifestyle and habits that occur during this transition are manifested in a lower level of PA (Varela-Mato et al., 2012), in part due to the elimination of required physical education classes (Chen et al., 2014). These, along with a change of city for the majority of students, are factors that may make PA problematic during the university period (Rona and Gokmen, 2005).

The assessment of healthy habits at these ages is particularly important given that these habits could affect overall self-concept. Self-concept is composed of five dimensions: academic, social, emotional, family, and physical. The relationship of these dimensions with the healthy behavior of adolescents can determine self-improvement actions (Marsh, 1989; Pastor et al., 2006) such as taking part in PA and having adequate nutrition, in the pursuit of quality of life (Serra-Majem et al., 2004; Wanden-Berghe et al., 2015). The performance of PA is related to self-concept (Slutzky and Simpkins, 2009), even to the point of possible changes in the student's personality and his capacity to understand his own behavior (Marsh and Redmayne, 1994), his relationship with others, his deficiencies, and his motivations. Physical self-concept was both an effect and a cause of exercise behavior (Marsh and Martin, 2011). For their part, Cerkez et al. (2015) attest to the fact that regular participation in PA has a positive relation with physical self-concept. When there exist a low level of participation in PA, the person may be vulnerable in his social self-concept due to dissatisfaction with his body image (Annesi, 2010; Chen and Lee, 2013; Zschucke et al., 2013; Owen et al., 2014). On the other hand, VPA can affect the emotional dimension of self-concept during the transition. This dimension measures the perception of a person's emotions and the degree of control he has over them. It is a significant dimension to investigate in adolescents who are entering university because of the stress and fatigue that VPA, such as the practice of sports, can cause (Strong et al., 2005).

For these reasons, the importance of PA is stressed, as a means by which adolescents can improve their physical condition and competence, body image, self-esteem, and self-concept (Crocker et al., 2000; Moreno et al., 2007; Rojas et al., 2011). Our hypothesis is that the level of self-concept is related positively to the level of participation in PA, expressed as VPA and/or MPA.

Despite the numerous studies of adolescents and university students which look at self-concept and its relation with PA, there are none which analyze if this relationship is different for high school students as compared to university students in order to understand the effect this school transition may have on these young adults. A better understanding of these associations, and the differences found between university and high school students, would improve our current understanding and help in designing intervention strategies focused on increasing PA as a path toward improved self-concept. Accordingly, the present study proposes two objectives. The first objective was to assess the levels of PA and self-concept during the transition from high school to university. The second objective was to analyze relationships between the level of PA and the self-concept dimensions.

MATERIALS AND METHODS

Participants and Procedure

We selected the school participants by a cluster sampling, taking into account the population from high schools and colleges situated in the South of Spain and in the North of Portugal. Initially, the recruitment of students was carried out through the same protocol in both countries. Twelve high schools (six from Spain and six from Portugal) and eight colleges (four from Spain and four from Portugal) were selected at random. All of them agreed to participate in the study except for one college in Portugal. Subsequently, the web link was sent to 400 high school students (200 from Spain and 200 from Portugal) and 400 university students (200 from Spain and 200 from Portugal). Of the total number of students, 311 from Spain and 163 from Portugal completed it. Finally, 34 participants were eliminated because of insufficient completion of the different instruments, leaving an uncompleted response rate of 7.17% (**Figure 1**). Our final sample consisted of 300 Spanish students [mean (*M*) age = 17.9, standard deviation (SD) = 3.4 years; weight *M* = 65.1, SD = 12.0 kg; height *M* = 171.2, SD = 9.2 cm] and 140 Portuguese students (age *M* = 18.4, SD = 3.1 years; weight *M* = 64.2, SD = 9.7 kg; height *M* = 170.3, SD = 9.5 cm). The participants were studying from the last two grades of the high school (before the transition) until the first two grades of university (after the transition). Their ages ranged from 16 to 21 years.

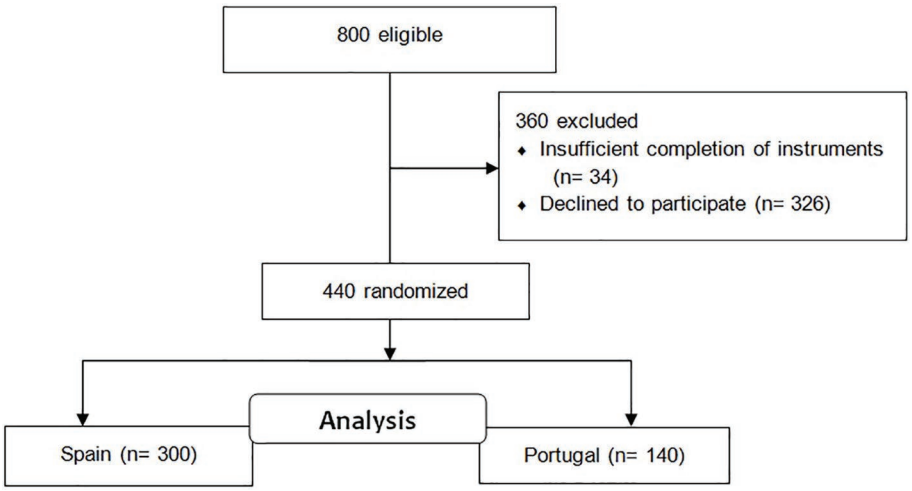

FIGURE 1 | Flow diagram of recruitment of participants.

A cross-sectional, descriptive, and observational quantitative methodology was used in this study. The parents, in the case of the high school students, were informed of the aims and signed the consent form prior to the participation of the students in this study, and all the participants also gave their written consent to voluntarily participate in the research. The study was approved by the Ethics Committee of the University of Granada (Spain) and followed the guidelines found in the Helsinki Declaration (2013) which establishes ethical principles for investigations using human beings and confidentiality. The authors sent an email invitation to participate in the study to the teachers of the institutions. When we received the acceptance to participate by the teacher, we sent the consent so they could sign it. All participants were measured for weight and height. In the case of high schools, these measurements were carried out by the physical education teacher, and in the colleges, the researchers of this study, always through the same instrument. Once we had the physical and socio-demographic characteristics, they were able to carry out the questionnaires *via* the Internet that were provided through the media of the groups. They received this email invitation that contained the web link to the study with aims and tests of the study. The identification of the student was never requested.

Instruments

Physical and social-demographic characteristics were collected from the participants through an ad-hoc test with questions regarding age, weight, height, sex, grade, and educational level. Electronic scale SECA (Hamburg, Germany) was used to measure body weight to the nearest 100 g and height was measured to the nearest 0.1 cm with a SECA electronic stadiometer (Seca Ltd., Medical Scales and Measurement Systems, Birmingham, United Kingdom). After that, we could calculate the overweight level of the participants using BMI according to Cole et al. (2000) and World Health Organization (2016) classification system (normal-weight if BMI < 25.0 kg·m^{-2}; overweight if BMI ≥ 25.0 kg·m^{-2}).

The Self-Concept Questionnaire, called Form 5, was validated for the Spanish sample (García and Musitu, 2001; level of reliability = 0.85), is based on the theoretical model created by Shavelson et al. (1976), and consists of five subscales, each one measured by six items: academic/occupational (items 1, 6, 11, 16, 21, and 26), social (items 2, 7, 12, 17, 22, and 27), emotional (items 3, 8, 13, 18, 23, and 28), family (items 4, 9, 14, 19, 24, and 29), and physical (items 5, 10, 15, 20, 25, and 30). In this way, using a Likert-type scale from 1 to 99, one single instrument measures the principal dimensions of self-concept (Grandmontagne and Fernández, 2004). In this study, the reliability level was $\alpha = 0.859$ (higher than original version with 0.810), where all the dimensions had optimized values (academic, $\alpha = 0.898$; social, $\alpha = 0.878$; emotional, $\alpha = 0.858$; family, $\alpha = 0.882$; physical, $\alpha = 0.779$).

To measure PA levels, participants completed the International Physical Activity Questionnaire-Short Form (IPAQ-SF; Booth, 2000). This questionnaire has been validated in different countries (Craig et al., 2003), and it has shown acceptable psychometric properties to assess PA levels with good reliability, as the Spearman correlation coefficient values are around 0.8. The Spanish IPAQ-SF reliability for measuring PA levels used for both high school and university students has been assessed and verified ($r = 0.49$, $p < 0.001$; Rodriguez-Muñoz et al., 2017). According to the official IPAQ scoring protocol, we calculated total daily PA by summing the product of reported time in PA level and sitting time.

Statistical Analysis

The influences of the country (Spain and Portugal) and the educational stage (high school and University) factors on academic, social, emotional, family, and physical dimensions of self-concept and PA variables [VPA, MPA, walking activities (WPA), and sitting time] were analyzed using two-way ANOVA after checking the normality and homogeneity assumptions (Pallant, 2011). A Bonferroni correction *post hoc* was performed to make comparisons between groups. Furthermore, an

independent samples *t*-test (not paired samples *t*-test) was used for educational stage as an independent variable (using the last grade of high school and the first year at university) after validating normality and homogeneity assumptions (Pallant, 2011). The effect size was presented as η^2 for a two-way ANOVA test and interpreted using the follow criteria: minimum effect ($\eta^2 \leq 0.02$), moderate effect ($0.02 < \eta^2 \leq 0.09$), and strong effect ($\eta^2 > 0.09$) (Lakens, 2013). For the case of independent samples *t*-test, Cohen's *d* was executed as effect size using the follow criteria: small effect ($d < 0.20$), moderate effect ($0.20 \leq d < 0.80$), and large effect ($d \geq 0.80$) (O'Donoghue, 2013). Finally, correlational analysis (Pearson's test) was carried out in order to assess the relationship between the self-concept dimensions and the PA variables. The data analysis was conducted using IBM SPSS (version 24.0) software for Windows and a statistical significance of 5% ($p < 0.05$) was defined.

RESULTS

In this section, we consider high school Spanish students (HS), university Spanish students (US), high school Portuguese students (HP), and university Portuguese students (UP). There was significant interaction (**Table 1**) between country and educational stage for academic self-concept ($F_{(1,440)} = 5.828$; $p = 0.016$; $\eta^2 = 0.013$; small effect size); emotional self-concept ($F_{(1,440)} = 8.879$; $p = 0.003$; =0.020; small effect size); physical self-concept ($F = 26.135$; $p = 0.001$; $\eta^2 = 0.057$; moderate effect size); VPA ($F_{(1,440)} = 69.646$; $p = 0.001$; $\eta^2 = 0.138$; large effect size); MPA ($F_{(1,440)} = 25.416$; $p = 0.001$; $\eta^2 = 0.055$; moderate effect size); WPA ($F_{(1,440)} = 5.26$; $p = 0.022$; $\eta^2 = 0.012$; small effect size); and sitting time ($F_{(1,440)} = 28.234$; $p = 0.002$; $\eta^2 = 0.061$; moderate effect size). In this case, an independent sample *t*-test was used for educational stage, with the observed groups being the last grade of high school and the first year at the university [**Figure 2A** (self-concept dimensions) and **Figure 2B** (PA variables)]. The academic and emotional dimensions and the sitting time were lower at university, although the MPA was higher ($p < 0.05$).

Finally, correlational analysis is shown in **Table 2**. Bivariate correlation analysis revealed that physical self-concept was positively related to VPA and MPA and negatively related to sitting time both in high school and university (with a greater correlation coefficient for VPA). Furthermore, VPA and MPA were negatively associated with the academic (high school) and emotional self-concept dimensions.

DISCUSSION

The purpose of the present study was, first, to evaluate the levels of practice of PA and self-concept in high school and university students, and second, to find relationships between these psycho-physical variables. The results indicated that there are differences of self-concept dimensions and PA variables between countries and educational stages. On the one hand, university Spanish students had lower self-concept scores

TABLE 1 | *t*-Test between high school and university students for the self-concept and PA variables, and two-ways ANOVA test (the three final columns) between country and educational stage factors.

		Spain		*p*	*d*	Portugal		*p*	*d*	$F_{(1,440)}$	p^*	η^2
		High school	University			High school	University					
Academic	(Points)	76.58 ± 15.14[a]	75.43 ± 11.94[a]	0.452	0.082	77.23 ± 7.66	69.23 ± 13.04	0.000	0.734	5.665	0.001	0.038
Social	(Points)	79.51 ± 14.07	78.91 ± 12.22	0.691	0.045	71.37 ± 12.44	74.54 ± 12.43	0.161	0.254	7.247	0.000	0.047
Emotional	(Points)	49.36 ± 24.69[b]	42.98 ± 19.11[b]	0.010	0.280	67.90 ± 6.67	48.34 ± 17.55[b]	0.000	1.434	19.207	0.000	0.117
Family	(Points)	84.76 ± 13.36	86.04 ± 9.93	0.331	0.105	88.65 ± 4.24	86.05 ± 10.11	0.060	0.327	1.839	0.139	0.012
Physical	(Points)	66.36 ± 18.87[c,b]	74.23 ± 11.02[b]	0.000	0.481	81.43 ± 6.75	72.41 ± 16.05[b]	0.000	0.714	16.529	0.000	0.102
VPA	(min·day^{-1})	22.46 ± 18.53[c]	38.73 ± 13.75	0.000	0.481	24.81 ± 17.72[c]	18.99 ± 17.30[c]	0.068	0.333	71.452	0.001	0.330
MPA	(min·day^{-1})	13.23 ± 12.89[c]	24.77 ± 13.53	0.000	1.426	13.68 ± 7.99[c]	17.11 ± 17.41[c]	0.155	0.247	45.418	0.001	0.238
WPA	(min·day^{-1})	25.25 ± 10.55	30.13 ± 10.71[d]	0.000	1.216	10.75 ± 7.60[c,d]	18.57 ± 14.23[b,c,d]	0.000	0.672	66.651	0.001	0.314
Sitting time	(min·day^{-1})	397.7 ± 208.8	251.2 ± 114.5[d]	0.000	0.975	225.6 ± 88.49[d]	270.7 ± 166.6[d]	0.059	0.332	28.526	0.001	0.164

*VPA, Vigorous physical activity; MPA, Moderate physical activity; WPA, Walking physical activity. *Two-ways ANOVA: significantly different at p < 0.05 compared with (Bonferroni Post hoc), [a]UP (academic self-concept; WPA). [b]HP (emotional self-concept; physical self-concept). [c]US (physical self-concept; VPA; MPA; WPA). [d]HS (WPA; sitting time).*

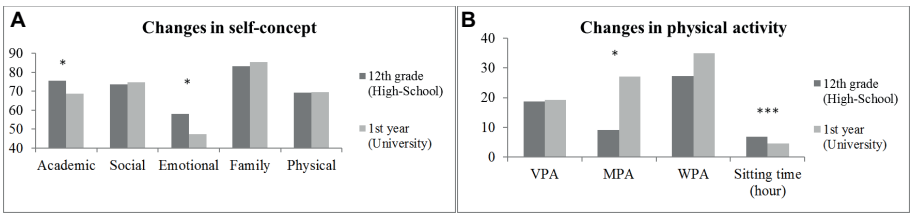

FIGURE 2 | (A) Changes in self-concept by grades. **(B)** Changes in physical activity by grades. *$p < 0.05$; ***$p < 0.001$.

TABLE 2 | Correlational analysis.

		Academic	Social	Emotional	Family	Physical
VPA	(High school)	–0.032	–0.020	–0.173**	0.059	0.288**
	(University)	0.153*	0.170*	–0.224**	0.112	0.204**
MPA	(High school)	–0.194**	–0.117	–0.160*	–0.016	0.129*
	(University)	0.029	0.017	–0.111	–0.076	0.019
WPA	(High school)	0.083	0.275**	–0.054	0.046	–0.161*
	(University)	0.251**	0.122	–0.215**	0.230**	0.126
Sitting time	(High school)	–0.075	0.044	0.082	–0.093	–0.283**
	(University)	–0.160*	–0.228**	–0.301**	–0.024	–0.056

*$p < 0.05$; **$p < 0.01$. *VPA, Vigorous physical activity; MPA, Moderate physical activity; WPA, Walking physical activity.*

(small effect size) although higher practice of PA and lower sitting time (large effect size) than high school Spanish students. On the other hand, university Portuguese students had lower self-concept scores (large effect size) and VPA, although higher sitting-time, WPA, and MPA (moderate effect size) than high school Portuguese students. This is in accordance with the scientific literature which shows that this educational transition could suppose important changes in adolescents, especially psychological and emotional changes (Ullrich-French et al., 2013; Akos et al., 2015). The sources of these psychosocial changes are, among others, the appearance of stress, social problems (friends or family), and physical changes characteristic of this age, which all affect personality development. Hagger et al. (2005) indicated that although there were also some statistically significant decreases in self-concept ratings across grade, the effect sizes were small and offered little evidence for developmental changes in physical self-concept. In this study, the effect size was large in both populations, although the tendency in Spanish students was increasing, and in Portuguese students, it was decreasing with respect to physical self-concept.

The university Spanish students had higher practice of PA in general (VPA, MPA, and less time sitting). These results differ from those found in the studies by Cocca et al. (2014) and Sevil et al. (2018), who observed lower scores in the practice of PA in university students, as occurred with the Portuguese students in our study. This could be due to the students' discipline of studies (science vs. humanities), mode of transport from residence to the campus, and in general, available free time. These changes in lifestyle can provoke personal, emotional, and social changes which may be manifested in tobacco and alcohol consumption, diet, and time spent sitting in front of the television (Romaguera et al., 2011). This, in turn, has the immediate consequence of a reduction in the emotional dimension of self-concept (appearing in all the students) and in the academic dimension (seen in the Portuguese university students), which ends up producing a change in personality (Slutzky and Simpkins, 2009). Nevertheless, the Spanish university students, in comparison with their high school counterparts, reduced their sitting time in favor of increasing their practice of PA.

This study also examined the differences in the existing associations between the psycho-physical variables found in both educational stages (high school and university). In a concrete way, there are several correlations between specific dimensions of self-concept and PA variables. This fact has been studied through various contributions by Marsh (Marsh and Redmayne, 1994; Marsh and Martin, 2011; among others), which confirms the causal existence and effects between this construct and the PA or physical fitness of children and adolescents. However, until now, the differences and relationships of these variables have not been described taking into account the educational transition to university, having knowledge of the contextual variables and evolution that this population has. To start, the academic, social, and family self-concept dimensions were positively related to the level of the practice of PA in accordance with other studies (Annesi, 2006; Esnaola and Revuelta, 2009; Contreras et al., 2010; Bean et al., 2012). Higher levels of practice had a positive effect on the social behavior and health of the adolescents (Esnaola et al., 2018). However, these relationships were seen mostly in the university students. In high school students, only the social and physical dimensions were positively related to WPA and VPA, respectively. A possible explanation could be that the mandatory requirement of physical education classes in high school, as opposed to the voluntary practice of PA by university students for social and health reasons,

produces a different effect on self-concept (Roberts et al., 2015). Sevil et al. (2018) conclude that intervention programs are needed to improve sports practice and the dimensions of self-concept in order to maintain or increase the levels of PA during the transition to university for the Portuguese students. On the other hand, the emotional dimension of self-concept was inversely related to VPA in all the students. This may have been due to the anxiety and stress associated with overtraining, or perhaps the type of sport practiced, given that repeated vigorous actions provoke a weakening of mental processes, which ultimately affects the emotional dimension (Strong et al., 2005). Finally, it is necessary to take into account the type of sport practiced, individually or as a team, the duration of the practice, the frequency of sports practice, and adherence. All of these are factors that can affect self-concept to a greater or lesser extent (Berger, 1996).

The present study has some limitations which should be considered in future research, one of which is the limited size of our sample. Even though our study included 440 participants from Spain and Portugal, this number should be increased in order to establish more robust statistical conclusions. Furthermore, the high rate of attrition in the Portuguese sample could be due to lack of interest to participate in the study, since the tests were provided through a web link and thus anonymity was maintained. This problem could have been solved by making some additional reminders or by expanding the sample bias in other universities even if they are more widely spaced. The results demonstrated that the university students had lower self-perceptions than students at the high school, and also it seems to have scarce relation to the practice of PA. Therefore, it is necessary to encourage future longitudinal studies to investigate intra-participant information. In this way, a cause-effect relationship could be confirmed on the generalizable fluctuation of the adolescent's self-concept. In addition, these results provided could be predetermined by other school stages, which strengthens the idea of carrying out future longitudinal studies. Another future line of research could be to investigate the effect of the university transition on males versus females. It is believed that there are differences to consider and discuss due to academic, emotional, and hormonal changes which occur in both sexes at these ages. Finally, it is possible to broaden the study by evaluating the relationship between levels of obesity and self-concept dimensions before and after the transition to university. The hypothesis would be that since these students have lower self-concept (than their normal-weight counterparts) in the physical, emotional, and social dimensions before the transition, the reduction in self-concept after the transition would possibly be lower.

In conclusion, the main findings of this study indicate that, on the one hand, the academic, emotional, and physical dimensions of self-concept and in the level of PA are lower in university students, admitting certain differences in the two countries studied. On the other hand, there exists a positive relationship between the self-concept dimensions in general and the level of practice of PA, and conversely, a negative relationship between the self-concept dimensions and the amount of time the adolescent spends sitting. In addition, all measures were self-reported and, as such, they could be biased upwards. For this reason, these results and the conclusions of this study should be taken into consideration with caution. Although the results provided correspond to different samples (inter-participant differences) where the independent variable has not been manipulated, we consider that these results could be supported by others whose study belongs to a longitudinal design. These results reinforce the need to promote active lifestyles in adolescents with the objective of enhancing his well-being and development in this stage of his life. The practical application of these findings is to serve as a stimulus for the promotion of the practice of PA during the transition to university, as it is a critical period in the life of adolescents.

ETHICS STATEMENT

The study was approved by the Ethics Committee of the University of Granada (Spain) and followed the guidelines found in the Helsinki Declaration (2013) which establishes ethical principles for investigations using human beings and confidentiality.

AUTHOR CONTRIBUTIONS

WO-O and AC-R contributed conceptualization, data curation, methodology, project administration, resources, supervision, validation, writing – original draft and review and editing. JC-M and FM contributed formal analysis, funding acquisition, investigation, methodology, project administration, resources, supervision, visualization, writing – original draft and writing – review and editing.

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Effect of Physical Activity on Self-Concept: Theoretical Model on the Mediation of Body Image and Physical Self-Concept in Adolescents

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Objective: The aim of this research was to study the mediation of body dissatisfaction, physical self-concept, and body mass index (BMI) on the relationship between physical activity and self-concept in adolescents.

Materials and Methods: A sample of 652 Spanish students between 12 and 17 years participated in a cross-sectional study. Physical self-concept and general self-concept were assessed with the Physical Self-Concept Questionnaire (CAF), body dissatisfaction with the Body Shape Questionnaire (BSQ), and physical activity was estimated with the International Physical Activity Questionnaire (IPAQ-SF). BMI was utilized as a measurement of body composition. Structural equation modeling was used to assess the results.

Results: The resulting models showed good fit indexes. Final model for all participants explained the 17% of the variance of body dissatisfaction, 57% of physical self-concept, and 60% of general self-concept. Physical activity had a positive and indirect effect on self-concept ($\beta = 0.29$, $p < 0.01$) and direct effects on body dissatisfaction ($\beta = -0.26$, $p < 0.01$) and physical self-concept ($\beta = 0.20$, $p < 0.01$). BMI had a direct effect on body dissatisfaction ($\beta = 0.31$, $p < 0.01$) and on physical self-concept ($\beta = -0.10$, $p < 0.01$) and an indirect effect on general self-concept ($\beta = -0.24$, $p < 0.01$). However, it was only associated with physical activity in males, playing a mediating role between physical activity and body dissatisfaction.

Conclusion: Physical activity can help individuals to achieve a positive self-concept and promote psychological well-being in adolescents through the improvement of physical perceptions and body satisfaction. The importance of BMI, body dissatisfaction, and physical self-concept on the configuration of the self-concept is also emphasized. Educational policymakers and Physical Education teachers should implement strategies to promote physical activity in the schools and provide a Quality Physical Education programs to increase physical activity during adolescence.

Keywords: physical activity, self-concept, physical self-concept, body image, structural equation model, adolescence

INTRODUCTION

Mental health has become a public health issue among youth all over the world, having reached a 20% prevalence rate within this population (World Health Organization, Department of Mental Health, Substance Abuse, World Psychiatric Association, International Association for Child, Adolescent Psychiatry, and Allied Professions, 2005; Belfer, 2008). In this line, physical activity (PA) is considered as one of the most important factors in the prevention and treatment of these kinds of issues (Ahn and Fedewa, 2011). Research has shown that PA can provide physiological and psychological benefits (Brown et al., 2013) related to mental health (Penedo and Dahn, 2005), including a reduction in depression and anxiety and an increase in executive function (Davis et al., 2011), psychological well-being (McMahon et al., 2017), body satisfaction (Campbell and Hausenblas, 2009), and self-concept (Marsh and Peart, 1988). Indeed, self-concept is especially relevant during the school ages, as it is considered to be a primary educational aim due to its general effects on mental status, psychological well-being, and human behavior (Rosenberg, 1985).

Many studies have associated the practice of PA with self-concept. Meta-analyses confirmed these positive relationships in PA program-based interventions aimed at improving self-concept (Liu et al., 2015), as well as in observational studies (Babic et al., 2014). However, some results seem contradictory; many studies proved that PA is positively related to self-concept (Sonstroem, 1997; Beasley and Garn, 2013; Sani et al., 2016), while others did not report that association (Annesi, 2006; Robinson et al., 2010) or made that relationship conditional on other mediating factors. For instance, some studies found that the positive relationship between PA and self-concept relied on the kind of sport practiced (Slutzky and Simpkins, 2009; Fernández-Bustos et al., 2010), only occurred among girls (Noordstar et al., 2016) or only among boys (Altıntaş et al., 2014), or was conditional based on body mass index (BMI) (Reddon et al., 2017).

Either way, according to the multidimensional and hierarchical conceptualization of self-concept (Shavelson et al., 1976), the possible effect of PA on the self-concept is mediated by one of its domains, the physical self-concept (Sonstroem, 1997; Slutzky and Simpkins, 2009). Under this theory's umbrella, Sonstroem and Morgan (1989), and later Sonstroem et al. (1994), proposed the exercise and self-esteem model (EXSEM) to explain how PA influenced self-esteem. According to this model, participating in physical activities increases the feelings of self-efficacy, improving the perceptions of sports competence and physical acceptance; in turn, this would foster general self-esteem. This model, besides having been empirically demonstrated by its authors, has been confirmed in other studies (McGannon and Spence, 2002; Murgui et al., 2016; Noordstar et al., 2016).

Body image (BI) is one of the most influential factors impacting psychological well-being, which determines the configuration of self-concept, particularly during adolescence (Thompson and Smolak, 2001; Fenton et al., 2010). Numerous studies focused on the idea that body satisfaction positively influences self-concept, as feeling comfortable with one's body produces overall positive feelings (Van den Berg et al., 2010; Buchanan et al., 2013; Fernández-Bustos et al., 2015). Nevertheless, body dissatisfaction levels are high during adolescence, especially among girls (Kantanista et al., 2015).

Likewise, another matter of concern for researchers has been how PA influences BI. A large amount of scientific literature has focused on proving how sports and PA are associated with an improved BI (Añez et al., 2018) or how sports and PA-based interventions can be utilized to improve BI (Martin-Ginis et al., 2014). Various meta-analyses and reviews have been carried out on this subject and, although it is accepted that the relationship between BI and PA is positive for males and females, the moderator role of sex is not clear. Even though Hausenblas and Fallon (2006) found a greater effect among women when compared with men, other reviews failed to find gender differences (Campbell and Hausenblas, 2009; Sabiston et al., 2018). Notwithstanding, McIntosh-Dalmedo et al. (2018) did not find enough evidence to suggest that sport- and exercise-based interventions could improve BI among female adolescents. Even so, the generalization of the findings has been disproportionately focused on women. Only one study precisely focused on men and boys (Bassett-Gunter et al., 2017), and its results showed that a positive BI was associated with a greater participation in PA. Although some mechanisms are likely to be shared between males and females, it is also possible that there is the existence of unique mechanisms. For example, a study conducted by Martin-Ginis et al. (2005) identified sex differences on the mechanisms underlying changes as a result of PA. Therefore, it is necessary to develop a better comprehension of the mechanisms underlying the effects of PA on BI between males and females.

Meta-analyses and reviews limit the whole understanding of the research into this subject, as these follow a unidirectional framework where PA improves BI, with a gap in the bidirectional nature of these associations. Unfortunately, there is no explicit theory or framework to guide the research on PA and BI. Consequently, some authors have tried to work upon the basis of other models. For instance, Martin-Ginis et al. (2012, 2014) tried to operationalize the EXSEM model (Sonstroem and Morgan, 1989), which was initially designed to describe the effects of PA on self-esteem in an effort to understand how PA has an impact on BI.

In spite of the major relationships that may exist between BI, self-concept, and PA, only a few studies have analyzed them concurrently. Fraguela-Vale et al. (2016) found that the practice of PA was simultaneously associated with both better perceptions of BI and a higher satisfaction with oneself. Blanco-Ornelas et al. (2017) showed that regular PA had an indirect and positive effect on personal self-concept through the subjective importance of physical fitness and appearance. However, Fernández-Bustos et al. (2016) found a relationship between PA and self-concept, but not between PA and physical appearance among female adolescents with body dissatisfaction. In addition to these studies, which are mainly correlational, stronger theories are needed to help us to understand the relationship between the practice of PA and self-concept and BI's role in these associations.

Therefore, this study aimed to determine the importance of PA in the configuration of self-concept in adolescents and the possible mediating role of BI and physical self-concept through a theoretical model. Additionally, we also studied the possible direct and indirect relationships between the different variables included in the model. To accomplish this objective, a new predictive model was designed by considering the EXSEM model (Sonstroem and Morgan, 1989) and a modification of Martin-Ginis et al. (2012), with the inclusion of BMI as a mediating variable. Alternative additional models were tested by sex to anticipate possible differences due to the uneven PA participation and body dissatisfaction (BD) between males and females. Moreover, adolescence is an essential period for the study of these constructs, as it is a sensitive stage for the self-concept and BI configuration and a consolidating period for lifelong PA habits.

MATERIALS AND METHODS

Participants

A total of 652 students (296 male and 356 female), aged between 12 and 17 years, participated in this study. They represented approximately 80% of the youth population of La Roda (Spain). These were all the students who were available during the day of the data collection and whose parents had previously signed an informed consent for participation. Eighteen cases were excluded for some errors in data completion or data tabulation. Therefore, the final sample included in the data analyses consisted of 634 participants (284 male and 350 female).

This is an appropriate sample size for avoiding inaccurate estimates of standard errors and fit indexes, according to the criterion proposed by Jackson (2003) for structural equation modeling (SEM). This author suggested that an ideal sample size should meet the ratio of 20 cases per each parameter to be estimated in the model or a less ideal ratio of 10 cases per parameter. Considering that our larger model contained 24 parameters to be estimated, the range of the ideal sample size would be between 240 and 480 participants.

Measures and Materials

General Self-Concept and Physical General Self-Concept

Two scales from the Physical Self-Concept Questionnaire (CAF) designed by Goñi et al. (2004) were utilized to assess the general physical self-concept (GPSC) and the general self-concept (GSC). This is the only physical self-concept questionnaire elaborated in Spanish without following any back-translation process. The questionnaire is completed by answering questions on a 5-point Likert scale (1 = false, 2 = usually false, 3 = sometimes true/sometimes false, 4 = usually true, 5 = true). Regarding the GPSC, students answered six items about their positive opinions and feelings (happiness, satisfaction, pride, and confidence) in the physical domain (e.g., "Physically, I am satisfied with myself"). With regard to the GSC, participants showed their overall satisfaction with their own selves and life by answering another six items (e.g., "I feel annoyed with myself"). The total questionnaire's reliability coefficient (Cronbach's alpha) for this study sample was $\alpha = 0.95$. By scale, it reached a reliability of $\alpha = 0.89$ for GPSC scale and $\alpha = 0.77$ for the GSC scale.

Body Dissatisfaction

The Body Shape Questionnaire (BSQ) by Cooper et al. (1987), adapted into the Spanish context (Raich et al., 1996), was used to assess body dissatisfaction (BD). The BSQ measures dissatisfaction of one's body, the fear of weight gain, physical appearance self-devaluation, the desire for weight loss, and the avoidance of situations in which one's physical appearance could get attention from others (e.g., "Have you been so worried about your shape that you have been feeling you ought to diet?"). The BSQ is a 34-item self-administered questionnaire with a 6-point Likert scale (i.e., 1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = very often, 6 = always). Concern about body image was determined from the total score of this questionnaire (scores >81). For this study sample, the internal consistency was $\alpha = 0.97$.

Body Mass Index

A calibrated digital scale with a sensibility of 0.1 kg (Tanita UM-075) and a 2-meter altimeter (Holtex) were used to measure each participant's weight and height, respectively. These measurements were collected by two ISAK level 1 researchers to calculate the participants' BMI. Students were measured and weighted barefooted and wearing light clothes (no long trousers or sweaters were allowed). The body weight and height of each participant were measured twice, and the average between both was taken. To standardize the BMI values, participants were classified according to the cut-offs of the International Obesity Task Force (IOFT) (Cole and Lobstein, 2012) for their corresponding age and sex.

Physical Activity

The short form of the International Physical Activity Questionnaire (IPAQ-SF) was utilized to estimate PA levels. This self-reported measurement has shown reliability and validity within different contexts (Craig et al., 2003), including with the Spanish adolescent population (Aibar et al., 2016). For this study, only data on frequency and duration of both, moderate PA and vigorous PA, were considered. Light PA was therefore disregarded. With these data, a score of accumulative total weekly minutes of moderate and vigorous PA was calculated.

Procedure

The present study followed a cross-sectional design. Participants were recruited from the entire population of high school students in a Spanish city (La Roda). Prior to data collection, we informed the participants and their parents about the

research aims, procedures, risks, and benefits of the study, and we obtained the required consent from the corresponding educational boards, high schools administrations, and parents of the students. Participation was voluntary with the parents' consent, and the anonymity of the participants and data confidentiality were guaranteed during the whole process. The study conformed to the deontological guidelines defined by the Declaration of Helsinki (Hong-Kong revision, 1989) and followed the recommendations of the Good Clinical Practice in the European Community (1 July 1991, document 111/3976/88) and the Spanish legislation on human clinical research (Royal Decree 561/1993 on clinical trials). The protocol was approved by the Ethics Committee on Human Research (University of Castilla La Mancha).

Questionnaires were administered in groups of 20–30 students in the assembly room of the high school (with a seating capacity of 350 people), which improved the concentration and privacy of the participants. Guidelines for fulfilling the questionnaires were verbally explained and were also written out before the start of the study. The proctors highlighted the need for the participants to carefully review each item and give sincere answers. To avoid social desirability in the answers, researchers insisted on the fact that the questionnaires were anonymous. The average duration of questionnaire fulfillment was 20 min, but the participants were given 25 min to complete the questionnaire. Once the questionnaires were completed, the students were led one by one to an adjoining room where they were weighted and measured by two expert researchers. During this process, the privacy and confidentiality of their data were similarly guaranteed.

Data Analysis

Structural equation modeling was used to analyze the data according to a predictive model. All statistical analyses were run using SPSS 24 and AMOS 24 for Windows.

Assumptions of linearity and multicollinearity were examined by inspecting the matrix scatter charts and the condition and variance inflation factor (VIF) indexes. These were obtained by using a regression analysis, with GSC as the dependent variable. The Durbin-Watson statistic was 1.88, so the variables were independent. All condition indexes were less than 7.34, except for BD (16.85), and the higher VIF value was 1.87; therefore, multicollinearity could be discarded. Finally, univariate kurtosis (range: −0.89 and 0.57) and skewness (range: −1.26 and 1.16) were examined. Although their values were not extreme, multivariate assumption was not strictly met. Nevertheless, Mardia's coefficient of multivariate kurtosis (14.95) was far from the cut-off of 70, so the use of maximum likelihood (ML) as a method of estimation was appropriate (Rodríguez and Ruiz, 2008). ML is robust to the non-normality, especially since the sample size is large (Iacobucci, 2010). To deal with this strict non-normality, SEM analysis was completed with a 1,000 replication bootstrap with a 95% bias-corrected confidence interval.

The proposed initial model and the subsequent ones included BMI and weekly minutes of PA as observable variables, while BD, GPSC, and GSC were considered latent variables with the items of the scales as their estimators. Concretely, the BD had the sum of the 34 items of BSQ as the only one indicator for this latent variable. Therefore, to achieve an identified initial model, the error's variance of the BSQ had to be estimated from its internal consistency coefficient and its variance by following Kline's (2011) suggestions. The initial model contained all theoretically possible paths (later explained) and, from this model, different nested models were proposed by following a trimming model process (Kline, 2011).

To test the fit of the models, chi-squared (χ^2), chi-squared by degrees of freedom ratio (χ^2/df), goodness of fit index (GFI), and root mean square error of approximation (RMSEA) were used as absolute fit indexes. Incremental or comparative fit indexes were also considered by including the Tucker-Lewis index (TLI) and the comparative fit index (CFI). Finally, regarding the parsimony-adjusted index, the Akaike's information criterion (AIC) and normed fit index (NFI) were used. A χ^2/df ratio < 3 was considered as acceptable (Iacobucci, 2010). Values >0.90 were considered as acceptable and > 0.95 as optimal for the NFI, TLI, GFI, and CFI indexes; for the RMSEA, the cut-off values were < 0.5 or < 0.6 as good and < 0.08 as acceptable (Hu and Bentler, 1999; Schumacker and Lomax, 2010).

RESULTS

Participants

The characteristics of the participants are shown in **Table 1**. They had an age range of 12–17 years, with a mean age of 14.59 (SD = 1.51). The weekly minutes of PA of the males was triple the time of PA undertaken by the females (♂ M = 281.46, SD = 203.19; ♀ M = 90.45, SD = 137.10). Both the GPSC and GSC were high among the males and significantly greater than among the females ($p < 0.001$). Similarly, the females were more concerned about their bodies than the males ($p > 0.001$), reaching a mean score of 85.14, which exceeded the cut-off value for body image concern of BSQ (>81).

TABLE 1 | Characteristics of the participants.

	Male (n = 284)		Female (n = 350)		All (n = 634)		
	M	SD	*M*	SD	*M*	SD	*p*
Age	14.50	1.51	14.66	1.50	14.59	1.51	0.177
BMI	22.36	3.93	21.81	3.64	22.05	3.78	0.069
PA minutes per week	281.46	203.19	90.45	137.10	176.01	194.57	0.000**
GPSC	23.88	5.26	19.67	6.49	21.56	6.32	0.000**
GSC	24.66	4.38	22.30	5.10	23.36	4.93	0.000**
BD (BSQ)	54.41	26.80	85.14	39.99	71.37	37.91	0.000**

*BMI, body mass index; PA, physical activity; GPSC, general physical self-concept; GSC, general self-concept; BD, body dissatisfaction. M, mean; SD, standard deviation. *p < 0.05; **p < 0.01; ***p < 0.001.*

Structural Models

The initial model (model A1; **Figure 1**) starts at the integration of the following theories and models:

1. The EXSEM model (Sonstroem and Morgan, 1989), which established the GPSC as a mediator between the effects of PA on GSC.
2. The operationalization of the EXSEM, which highlights that the effect of PA on GSC is mediated by body satisfaction and physical perceptions (Martin-Ginis et al., 2012, 2014).
3. The model hypothesized by Fox and Corbin (1989), which reflects the multidimensional and hierarchical nature of physical self-concept by placing the perceptions of physical attractiveness as one of its dimensions. Considering body image as a dimension of physical self-concept (Fernández-Bustos et al., 2015), body satisfaction should be a mediator between PA and physical self-concept.
4. The BMI as an exogenous self-contained variable influencing body satisfaction.
5. The model of Mak et al. (2016) suggests that BMI is a mediator between PA and self-esteem.
6. Additionally, for the initial model, the possible direct effects of PA and BD on GSC were included.

The initial model fit could be improved (**Table 2**), as χ^2/df exceeded the established cut-off (χ^2/df = 3.21; GFI = 0.976; RMSEA = 0.059; CFI = 0.974; TLI = 0.956; NFI = 0.963; AIC = 115.48), and four paths reported nonsignificant effects. Therefore, we continued with the model trimming process. First, this study found no relationship between PA and BMI. Since in other studies (Kantanista et al., 2015; Sani et al., 2016) this relationship was also nonsignificant, it was excluded (model A2). This slightly improved the model fit, but the ratio χ^2/df continued to exceed the established threshold. After that, a third model (model A3) was tested by removing the effect of PA on GSC from model A2, which was the next most nonsignificant path. This step was supported by hypotheses holding that this effect is not direct but through the physical self-concept (Sonstroem and Morgan, 1989). This modification also slightly improved the model fit reaching an acceptable value of χ^2/df (2.968). Model A3 did not show a significant effect of BD on GSC. The nonexistence of this path would support the multidimensional, hierarchical conceptualization of self-concept, where BI would be a subdimension of GPSC and an influence through the GPSC (Fox and Corbin, 1989). Thus, another model (model A4) that excluded this effect was tested, showing an optimal fit (χ^2/df = 2.90; GFI = 0.975; RMSEA = 0.054; CFI = 0.975; TLI = 0.962; NFI = 0.962; AIC = 111.66) and significant effects for all the included paths (**Figure 2; Table 2**). After comparing the last two models, no statistical difference was apparent ($\Delta\chi^2$ = 1.395, Δdf = 1, p = 0.237), so we accepted the model A4 as the final model since it showed a better parsimony fit index (AIC = 111.666).

Standardized regression coefficients for each proposed direct path in the final model reached significance at $p < 0.001$ level. The strongest direct effects were reported for GPSC on GSC (β = 0.78), being positive, and between BD and GPSC (β = −0.64), being negative (**Table 3**). The results also showed that PA positively and directly influenced GPSC (β = 0.20, $p < 0.01$) and indirectly through BD (β = 0.17, $p < 0.01$). Similarly, PA had a direct effect on BD (β = −0.26, $p < 0.01$) and an indirect effect on GSC mediated by GPSC and BD (β = 0.29, $p < 0.01$). The BMI had a direct influence on BD (β = 0.32, $p < 0.01$) and GPSC (β = −0.10, $p < 0.01$) and an indirect effect on GPSC (β = −0.15, $p < 0.01$) and GSC (β = −0.14, $p < 0.01$). The final model explained 60% of the variance of GSC and 57% of the variance of GPSC.

Structural Models by Sex

The initial model A1 was further analyzed to test whether the relationships between PA and GSC were different between males and females. The same procedure was followed from the initial model, but the samples of male (model M1) and females (model F1) were considered separately. The initial models M1 and F1 showed modest fit indexes for both males and females (**Table 2**) and included different nonsignificant paths in each group. For this reason, the design of the subsequent models was different for each group, but in both cases, a model trimming process was used.

Regarding the male sample, the model M1 included three nonsignificant paths: PA→GSC, PA→BD, and BD→GSC.

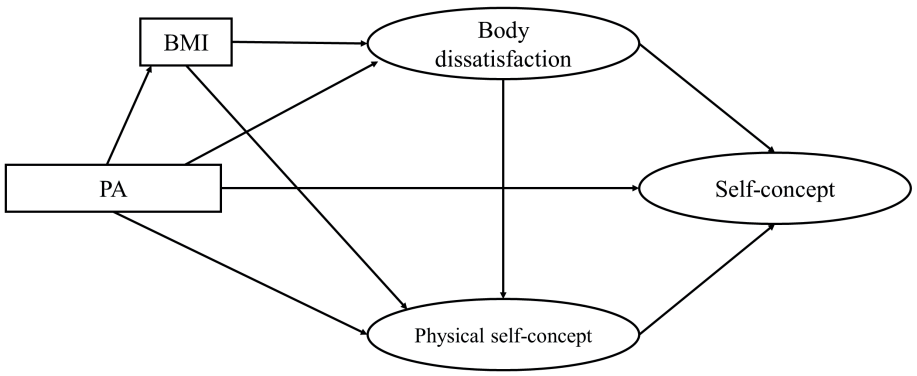

FIGURE 1 | Initial theoretical model (model A1).

TABLE 2 | Fit indexes by model and group.

Model	χ^2	*df*	χ^2/df	GFI	RMSEA	CFI	TLI	NFI	AIC
Model A1	67.487	21	3.213	0.976	0.059	0.974	0.956	0.963	115.487
Model A2	67.877	22	3.085	0.976	0.057	0.974	0.958	0.963	113.877
Model A3	68.271	23	2.968	0.975	0.055	0.975	0.960	0.963	112.271
Model A4*	69.666	24	2.902	0.975	0.054	0.974	0.962	0.962	111.666
Model M1	49.924	21	2.377	0.960	0.069	0.955	0.924	0.927	97.924
Model M2	50.063	22	2.275	0.960	0.067	0.957	0.929	0.927	96.063
Model M3*	50.980	23	2.216	0.960	0.065	0.957	0.933	0.926	94.980
Model M4	57.836	24	2.409	0.954	0.070	0.948	0.922	0.916	99.836
Model F1	40.454	21	1.926	0.974	0.051	0.980	0.966	0.960	88.454
Model F2	40.469	22	1.839	0.974	0.049	0.981	0.969	0.960	86.469
Model F3	40.566	23	1.763	0.974	0.046	0.982	0.972	0.960	84.566
Model F4*	40.936	24	1.705	0.974	0.044	0.983	0.974	0.960	82.936
Model F5	44.616	25	1.784	0.972	0.047	0.980	0.971	0.956	84.616

*A, all; M, males; F, females.*Final model.*

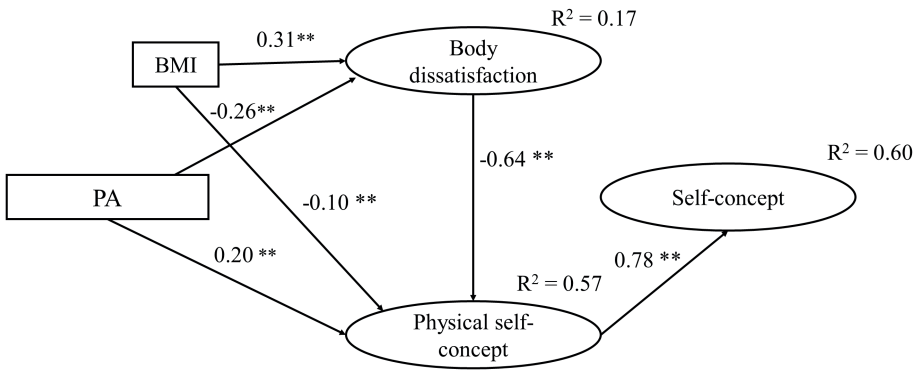

FIGURE 2 | Final theoretical model (model A4) with standardized regression coefficients (betas). *$p < 0.05$; **$p < 0.01$.

TABLE 3 | Standardized regression coefficients (direct, indirect and total effects). Final models.

	Model A4			Model M3			Model F4		
Path	D	I	T	D	I	T	D	I	T
PA→BD	−0.26**	–	−0.26**	–	−0.08**	−0.08**	−0.09	–	−0.09
PA→BMI	–	–	–	−0.20**	–	−0.20**	–	–	–
PA→GSC	–	0.29**	0.29**	–	0.17**	0.17**	–	0.21*	0.21**
PA→GPSC	0.20**	0.17**	0.37**	0.16**	0.07**	0.23**	0.21**	0.07	0.28**
BD→GSC	–	−0.50**	−0.50**	−0.28	−0.29***	−0.57**	–	−0.51**	−0.51**
BD→GPSC	−0.64**	–	−0.64**	−0.44**	–	−0.44**	−0.69**	–	−0.69**
BMI→BD	0.31**	–	0.31**	0.44**	–	0.44**	0.43**	–	0.43**
BMI→GSC	–	−0.24**	−0.24**	–	−0.36**	−0.36**	–	−0.29**	0.29**
BMI→GPSC	−0.10**	−0.20**	−0.30**	−0.17*	−0.19**	−0.36**	−0.10*	−0.29**	−0.39**
GPSC→GSC	0.78**	–	0.78**	0.65**	–	0.65**	0.74**	–	0.74**

*D, direct effects; I, indirect effects; T, total effects; BMI, body mass index; PA, physical activity; GPSC, general physical self-concept; GSC, general self-concept; BD, body dissatisfaction. *p < 0.05; **p < 0.01; ***p < 0.001.*

Therefore, different models were designed by following a procedure similar to the one used with the total sample. Among them, the model M3, which excluded the effects of PA on GSC and BD, showed the best fit (χ^2/df = 2.21; GFI = 0.960; RMSEA = 0.065; CFI = 0.957; TLI = 0.933; NFI = 0.926; AIC = 94.98). This model also included the effect of BD on GSC, whose coefficient was close to the level of significance (β = −0.28, p = 0.05). Additionally, a fourth model (model M4), which excluded that effect, was tested, but it demonstrated worse fit indexes (**Table 2**). As there were no statistical differences between M2 and M3 ($\Delta\chi^2$ = 0.916, Δdf = 1, p = 0.338), we opted for model M3 (**Figure 3**) as the final model for males because it yielded more appropriate RMSEA and AIC fit indexes.

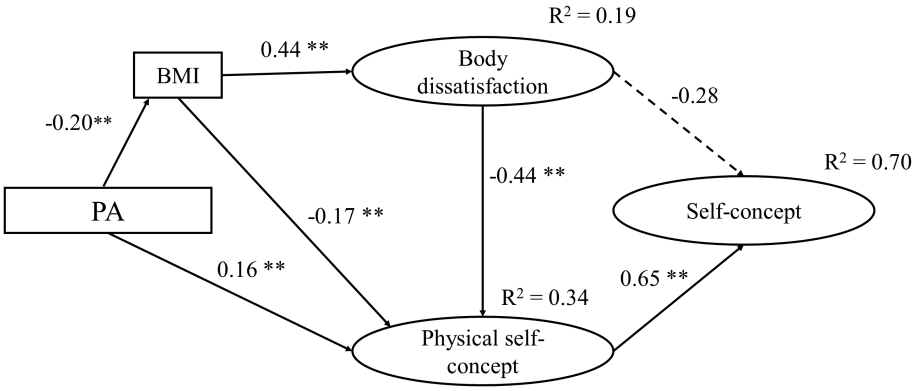

FIGURE 3 | Final model for males (model M3). *$p < 0.05$; **$p < 0.01$.

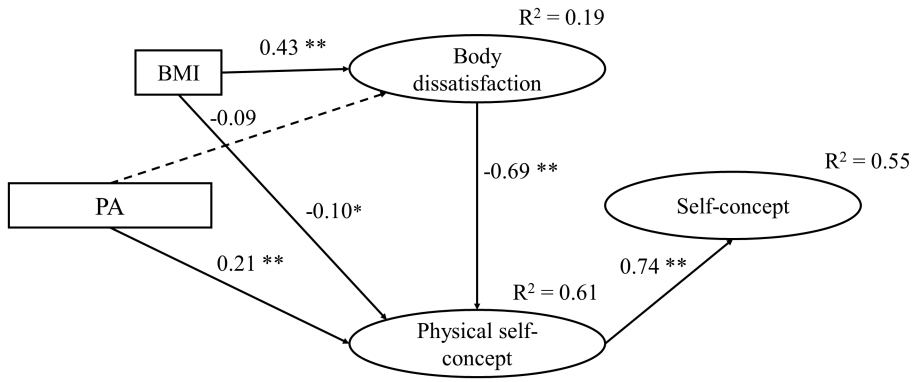

FIGURE 4 | Final model for females (model F4). *$p < 0.05$; **$p < 0.01$.

Concerning the female sample, four models were created in addition to model F1 by following a procedure similar to the one used with the total sample. As in model M1 for males, in model F4 for females, the effect of PA on BD was nonsignificant. Thus, we additionally tested a model F5 excluding that effect. However, the fit indexes were less acceptable than those demonstrated by the previous models (**Table 2**). Model F4 had the best fit ($\chi^2/df = 1.70$; GFI = 0.974; RMSEA = 0.044; CFI = 0.983; TLI = 0.974; NFI = 0.960; AIC = 82.93) and was not statistically different from either model F3 ($\Delta\chi^2 = 0.369$, $\Delta df = 1$, $p = 0.543$) or model F5 ($\Delta\chi^2 = 3.680$, $\Delta df = 1$, $p = 0.055$). Thus, model F4 (**Figure 4**) was selected as the final model for females. This model included the effect of PA on BD, which demonstrated a standardized coefficient very close to significance, but without reaching it ($\beta = -0.10$, $p = 0.05$).

The main differences between the final models (**Table 3**) for males (model M3) and females (model F4) were found in the direct effect of BD on GPSC (♂ $\beta = -0.44$; ♀ $\beta = -0.69$) and the indirect effect of BD on GSC (♂ $\beta = -0.29$; ♀ $\beta = -0.51$). In addition, among males, the path between PA and BMI was also considered. A negative, direct effect was found ($\beta = -0.20$, $p < 0.05$), placing BMI as a mediator between PA and BD; while among women, only a very little and direct effect of PA on BD was found ($\beta = -0.10$, $p = 0.05$). The final model for males explained 34% of the variance of GPSC and 70% of the variance of GSC, while for females, the final model explained 61 and 55%, respectively.

DISCUSSION

The aim of this study was to design a complementary and explanatory model of the relationships between PA and self-concept. For that purpose, BD, which in previous studies had been related to PA, was included in the model as a determining factor in the self-concept configuration of adolescents. GPSC was also included as a mediating variable. BMI was finally added, assuming its influence on PA, BD, and GPSC. Additionally, we aimed to know whether it was possible to yield different models distinguishing by sex. This was especially necessary as it was previously evidenced a higher physical self-concept for males (Hagger et al., 2005) and no clear moderating role of sex appears to exist in the relationship between PA and BI (Bassett-Gunter et al., 2017). This situation is evident from the different influence of the aesthetic model in men and women, which is internalized early, and especially affects females with the impetus to be thin. This makes female adolescents

feel much more dissatisfaction with their bodies than their male peers (Grogan, 2006; Kantanista et al., 2015) and to have lower levels of self-esteem (Robins and Trzesniewski, 2005), as was found in the participants of the present study.

For the design of the initial model, we considered the theory about the effect of PA on self-concept and the effect of PA on BI. We started from an adaptation of EXSEM (Sonstroem and Morgan, 1989) and some aspects from the variant proposed by Martin-Ginis et al. (2012) or the role of BMI on PA and BI (Mak et al., 2016). The possible direct effects among some variables, such as PA and GSC (Sani et al., 2016), were also included. From the initial model, other different models were proposed, and those that yielded the best fit indexes and theoretically coherent were chosen as the final models. In any case, even though the most relevant theoretical aspects coincided, the final models differed between males and females.

In all cases, the important positive effect of PA on the self-concept of adolescents was confirmed, as has been seen in previous studies (Beasley and Garn, 2013; Liu et al., 2015) with no sex differences (Reddon et al., 2017). The suggested models explained more than 50% of the variance of GSC. However, the effect of PA on GSC was not direct but through one of the dimensions of self-concept, the physical self-concept (Sonstroem, 1997). Thus, in line with other studies that included the physical self-concept as a mediating variable, both the hierarchical and multidimensional conception of self-concept (Shavelson et al., 1976) and the EXSEM model are confirmed. Previous studies found a direct association of PA with self-concept but without including physical self-concept in the model (Sani et al., 2016).

Within this hierarchical model, working on GPSC, or some of its subdomains, would be easier than working on the GSC itself. The former's effect on the latter will be based on the importance that each subject confers to the physical domain (Zulaika, 2002). During adolescence, physical self-concept takes on special significance due to the importance conferred to everything that is related to the physical domain since this dimension is one of the most influential factors on the self-concept configuration in youths (Harter, 1999). In this study, that situation can be seen in the emphasized effect of GPSC on GSC in all models, being slightly more important for females.

The most well-known models explaining the physical self-concept (Fox and Corbin, 1989; Marsh et al., 1994) include physical appearance as a subdomain of physical self-concept. BI is closely related to the physical attractiveness domain, understanding the latter as one's perceptions about his/her physical appearance and his/her satisfaction and confidence with his/her self-image (Goñi et al., 2004). Therefore, BI would be a part of physical self-concept (Burns, 1990; Fernández-Bustos et al., 2015). Despite the link between BI and physical self-concept, there are only a few studies that show the relationship between them. The model presented in this study proves the large direct effect of BI on GPSC in adolescence, along with the effect on GSC, which are both very high and indirect. This supports the hierarchical and multidimensional model previously explained. In this way, many studies highlight the important relationship between BD and self-esteem in both males and females (Van den Berg et al., 2010; Fernández-Bustos et al., 2015).

Considering the lack of physical self-concept subdomains other than BI in the suggested model, PA had a positive and direct effect on GPSC, as was supported in all the previous literature, which is reinforced by the results of the meta-analysis carried out by Babic et al. (2014). Similarly, following the hierarchical model, PA indirectly influenced GPSC through its subdimension of BI, as measured by BD.

Regarding the effect of PA on BD, the three final models yielded different results. For all participants, the positive and direct effect of PA on body satisfaction was confirmed (Añez et al., 2018); this effect, however, was more relevant in females than males, which is consistent with Hausenblas and Fallon's (2006) findings. In the case of males, there was no direct effect of PA on BD, but it was mediated by BMI.

BMI was shown as a variable of especial interest in the suggested models. On the one hand, BMI proved that it plays a determining role in body satisfaction (Strauss, 2000), having a negative effect on both males and females. Indeed, high adiposity is thought to be a promoter of body dissatisfaction, as it is opposed to the aesthetic model of males and females. Therefore, the larger the deviation degree from the ideal physical shape, the greater the dissatisfaction with the resulting body (Stice and Shaw, 2002). On the other hand, BMI demonstrated negative direct and indirect effects on the perceptions of GPSC and an indirect effect on GSC. Several studies agreed that there was a relationship between obesity and lower self-esteem and worse physical perceptions (Griffiths et al., 2010; McClure et al., 2010). Altıntaş et al. (2014) considered BMI to be the best predictor of self-esteem and body satisfaction in female adolescents, being slightly less important among males. Sani et al. (2016) tried to create a model to explain the relationships between PA, BI, and self-esteem, but they only found a direct association of BMI with BI and no association with self-esteem.

Nevertheless, even though some studies associated PA with lower values of BMI (Du et al., 2013), in the present study, this was only evidenced in males, in accordance with Kantanista et al. (2015). This result can be explained in view of some evidence among females that associated a higher BMI with higher PA levels triggered by their desire to exercise to lose weight (Ingledew and Sullivan, 2002). Additionally, the possible mediating role of BMI in the relationship between PA and GSC, already hypothesized in previous studies (Reddon et al., 2017), was only supported among males, which is in line with Mak et al. (2016).

In practice, the results of this research should help to explain how the effect of PA on students' BI and self-concept is produced and to place value on the promotion of PA in educational centers. By doing that, educational policymakers will contribute to the development of not only the physical health of adolescents but also their psychological well-being at an educational stage of special difficulty, where PA tends to decrease alarmingly in comparison to early stages. These results are also relevant for Physical Education teachers to stress the importance of optimizing the time of PA during their lessons; the results can be also

useful for providing a Quality Physical Education that makes students improve their physical perceptions, find pleasure in exercise, and achieve autonomous active lifestyle behaviors outside of school.

This study presents some limitations that must be taken into consideration. Among these, the assessment of a unique aspect of BI – the dissatisfaction in terms of weight loss – must be pointed out. This is particularly relevant for males, who presented an aesthetic model that tends to drive for muscularity and away from obesity. That is, BD in terms of desiring a more muscular body has been omitted, and this especially influences males. Another limitation would be the lack of more indicators of PA, in addition to the weekly minutes, as the type of activity (endurance, strength, etc.) may determine the perceptions of BI and the physical self-concept itself.

It is necessary to continue with the study of the moderating effect of sex in the relationship between PA and BI. It is also necessary to examine the potential moderators that are exclusive to male or female samples in future research and interventions. To do so, besides taking into account the differences in the configuration of the body image in both sexes, there is a need to include variables that determine the relationship between PA and BI, such as the aesthetical reasons that lead to the practice of PA or the effect of different types of physical exercises or sports on BI.

CONCLUSION

To conclude, the suggested model put emphasis on how PA is associated with a more positive self-concept during adolescence, although this effect is mediated by both physical self-concept and BI. Likewise, PA is associated with a lower BD, while BMI is shown as an important external variable in the model, whose role varied by sex. The importance of body satisfaction and physical self-concept in the configuration of GSC in adolescents is also highlighted, especially among females.

DATA AVAILABILITY

The raw data supporting the conclusions of this manuscript will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

Prior to data collection, we informed the participants and their parents about the research aims, procedures, risks, and benefits of the study, and we obtained the required consent from the corresponding educational boards, high schools administrations, and parents of the students. Participation was voluntary with the parents' consent, and the anonymity of the participants and data confidentiality were guaranteed during the whole process. The study conformed to the deontological guidelines defined by the Declaration of Helsinki (Hong-Kong revision, 1989) and followed the recommendations of the Good Clinical Practice in the European Community (1 July 1991, document 111/3976/88) and the Spanish legislation on human clinical research (Royal Decree 561/1993 on clinical trials).

AUTHOR CONTRIBUTIONS

JGF-B designed the study, collected the data, wrote the article, and collaborated on the data analysis. AI-P analyzed the data and collaborated on the article wording. RC collaborated on the article wording and review. ORC designed the study and collaborated on the review of the article.

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A Single Question of Parent-Reported Physical Activity Levels Estimates Objectively Measured Physical Fitness and Body Composition in Preschool Children: The PREFIT Project

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Physical inactivity is recognized as a determinant of low physical fitness and body composition in preschool children, which in turn, are important markers of health through the lifespan. Objective methods to assess physical activity, physical fitness and body composition in preschool children are preferable; however, they have some practical limitations in the school context. Therefore, the aim of this study was to test whether a single question regarding physical activity level of preschool children, reported by their parents, could be used as an alternative screening tool of physical fitness and body composition. The information was obtained from 10 different cities throughout Spain, gathering a total of 3179 healthy preschool children (52.8% boys and 47.2% girls) aged 3–5 years. Physical activity levels of preschool children were reported by parents using a single question with five response options (very low, low, average, high, or very high). Physical fitness and body composition were assessed with the PREFIT fitness battery. The results showed that parents' perception of their children's physical activity was positively associated with all objectively measured physical fitness components (β_{range} = −0.094 to 0.113; all $p < 0.020$); and negatively with body composition indicators as measured (β_{range} = −0.113 to −0.058; all $p < 0.001$). The results showed significant differences in all physical fitness and body composition *z*-scores across the

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parent-reported physical activity levels (all $p < 0.017$ and all $p < 0.001$, respectively), as well as, for the fitness index ($p < 0.001$). Our study suggests that in school settings with insufficient resources to objectively assess fitness and body composition, parents-reported physical activity level by means of a single question might provide useful information about these important health markers in preschool children.

Keywords: physical fitness, motor activity, body composition, fatness, physical activity, preschool children

INTRODUCTION

Obesity is a worldwide concern that is growing among children and adolescents (Abarca-Gómez et al., 2017), and has even begun to occur in preschool children (Cadenas-Sánchez et al., 2019a). The early onset of obesity seems to be related to the occurrence of associated complications such as metabolic and cardiovascular disorders, and the risks depend partly on the age of onset and on the duration of obesity (Umer et al., 2017; Ho et al., 2019). Particularly worrying is the data coming from the World Health Organization (WHO) whose results demonstrated that in 2014 more than 41 million of children under 5 years old were classified as overweight/obese, and this fact will continue to worsen (World Health Organization, 2016). At European level, a higher prevalence of overweight/obese preschool in the south of Europe was observed, compared to those children from the north (Cadenas-Sanchez et al., 2016b). In addition, in a European cohort of 3120 children aged 2–9 years old (1016 from 2 to 6 years old) objectively measured physical activity was found an important factor to protect against clustering of CVD risk factors in young children (Jiménez-Pavón et al., 2013). At the national level, our group found that 35% of the preschoolers examined presented overweight/obesity were already 1.3% morbid obese (Cadenas-Sánchez et al., 2019a). A recent study with a population-based sample of 51,505 children found that the most rapid weight gain occurs between 2 and 6 years of age being those obese at that age also obese adolescents (Geserick et al., 2018). Despite preschool years represents an opportunity for obesity surveillance it is still challenging in the WHO European Region (Jones et al., 2017).

In addition to obesity, a low physical fitness level in childhood/adolescence has been considered a marker of poor health and a risk factor for multiple health outcomes at these ages and later in life (Ortega et al., 2008b; Ruiz et al., 2009). In this context, it has been shown that higher levels of cardiorespiratory fitness during childhood are related to lower risk of becoming overweight/obese across puberty (Ortega et al., 2011). However, such information is not available in preschool children, which could be due, at least partially, to the fact that there was no information about which fitness tests should be used in preschool children. A systematic review searching for any study relating fitness in preschool age with health outcomes, found no studies in this direction (Ortega et al., 2015). Fortunately, over the last years, more evidence has been accumulated on which fitness tests are more feasible, reliable and valid to be used in preschool children, in particular the PREFIT (Assessing FITness in PREschoolers) battery, which will provide new avenues to study the role of fitness in health at these early ages and later in life (Cadenas-Sánchez et al., 2014; Ortega et al., 2015; Sanchez-Delgado et al., 2015; Cadenas-Sanchez et al., 2016a; Mora-Gonzalez et al., 2017). In this context, the PREFIT project group has recently provided for the first time the physical fitness reference standards for preschool children (Cadenas-Sánchez et al., 2019b).

Since obesity and low fitness are important markers of health through the lifespan (Ortega et al., 2018), it is of public health interest to study determinants of these two modifiable risk factors as early as possible, being preschool age a sensitive stage of life. Thus, physical inactivity is a recognized determinant of obesity and low physical fitness, and it would be interesting to explore associations of physical activity with physical fitness and body composition in preschool children. Although objective methods, such as accelerometers, to assess physical activity in young individuals are preferable (Migueles et al., 2017), they have some practical limitations and most importantly they are not feasible under certain circumstances in the school context. Alternatively, parent-reported physical activity levels of their children are an alternative method, and it is of interest to test whether a single question on parents' rated physical activity level is able for screening a set of important physical fitness and body composition markers in preschool children. If so, this method could be a very useful and economic tool to be used as a predictor of health markers in preschool, similarly to what self-reported PA of older children (10–12 years old) showed in a large epidemiological study (Jiménez-Pavón et al., 2012).

Therefore, the aim of this study is to test whether a single question regarding the physical activity of children, reported by their parents, could be used as a screening tool of objectively measured physical fitness and body composition in preschool children.

MATERIALS AND METHODS

Participants and Study Design

The present study was performed under the framework of the PREFIT project[1] (Cadenas-Sánchez et al., 2014; Ortega et al., 2015; Sanchez-Delgado et al., 2015; Cadenas-Sanchez et al., 2016a; Mora-Gonzalez et al., 2017; Labayen et al., 2018). Briefly, the aim of the project was to propose a physical fitness test battery of feasible and reliable field-based tests to assess physical fitness in children aged 3–5 years and to report reference values for a better interpretation of physical fitness assessment (Cadenas-Sánchez et al., 2019a,b).

[1] http://profith.ugr.es/prefit

After several methodological studies to define the PREFIT fitness battery (Cadenas-Sánchez et al., 2014; Ortega et al., 2015; Sanchez-Delgado et al., 2015; Cadenas-Sanchez et al., 2016a; Mora-Gonzalez et al., 2017), we set up PREFIT-Spain, aiming to measure physical fitness in a geographically distributed sample of preschool children across Spain. The project involved data collection in 10 cities from the south, center, and north of Spain, gathering a total of 3179 (*M*: 4.60; SD: 0.87) healthy preschool children (52.8% boys and 47.2% girls) aged between 3 and 5 years (Cadenas-Sanchez et al., 2016a). Parents or legal guardians were informed about the purpose of the study and written informed consent was obtained from the parents of all participants. The study protocol was performed in accordance with the ethical standards and was approved by the Review Committee for Research Involving Human Subjects at the University of Granada (n° 845).

Procedure and Measures

The PREFIT battery comprises the following tests[2]: the PREFIT 20-meters shuttle-run test (PREFIT 20 m SRT) to assess cardiorespiratory fitness, handgrip strength and standing long jump tests to assess muscular strength (upper and lower limbs, respectively), 4 × 10 m SRT to assess speed-agility and one-leg stance test to assess balance (Cadenas-Sanchez et al., 2016a); and weight, height, body mass index (BMI), waist circumference, and waist-to-height ratio to assess body composition indicators. Children were assessed individually in a school-setting by trained evaluators using the following standardized equipment and procedures. Before starting the tests, evaluators performed an example to ensure that the child understood the test correctly.

Physical Fitness Measures

Cardiorespiratory fitness was assessed using a modified version of the original 20 m shuttle run test (SRT): the PREFIT 20 m SRT (Cadenas-Sánchez et al., 2014; Mora-Gonzalez et al., 2017). Participants had to run back and forth between 2 lines 20 m apart with an audio signal. The test finished when the child failed to reach the end lines concurrent with the audio signal on two consecutive occasions or when the child stops because of exhaustion. The initial stage of the PREFIT 20 m SRT was 6.5 km h^{-1}.

The handgrip strength test measures the maximal strength of the upper limb using an analog dynamometer (TKK 5001, Grip-A, Takei, Tokyo, Japan). The test protocol is reported elsewhere (España-Romero et al., 2010). The grip spans were fixed at 4.0 cm (Sanchez-Delgado et al., 2015). The best value of the two attempts for each hand was chosen, and the average of both was registered in kilograms (kg). The standing long jump test assesses the explosive strength of the lower limbs. This test consisted of jumping as far as possible with the feet together and remaining upright. The distance was measured from the take-off line to the point where the back of the heel nearest to the take-off line lands on the ground. The better of two attempts were recorded in centimeters (cm).

The 4 × 10 m SRT was used to assess speed/agility. This test consisted of running and turning as fast as possible between two parallel lines (10 m apart). To make this test easier to understand and perform for preschool children, we did not use sponges to be exchanged when crossing the lines (4 × 10 m), as the original protocol does in older children (Ortega et al., 2008a). Instead, two evaluators were located behind each line and participants had to touch the examiner's hand and go back at maximum speed. The result was measured with a stopwatch (Tremblay, CHRO 300, Gleizé, France) to the nearest 0.1 s. The best of two attempts was recorded in seconds. A higher score indicates worse performance.

Body Composition

Weight (kg) was measured without shoes and in light clothing using an electronic scale (SECA Model 869, Hamburg, Germany). Height (cm) was measured in the Frankfort plane without shoes using a stadiometer (SECA Model 213). BMI was calculated based on weight divided by height squared. The cut-off points used to classify weight status categories were those established by World Obesity Federation (WOF)[3], formerly International Obesity Task Force (IOTF) (Cole and Lobstein, 2012) and by the WHO (de Onis et al., 2007). Waist circumference (cm) was measured at the umbilical location with a non-elastic tape (SECA Model 200) at the end of a normal expiration without the tape compressing the skin. The waist-to-height ratio was calculated as waist circumference divided by height in centimeters. All measures were taken twice and the mean of the two measurements was used for analyses. All measurements were harmonized following a strict protocol to ensure standardization.

Physical Activity

As an indirect measure of the physical activity level of the children, parents were asked to answer the following question: "Your children's physical activity level excluding school time is . . .?" The response options were very low, low, average, high, or very high. The response frequency by categories of parent-reported physical activity levels is shown in **Supplementary Figure S1**. For analyses, the very low and low categories were merged due to the low response frequency of the very low category.

Confounders

Paternal and maternal educational was assessed by self-report questionnaire and can be consulted elsewhere (Merino-De Haro et al., 2018). A variable with three categories was calculated for analyses and for each parent: low (no education or primary school education), medium (secondary school education, upper-secondary school education, or technical training), and high (university education). Only, age, gender, and maternal education level were introduced as potential confounders.

Statistical Analysis

Firstly, we explored which potential confounders were more strongly correlated with the study outcomes. Maternal education was more strongly associated than paternal education with

[2]http://profith.ugr.es/recursos-prefit?lang=en

[3]http://www.worldobesity.org/

TABLE 1 | Descriptive characteristics of the study population (n = 3.179).

	All (n = 3.179)		Boys (n = 1.678)						Girls (n = 1.501)					
			3 years		4 years		5 years		3 years		4 years		5 years	
Age (years)	4.60	0.87	3.53	(0.30)	4.50	(0.28)	5.54	(0.34)	3.50	(0.31)	4.53	(0.29)	5.53	(0.32)
Height (cm)	106.93	7.51	99.90	(4.67)	106.91	(4.77)	113.93	(5.49)	98.73	(4.53)	106.01	(4.74)	112.89	(4.85)
Gender [n (%)]														
Female	1501	(47.22)							443	(47.48)	509	(47.0)	549	(47.21
Male	1678	(52.83)	490	(52.52)	574	(53.0)	614	(52.79)						
Maternal education [n (%)]														
Low	210	(7)	33	(6.98)	27	(5.06)	49	(8.69)	23	(5.45)	33	(6.92)	45	(8.70)
Medium	1382	(46.34)	202	(42.71)	262	(49.06)	272	(48.23)	185	(43.84)	212	(44.44)	249	(48.16)
High	1395	(46.76)	238	(50.32)	245	(45.88)	243	(43.09)	214	(50.71)	232	(48.64)	223	(43.13)
Physical fitness														
PREFIT 20 m SRT (laps)	20.02	11.64	12.85	(7.65)	21.19	(9.51)	28.86	(13.05)	10.86	(6.36)	18.56	(8.21)	23.96	(11.45)
Handgrip strength (kg)	7.03	2.48	5.20	(1.69)	7.17	(1.90)	9.27	(2.25)	4.66	(1.58)	6.56	(1.72)	8.37	(1.97)
Standing long jump (cm)	73.63	22.25	57.57	(17.72)	77.93	(16.91)	91.45	(17.36)	50.81	(17.12)	70.60	(16.06)	84.48	(18.10)
4 × 10 m SRT (s)	16.81	2.52	18.82	(2.33)	16.36	(1.76)	14.83	(1.40)	19.77	(2.50)	16.72	(1.59)	15.46	(1.49)
Fatness														
Weight (kg)	18.99	3.75	16.55	(2.33)	18.78	(2.95)	21.62	(4.04)	16.12	(2.16)	18.52	(2.93)	21.16	(3.59)
BMI (kg/m^2)	16.48	1.76	16.53	(1.50)	16.36	(1.63)	16.55	(2.03)	16.48	(1.33)	16.41	(1.80)	16.54	(2.01)
Waist circumference (cm)	53.16	5.02	50.88	(3.80)	52.59	(4.24)	54.95	(5.57)	51.24	(3.86)	53.29	(4.88)	55.19	(5.47)
Waist-to-height ratio	0.50	0.04	0.51	(0.03)	1.49	(0.03)	0.48	(0.04)	0.52	(0.03)	0.50	(0.04)	0.49	(0.04)

SD, standard deviation; SRT, shuttle run test; BMI, body mass index. Values are presented as mean and standard deviation.

study outcomes and, thus, it was a better predictor. Partial correlation adjusted for potential confounders were used to examine the association of parent-reported physical activity levels with physical fitness and body composition indicators.

To study the association of parent-reported physical activity levels with physical fitness (PREFIT 20 m SRT, handgrip strength test, standing long jump, 4 × 10 m SRT) and body composition outcomes (weight, BMI, waist circumference, waist-to-height ratio), we conducted linear regression analysis inserting the physical fitness and body composition outcomes as dependent variables and parent-reported physical activity levels as independent variable, adjusted for sex, age and maternal education. Additionally, physical fitness and body composition *z*-scores were created and explored using analysis of covariance (adjusted for confounders) with a Bonferroni adjustment according to parent-reported physical activity levels. Also, it was created a fitness index using the average of physical fitness z-scores divided by the number of fitness outcomes (PREFIT 20 m SRT, standing long jump, 4 × 10 m SRT), and explored with an analysis of covariance with a Bonferroni adjustment according to parent-reported physical activity levels. All analyses were performed using the Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, version 21.0, Armonk, NY) and the level of significance was set at $p < 0.05$. Graphics were performed using Sigmaplot version 12.5 for Windows (Systat Software, Inc., San Jose, CA, United States).

RESULTS

Descriptive characteristics of the physical fitness and body composition indicators of the sample stratified by sex and age groups (3, 4, and 5 years) are presented in **Table 1**, as means and standard deviation. The response frequency of parent-reported physical activity levels (for the whole sample and by sex) is illustrated in **Supplementary Figure S1**.

The results show the association of parent-reported physical activity levels between physical fitness and body composition measures after adjusting for sex, age and maternal education in preschool children. Children whose parents reported to have higher physical activity levels had a higher level of physical fitness in all indicators ($\beta_{range} = -0.094$ to 0.113, and *p*-value from 0.020 to <0.001) (**Table 2**). Otherwise, it was observed a negative association between parent-reported physical activity levels and all body composition indicators after adjusting for sex, age and maternal education ($\beta_{range} = -0.058$ to -0.113, all $p < 0.001$). The results showed similar trends for physical fitness and body composition of children with different age and sex (see **Supplementary Tables S1** and **S2**, respectively).

The results show the differences in objectively measured physical fitness *z*-scores (panel A) and body composition *z*-scores (panel B) across parent-reported physical activity levels. The results showed significant differences in all physical fitness and body composition *z*-scores across the parent-reported physical activity levels (all $p < 0.017$ and all $p < 0.001$, respectively) (**Figure 1**). There were pairwise significant differences in PREFIT 20 m SRT, standing long jump and the 4 × 10 m SRT between each category of the parent-reported physical activity levels after a Bonferroni adjustment (all $p < 0.038$). There were pairwise significant differences in each category of the parent-reported physical activity levels after a Bonferroni adjustment and all body composition *z*-scores between (all $p < 0.036$). However, these pairwise significant differences were not seen between the high and very high categories in neither physical fitness *z*-scores nor body composition *z*-scores ($p_{range} = 0.059$ to 0.934 and $p_{range} = 0.128$ to.355, respectively).

The results show the differences in physical fitness index across parent-reported physical activity levels, by age (**Figure 2A**) and gender (**Figure 2B**). The results showed significant differences in the fitness index across the parent-reported physical activity levels ($p < 0.001$). There were pairwise significant differences in the fitness index between each category of parent-reported physical activity levels after a Bonferroni adjustment (all $p < 0.001$). However, these pairwise significant differences were not seen between the high and very high categories ($p = 0.102$). No interaction effect was seen for age groups ($p = 0.233$) nor gender ($p = 0.722$).

DISCUSSION

This study provides evidence supporting that a single and very simple question of physical activity reported by parents can significantly estimate the physical fitness and body composition of preschool children (aged 3–5 years). More specifically, our findings support that: (1) parent-reported physical activity levels are positively associated with objectively measured physical fitness, as measured by means of the PREFIT 20 m SRT, handgrip strength, standing long jump and the 4 × 10 m SRT in children aged 3–5 years; (2) parent-reported physical activity levels are negatively related to body composition indicators, as measured by weight, BMI, waist circumference and waist-to-height ratio in children aged 3–5 years; and (3) there

TABLE 2 | Associations of parents-reported physical activity levels with objectively measured physical fitness and body composition in preschool children (*n* = 3.179).

	β	*B*	CI (95%)	*p*
PREFIT 20 m SRT (laps)	0.113	1.714	(1.252, 2.176)	< 0.001
Handgrip strength (kg)	0.031	0.100	(0.016, 0.185)	0.020
Standing long jump (cm)	0.102	2.971	(2.174, 3.768)	< 0.001
4 × 10 m SRT (s)*	−0.094	−0.309	(-0.394, -0.224)	< 0.001
Weight (kg)	−0.058	−0.284	(-0.429, -0.139)	< 0.001
BMI (kg/m^2)	−0.097	−0.223	(-0.307, -0.139)	< 0.001
Waist circumference (cm)	−0.100	−0.658	(-0.883, -0.433)	< 0.001
Waist-to-height ratio	−0.113	−0.006	(-0.008, -0.004)	< 0.001

*SRT, shuttle run test; BMI, body mass index; β, beta standardized coefficients; B, beta unstandardized coefficients; CI, confidence interval (upper, lower). Parent-reported physical activity levels were considered as a predictive variable and physical fitness outcomes (PREFIT 20 m SRT, handgrip strength test, standing long jump and 4 × 10 m SRT) and body composition outcomes (weight, BMI, waist circumference and waist-to-height ratio) were considered as dependent variables. The analyses were adjusted by age, sex, and maternal education. *Lower values indicate better performance.*

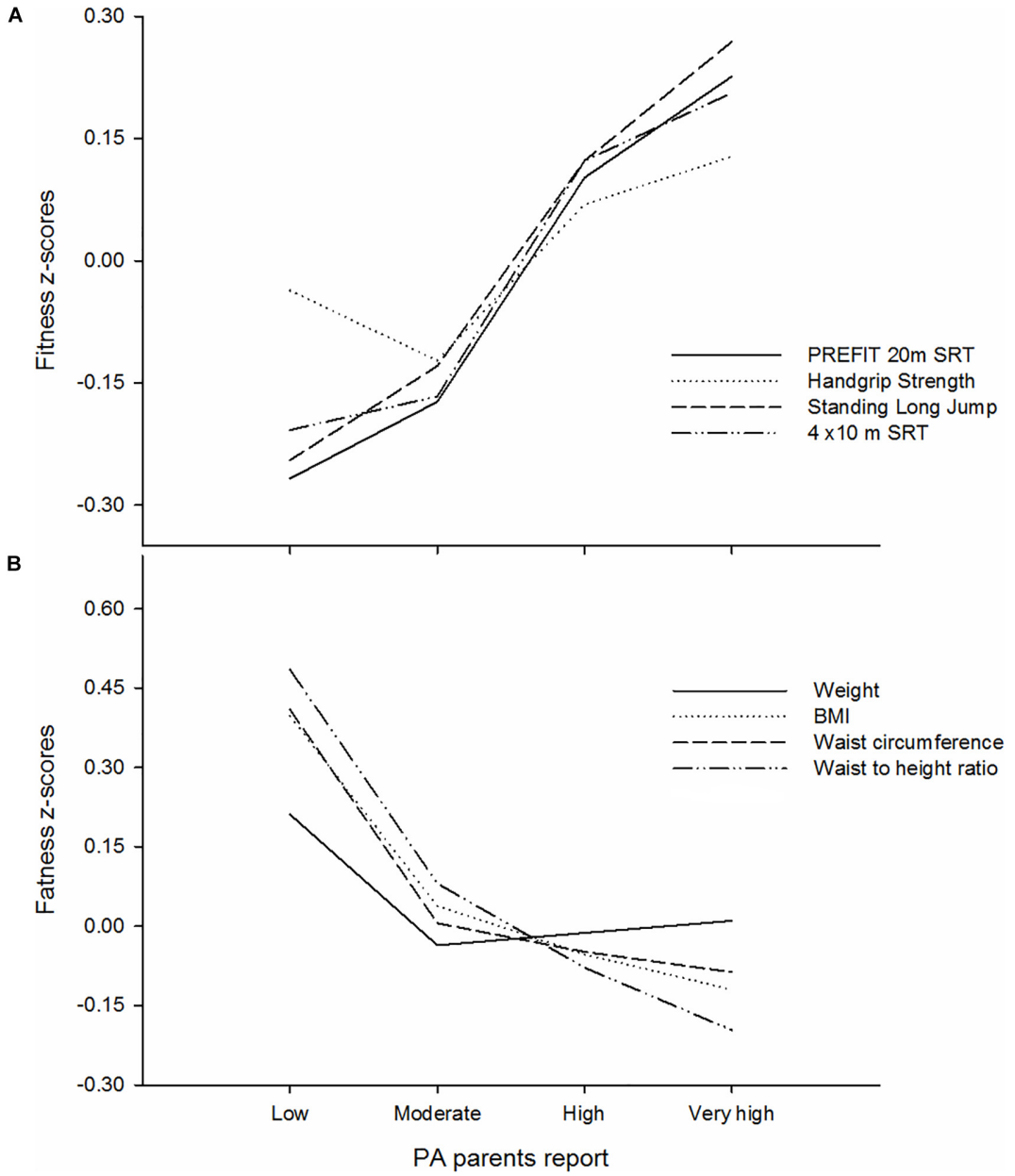

FIGURE 1 | Differences of objectively measured physical fitness *z*-scores **(A)** and body composition *z*-scores **(B)** across parents-reported physical activity levels in preschool children (n = 3.179). SRT, shuttle run test; BMI, body mass index; PA, physical activity. The analyses were adjusted by age, sex, and maternal education.

are pronounced differences in all physical fitness and body composition *z*-scores, as well as, in the fitness index across each category of the parent-reported physical activity levels in children aged 3–5 years.

This study shows a positive association between parent-reported physical activity levels and the PREFIT 20 m SRT. These results are in agreement with previous findings in the adult population (Emaus et al., 2010; Minder et al., 2014). For instance, Murphy et al. (1988) who found that a reported physical activity single question was associated with maximal oxygen consumption, measured by a more valid and reliable technique. Likewise, Aadahl et al. (2007) showed that reported physical activity was related to objectively measured cardiorespiratory fitness. Nevertheless, in our study inconsistent associations were seen between parent-reported physical activity levels and handgrip strength (see **Supplementary Table S1**). In fact, when analyses were undertaken by age group only was seen as an association in those older preschool children. This result does not concur with those found in other population of adults where self-reported measures of physical activity were correlated with handgrip strength (Leblanc et al., 2015). In fact, a recent systematic review has found inconsistent associations between

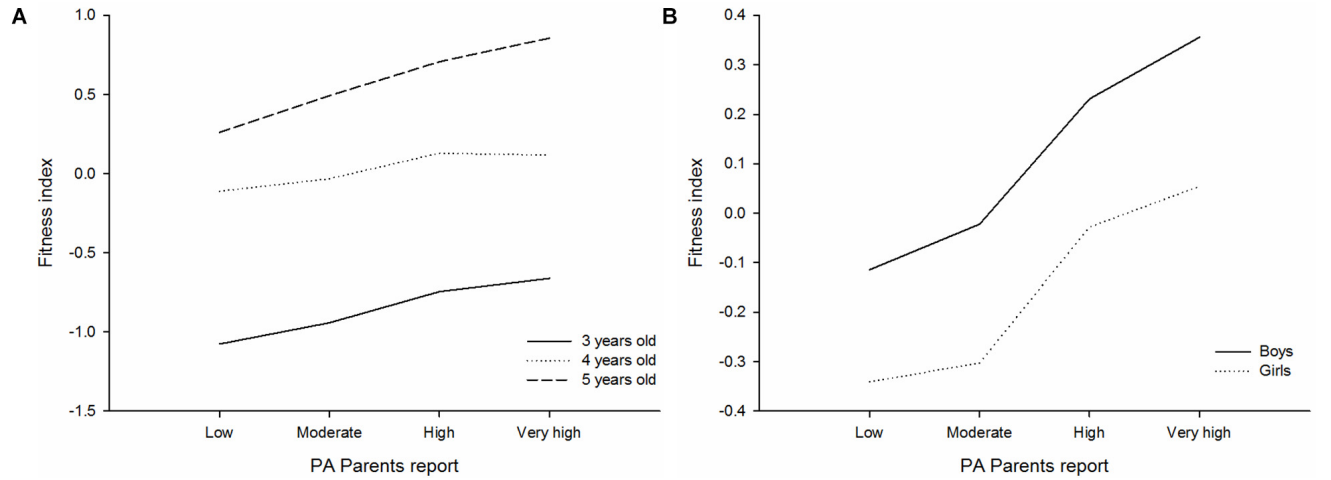

FIGURE 2 | Differences of physical fitness index across parent-reported physical activity levels, by age **(A)** and gender **(B)** in preschool children (n = 3.179). SRT, shuttle run test; PA, physical activity. The analyses were adjusted by age, sex, and maternal education.

muscular fitness and self-reported physical activity in children and adolescents (Smith et al., 2019). Otherwise, our data showed that parent-reported physical activity levels correlate strongly with lower body strength as measured by means of standing long jump. In this sense, it can be hypothesized that uncontrolled variables (fat-free mass, fat mass) in our sample might explain the discrepancies between the associations of parent-reported physical activity levels and the distinct components of the muscular strength (Artero et al., 2010).

A negative association between parent-reported physical activity levels and body composition indicators was found in this investigation. To our knowledge, there are no studies that analyze this association in preschool children, and that's why this study opens a new window in order to estimate childhood obesity based on physical activity information reported by parents. Recent studies have found that higher moderate-to-vigorous physical activity (MVPA) and/or vigorous physical activity of preschool children are associated with better body composition (Leppänen et al., 2016, 2017; Fang et al., 2017). In this context, a self-reported methodology to assess physical activity levels of preschool children has not been recommended (Oliver et al., 2007), however, parents might do with somewhat validity (Pate et al., 2010). Taking this evidence together, it can be suggested that parent-reported physical activity levels of preschool children might be an alternative to estimate objectively measured body composition indicators since physical activity is associated with body composition at an early age.

Our results also showed that there was a pronounced difference between children with very low/low physically active (who had worse physical fitness and body composition) and the rest of the categories with higher reported physical activity; however, the question did not discriminate so accurately between those preschool children reported by their parents as being moderate, high and very high active. This finding suggests that our question might be more useful in more extreme cases (between very low/low and high/very high active). In this context, the question proposed in this investigation could be used to perform the first screening with large samples of preschool in order to detect the most extreme cases with a marked risk of worse physical fitness and body composition. Thus, objective and direct measures could be administered only in those participants who have already been detected at higher risk. Therefore, this single question about PA levels would serve to identify children at a higher risk of low fitness and worse body composition avoiding the complications associated with direct and objectively measurement.

Limitations and Strengths

This research has several limitations. The cross-sectional nature of the study and the use of an indirect measure of physical activity levels should be considered with caution. In addition, despite all associations of parent-reported physical activity levels between physical fitness and body composition were statistically significant the standardized regression coefficients were small. Likewise, the reliability of the single question has not been yet proved, which could be another drawback. To our knowledge, this large, population-based study on preschool children is the first that covers geographically most of the regions of Spain. Also, the use of a quick and single question able to identify vital markers of physical health at such early ages should be considered as something powerful.

CONCLUSION

Our study suggests that a single question of parent-reported physical activity levels might provide meaningful information to identify children at a higher risk of important physical health markers such as physical fitness and body composition in preschool children. Therefore, a single question could be an alternative for a physical health screening at early ages, especially for epidemiological and intervention studies with insufficient

resources or even in school settings where objective methods cannot be applied.

DATA AVAILABILITY

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The study protocol was performed in accordance with the ethical standards and was approved by the Review Committee for Research Involving Human Subjects at the University of Granada (number 845).

AUTHOR CONTRIBUTIONS

CC-S and FBO conceptualized and designed the study. CC-S organized the database. AM-M, CC-S, FBO, and JV-C carried out the statistical analysis. PP, AM-M, JC, PB, FBO, and JV-C wrote the first draft of the manuscript. PP, AM-M, JC, PB, FBO, and JV-C wrote the sections of the manuscript. All authors contributed to the manuscript revision, read, and approved the final version of the manuscript.

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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.2019.01585/full#supplementary-material

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Dual Career of the U-23 Spanish Canoeing Team

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Canoeing is one of the sport disciplines that brings great success to Spain in international competitions and Olympic Games (of the 17 medals won in Rio in 2016, four were in this sport, including three gold). However, the journey to become an elite athlete coincides in time with the challenge of pursuing an academic education, which often involves making difficult choices in the training-university dichotomy. The aim of this research was to ascertain how the Spanish under-23 calm water canoeing team perceives their athletic and academic careers. The present study was carried out with the Spanish under-23 flat water canoeing team, the step prior to competition at the highest level. The study sample comprised the whole population, namely the entire national team, made up of 21 athletes (11 women and 10 men) with a mean age of 20.57 ± 2.64 years and 10.00 ± 3.49 years of experience. These athletes are usually based at La Cartuja High Performance Center (Seville) and combine their sports activity with studying toward a university degree. A double qualitative and quantitative methodology was used. For the first of these, an interview script was elaborated based on the theoretical model by Wylleman et al. (2013). Applicable consents were requested from the Spanish Royal Canoeing Federation, coaches and paddlers. Interviews were carried out with each athlete twice: at the beginning and at the end of the season/academic year, which were recorded and subsequently tabulated and analyzed. Concerning quantitative methodology, the ESTPORT dual career questionnaire validated by Sánchez-Pato et al. (2016) was used. The results show that for all the paddlers canoeing is very important. It is typically complicated for them to attend classes, and subject planning is usually based on their training schedules. In the second/last part of the course, it is stressful for these athletes to combine both activities and some drop out of school. During the course, though, they appreciate having another activity that allows them to escape from the training routine. In addition, they miss not having an academic tutor to guide and advise them. These student-athletes are aware that their sport causes them to miss out on many moments with family and friends due to training or competing. However, at present this is offset, largely because of their high level of performance, which makes it easier for them to obtain scholarships that provide economic support.

Keywords: dual career, psychological well-being, canoeing, high-education, sport

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INTRODUCTION

The transition of any young person when he or she enters university is not an easy process, but when this must also be combined with training and competitions, this step becomes even more important (Tekavc et al., 2015). The dual career (DC) path undertaken by athletes involves the challenge of combining a career in sports with studies or work, a concern for most high-performance athletes (Ryba et al., 2015). In the case of student-athletes the optimal DC balance has been defined by Stambulova et al. (2015) as the combination of sport and studies that helps athletes achieve their academic and athletic goals and live a satisfying private life, maintaining their health and well-being.

It is well known that the practice of sport has been included in the strategic agenda of the European Union to promote integration among nations and cultures (European Commission, 2007). Nonetheless, when high levels of specialization and competition are achieved, the young people involved face the challenge of combining their athletic and educational preparation (Conzelmann and Nagel, 2003; Capranica and Millard-Stafford, 2011; Lobillo and Guevara, 2018), which quite often leads to their abandoning the practice of high-level sports in order to give priority to education with the aim of benefiting from future employment opportunities (Amara et al., 2004) or, conversely, to neglect academic preparation (Capranica and Millard-Stafford, 2011; Aquilina, 2013; Sohn and Hong, 2014; Guidotti et al., 2015; López de Subijana et al., 2015; Huang et al., 2016; Miro et al., 2017; Sum et al., 2017; Barriopedro et al., 2018; Krueger et al., 2018), resulting in low academic performance and limiting future and adequate inclusion in the working world (Conzelmann and Nagel, 2003; Kuettel et al., 2017; Vilanova and Puig, 2017; Barriopedro et al., 2018; López de Subijana et al., 2018).

All types of athletes are affected by the DC, regardless of social status, type of sport, location, the sex of the athlete or his or her experience (Erpič et al., 2004). According to Ryba et al. (2017), one of the main challenges faced by elite athletes between the ages of 12 and 25 is to successfully combine education and high-performance sport.

Early research (Purdy et al., 1982) indicated the negative effects of a double career on academic success. However, the most recent research suggests that talented athletes tend to perform well not only in sports, but also in the academic environment because they are highly motivated to perform well in both domains (Guidotti et al., 2015; Lupo et al., 2015; Fuchs et al., 2016; De Brandt et al., 2017; Isidori et al., 2017; Jordana et al., 2017; Kristiansen, 2017; Kuettel et al., 2017; Miro et al., 2017; Budevici-Puiu, 2018; Guirola et al., 2018; Kerstajn et al., 2018; Knight et al., 2018; Krueger et al., 2018; López de Subijana and Equiza, 2018; Ronkainen et al., 2018; Stefano and Ginevra, 2018; Tekavc and Erpic, 2018). Supporting this idea, O'Neill et al. (2013) concluded that student-athletes were determined to combine their education and sport, explaining that both dimensions strengthen their sense of identity, purpose and well-being.

Among athletes who abandoned their athletic careers due to different personal situations, a better transition and incorporation into working life was observed in those who had combined their double careers compared to those athletes who focused exclusively on their athletic careers (Aquilina, 2013; Torregrosa et al., 2015; Tshube and Feltz, 2015). Therefore, according to Stambulova and Wylleman (2015), to become long-term winners, student-athletes should first "win in the short term," i.e., adapt well to their current DC programs for possible future benefits.

The DC guarantees that the athlete will have a future outside of sports when his or her high-level career ends (Stambulova and Wylleman, 2015), although it is true that during the years in which the athlete tries to combine sport and studies, this situation causes episodes of tension and anxiety (Gustafsson et al., 2008; Aquilina, 2013; O'Neill et al., 2013; Torregrosa et al., 2015; Sorkkila et al., 2017). For this reason, in some cases, the help and support of psychologists is needed to guide the athlete to successfully continue the DC (Stambulova et al., 2009; Mateos et al., 2010). Consequently, many athletes are convinced of the importance of combining the highest level of athletic life with academic life, especially in those minority sports that do not have sufficient financial support and/or their athletic life is short (Conzelmann and Nagel, 2003; Debois et al., 2015; Gledhill and Harwood, 2015; Kuettel et al., 2017; Barriopedro et al., 2018; López de Subijana et al., 2018; Pink et al., 2018). Aware of the consequences for athletes of combining two careers, many universities and organizations at the national and state levels have created support programs (Park et al., 2013; Brown et al., 2015; López de Subijana et al., 2015; Pink et al., 2015). Also relevant are the results of Barriopedro et al. (2018), which support the holistic vision of the development of the athletic career, showing an interrelation between the academic-vocational and the athletic areas, indicating the possible role of gender in the pursuit of both careers.

We see the opposite side of this situation with some athletes who are still not aware of the reality in which they live. Everything that is not related to their athletic career is indifferent to them or they do not give it the importance they should, which causes them to miss out on opportunities that exist outside their sport (Gorley et al., 2001; Lavallee and Robinson, 2007; Stambulova et al., 2009; Kelly and Hickey, 2010; Aquilina, 2013).

All athletes have their moment and it is at that point when a conscious change is noted that their athletic career is about to end and they search for a strategy to plan for the future (Park et al., 2012). According to the study by North and Lavallee (2004), it was observed that 79% of the athletes who sensed that in a few years their athletic career would come to an end, began to plan their future for that time, showing less interest in dedicating time to training and even defending the importance of work outside the realm of sport.

However, no studies currently exist on canoeing, one of the most internationally successful sports in Spain. We therefore consider this research to be innovative as the aim of our study was to gain insight into how the Spanish under-23 flat water canoeing team members (those who are called to take over from

the paddlers in the international competitions) experience the duality between their athletic and academic careers.

METHODOLOGY

Participants

The study participants comprised 21 paddlers (10 men and 11 women) with a mean age of 20.57 ± 2.64 years y 10.00 ± 3.49 years of experience from the permanent pool of the Spanish Under-23 Flat Water Canoeing Team at CEAR La Cartuja (Specialized Center for High Performance Rowing and Canoeing) in Seville. All the paddlers, in addition to competing at an international level, are enrolled in a university degree program. **Table 1** shows the characteristics of the participants. To avoid potential identification, areas of study were classified as either Sciences or Social Sciences.

Procedure

The methodology used was twofold: qualitative-quantitative. Consents were requested from the Royal Spanish Canoeing Federation, coaches and paddlers. Subsequently, individual contact was made with each athlete to arrange the date and time. In all cases, the place chosen was the facilities of CEAR La Cartuja, a space where all the athletes feel comfortable. The purpose of the study was explained to them and they were asked to consent to the use of the information, notifying them of the confidential nature and providing a brief explanation of the study. The interviews lasting between 10 and 15 min were recorded then later transcribed and analyzed-codified according to the levels of the theoretical model described. The five levels were analyzed according to two criteria, facilitators and barriers.

TABLE 1 | Characteristics of the participants.

Athlete	Sex	Age	Years of experience	Specialty	University Degree
1	Female	18	10	Kayak	Sciences
2	Female	24	12	Kayak	Social Sciences
3	Female	24	13	Kayak	Social Sciences
4	Female	19	7	Kayak	Social Sciences
5	Female	20	8	Kayak	Sciences
6	Female	18	9	Kayak	Sciences
7	Female	18	6	Kayak	Sciences
8	Female	23	7	Kayak	Social Sciences
9	Female	22	10	Kayak	Social Sciences
10	Female	27	19	Canoe	Social Sciences
11	Female	17	5	Canoe	Social Sciences
12	Male	23	14	Kayak	Social Sciences
13	Male	23	14	Kayak	Social Sciences
14	Male	19	9	Kayak	Sciences
15	Male	22	15	Kayak	Sciences
16	Male	19	5	Kayak	Social Sciences
17	Male	20	10	Kayak	Social Sciences
18	Male	19	9	Kayak	Social Sciences
19	Male	20	9	Canoe	Social Sciences
20	Male	19	9	Canoe	Social Sciences
21	Female	18	10	Kayak	Sciences

Instruments

The qualitative portion used a semi-structured interview based on the theoretical model by Wylleman et al. (2013), which is based on three main themes: (a) balancing studies and athletic career; (b) balancing economic level and athletic career and complementary studies/activity; (c) balancing psychosocial level and athletic career and complementary studies/activity. This model is a reformulation of the original holistic model by Wylleman and Lavallee (2004) which defined four stages in the athletic career: initiation, development, mastery and discontinuation. According to the holistic model of the athletic career, not only should the athletic dimension be taken into account, but also other facets involved in the development of the person such as the individual, psychosocial, academic/vocational and financial aspects. In this way, the athlete can be better understood from an overall perspective. Despite sharing elements with previous models, the differential contribution of these authors was that of presenting the athletic stages in a coordinated manner together with psychological, psychosocial and academic-vocational stages thus contributing a holistic perspective to the concept of the athlete and defining both stages and transitions for each area, adding the economic dimension in the 2013 version. In our case, the athletes studied were classified according to the above-mentioned model at the level of mastery, as they are members of the permanent Spanish Canoeing Federation team; at the psychological level at the end of adolescence/beginning of adulthood; at the psychosocial level according to their relationship with peers, family, coaches and teammates, university classmates/professors; at the academic and vocational levels as a semi-professional or professional athlete and university student and finally at the economic level with financial support from government scholarships, sponsors, and family.

The interview was therefore structured around the three basic pillars established by Wylleman et al. (2013): balancing academic career with athletic career (Athletic Level and Academic/Vocational Level blocks); balancing psychosocial level with athletic and academic careers (Psychosocial Level block); and balancing economic level with athletic and academic careers (Economic Level block). The psychological level was left out since the purpose of this research was not to assess the level of psychological maturity of the subjects.

The quantitative methodology used was the DC questionnaire called ESTPORT validated by (Sánchez-Pato et al., 2016). This questionnaire is the result of a project approved by the European Commission in 2014 entitled the "Development of an Innovative European Sport Tutorship Model for the Dual Career of Athletes" ESTPORT the aim of which was “to develop, transfer and implement an innovative EU Sport Tutorship program in different European Universities” in order to comply with the EU’s DC guidelines for athletes. Therefore, due to these characteristics, this questionnaire was considered an appropriate tool and with great potential to be extrapolated to other countries.

This questionnaire was administered after the interview and completed in the presence of the interviewer. ESTPORT consists of two large blocks: the first on sociodemographic variables and the second on the DC, which in turn is divided into academic career and athletic career. The paddlers answered the questions in these blocks, which were structured into two types of answers: yes or no; or on a Likert scale ranging from very easily/totally agree, to very difficult/totally disagree, depending on the question.

Data Analysis

The statistical software packages used were *SPSS* for *Windows v.23* (*IBM SPSS Statistics*, Chicago, IL, United States) and *Microsoft Office Excel (Microsoft Corp*., Redmond, WA, United States). To verify the normality of the variables, the *Kolmogorov–Smirnov* test was performed, and a reliability analysis was carried out using *Cronbach's alpha* statistic of the closed-ended questions on the Likert scale, regarding the perceptual dimensions of academic career, athletic career and digital competence of the athlete. Subsequently, a *t*-test was conducted with the independent variable of sex and category (semi-professional or professional). The effect size (*d*) was also calculated, which quantifies the size of the difference between the two groups (Coe and Merino, 2003). Threshold values for the effect sizes on the ANOVA test were small, 0.10; moderate, 0.25; and large, 0.40 (Cohen, 1988). The level of significance was set at $p < 0.05$.

RESULTS

This study includes both quantitative and qualitative results.

Quantitative Results

Table 2 shows the results of the reliability testing for the dimensions of academic career, athletic career and digital competence of the athlete. The dimensions evaluated show medium–high reliability values. Reliability data reported for the athletic career are scarce mainly due to the diversity in the type of response. In some cases, the responses were categorized as dichotomous values yes (1) and no (0), and in others, the answers were Likert type ranging from 1 to 5. This variety causes fluctuation in the reliability of the scale values, which suggests it would be preferable to use only one type of response. Moreover, in the academic career according to sex, reliability was lower because the perception of male athletes differs due to the type of university studies and the future professional career that they believe possible through these studies. In addition, an example of this was found in the categorization between semi-professionals and professionals, as it was observed that in the latter there were differing perceptions regarding their academic career, possibly due to the success achieved in their athletic career.

To gain insight into how student-athletes perceive their DC, it is essential to verify the variance that exists between the populations studied. **Table 3** shows the differences in perception between young men and women athletes of their academic career. There was little gender variance, with just two differences noted. The first was the distance between residence and university, with the female athletes living closer to the university than the male athletes. The second item corresponded to the importance of a better result, which the male athletes attached greater importance to than the female athletes. This lack of differences was due to the homogeneity of the sample, as they all practiced the same sport and were in a position to combine their athletic career with their university career.

The perception of the sports career of the athletes participating in the study was similar according to gender (**Table 4**). Regarding digital competence, the men used Twitter teaching support more frequently than the women ($P < 0.05$). In addition, the item of use of assignments as teaching support was marginally different ($P = 0.06$), with a higher frequency in the women.

In the athlete's perception of his or her academic career according to category (semi-professional or professional), there were once again two significant differences (**Table 5**). The first of these was regarding the time taken away from studying by their other tasks as an athlete, on which the semi-professional athletes scored 1.83/5 points, indicating that sport-related activities did not interfere with their academic work ($P < 0.05$; $d = 1.08$). The second item with the greatest variance was losing contact with their peers, on which the professional athletes had a better score (approaching disagreement), thus positively assessing their DC ($P = 0.05$; $d = 1.02$).

On the perception of athletic career and digital competency (**Table 6**) by category, no significant differences were observed, despite the fact that the effect sizes (Cohen's *d*) were large in items 72 and 73 ($d = 0.88$ y 0.84, respectively) regarding athletic career and the use of chat to support teaching ($d = 0.73$).

Qualitative Results

For a better understanding of the qualitative results, we established two blocks: circumstances that enable the athlete to maintain continuity between both careers: athletic and academic, which we call "facilitators," and by contrast, other reasons that lead the athlete to choose just one of the careers that we call "barriers."

Facilitators

Concerning the "facilitators," in the athletic realm we note that that the coaches themselves are concerned about the need and importance of the academic education of their paddlers. In fact, they view the DC as positive because this way they also think about other things, in fact E1 commented: "*It is better that they study, that they interact with other people who have nothing to do with canoeing. This way they have other things to think about… if not, if one day training goes poorly, they will be thinking about how badly they did it… if they have to think about having to go to the Faculty, etc. they forget about it sooner," "the things in the water stay in the water and have to be fixed in the water, driving themselves crazy about it only makes it worse."*

Consistent with these words, the coaches have scheduled start times for each of the daily training sessions, although all paddlers say that coaches do not impose an obligation to attend each day's training, and even tend to modify training schedules so that their paddlers can combine going to class and training.

TABLE 2 | Reliability of the psychological variables studied.

	Cronbach's α				
	All	**Men**	**Women**	**Semi-professionals**	**Professionals**
Academic Career	0.590	0.478	0.836	0.944	0.624
Athletic Career	0.531	0.554	0.492	0.637	0.352
Digital Competence	0.871	0.711	0.714	0.723	0.661

TABLE 3 | Descriptive statistics on the perception of university student high-level athletes of their academic career.

	Item	**Men (*n* = 10)**	**Women (*n* = 11)**	***T***	***P***	***d***
Flexible Curriculum	Item 21	2.90 ± 0.994	3.00 ± 0.894	−0.243	0.811	0.11
Distance learning	Item 22	2.56 ± 1.014	2.91 ± 0.944	−0.806	0.431	0.36
Univ. far from home	Item 26	4.10 ± 0.994	2.55 ± 1.440	2.849	0.010	1.25
Univ. far from training	Item 27	3.90 ± 0.994	2.91 ± 1.375	1.875	0.076	0.83
Studies * training	Item 28	3.40 ± 1.506	3.27 ± 1.272	0.210	0.836	0.09
Employment * studies	Item 29	2.44 ± 1.509	2.82 ± 0.982	−0.668	0.512	0.30
Caring for family	Item 30	2.13 ± 1.246	2.09 ± 1.446	0.054	0.958	0.03
Habitual tiredness	Item 31	3.90 ± 0.994	3.82 ± 1.328	0.158	0.876	0.07
I lose course rhythm	Item 32	3.70 ± 0.949	3.82 ± 0.874	−0.297	0.770	0.13
I lose contact with peers	Item 33	3.20 ± 1.476	2.91 ± 0.944	0.544	0.593	0.23
High cost of studies	Item 34	3.78 ± 1.202	3.00 ± 1.342	1.350	0.194	0.61
University support	Item 35	4.10 ± 0.994	3.73 ± 1.348	0.715	0.484	0.31
Inflexible study schedule	Item 36	4.50 ± 0.707	3.91 ± 1.375	1.218	0.238	0.54
Inflexible training schedule	Item 37	2.50 ± 1.434	3.09 ± 1.514	−0.916	0.371	0.40
Virtual tools	Item 44	2.90 ± 1.449	3.18 ± 1.168	−0.493	0.628	0.21
Importance of studies	Item 45	4.40 ± 0.966	4.55 ± 1.214	−0.302	0.766	0.14
Time to improve grades	Item 46	3.70 ± 1.160	3.55 ± 0.820	0.355	0.726	0.15
Usefulness of studies	Item 47	4.30 ± 0.949	4.55 ± 0.934	−0.597	0.558	0.27
Satisfaction with studies	Item 48	2.30 ± 1.418	2.27 ± 0.786	0.055	0.957	0.03
Capability for high grades	Item 49	1.90 ± 1.287	2.82 ± 1.401	−1.559	0.136	0.68
Earn university degree	Item 50	4.60 ± 0.843	4.73 ± 0.467	−0.433	0.670	0.19
Importance of best result	Item 51	4.70 ± 0.675	3.73 ± 1.104	2.405	0.027	1.06
Course content	Item 52	3.50 ± 1.434	4.09 ± 1.375	−0.964	0.347	0.42
Reason for university degree	Item 53	3.30 ± 1.636	3.09 ± 1.136	0.343	0.735	0.15
Effort for qualifications	Item 54	2.50 ± 1.434	2.09 ± 1.375	0.667	0.513	0.29
Difficult assignments	Item 55	3.00 ± 1.414	3.09 ± 1.514	−0.142	0.889	0.06
Studies knowledge and skills	Item 56	4.20 ± 1.135	4.55 ± 0.934	−0.764	0.454	0.34
Importance of univ. degree	Item 57	4.20 ± 1.135	4.55 ± 0.820	−0.805	0.431	0.35
University degree * work	Item 58	4.10 ± 1.101	4.27 ± 0.905	−0.394	0.698	0.17

Univ., university.

P6 Comments: *"My coach, whenever possible, tries to help us., sometimes he lets us train later or earlier, but it's not good to train every day alone either. Besides, he doesn't force us to train, but if we push it, he reminds us that we are here thanks to a scholarship from the Federation."*

On the psychological level, all canoeists comment on how important canoeing is and has been for them, and that, today, they do not understand and would not understand their lives without this sport. At the beginning it was the social environment that stood out (P11: *"I liked most the atmosphere, my teammates, I enjoyed training at the club, I had fun"*). Whereas, today, what motivates them is to be where they are and to be able to have it all. (P2: *"I love the sensation and the appetite for more. I'm very much a perfectionist and wanted to achieve more things")*.

In relation to the psychosocial aspect, the affective part: surrounding themselves with their loved ones and their friends, this is their best time and although they have little time, and many see friends and relatives very occasionally, those days serve to "recharge batteries, escape and draw energy to continue training and their day to day" P14.

P19 comments: *"The basic pillar in all of this are friendships and your group of friends, if not, you go crazy. Family is fundamental. You need to clear your head on the weekends, get out a little bit, be with different people."*

TABLE 4 | Descriptive statistics of the perception of university student high-level athletes of their athletic career and digital competence.

Athletic career	Item	Men (*n* = 10)	Women (*n* = 11)	*T*	*P*	*d*
DC sports monitoring	Item 59	2.40 ± 1.265	2.36 ± 0.924	0.076	0.940	0.04
Weekly training sessions	Item 60	9.80 ± 1.135	9.55 ± 0.820	0.593	0.560	0.25
Hours of weekly training	Item 61	4.70 ± 0.483	4.36 ± 0.924	1.028	0.317	0.45
Help with studies	Item 62	3.20 ± 1.476	2.73 ± 1.272	0.788	0.440	0.34
Training and academic performance	Item 63	4.10 ± 1.287	4.45 ± 0.688	−0.798	0.435	-0.34
Coordinate studies	Item 72	1.40 ± 0.894	1.57 ± 0.976	-0.310	0.763	−0.18
Final expectations	Item 73	1.67 ± 1.211	1.20 ± 0.447	0.811	0.438	0.53
Digital competence						
Virtual campus	Item 65	3.56 ± 1.333	4.27 ± 1.348	−1.189	0.250	0.53
Forums	Item 66	2.11 ± 0.601	2.45 ± 1.635	−0.596	0.559	0.28
Assignments	Item 67	2.78 ± 1.202	3.91 ± 1.300	−2.002	0.061	0.90
Chat	Item 68	2.63 ± 1.598	2.18 ± 1.401	0.642	0.529	0.30
Skype	Item 69	1.44 ± 0.527	1.73 ± 1.348	−0.591	0.562	0.28
Facebook	Item 70	2.11 ± 1.364	2.18 ± 1.537	−0.108	0.916	0.05
Twitter	Item 71	2.33 ± 1.323	1.27 ± 0.647	2.348	0.031	1.02

DC, dual career.

TABLE 5 | Student's *t*-test score by academic career category.

	Item	Semi-professional (*n* = 6)	Professional (*n* = 15)	*T*	*P*	*d*
Flexible Curriculum	Item 21	2.50 ± 1.049	3.13 ± 0.834	−1.464	0.159	0.70
Distance learning	Item 22	2.80 ± 0.447	2.73 ± 1.100	0.130	0.898	0.08
Univ. far from home	Item 26	3.67 ± 1.033	3.13 ± 1.598	0.904	0.381	0.40
Univ. far from training	Item 27	3.50 ± 1.378	3.33 ± 1.291	0.262	0.796	0.13
Studies * training	Item 28	2.50 ± 1.643	3.67 ± 1.113	−1.896	0.073	0.83
Employment * studies	Item 29	1.83 ± 0.983	3.00 ± 1.177	−2.123	0.048	1.08
Caring for family	Item 30	1.50 ± 0.837	2.38 ± 1.446	−1.382	0.185	0.74
Habitual tiredness	Item 31	3.17 ± 1.472	4.13 ± 0.915	−1.836	0.082	0.78
I lose course rhythm	Item 32	3.83 ± 0.408	3.73 ± 1.033	0.227	0.823	0.13
I lose contact with peers	Item 33	3.83 ± 0.983	2.73 ± 1.163	2.036	0.050	1.02
High price of studies	Item 34	3.00 ± 1.225	3.47 ± 1.356	−0.681	0.505	0.36
University support	Item 35	4.00 ± 0.894	3.87 ± 1.302	0.228	0.822	0.12
Inflexible study schedule	Item 36	4.33 ± 1.033	4.13 ± 1.187	0.360	0.722	0.18
Inflexible training schedule	Item 37	2.33 ± 1.033	3.00 ± 1.604	−0.936	0.361	0.50
Virtual tools	Item 44	3.00 ± 1.549	3.07 ± 1.223	−0.105	0.918	0.05
Importance of studies	Item 45	4.17 ± 1.169	4.60 ± 1.056	−0.826	0.419	0.39
Time to improve grades	Item 46	4.00 ± 1.095	3.47 ± 0.915	1.143	0.267	0.53
Usefulness of studies	Item 47	4.50 ± 0.548	4.40 ± 1.056	0.218	0.830	0.12
Satisfaction with studies	Item 48	2.33 ± 0.816	2.27 ± 1.223	0.122	0.904	0.06
Capability for high grades	Item 49	2.33 ± 1.506	2.40 ± 1.404	−0.096	0.924	0.05
Earn university degree	Item 50	4.83 ± 0.408	4.60 ± 0.737	0.725	0.477	0.39
Importance of best result	Item 51	4.50 ± 0.548	4.07 ± 1.163	0.865	0.398	0.47
Course content	Item 52	3.67 ± 1.751	3.87 ± 1.302	−0.289	0.776	0.13
Reason for university degree	Item 53	2.67 ± 1.506	3.40 ± 1.298	−1.120	0.277	0.52
Effort for qualifications	Item 54	2.17 ± 1.169	2.33 ± 1.496	−0.243	0.810	0.12
Difficult assignments	Item 55	3.00 ± 1.095	3.07 ± 1.580	−0.094	0.926	0.05
Studies knowledge and skills	Item 56	4.50 ± 0.837	4.33 ± 1.113	0.330	0.745	0.17
Importance of univ. degree	Item 57	4.50 ± 0.837	4.33 ± 1.047	0.347	0.733	0.18
University degree * work	Item 58	4.33 ± 1.211	4.13 ± 0.915	0.413	0.684	0.19

Univ., university.

TABLE 6 | Student's *t*-test score by category of athletic career and digital competency.

Athletic career	Item	Semi-professional (*n* = 6)	Professional (*n* = 15)	*T*	*P*	d
DC sports monitoring	Item 59	2.00 ± 1.265	2.53 ± 0.990	−1.032	0.315	0.50
Weekly training sessions	Item 60	9.67 ± 1.033	9.67 ± 0.976	0.000	1.000	0.00
Hours of weekly training	Item 61	4.33 ± 1.211	4.60 ± 0.507	−0.728	0.476	0.29
Help with studies	Item 62	3.17 ± 1.329	2.87 ± 1.407	0.448	0.659	0.22
Training and academic performance	Item 63	4.00 ± 1.549	4.40 ± 0.737	−0.815	0.425	0.33
Coordinate studies	Item 72	1.00 ± 0.000	1.60 ± 0.966	−1.964	0.081	0.88
Final expectations	Item 73	1.00 ± 0.000	1.63 ± 1.061	−1.667	0.140	0.84
Digital competence						
Virtual campus	Item 65	4.40 ± 1.342	3.80 ± 1.373	0.850	0.406	0.44
Forums	Item 66	2.20 ± 1.304	2.33 ± 1.291	−0.200	0.844	0.10
Assignments	Item 67	3.80 ± 1.789	3.27 ± 1.223	0.754	0.460	0.35
Chat	Item 68	3.25 ± 1.708	2.13 ± 1.356	1.393	0.181	0.73
Skype	Item 69	1.60 ± 0.894	1.60 ± 1.121	0.000	1.000	0.00
Facebook	Item 70	2.00 ± 1.732	2.20 ± 1.373	−0.265	0.794	0.13
Twitter	Item 71	2.00 ± 1.732	1.67 ± 0.900	0.567	0.578	0.24

DC, dual career.

The academic level causes them the most distress, since attending class is very complicated as it usually coincides with training. So what they usually do is organize themselves at the beginning of the course/season. They ask their coach about the training schedules, and based on the schedule published in the faculty, they register for the courses they think they will be able to attend.

P3: *"In September, when I arrive here, I ask the coach about the timetables and I outline the practical classes I can attend, since the theoretical ones are not compulsory, if I can attend, I go, but the other ones, I enroll because I can attend class. I try to maintain this throughout the course. although when the end of the course arrives, which coincides with the peak of the (sports) season, I spend weeks without going to the University, I'm dead!".*

In addition, peer support is essential to address this situation.

P8: *". . .Having classmates who understand your situation and support you in everything (notes, group work, exams) is priceless!! To them, I owe half my degree."*

P10: *"My classmates know that I can't always go to class, they leave me their notes or let me know about important things the teacher has said. That way I can keep up to date. They also count on me for group work because they know that I need it so that I don't fall behind in the subject."*

Currently, the economic aspect is not an obstacle for these paddlers since most have a maintenance grant from the Federation. In addition, some meet the requirements for other grants.

P16: *"There are scholarships to help you pay the university tuition and if you can get them it is very helpful. I also usually apply for sports scholarships based on the results. In my case, the government of my region doesn't give me anything, but there are other colleagues who receive other assistance because they are Basque or Galician. . .".*

P7: *"I applied for a grant from the ministry, which I imagine they will give me. I have also just applied for the Galician high-level athlete grant and in theory they have to give me financial aid."*

Barriers

Athletic

In general, for all the paddlers on the under-23 team who combine studies and training, both commitments overlap in time. Training schedules usually coincide with class schedules, so fulfilling both obligations is impossible. The most common option is to attend only the required classes (practical) and when these overlap, change the training schedule, even if this means training alone (without teammates or coach).

P13: "*Practically it is the day to day... mainly the practical classes usually coincide with training. I have to train here very early to arrive just in time for class or late and the truth is that it makes everything difficult for me because I arrive at class tired. it is hard to manage. . . at the beginning of the season, I can still. . . but when the peak season comes. I am just dead when I get out of the water and cannot even climb the ladder, so just imagine going to the University.*'

This academic-athletic situation affects the athlete at the psychological level with a considerable load of stress, since, as we have seen, being able to combine both activities on a daily basis is quite a complicated task.

P15: *"Since practice is in the morning and the afternoon, I try to squeeze everything into a single session (I know I lose training quality and don't get enough rest between one and the other), but either I race against the clock or I can't manage."*

P17: *"I finish training between 1:00 and 2:00 p.m., I get home like at 3:30p.m. I take the bike to go to the university from 4:00 to 8:00 p.m., you get home and you have to start studying because if not, you have no other time to do it."*

P11: *"I eat in a hurry because at 3:00 pm I have to leave to go to class, which I have from 4:00 to 8:00 p.m., when I come back to*

CEAR I stay there studying, doing homework or reading a little and at about 12:00 a.m. I go to sleep."

As we can see, in the life of the under-23 paddler there is no time for anything other than training, going to class, eating and resting. In this sense, the psychosocial aspect is the most neglected, certainly not because they want to, but because of lack of time. The most surprising thing is that they accept it and as it stands today their sacrifice is compensated.

P1: "*After so much time maintaining this rhythm it's something I've internalized, but it's complicated to handle, I sacrifice many moments with friends and family. Lose many weekends, holidays, birthdays, and even evenings with friends to disconnect. You have to devote many hours to training, rest if you want to achieve something in this… and in your free time, study.*"

P11: *"Friends are those who are in Galicia, I see them at Christmas or summer and that's it."*

P12: *"It's very complicated, because at the Faculty they tell me to stay for a drink, but for me, I would love to stay, but I have to train, I have to complete a training session, and maybe I could after dinner, around 9.30 at night, but the next day at 7:00 a.m. it wouldn't be realistic. so you have to be clear about what you are here for."*

Academics

The academic realm presents the most barriers, and in greater number as the course and season progresses: attendance at classes, practical work, group work, exams...to which we should add training, gatherings outside Seville and the competitions, in many cases international. Successfully combining academic and athletic life becomes impossible even with good organization and, most of the time, one of the two facets is given up due to incompatibility. In all cases, it is academic life that is abandoned because the current university system does not benefit these athletes. In fact, many of them have chosen to switch from physically attending university to distance learning because of all these issues, while others have dropped out of university completely.

P3: *"I started at the Complutense University of Madrid, when the Senior Lady's team was based at the Joaquín Blume residence in Madrid, and the following year when they told us that the training location would be changed, I decided to reconsider because the training location would be a bit volatile and I'm not going to be able to advance normally."*

P19: *"The first year I only passed one subject and last year I repeated the first year and passed a few more, I saw that it was impossible and that I was not going to be able to manage it if I wanted to continue training at a high level and I was not going to be able to pursue a career in Medicine, it is a career that you have to dedicate all your time to and be very focused, I loved it, I thought it was amazing but with this sport and the level at which I do it, for me, at least it is impossible." "The second quarter of the first year was very complicated. In the morning it was impossible to go to class. I trained every morning which is class time that you cannot change and that was the most complicated part really. Without going to class it is almost impossible to complete a career of that caliber."*

Finally, from an economic standpoint, while there are scholarships to help these athletes, very few of them benefit from an athletic scholarship since they only receive one if they have been successful in international competitions and that is usually very difficult. These athletes spend years training at the highest level but are not assured that they will have compensation that will enable them to support themselves and to achieve independence. Some of them comment that they have had to look for an apartment outside the High Performance Center, because due to poor results in the previous year, they were not granted a scholarship, even though they are still on the team. Therefore, they need economic support from their family.

P13: *"I don't receive any help or sponsorship, not from the club, or from the Asturian federation, and I don't any opportunity for a scholarship to the University because I'm not registered for the whole course, so I' m not entitled to it."*

P5: *"Canoeing in itself is not a sport that makes it easy for you on an economic level: you often have to pay for a competition yourself or if the Federation does not pay for the physiotherapist, you have to pay for the treatment yourself. Then regarding studies there are more and more scholarships, but there are no scholarships linking athletes with their studies, many scholarships are awarded for getting very good grades or for passing everything, and of course an athlete does not have the same chance as a normal student to pass everything or to get very good grades."*

These are other reasons why the paddlers admit that they cannot quit studying because they know that the day they do not get results, they will have to find another way to make a living, and without a university degree, the options are very scarce.

P9: *Who lives from canoeing in Spain? Maybe just one or two, and that's because they are civil servants, and they are able to train because they have facilities at work. I'm doing this to get to Tokyo 2020, to have the experience of an Olympic Games, not because it compensates financially."*

DISCUSSION

The purpose of the present study was to gain an understanding of the perception of life both in the athletic and the academic careers of the Spanish under-23 flat water canoeing team. The athletes showed some significant differences according to gender. The men live farther away from the university area and the sports facilities where they carry out their DC, an issue that may be related to their economic situation. Sometimes, when the problems are perceived by both populations, it is due to the university campus as well as the location where the training sessions are held frequently being located on the outskirts of the city. In addition, it is more difficult for the men to achieve a better result in their academic careers. This greater difficulty shown by the men may be associated with the constant concern that these athletes have for their future outside of sport (Stambulova and Wylleman, 2015), which translates into greater tension and anxiety (Gustafsson et al., 2008; Aquilina, 2013; O'Neill et al., 2013; Torregrosa et al., 2015; Sorkkila et al., 2017). Concluding the academic section according to gender, of note is that all the male athletes showed high scores on earning a university degree, the association between a university degree and finding work and

having knowledge and skills, which indicates that they perceive excessive difficulty in achieving these goals. These concerns or difficulties demonstrate the need to incorporate tutors at universities for high-level athletes to help and support these athletes providing optimal academic guidance (Stambulova et al., 2009; Mateos et al., 2010). The perception of the sports career, however, showed no significant differences according to gender.

These athletes were classified according to their level of expertise, differentiating between professionals and semi-professionals. The former showed greater difficulty and confirmed that training time takes time away from their studies, leading to the conclusion that it is more challenging for them to combine their studies with their athletic career. In contrast, the semi-professionals claimed that training time causes a loss of contact with peers. Some studies corroborate that many athletes, especially in minority sports, are aware of the importance of combining athletic life at the highest level with academic life, mainly due to the fact that athletic careers are short (Conzelmann and Nagel, 2003; Debois et al., 2015; Gledhill and Harwood, 2015; Kuettel et al., 2017; Barriopedro et al., 2018; López de Subijana et al., 2018; Pink et al., 2018).

On a qualitative level, we have seen the shift in research on the DC since the early studies by Purdy et al. (1982) advised against it because of poor academic results, while more current studies (Guidotti et al., 2015; Lupo et al., 2015; Stambulova and Wylleman, 2015; Fuchs et al., 2016; De Brandt et al., 2017; Isidori et al., 2017; Jordana et al., 2017; Kristiansen, 2017; Kuettel et al., 2017; Miro et al., 2017; Budevici-Puiu, 2018; Guirola et al., 2018; Kerstajn et al., 2018; Knight et al., 2018; Krueger et al., 2018; Ronkainen et al., 2018; Stefano and Ginevra, 2018; Tekavc and Erpic, 2018) corroborate the desirability of a double life (academic and athletic), with which our results coincide.

Studies by Stambulova et al. (2015) suggest that the optimal balance in the DC is the combination of sport and studies, whereas Gustafsson et al. (2008), Aquilina (2013), O'Neill et al. (2013), Torregrosa et al. (2015), Ryba et al. (2017), and Sorkkila et al. (2017), warn of the complexity of successfully combining these two spheres, causing anxiety, stress and tension. This has also been verified in our study, and when these appear, the paddlers abandon their academic career, first partially (they only attend the required classes) and if their stress is very high, they drop out completely, which is consistent with the research by Purdy et al. (1982).

Concerning the economic aspect, our results agree with those of other studies such as the results by Conzelmann and Nagel (2003), Debois et al. (2015), Gledhill and Harwood (2015), Kuettel et al. (2017), Barriopedro et al. (2018), López de Subijana et al. (2018), and Pink et al. (2018) since our paddlers, despite having a maintenance grant, are aware that they must have an academic career, as no matter how successful a sporting career may be, they will never be able to earn a living from it.

This study has several limitations that must be taken into account. First, the questionnaire validated by a group of Spanish researchers in a sample of Spanish athletes appears to have discrepancies concerning the reliability and validity of the elements that comprise the sport category. Experts have proven that some of the items that refer to the knowledge of applications and use of social networks should not be considered in the athletic career category. Accordingly, we view this as a limitation and thus propose designing a new questionnaire that includes all the variables and categories in a comprehensive manner. Furthermore, it could be very interesting to consider differences in other types of sports, whether team, opponent or individual. Athletes in team sports, for example, are thought to have different perceptions of their DC, enabling variations to be found in items that can be improved or palliated due in part to a process of intervention, tutoring or mentoring, embedded within the university itself.

CONCLUSION

This is the first study to describe the perception of the DC in both professional and semi-professional under-23 canoeists. This information makes it possible to verify the difficulties currently encountered by these paddlers. According to the data extracted from the results section of the qualitative methodology, the athletes encounter specific problems that make it difficult to efficiently combine their DC. Due to the existence of these complications, we recommend the incorporation of the position of a tutor for high-level athletes into the university system to support, help and guide athletes during the times they need greater attention.

DATA AVAILABILITY

All datasets generated for this study are included in the manuscript and/or the supplementary files.

ETHICS STATEMENT

This study was performed in compliance with the 1964 Declaration of Helsinki, revised in 2013, which defines the ethical guidelines for research involving human subjects. Prior to the study, written informed consent was obtained from the participants and their legal guardians. Throughout the entire research process and afterward, the provisions of the Organic Law 15/1999 of 13 December, on the protection of personal data were applied. All the participants were treated following the ethical guidelines of respect, confidentiality and anonymity in data processing.

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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Levels of Physical Activity Are Associated With the Motivational Climate and Resilience in University Students of Physical Education From Andalucía: An Explanatory Model

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Background: The practice of Physical Activity (PA) is a key factor for the improvement of physical and mental health, making the study of the motivational processes that take part in the development of active lifestyles of interest.

Methods: This cross-sectional study was conducted on 775 university students of Physical Education (PE) from Spain. This research aims to develop an explanatory model for the relationships between motivational climate and resilience according to the level of PA, using structural equations analysis. The main instrument used were the Perceived Motivational Climate in Sport (PMCSQ-2) and the Connor-Davidson Resilience Scale (CD-RISC).

Results: A negative relationship was observed between task-oriented climate (TC) and ego-oriented climate, which acquired greater correlation strength in the respondents who did less PA. Likewise, a positive relationship was obtained between TC and resilience, which was higher in participants who did more than 3 h of weekly PA. Finally, it was observed that resilience was highly correlated with personal competence, tenacity and control capacity in the most active respondents.

Conclusion: The importance of promoting task-oriented motivational climates in PA is highlighted, since this could develop a better resilience capacity in university students and will favor the tolerance to adversity and the positive acceptance of changes.

Keywords: resilience, motivational climate, physical activity, sport, university

INTRODUCTION

Given the benefits produced for physical and mental health, there's been an expansion in recent decades in the promotion of healthy lifestyles (Ekelund et al., 2016; Lewis et al., 2017). One of the main ways to achieve this aim is the practice of Physical Activity (PA). This is defined as all body movements that involve an energy expenditure, while the practice of physical exercise implies a prescription of PA with a specific load and rest periods. Moreover, sport is a more specific

concept that can be defined as a regulated and institutionalized PA that can involve competition in different ways. Thus, an adequate prescription of these habits will provide multiple benefits at the physiological level, and its promotion is essential from an early age (Bouchard et al., 2018). Specifically, World Health Organization [WHO] (2010) recommends performing at least 150 min of moderate PA or 75 min of intense PA per week in adults aged between 18 and 64 years old. This recommendation is especially important in university students, which are approaching adulthood (Arnett and Tanner, 2016). This stage is a period of labor and social complexity, in which several harmful habits can arise due to peer influence. Some of these habits include the consumption of legal drugs, sedentary digital leisure or unhealthy food intakes (Chacón-Cuberos et al., 2018a; Erturan-Ilker et al., 2018).

Among the benefits provided by positive habits figures a decrease in the risk of suffering from diseases such as osteoporosis, cancer or obesity (Warburton and Bredin, 2017). PA produces an improvement in insulin sensitivity, develops cardiorespiratory fitness through adaptations in the cardiovascular system and helps decrease the percentage of fat mass (Fransson et al., 2018; López-Sánchez et al., 2018). In addition, PA also generates a multitude of benefits at a cognitive level, which are the focus of this research work. For example, Sink et al. (2015) demonstrated that older adults who followed an active lifestyle based on PA for 24 months improved cognitive function and reaction time. Likewise, Plotnikoff et al. (2015), Donnelly et al. (2016) revealed that adolescents who performed physical exercise improved their cerebral neuroplasticity, attention capacity and academic performance. In fact, the practice of PA is associated with improvements in several psychosocial factors, such as self-esteem, perceived well-being, self-concept or resilience (Kavosi et al., 2015; Plotnikoff et al., 2015; Prakash et al., 2015).

Due to the positive effects for the health linked to the practice of PA, it is interesting to study the motivational processes that promote its practice. The Self-Determination Theory (Ryan and Deci, 2017; Chacón-Cuberos et al., 2018b) and the Achievement Goals Theory (Mascret et al., 2015; Chacón-Cuberos et al., 2018a) represent the two main models that explain the development of behaviors in the sport context. The first theory states that the level of motivation linked to a behavior establishes a continuum which varies from higher to lower level of self-determination. The most self-determined area includes more autonomous and controlled forms of motivation such as intrinsic motivation, while amotivation is found in the less self-determined area. In the middle zone the extrinsic motivation can be found, which is characterized by behaviors which are done in order to obtain some separable outcome or rewards. It is also important to point out that this level of self-determination will be mediated by three basic components, such as competence, autonomy, and relationship with others (Ryan and Deci, 2000; Gorelik et al., 2018). Briefly, the need of competence is linked to the ability to control actions effectively in order to obtain the desired result. The need for autonomy is associated with the desire of the person to build and determine their own behavior and modify it according to the need of the context. Finally, the need of relationship is linked to behaviors that improve the social world of the athlete, integrating a socializing component (Ryan and Deci, 2017; Erturan-Ilker et al., 2018).

The second model establishes that the goals fixed by a person in the sport practice depend on the perception that people have of their abilities and skills (Harwood et al., 2015; Gorelik et al., 2018; Castro-Sánchez et al., 2019). The motivational climate is defined as the set of social and contextual signals through which social agents are related, which define the keys to success or failure (Moreno et al., 2008). Thus, two types of motivational climates can be developed as a result of the relationships between peers, rivals, coaches and other agents; the task-oriented motivational climate and the ego-oriented motivational climate. Moreover, several authors have demonstrated the link between the motivational climate and the theory of self-determination (Moreno et al., 2008; Jaakkola et al., 2017). The task-oriented climate (TC) is associated with intrinsic motivations that are related to teamwork, learning new skills and enjoying the PA. On the contrary, the ego-oriented climate (EC) is related to extrinsic motivations linked to competition and obtaining better results than rivals in sports practice (Chacón-Cuberos et al., 2018b; Monteiro et al., 2018; Cordo-Cabal et al., 2019).

Under this perspective, several studies have shown how the development of TCs in sport favors the promotion of healthy habits, while the ego-oriented motivational climate is associated with greater non-adaptive behaviors (Harwood et al., 2015; Chacón-Cuberos et al., 2018b). As an example of this basis, Reinboth and Duda (2006) show how people who practice collective sports, whose coach generates a task-oriented motivational climate, have higher levels of well-being. Similarly, Chacón-Cuberos et al. (2018a) reveal that the mastery climate is related to higher levels of PA and a better quality diet, while the EC is associated with greater alcohol consumption. Finally, and taking into account other psychological factors, Vitali et al. (2015) show that TC acts as a protective factor against burnout situations, as well as helping the development of resilience capacity.

The resilience capacity has been widely studied in the sport and academic context (Connor and Davidson, 2003; Doll et al., 2014; Vitali et al., 2015). This psychosocial factor refers to the ability to overcome situations of adversity (Connor and Davidson, 2003). In fact, resilience is closely associated with situations of stress and anxiety, since these negative factors are generated in situations in which an individual is not perceived with sufficient competence to overcome an event (Olmedilla et al., 2018; Zurita-Ortega et al., 2018). Therefore, it is of special interest to carry out actions that improve resilience capacity, since it acts as a protective factor against many vital experiences (Al-Haramlah, 2018). Sarkar and Fletcher (2014) show how the development of personal factors such as confidence, self-determined motivation and social support helps improve resilience and reduce the effect of stressors in the sport context. Moreover, Galli and Gonzalez (2015) highlight the importance of developing intervention programs based on the development of personal beliefs and the ability to control negative situations. In addition, and considering the association with the theoretical framework developed, it is interesting to

know its association with PA and motivation. For example, the study conducted by Hegberg and Tone (2015) reveals through a linear regression analysis how the PA and the perceived resilience are positively related, which is mediated by the trait anxiety levels. Furthermore, Ka et al. (2015) point out in a study conducted in young people from China how PA was related to mental wellbeing, self-efficacy and resilience, which shows the potential of this psychosocial factor and its association with healthy habits.

This research considers the motivational orientations involved in PA and the relationships of the motivational climate on the resilience capacity in different context. The present study sought to answer the following research question: are there differences in the relationship between motivational climate and the capacity of resilience according to the level of PA done? Given the findings of previous research the following hypotheses are proposed:

- Hypothesis 1 (H1): TC will be directly related to the resilience capacity, while EC will be inversely associated with resilience.
- Hypothesis 2 (H2): University students who follow a more active lifestyle will show a stronger relationship between the TC and resilience capacity.

Thus, the following aims are set in the present study: (a) to develop an explanatory model about the relationships between motivational climate, resilience and its different indicators; (b) to contrast the structural equation model (SEM) developed according to the level of PA through multi-group analysis.

MATERIALS AND METHODS

Subjects and Design

This study presents a cross-sectional design with a single measurement in a single group. The study sample consisted of 775 university students of Physical Education (PE) from the eight provinces of the Autonomous Community of Andalusia (Spain), with 58.7% (n = 455) men and a 41.3% (n = 320) women. The age of the respondents was between 21 and 35 years old (22.22 $\pm$ 3.76). A total of 1167 students were enrolled in the mention of PE (degree in Primary Education) during the academic year 2016/2017 (data provided by the different universities). Considering the university centers that accepted to participate in this study and the selection criteria [(1) To study PE degree; (2) To attend regularly to university -at least 75% of attendance in class considering the check-list of their professors-; (3) Not to suffer from important pathologies], a sample of 829 subjects was considered using simple random sampling. A total of 54 questionnaires had to be eliminated because they were wrongly completed, obtaining a final sample of 775 university students. It can be considered that a representative sample was obtained for the studied population (university students of PE), with a sampling error of 0.05 and a CI of 95.5%. All the participants gave written informed consent.

Measures

This study used some main instruments as described below.

Perceived Motivational Climate in Sport Questionnaire (PMCSQ-2) (Walling et al., 1993). The Spanish version validated by González-Cutre et al. (2008) was used. This instrument allows to evaluate the motivational climate in sport and it is composed of 33 five-point items ranging from 1 to 5 (1 = Strongly Disagree; 5 = Strongly Agree). This scale establishes two dimensions (TC and ego-oriented climate), each containing three factors. These are Effort/Improvement, Cooperative learning, and Important role for the TC and Punishment for mistakes, Member rivalry, and Unequal recognition for the ego-oriented climate. This instrument has an acceptable value for Cronbach's alpha ($\alpha = 0.85$), showing an appropriate internal consistency. For each dimension, TC showed an excellent value of $\alpha = 0.92$, while EC ghas a value of $\alpha = 0.93$.

Connor–Davidson Resilience Scale (CD-RISC), developed by Connor and Davidson (2003) and validated into Spanish by Olmo et al. (2017), which allows the assessment of the resilience capacity of respondents. This instrument is composed of 25 five-point items ranging from 0 to 4 (0 = I totally disagree; 4 = I totally agree). The 25 items conform to five factors related to resilient behavior, such as personal ability and tenacity, confidence and tolerance for adversity, positive acceptance of changes, capacity of control and spiritual influence. This instrument has an excellent reliability in the present study, showing an alpha value of $\alpha = 0.90$. For each dimension the values were: Personal competence ($\alpha = 0.85$), Tolerance to adversity ($\alpha = 0.71$), Positive acceptance to changes ($\alpha = 0.72$), Control capacity ($\alpha = 0.65$), and Spirituality ($\alpha = 0.59$).

International Physical Activity Questionnaire (IPAQ) (Craig et al., 2003), validated into Spanish by Mantilla and Gómez-Conesa (2007), allowed the evaluation of levels of PA done in the last week by respondents. This scale is scored through a five-point Likert scale with seven items (0 = Never; 4 = Always) obtaining a summation that establishes the global level of PA in the last 7 days. Subsequently, a variable of categorical type was created, which determined whether the participants performed more than 3 h per week of PA outside academic hours. This variable of dichotomous type (1 = Yes; 2 = No) was used for the multi-group analysis of the two structural equation models. This research obtained an acceptable reliability in this research ($\alpha = 0.86$).

Procedure

First, the collaboration of the respondents was requested through an informative letter created by the Corporal Area of the University of Granada. This was provided to the university students who attended the Mention of PE of the degree of Primary Education of the eight Andalusian provinces. This document detailed the proposal of the research, as well as the objectives of the same. In addition, the informed consent of the participants was requested. This was obtained and written.

The application of the described instruments was subsequently done. A total of 829 university students took part in the study. Data collection was done during school hours in the different university centers without any type of incident. Moreover, researchers were present in order to ensure the correct application of the instruments. A total of 54 questionnaires had

to be eliminated because they were wrongly filled out, leaving a final sample of 775 university students.

The anonymity of all subjects has been respected, as well as the Declaration of Helsinki of 1975 for studies with humans. Similarly, the Research Ethics Committee of the University of Granada (Spain) approved this study (462/CEIH/2017). Respondents participated voluntarily in this research.

Statistical Analysis

First, the IBM SPSS®23.0 (IBM Corp., Armonk, NY, United States) software was used to check the normal distribution of the sample through the values of asymmetry and kurtosis of the items of the scales. In this case, no value equal to or greater than 2 was obtained, showing a normal distribution. In addition, frequencies and means were used for the basic descriptive and the *T*-test to verify the existence of statistically significant differences between variables. On the other hand, the IBM AMOS®23 (IBM Corp., Armonk, NY, United States) software was used to analyze the relationships between the involved constructs of the structural model. Once the theoretical model is developed, a SEM is carried out considering the relationships of the matrix from a multi-group analysis according to the level of practice of PA. The SEM is made up of 11 observable variables and three latent variables to determine the indicators (**Figure 1**). In these, explanations of the associations between the latent variables are formulated from the observed relationships. Likewise, measurement errors (circles) are included in the observable variables so that they are directly controlled. The arrows are lines of relationships between the variables and these are interpreted as regression coefficients.

The SEM showed in **Figure 1** is composed of three latent variables (ovals) and 11 observed variables (squares). Task Climate (TC) and Ego Climate (EC) are the latent and exogenous variables. These two exogenous variables were inferred by the following six observed variables: Important Role (RI), Cooperative Learning (CL), and Effort/Improvement (EI) for Task Climate (TC), and Member Rivalry (MR), Unequal Recognition (UR), and Punishment for Mistakes (PM) for Ego Climate (EC). Another latent variable was Resilience (RES), which was inferred by Personal Competence (PC), Tolerance to Adversity (TA), Positive Acceptance to changes (PA), Control Capacity (CO), and Spirituality (S).

The method of maximum likelihood (ML) was used to estimate relationships between variables. We chose this method because it is consistent, unbiased and invariant to types of scale, given variables with a normal distribution. Model fit was examined to verify the compatibility of the proposed model and the empirical information gathered. Goodness of fit was tested using a number of indices described (Barrett, 2007). Chi-squared analysis followed when non-significant p-Values indicated a good model fit. Comparative fit index (CFI), normalized fit index (NFI) and increase fit index (IFI) values higher than 0.90 indicate acceptable model fit while values higher than 0.95 indicate excellent model fit. Root mean square error of approximation (RMSEA) values below 0.08 indicate acceptable model fit while values below 0.05 indicate excellent model fit.

RESULTS

First, descriptive data of the sample are shown in relation to the variables (motivational climate and resilience), considering the gender [men = 58.7% (n = 455); women = 41.3% (n = 320)] and the practice of more than 3 h per week of PA [+3 h/week = 74.1% (n = 574); −3 h/week = 25.9% (n = 201)]. Specifically, **Table 1** shows the differences between men and women for all sub-dimensions of the ego-oriented climate, being higher in men. Considering the practice of weekly PA, it was observed that those who practiced more than three weekly non-teaching hours had higher scores in the global TC, cooperative learning, unequal recognition and rivalry between members.

Table 2 shows the levels of resilience based on gender and the practice of PA. Statistically significant differences were observed in global resilience, personal competence and positive acceptance to change, with higher scores in men. In addition, statistically significant differences were revealed with regards to the levels of PA, with higher scores for those respondents who do more PA in global resilience, personal competence and tolerance to adversity.

Subsequently, the SEM was carried out, including the motivational climate and resilience, through a multi-group analysis according to the practice of PA. The path model showed correct fit indices in the parameters analyzed. *P*-value reveals a statistically significant value (χ^2 = 210.200, df = 82, $p < 0.001$). This index should not be interpreted in a standardized way due to its sensitivity to sample size. In this way, other fit indices were included as established by Marsh (2007). The NFI revealed an acceptable value of 0.94, while the CFI and the Increment Fit Index (IFI) showed excellent an value of 0.96 for both parameters. Moreover, an acceptable value of 0.05 was obtained for the RMSEA.

First, it is showed the SEM for respondents considered physically active (more than 3 hours of PA/week) (**Figure 2** and **Table 3**). Statistically significant differences were obtained at the $p < 0.001$ level in the associations given between the two dimensions of motivational climate and its indicators. In this sense, the indicator that had the greatest influence on TC was CL (b = 0.91), while the indicator that obtained the lowest regression weight was the Effort/Improvement (EI) (b = 0.83). For EC the highest correlation was showed by the UR (b = 0.91), while the indicator with the least influence was the Rivalry between members (MR) (b = 0.70). Likewise, the TC and EC were inversely related (b = −0.54, $p < 0.001$).

Statistically significant differences ($p < 0.001$) were observed between resilience capacity (RES) and all its indicators, showing direct relationships. The variable with the highest influence was Personal competence and tenacity (PC) (b = 0.92), while the one with the lowest regression weight was Spirituality (S) (b = 0.31). Moreover, the relationships between the motivational climate and the RES were positive and direct, acquiring a greater correlation strength for the TC (b = 0.52, $p < 0.001$) than for the EC (b = 0.16, $p < 0.05$).

Figure 3 and **Table 4** show the regression weights of the SEM designed for those university students who follow a less active lifestyle (less than 3 h of PA/week). Statistically significant differences were obtained for the relationships given between all

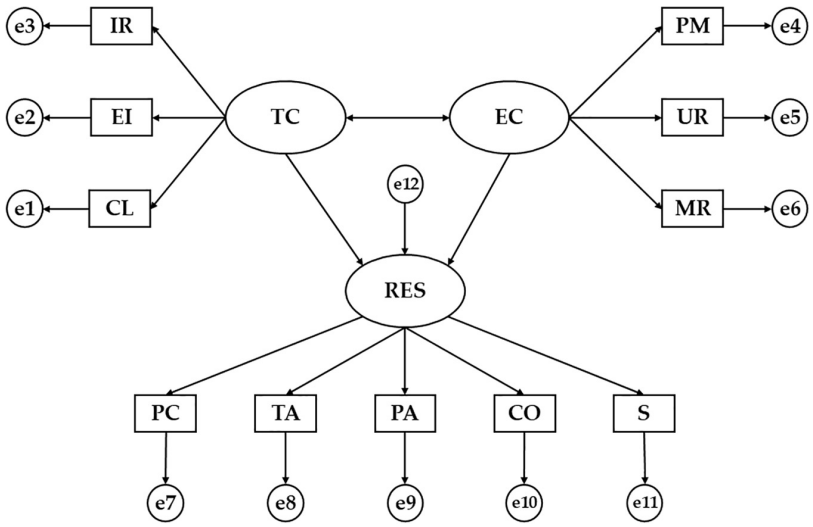

FIGURE 1 | Theoretical Model. TC, task-oriented climate; IR, important role; EI, effort/improvement; CL, cooperative learning; EC, ego-oriented climate; PM, punishment for mistakes; UR, unequal recognition; MR, member rivalry; RES, resilience; PC, personal competence; TA, tolerance to adversity; PA, positive acceptance to changes; CO, control capacity; S, spirituality.

the indicators and the two dimensions of the motivational climate ($p < 0.001$) as showed by the previous SEM. In this case, the indicator with the highest regression weight for the TC was the RI ($b = 0.91$), while the variable with the least association was the EI ($b = 0.76$). The highest correlation was shown with UR ($b = 0.93$) for the CE dimension, with the least regression weight for MR ($b = 0.65$).

In a similar line, statistically significant relationships ($p < 0.001$) are shown for all the indicators of the RES except for the S. The variable with the greatest regression weight was the PC ($b = 0.87$), while the one with the least influence was the CO ($b = 0.63$). Likewise, statistical associations were only observed for the relationship between TC and RES in the university students linked to a lower level of PA, showing a positive and direct association ($b = 0.30$, $p < 0.01$).

DISCUSSION

This research aims to analyze the relationships between motivational climate in sport and resilience capacity in university students using a SEM with multi-group analysis. This association

TABLE 1 | Levels of motivational climate according to gender and PA.

Motivational climate	Gender	Mean ± SD	Motivational climate	PA	Mean ± SD
TC	Men	3.90 ± 0.66	TC*	+3 h/week	3.91 ± 0.67
	Women	3.87 ± 0.65		−3 h/week	3.80 ± 0.59
CL	Men	3.90 ± 0.79	CL*	+3 h/week	3.92 ± 0.81
	Women	3.89 ± 0.81		−3 h/week	3.78 ± 0.80
EI	Men	3.93 ± 0.67	EI	+3 h/week	3.89 ± 0.65
	Women	3.86 ± 0.62		−3 h/week	3.83 ± 0.58
IR	Men	3.85 ± 0.76	IR	+3 h/week	3.88 ± 0.81
	Women	3.87 ± 0.80		−3 h/week	3.82 ± 0.69
EC*	Men	2.43 ± 0.78	EC	+3 h/week	2.30 ± 0.82
	Women	2.22 ± 0.84		−3 h/week	2.25 ± 0.83
PM*	Men	2.18 ± 0.80	PM	+3 h/week	2.07 ± 0.80
	Women	2.03 ± 0.83		−3 h/week	2.12 ± 0.91
UR*	Men	2.53 ± 0.98	UR*	+3 h/week	2.39 ± 1.02
	Women	2.29 ± 1.04		−3 h/week	2.27 ± 1.03
MR*	Men	2.71 ± 0.78	MR*	+3 h/week	2.54 ± 0.86
	Women	2.44 ± 0.86		−3 h/week	2.45 ± 0.78

*TC, task-oriented climate; IR, important role; EI, effort/improvement; CL, cooperative learning; EC, ego-oriented climate; PM, punishment for mistakes; UR, unequal recognition; MR, member rivalry; SD, standard deviation. *Statistically significant differences ($p < 0.05$).*

TABLE 2 | Levels of resilience according to gender and PA.

Resilience	Gender	Mean ± SD	Resilience	PA	Mean ± SD
RES*	Men	3.05 ± 0.56	RES*	+3 h/week	3.01 ± 0.50
	Women	2.96 ± 0.46		−3 h/week	2.90 ± 0.48
PC*	Men	3.21 ± 0.65	PC*	+3 h/week	3.16 ± 0.60
	Women	3.10 ± 0.57		−3 h/week	3.02 ± 0.56
TA	Men	2.98 ± 0.60	TA*	+3 h/week	2.88 ± 0.55
	Women	2.80 ± 0.53		−3 h/week	2.79 ± 0.59
PA*	Men	3.18 ± 0.62	PA	+3 h/week	3.18 ± 0.59
	Women	3.14 ± 0.59		−3 h/week	3.00 ± 0.64
CO	Men	3.00 ± 0.71	CO	+3 h/week	3.03 ± 0.69
	Women	3.02 ± 0.67		−3 h/week	2.94 ± 0.64
S	Men	2.42 ± 0.96	S	+3 h/week	2.39 ± 0.89
	Women	2.40 ± 0.83		−3 h/week	2.46 ± 0.77

*RES, resilience; PC, personal competence; TA, tolerance to adversity; PA, positive acceptance to changes; CO, control capacity; S, spirituality; SD, standard deviation. *Statistically significant differences ($p < 0.05$).*

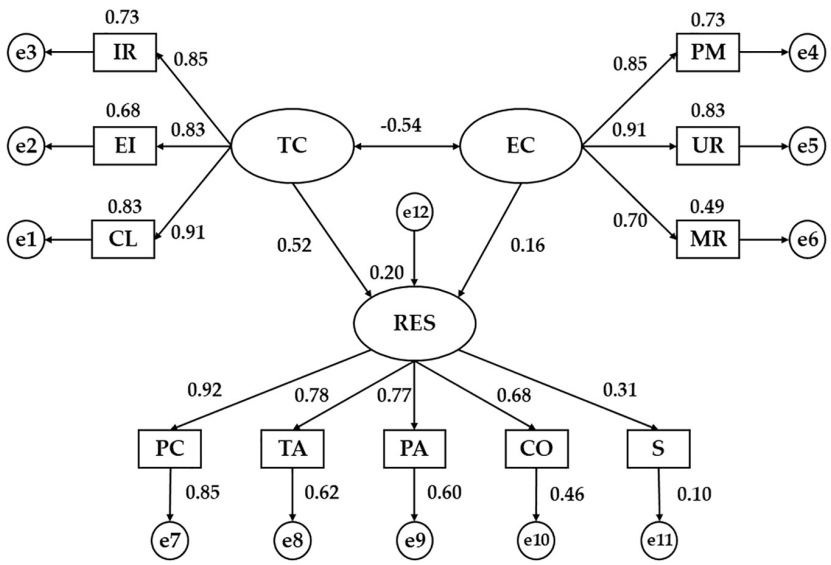

FIGURE 2 | Structural Equation Model for active students (>3 h/week of PA). TC, task-oriented climate; IR, important role; EI, effort/improvement; CL, cooperative learning; EC, ego-oriented climate; PM, punishment for mistakes; UR, unequal recognition; MR, member rivalry; RES, resilience; PC, personal competence; TA, tolerance to adversity; PA, positive acceptance to changes; CO, control capacity; S, spirituality.

is analyzed according to the level of PA in order to verify the relationship between these variables depending on the practice of more than 3 h per week of PA. Supporting this study, other similar researches are those carried out by Lee and Loke (2005), Schnettler et al. (2015), Chacón-Cuberos et al. (2018a), Zurita-Ortega et al. (2018), which address physical and mental health in university students as a risk group for harmful behaviors.

First, the influence exerted by the indicators of each dimension of the motivational climate is analyzed. The SEM showed that CL was the most influential indicator in the TC for students who practice more PA. The IR was the indicator with the higher regression weight for the respondents who did less than 3 h per week of PA. These results can be explained by the findings of Parish and Treasure (2003), who demonstrate how the most self-determined motivations favor higher levels of PA, which is linked to the TC as it is shown in the present research. Moreover, teamwork is more associated with intrinsic motivations given the hedonistic and social component involved in sports practice, which makes university students want to maintain this habit (Monteiro et al., 2018; Montero-Cobo et al., 2018). Nevertheless, the IR is established as an indicator that can be associated with both intrinsic and extrinsic motivations (Hodge and Gucciardi, 2015). For this reason, university students who are related to extrinsic motivations such as competition, practice sports with less frequency (Winter and Collins, 2015).

According to the ego-oriented climate, the UR obtained the greatest regression weight for active and non-active students, although this showed a higher score in the non-active students despite the difference being minimal. This lower influence can be justified by the premises previously explained, given that

TABLE 3 | Regression weights and standardized regression weights in active students (>3 h/week of PA).

Relationship between variables			RW				SRW
			EST	SE	CR	*P*-values	EST
RES	←	TC	0.388	0.052	7.398	***	0.517
RES	←	EC	0.131	0.056	2.349	*	0.161
CL	←	TC	1.000	–	–	***	0.912
EI	←	TC	0.724	0.036	19.942	***	0.826
IR	←	TC	0.940	0.045	21.058	***	0.855
PM	←	EC	1.000	–	–	***	0.853
UR	←	EC	1.368	0.074	18.375	***	0.910
MR	←	EC	0.891	0.063	14.241	***	0.698
PC	←	RES	1.000	–	–	***	0.920
TA	←	RES	0.789	0.044	17.831	***	0.784
PA	←	RES	0.827	0.047	17.441	***	0.773
CO	←	RES	0.857	0.059	14.462	***	0.681
S	←	RES	0.505	0.088	5.708	***	0.313
EC	↔	TC	−0.273	0.035	−7.712	***	−0.542

*TC, task-oriented climate; IR, important role; EI, effort/improvement; CL, cooperative learning; EC, ego-oriented climate; PM, punishment for mistakes; UR, unequal recognition; MR, member rivalry; RES, resilience; PC, personal competence; TA, tolerance to adversity; PA, positive acceptance to changes; CO, control capacity; S, spirituality; SRW, standardized regression weights; SE, estimation of Error; CR, critical ratio; RW, regression weights; EST, estimation. *p < 0.05 and ***p < 0.001.*

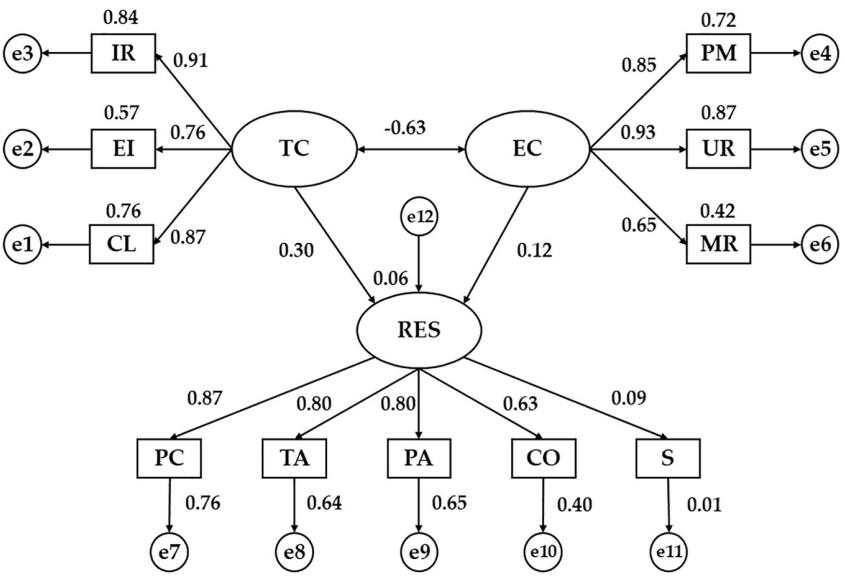

FIGURE 3 | Structural Equation Model for non-active students (<3 h/week of PA). TC, task-oriented climate; IR, important role; EI, effort/improvement; CL, cooperative learning; EC, ego-oriented climate; PM, punishment for mistakes; UR, unequal recognition; MR, member rivalry; RES, resilience; PC, personal competence; TA, tolerance to adversity; PA, positive acceptance to changes; CO, control capacity; S, spirituality.

university students who practice less PA are linked to external motivations associated with specific rewards and competition (Winter and Collins, 2015; McLaren et al., 2017). Specifically, Castro-Sánchez et al. (2018) established that the sport practice associated with competition can be linked to negative emotions that emerge from unwanted results, such as defeat, anxiety or frustration. This causes these individual to stop practicing sport due to these negative feelings, which make them less physically active (McLaren et al., 2017; Castro-Sánchez et al., 2018). Likewise, this type of motivation can be linked to non-adaptive behaviors, such as the consumption of harmful substances, the intensive use of technological devices or poor diets (Chacón-Cuberos et al., 2018b).

Personal competence and control capacity acquired a slightly higher regression weight for resilience in active people. These findings highlight that PA can be linked to an improvement of personal competence through tenacity and the ability to overcome negative situations. It is because the practice of PA

TABLE 4 | Regression weights and standardized regression weights in non-active students (<3 h/week of PA).

Relationship between variables			RW				SRW
			EST	SE	CR	*P*-values	EST
RES	←	TC	0.215	0.072	2.970	**	0.300
RES	←	EC	0.086	0.071	1.220	0.222	0.122
CL	←	TC	1.000	–	–	***	0.871
EI	←	TC	0.633	0.047	13.525	***	0.758
IR	←	TC	1.047	0.061	17.176	***	0.915
PM	←	EC	1.000	–	–	***	0.851
UR	←	EC	1.383	0.089	15.550	***	0.930
MR	←	EC	0.729	0.068	10.676	***	0.650
PC	←	RES	1.000	–	–	***	0.871
TA	←	RES	0.947	0.069	13.698	***	0.802
PA	←	RES	0.916	0.067	13.719	***	0.804
CO	←	RES	0.839	0.083	10.051	***	0.631
S	←	RES	0.146	0.110	1.329	0.184	0.094
EC	↔	TC	−0.345	0.050	−6.859	***	−0.633

*TC, task-oriented climate; IR, important role; EI, effort/improvement; CL, cooperative learning; EC, ego-oriented climate; PM, punishment for mistakes; UR, unequal recognition; MR, member rivalry; RES, resilience; PC, personal competence; TA, tolerance to adversity; PA, positive acceptance to changes; CO, control capacity; S, spirituality; SRW, standardized regression weights; SE, estimation of error; CR, critical ratio; RW, regression weights; EST, estimation. **$p < 0.01$ and ***$p < 0.001$.*

generates endorphins and reduces stress, helps maintain levels of effort, allows the setting of attainable goals and favors the development of self-determined motivations (Mandolesi et al., 2018; Zurita-Ortega et al., 2018). In addition, Shoenfelt (2016) establish how the practice of sport improves the control capacity, since the athlete will learn to fight against situations of adversity such as defeat, and negative emotions such as anxiety, frustration or fear. In contrast, tolerance to adversity and positive acceptance of changes were the indicators more related to resilience in the respondents who practice fewer than 3 h of PA per week. This situation may be due to a lower capacity of these students to maintain behaviors when establishing goals, being less persistent and forced to accept the new events (Morgan et al., 2017). Thus, the respondents who practice more PA are more optimistic and empathic, which makes them more resilient without the need to achieve their objectives (Laborde et al., 2016).

The relationship between motivational climate and resilience revealed a positive relationship between TC and resilience capacity, which was higher in the more active respondents. From these results, it can be inferred that those students who practice more PA linked to intrinsic motivations such as hedonism, learning improvement or socialization, are more resilient. Specifically, Vitali et al. (2015) demonstrate how coaches who develop task-oriented motivational climates help improve the level of achievement in athletes, sports devaluation and burnout levels, acting as a protective factor and improving resilience. On a similar note, Martin and Dowson (2009) emphasize that positive psychology, which has certain elements in common with self-determined motivations, can be positively related to resilience. Specifically, it highlights the importance of favoring adaptive behaviors within the cognitive sphere such as goals oriented toward mastery, self-efficacy and the value of work (Crane et al., 2017; Chacón-Cuberos et al., 2018b). Likewise, within the field of behavior, emphasis is placed on developing persistence, planning and the ability to organize work tasks (Martin and Dowson, 2009; Secades et al., 2016).

The EC showed a lower association with resilience, and only in active people due to the relationship that exists between both motivational climates in those people who practice sports frequently. Specifically, Matosic et al. (2017) remember how the promotion of both motivational climates generates a positive effect on the adherence of university students to sports practice, justifying these findings. Nevertheless, the development of intrinsic motivations should not be neglected, since several works establish how motivational climates oriented exclusively to the ego are linked to situations of self-handicap, disgust, poor control and avoidance of failure (Martin and Dowson, 2009; Verner-Filion et al., 2014). This is due to situations in which the desired results are not achieved, when there is excessive competition or when these two factors lead to high levels of state anxiety, stress or sports burnout (Smith et al., 2007). Therefore, it can be concluded that the promotion of motivational climates oriented to the task could favor the resilient capacity and act in a preventive way with negative emotions in sports.

It is important to establish the main limitations of this study. The first is associated with the study design, since a cross-sectional research do not allow to show cause-effect relationships. However, the SEM is useful to know the associations between the psychosocial variables which have been studied. Moreover, multi-group analysis is used in order to compare the regression weights of this relationship according to a dichotomous variable as the practice of PA. Another limitation is linked to the study sample, since only university students who attend PE degrees were considered. Consequently, it can be established that this sample already has a relatively high level of PA. Therefore, there is a need to replicate this study in other types of university students,

since students from other degrees may be more sedentary and may develop more harmful habits such as a poor diet or substance abuse. In this way, we could expand the vision of the existing relationships between PA level, resilience and motivation in sports as future perspectives. Finally, it would also be interesting to include other psychological factors associated with resilience, such as self-concept or burnout syndrome.

CONCLUSION

Considering the research question, it can be established that resilience is associated with the type of motivational climate in sport and the levels of PA of university students. Nevertheless, this relationship depends on the type of motivational climate, showing different types of influence in this capacity. Therefore, we should point out about the hypothesis:

- Hypothesis 1 (H1) was partially fulfilled, since TC was positively related to resilience. However, EC was not inversely associated with resilience, showing a positive relationship in respondents who practice more PA.
- Hypothesis 2 (H2) was fulfilled. The university students who practice more than 3 h per week of PA showed a stronger relationship between TC and resilience capacity.

As a main conclusion, it can be established that the practice of PA could be associated with more favorable motivational climates and levels of resilience capacity in university students. Specifically, respondents who do more than 3 h of PA per week showed slightly higher levels of TC, which were linked to a greater resilience. This factor was mainly influenced by a personal competence and the capacity of control.

DATA AVAILABILITY

The datasets for this manuscript are not publicly available because the reason is that they are part of a project and belong to the research group. Requests to access the datasets should be directed to the corresponding author.

ETHICS STATEMENT

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Written informed consent was obtained from all individual participants included in this study.

AUTHOR CONTRIBUTIONS

RC-C, EO-M, and FZO conceived the hypothesis of this study. FZO, JP-T, and MC-S participated in the data collection. RC-C and MC-S analyzed the data. All authors contributed to the data interpretation of the statistical analysis, and read and approved the final manuscript. RC-C, EO-M, and MC-S wrote the manuscript with the significant input from FZO and JP-T.

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Self-Determined Motivation and Competitive Anxiety in Athletes/Students: A Probabilistic Study Using Bayesian Networks

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This study attempts to analyze the relationship between two key psychological variables associated with performance in sports – Self-Determined Motivation and Competitive Anxiety – through Bayesian Networks (BN) analysis. We analyzed 674 university students that are athletes from 44 universities that competed at the University Games in Mexico, with an average age of 21 years (SD = 2.07) and with a mean of 8.61 years' (SD = 5.15) experience in sports. Methods: Regarding the data analysis, firstly, classification using the CHAID algorithm was carried out to determine the dependence links between variables; Secondly, a BN was developed to reduce the uncertainty in the relationships between the two key psychological variables. The validation of the BN revealed AUC values ranging from 0.5 to 0.92. Subsequently, various instantiations were performed with hypothetical values applied to the "bottom" variables. Results showed two probability trees that have extrinsic motivation and amotivation at the top, while the anxiety/activation due to worries about performance was at the bottom of the probabilities. The instantiations carried out support the existence of these probabilistic relationships, demonstrating their scarce influence on anxiety about competition generated by the intrinsic motivation, and the complex probabilistic effect of introjected and identified regulation regarding the appearance of anxiety due to worry about performance.

Keywords: Bayesian networks, self-determined motivation, competitive anxiety, athletes, students

INTRODUCTION

One of the biggest problems facing social science is the great difficulty involved in predicting human behavior. It may be due to the large number of variables that bear influence on it, however, other explanations have also been proposed within the framework of information theory (IT) and the entropy inherent in the development of open and closed systems, although they do not form part of the currently valid paradigm in psychological research (Luce, 2003; Chen and Huang, 2018; Olmedilla et al., 2018). As far as statistical methods in Psychology are concerned, something very

similar to the analysis derived from Bayes' theorem has arisen, which has a very direct relationship with the classic concept of Entropy (Laming, 2001; Farr et al., 2018). Adding sense to the similarity between these two concepts, we can argue that "IT provides a constructive criterion for setting up probability distributions on the basis of partial knowledge, and leads to a type of statistical inference that is called the (Jaakkola et al., 2000).

Therefore, it is plausible to assume that the conceptual framework of entropy is quite fitting when attempting to explain the situation of an athlete before a competition at a given moment in time. The so-called entropic "time arrow" – which implies irreversibility of events, by prohibiting the symmetry between past and future – understood psychologically, implies the generation of a past, through past events recall and memory-building, in the face of a mobile future that is configured mainly on the basis of expectations and a broad spectrum of emotions ranging from hope to fear.

In the case of sports psychology, one of the most relevant issues already extensively studied but still open to discussion affects precisely these two aspects of the "time arrow": how do emotions associated with future performance combine with the athletes' motivational past?

Motivation is one of the most studied variables in the context of sport (Lindahl et al., 2015; Clancy et al., 2016), and it is defined as the cause of a behavior, which operates at a psychological level within the individual and determines the execution or not of a certain activity (Tohidi and Jabbari, 2012). Intrinsic motivation can be defined as one in which individuals move autonomously toward new challenges, broader experience frameworks, and greater coherence in understanding. It represents a behavior that interests them, seeks encouragement, limits evidence, and openly assimilates novelty. On the other hand, there are four motivational norms that offer a broader framework on external motivation. The first of these is external regulation, in which the individual regulates his behavior through externally controlled rewards and punishments; the second is introjected regulation; in that regulation, the individual, by complying with internal demands, can develop certain forms of self-esteem, self-satisfaction and feelings of pride about himself; in identified regulation people value the importance of certain behavior and see it as something important for themselves; in integrated regulation, it implies that the individual brings a value or regulation in congruence with the other aspects of himself; with his basic psychological needs and with his other identifications. Finally, a motivation describes a state in which the individual is not motivated to behave or behaves in a way that is not mediated by intentionality (Ryan and Deci, 2017).

On the other hand, another of the most widely studied variables in regard to the activation of individual and sports performance is anxiety (Patel et al., 2010; Ponseti F. et al., 2016). This is defined as an immediate emotional state, characterized by apprehension and tension, associated with the activation of the organism that occurs in situations of competition (Martens, 1977). Also, competitive anxiety has been characterized by two cognitive components. One of these is worry, which is understood as restlessness about the potentially negative consequences associated with poor performance; and the second is de-concentration, which is associated with the athlete's difficulty to focus on key aspects of the task to be performed that impede clarity of thought during the competitive situation (Grossbard et al., 2009).

That is why, in view of the scarcity of relevant literature (Fuster-Parra et al., 2015), the objective of this paper is to investigate the relationships that exist between motivational regulations (intrinsic regulation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation) and anxiety (cognitive anxiety, worry, and de-concentration), in relation to competition in sports. The study of the relationship between these variables is of particular importance, since some authors (Nuñez and García-Mas, 2017) even affirm the possibility that anxiety in its different dimensions (e.g., cognitive, somatic, and motor) in certain conditions and based on the intrinsic characteristics of the individuals, such as their motivational regulation, can play a facilitating role of performance in competitive contexts.

In our study, framed within a closed IT system (a sports competition directed at a homogenous sample of athletes/students), we decided in favor of using a tool recommended for this type of situation, namely analysis through a machine learning classification and Bayesian networks (BN) (Puga et al., 2007; Trafimow and Marks, 2015). This approach should allow us – in part – to simulate the reversal of the "time arrow" when modifying parameters in the temporal succession of events based on the principles of probability inherent to the BNs, which presuppose independence between the events under study.

Bayesian networks are beginning to be more widely used in the field of Social Science (Ranganathan et al., 2014; Lewandowski et al., 2015; Fuster-Parra et al., 2017; Chen and Huang, 2018) and, more recently, they have been introduced as a useful methodology in Sports Psychology, given their ability to provide information on the probability of occurrence of events (some of them psychological) related to performance in sports or, for example, the likelihood of sports injuries. BN have been used to discover relationships between negative features in sport, co-operative team work, motivation and types of sporting cooperation among players on competing teams, motivational climate and anxiety (Jones and Hanton, 2001) and relative age effect (Fuster-Parra et al., 2014, 2016; Ishigami, 2016; Ponseti F.J. et al., 2016).

Before the application of the BN, a machine learning classification model, namely CHAID (Chi-squared Automatic Interaction Detector), is used to discover the dependence links between anxiety and motivation.

As indicated, the psychological variables selected (the motivational and anxiety features of competing athletes/students) are located on both sides of the fulcrum of the present, between past and future. On the basis of the rationale expressed above, our aim in this study is to ascertain the probabilistic links between the different factors of self-determined motivation (Li et al., 2017) and those related to the anxiety associated with competition in young athletes from different sports specialties, especially to attempt to reduce the likelihood of anxiety occurring, and then to

interpret the results obtained according to the entropy inherent in the system under study.

MATERIALS AND METHODS

Participants

The study was performed in Mexico with 674 university students that are athletes who competed in the University Games (Universiade) in 2017. They were from 44 universities, at least one athlete from each participating university, with a mean age of 21 years old (SD = 2.07) and a mean sports experience of 8.61 years (SD = 5.15). All universities took part in this study. All participants were previously informed about the protocol and purposes of the study. The study protocol was approved by the local ethics committee of the Universidad Autónoma de Nuevo León (Mexico) in accordance with current ethical standards in sport and scientific research.

Instruments

Competitive anxiety in sport was measured using the Spanish language adaptation (*Escala de Ansiedad Competitiva*), (Pineda-Espejel et al., 2016) of the Sport Anxiety Scale 2 (SAS-2) (Smith et al., 2006). The SAS-2 consists of three 5-item scales to measure three factors: somatic anxiety, worry, and lack of concentration or de-concentration. Each item was answered on a 4-point Likert scale with a range between "not at all" and "very much."

Self-determined motivation. An adapted version of the Sports Motivation Scale (Pelletier et al., 2013) was used in this study. This measure had been previously translated into Spanish cpssnm(Martín-Albo et al., 2006). The SMS-II is an 18-item inventory comprising six factors of behavioral regulation. These factors were extracted from the Self-determination Theory to test a model that would enable us to assess Autonomous and Controlled Motivation. The subscales are intrinsic motivation (e.g., "*for the pleasure it gives me to know more about the sport I play*"); identified regulation (e.g., "*because in my opinion it is one of the best ways to meet people*"); introjected regulation (e.g., "*because it is absolutely necessary to do sports if one wants to be in shape*"); external regulation (e.g., "*because it makes me better regarded by people I know*"); and a-motivation (e.g., "*I used to have good reasons for doing sports, but now I am wondering whether to carry on doing it*"). Each item was answered on a 7-point Likert scale with a range between "not at all" and "very much."

Procedure

The data was collected during the University Games (Universiade). Personal contact was first made with team coaches to inform them about the project. Instruments were applied in the concentration hotels, prior to their participation in the sporting event, at least one researcher was present to give instructions and answer athletes' questions. Emphasis was placed on the confidentiality of athletes' individual responses as well as on the need to answer honestly. In addition, the researcher explained to them that responding to the questionnaires implied voluntarily accepting to participate in the research.

Data Analysis

The CHAID (Chi-squared Automatic Interaction Detector) algorithm is used to discover relationships between a categorical or ordinal dependent variable and other categorical predictors. It computes a decision tree, which includes meaningful nodes that classify a nominal or ordinal dependent variable (Magidson and Vermunt, 2005). It is a convenient way to summarize data since it makes it easy to view relationships. It relies on the Chi-square test to determine the best next split at each node of the tree. To obtain the decision tree, the R package "CHAID" was used in the dataset. To apply the algorithm, a dependent variable and the independent variables need to be chosen beforehand. We selected "somatic anxiety" as the dependent variable and the remaining variables as the independent variables.

To obtain a BN (Bayesian network), it was necessary to determine a structure (defined by a twofold method). First, through a Directed Acyclic Graph (DAG) and the conditional probabilities assigned to each node of the DAG, and secondly, restricting pathways by using the CHAID algorithm on the resulting graph. Therefore, learning a BN implies the following two tasks: (i) structural learning, i.e., the identification of the topology of the BN, and (ii), parametric learning, i.e., the estimation of numerical parameters (conditional probabilities) given a network topology.

Structural learning was used to obtain the BN, the bnlearn package (Scutari, 2010) of the R language (Rosselet, 1987). To obtain the structure, we could follow either a search and score algorithm (Korb and Nicholson, 2010), which assigns a score to each BN structure and selects the model structure with the highest score, or a constraint-based search algorithm (Spirtes et al., 1993), which establishes conditional independence analysis on the data where an undirected graph is generated and converted into a BN using an additional independence test. We used the score-based algorithm Tabu (Korb and Nicholson, 2010), which gave us a plausible model for our data. The search procedure finds the structure that best improves the score, i.e., using the highest score (Bayesian Information Criterion – BIC).

RESULTS

In regard to the values found in the variables under study, the lack of importance of external regulation compared with the values of intrinsic motivation, and, to a lesser extent, with those of amotivation, are relevant. The subscales of the intrinsic and internalized regulation values are high, with regulation being identified as the one with the lowest values. Descriptive data of the variables studied are shown in **Table 1**.

When we observe the values of anxiety related to competition, we can see that they are below the average in the ranges. Anxiety related to competition shows values below the mean scores in the possible ranges in all cases. Somatic anxiety and lack of concentration are the dimensions with the lowest values, while worry about performance is higher than the average. SD values – with the exception of one case – are consistent with a relatively homogeneous sample and none of the values found is especially significant. The SD value of amotivation is very close to the

TABLE 1 | Descriptive data of the variables studied, mean and standard deviation (N = 674).

Variables	*M*	*SD*
Somatic anxiety	1.71	0.62
Worry anxiety	2.75	0.80
Lack of concentration anxiety	1.73	0.63
Intrinsic regulation	6.22	0.18
Integrated regulation	6.13	0.56
Identified regulation	4.17	0.74
Introjected regulation	5.83	0.15
External regulation	1.61	0.65
Amotivation	2.59	0.98

mean values, indicating that answers about this variable were not overly homogeneous.

When the values for anxiety related to competition are observed, one can see that they are below the average in each range. Anxiety related to competition returns values in all cases below the mean score in the possible ranges. Somatic anxiety and lack of concentration are the dimensions with the lowest values, while concern about performance is above average. The SD in all cases are consistent with a relatively homogeneous population, and none of the values found is especially remarkable.

Figure 1 shows the result of applying the CHAID algorithm, which revealed a tree prediction model for the "Somatic Anxiety" variable; therefore, uncertainty in the data obtained was reduced, allowing for BN analysis with restrictions and thus reducing the complexity of the entire system. Five variables were found to predict "Somatic Anxiety." Four of these were motivational: intrinsic and external global regulations, and two subscales of intrinsic motivation, identified and integrated regulation; and the last one being anxiety related to performance.

The CHAID tree starts with the top "External Regulation" decision node, with the 674 instances of the data set divided into two partitions, based on the result of splitting this node into two categories – "High" (n = 67) and "Low" (n = 607). The "Low" category shows the majority of cases are associated with "Somatic Anxiety." This node is further split on the basis of the value of the "Anxiety from Worry about performance" predictor variable, resulting into two more nodes based on this category. Splitting continues until either the new split does not help to improve prediction accuracy, or a node contains less instances than a pre-defined size.

As for the BN, validation was performed using a 10-fold cross validation, taking into consideration the area under the curve (AUC), which is defined as the probability of correctly identifying a pair of cases (positive and negative). As can be seen in **Table 2**, the validation values generated in the BN with all the variables under study are acceptable. However, in the same line as the descriptive values, the minor AUC values correspond to amotivation, the identified regulation, as well as to anxiety from worry about performance. To achieve a better understanding of the accuracy of the classification, sensitivity and specificity were calculated. While it is possible to find high accuracy in some variables, when sensitivity and specificity are observed, we detect a null positive classification ability on identified regulation, low classification on intrinsic and integrated regulation, and a generally high negative classification ability.

Figure 2 shows the BN generated with the restrictions found after the CHAID analysis using an acyclic graph. The top variable is the external regulation, showing low probability, while the bottom variables (probabilistically dependent on the others) are the identified regulation, which in turn is dependent on global intrinsic regulation. The two intermediate variables – no nodes were found – are Anxiety from Worry about performance and the sub-variable of Identified Intrinsic regulation. The probability values found in the sample group indicate that the participants in our study have a high probability of being intrinsically motivated, with a low probability of perceiving external rewards or benefits (although this variable is shown as key to triggering the likelihood of the other variables occurring), as well as the presence of mean probability of anxiety from worry about performance, which acts as a buffer for the other variables.

BN Instantiations With Hypothetical Data

The global Markov property was applied to maximize and minimize the likelihood values for different variables. The global Markov property states that any node X is conditionally independent of any other node given its Markov blanket (a Markov blanket of X in a BN is the set of nodes consisting of X's parents, X's children and other parents of X's children). The features instantiated were in the Markov blanket of different features, therefore given its Markov blanket, each feature is independent of the remaining features. The two variables selected are: (1) the most relevant Anxiety subscale found, the one relating to worry about performance, as appears in the BNs; and (2) overall intrinsic motivation, which is the most significant node in the two BNs.

We began by attempting to maximize the likelihood of anxiety due to worry about performance occurring, in this case, on the CHAID restricted BN (see **Table 3**). The first two steps are the ones that produce the most significant changes; indeed, probability of "lack of concentration" and "introjected regulation" decrease to give an 18% increase in low level probability of anxiety from worry, which comes from a low value: one third of detected likelihood. The following steps have less weight and, in order of significance, include a reduction in somatic anxiety and different sub-scales for self-determined success motivation, although the latter represents a reduction of less than one tenth of the likelihood, which reaches a maximum of 64.83% (barely double the probability actually obtained in the sample, which is 35.88%). This indicates that the existence of anxiety from worry about performance is very strong and cannot be reduced even if it is forced by using hypothetical "anti-entropic" values and will only return values within the average likelihood of occurrence.

In **Table 4**, it can be seen that when trying to reach the maximum probability of the identified intrinsic motivation sub-scale (which is the most relevant bottom motivational variable in the NB with restrictions), the reversed BN only achieves an increase of 6%. In this sense, it is unquestionably a very solid variable. This maximum value is reached in three

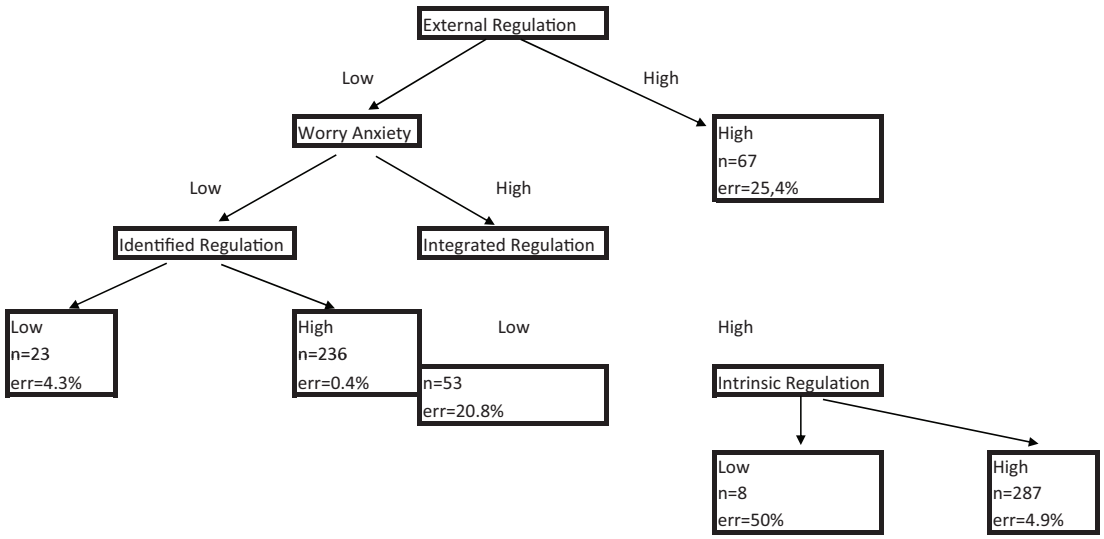

FIGURE 1 | Chi-squared Automatic Interaction Detector algorithm defining the inter-dependent variables.

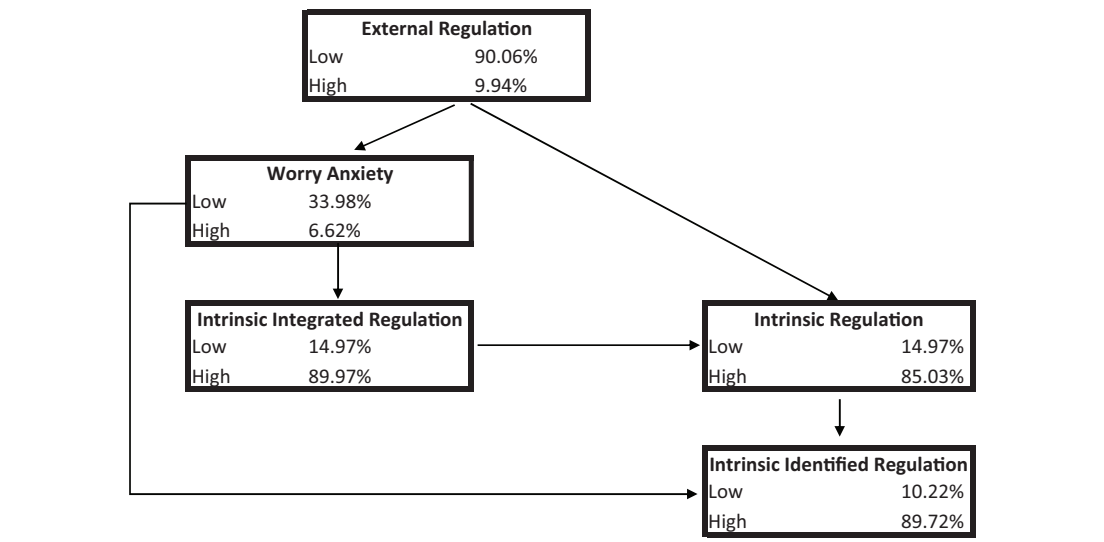

FIGURE 2 | Bayesian Networks generated using the restrictions made after the CHAID algorithm (inter-dependent variables only).

steps, with very similar values, two of them imply reaching the maximum probability of overall intrinsic motivation and introjected regulation, and then to the minimum value for anxiety from worry about performance.

DISCUSSION

Our aim in this study was to ascertain the probabilistic links between the different factors of self-determined motivation and those related to anxiety, particularly attempting to reduce the likelihood of anxiety occurring. Firstly, in response to the objective and question posed, it should be noted that all the analyses carried out demonstrate that it is possible to reduce uncertainty in the relationships between motivation and anxiety in the field of competitive sports.

The main findings can be summarized by the statement that competitive anxiety is completely "disassembled" in its three factors with respect to its probabilistic weight of occurrence: the predecessor variable of the others is worry about performance, while the other two dimensions have occupied some key positions as well. De-concentration (or lack of concentration) anxiety (the one most responsible for diminished performance) acts as a "modulator" on anxiety from worry triggered by the weight of the probability of external motivation, while somatic anxiety becomes the "final" sub-product of the other variables. Further studies on our group have demonstrated the caution with which somatic signs of anxiety must be taken by external observers

TABLE 2 | Validation of the BN developed with the variables studied: AUC values, accuracy, sensitivity, and specificity.

Variables	AUC	Accuracy	Sensitivity	Specificity
Somatic anxiety	0.79	0.93	0.97	0.62
Worry anxiety	0.59	0.64	0.39	0.80
Lack of concentration anxiety	0.83	0.94	0.98	0.68
Intrinsic regulation	0.60	0.94	0.25	0.98
Integrated regulation	0.61	0.86	0.24	0.98
Identified regulation	0.51	0.90	0.00	1
Introjected regulation	0.63	0.80	0.31	0.96
External regulation	0.84	0.95	0.98	0.70
Amotivation	0.54	0.78	0.96	0.11

TABLE 3 | Step-by-step instantiations leading to maximization of the likelihood of low perfomance' Worry anxiety in the BN with CHAID restrictions.

Step	Instantiaded variable	Level	Value
1	None (initial value)	Low	35.88
2	Lack of concentration	Low	43.44
3	Introjected regulation	Low	51.00
4	Somatic anxiety	Low	54.05
5	Identified regulation	Low	57.55
6	Integrated regulation	Low	64.07
7	External regulation	Low	64.42
8	Amotivation	Low	64.83

TABLE 4 | Step-by-step instantiations leading to maximization of the likelihood of high identified intrinsic regulation in the BN with CHAID restrictions.

Step	Instantiaded variable	Level	Value
1	None (initial value)	high	89.16
2	Global intrinsic motivation	high	91.07
3	Perfomance worry anxiety	low	92.99
4	Introjected motivation	high	95.19

when determining the ability of subjects to perform their tasks (García-Mas et al., 2016).

All the analyses carried out demonstrate that it is possible to reduce uncertainty in the relationships between motivation and anxiety when in the performance of competitive sport. Participants in the sample have a high probability of being intrinsically motivated, with a low probability of perceiving external rewards or benefits.

However, it should be noted that this sample – composed of young student/athletes of medium rather than top performance level – presents several clear biases: low probability of anxiety and external regulation and amotivation, contrasting with high probability of emergence of self-determined motivation, without any clear predominance of the source of intrinsic regulation (Ntoumanis, 2001; Standage et al., 2003). As indicated in other studies (Wolf et al., 2015), competition-related anxiety cannot be taken as a whole but, rather, its three factors must be considered separately in both the psychological evaluation and intervention, as is clearly shown in the BN without restrictions for somatic anxiety.

The results found in the BN with restrictions showed that there were five variables to predict somatic anxiety. Four of them are motivational: intrinsic and external global regulations, and two sub-scales of intrinsic motivation, identified and integrated regulation, with the last one being anxiety related to performance.

The probability values found in our study group indicate that the participants in the sample have a high probability of being intrinsically motivated, with a low probability of perceiving external rewards or benefits, although this variable triggers the probability of the other variables occurring, as well as the presence of average likelihood of anxiety related to performance, which acts as a buffer for the other variables.

Working with instantiations leaves the probability landscape much clearer. To obtain the lowest possible probability value for Anxiety from Worry (which is the one least associated with decreased performance (Pulido et al., 2018), several variables need to change their likelihood. The two variables whose probable occurrence is most likely to be reduced are de-concentration and introjected regulation [which is usually accompanied by "negative" emotions, such as guilt (Fenton et al., 2016)]. To a lesser extent, the likelihood of occurrence should also be reduced for somatic signs of anxiety and for high levels of motivation, both intrinsic and extrinsic. If we combine this data with the "actual" probabilities found in the BNs and the nodal or predecessor position that anxiety from worry about performance holds, we can see that perhaps the latter is indeed the key element in the system under study. Further support for this idea is given by the fact that zero probability (100% Low) cannot be achieved, which may perhaps be indicative of a specific characteristic in this type of athlete, namely athletes that are also concerned about their academic careers (Aquilina, 2013; Vilanova and Puig, 2016) and who may have some kind of "immunity" toward external regulation, which in turn triggers a lower likelihood of somatic anxiety.

Further to the previous argument, by obtaining the maximum intrinsic regulation [the one identified as the bottom variable in both BN and which is based on a high probability value (almost 90%)], it is possible to increase its likelihood when introjected and global intrinsic regulations reach 100% probability of occurrence, and when anxiety due to worry about performance is at 100% low probability, i.e., zero. Therefore, strong opposition clearly exists between the emotion of guilt and anxiety due to worry about performance in athletes' minds.

In an attempt to summarize the results obtained more succinctly, we can conclude that the athletes in our survey start with high values of self-motivation and low anxiety associated with competition; that the BNs performed show a probabilistic "constellation" that situates anxiety due to worry about performance and external regulation as the basic predecessors, and intrinsic regulation and somatic anxiety as the bottom variables, while amotivation and the de-concentration

lack any informative value. All these findings are confirmed when hypothetical values are inserted in these key variables and we are able to see how the likelihood of other variables need to be changed in order to reach their maximum or minimum probability of occurrence. Also, the obtained results reinforce that the adapted version of the Sport Anxiety Scale (SAS-2) is an adequate and valid measure for the assessment of anxiety in young athletes.

The reduction of uncertainty derives from the successive application of two statistical models. First, the CHAID algorithm has made clear the relationships (or not) of the variables studied, simplifying the subsequent probabilistic analysis. Once the BN has been carried out, the uncertainty has been further reduced by making clear the "chains" of probabilistic impact of each variable with respect to the other relevant ones. In addition, in the same sense, the instantiations have further clarified the landscape (reinforcing some of the results and weakening some others), so that the ambiguity in the probability of occurrence of the variables has been reduced in a very relevant way.

From a practical point of view, thanks to this study we know more about how to cope with Dual Career students/athletes, regarding their motivation (mostly intrinsic, which affects the type of reinforcements and incentives to use with them); or to the relevant importance of the Worry anxiety in contrast with the lower importance of the somatic anxiety in terms of detrimental performance, which is paradoxically often the one that receives the most attention from sports professionals, including psychologists.

This study entails certain limitations, the most important being those derived from the characteristics of the sample studied, as well as the impossibility of relating the variables under study to the performance (either subjectively and/or objectively evaluated) of the athletes/students. Also, the bias that these athletes reveal in regard to their type of motivation and competitive anxiety have limited the results obtained when BNs are used with limited hypothetical values.

When considering the study as a whole, the next step in the research should be to structure the system under study in a more useful manner, firstly, to analyze the concept of "dual career" completely "from the inside," which would be useful to understanding our athletes' specific motivational features; and secondly, to improve the quality of the instantiations made through longitudinal and "survival" studies in order to confirm the predictions derived from this use of probabilistic BNs.

DATA AVAILABILITY

All datasets generated for this study are included in the manuscript and/or the supplementary files.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the local ethics committee of the Universidad Autónoma de Nuevo León (Mexico). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FP, PA, AO, and AG-M: conceptualization of the study. BM and AG-M: methodology, software, validation, and formal analysis. OR and JL-W: investigation. JL-W, AO, and BM: resources. FP: writing – original draft preparation and visualization. FP, JL, PA, and AG-M: writing – review and editing. AG-M, JL-W, and AO: supervision. All the authors contributed to the revision of the manuscript, and read and approved the presented version.

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Gendered Career Choices: Paths Toward Studying a Degree in Physical Activity and Sport Science

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Drawing on Social Cognitive Career Theory (SCCT), we examined factors affecting interest in pursuing a degree in Physical Activity and Sport Science (PASS) among Spanish teenage students. Although women were awarded 55.1% of all bachelor degrees in Spain in 2017–2018, female enrollment in PASS degrees is decreasing and currently stands below 20% across the country. To better understand the under-representation of women in this field, 4146 students (50.2% girls; mean age = 16.82 years; *SD* = 0.837) participated in a survey designed to measure a series of SCCT constructs: interest in studying a PASS degree, career outcome expectations, goal representations, and perceived social supports. With these data, we tested a set of path analysis models to explain gender differences in interest in studying a degree in PASS. These models tested the assumption that interest in PASS would mediate the paths from outcome expectations and social supports to goal representations. Model 1 assumed that interest would partially mediate the path from outcome expectations to goal representations, Model 2 assumed complete mediation, and Model 3 assumed absence of mediation. All models were tested separately for boys and girls. Our results provide information on how male and female students set personal goals based on expected career outcomes and show that this process is affected by gender stereotypes. The lack of interest by young women in studying a degree in PASS (only 7.8% of girls expressed this interest compared with 19.0% of boys), together with the gender differences observed in perceived social supports, outcome expectations, and goal representations, have several important theoretical and practical implications. The present research suggests that interventions that foster positive outcome expectations and social support are necessary to increase interest in studying PASS among teenage girls.

Keywords: career choice, social support, gender differences, young people, physical education, interest

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INTRODUCTION

Although women were awarded 55.09% of all bachelor's degrees in Spain in 2017/18, they remain under-represented in science, technology, engineering, and mathematics (STEM) fields (Ministerio de Educación Cultura y Deporte, 2019). Female enrollment in physical activity and sport science (PASS) degrees in Spain is also worryingly low, at 18% (Serra et al., 2019). This tendency is even

more alarming considering the fact that enrollment has been falling since 2000, when women accounted for 40% of all PASS students (Serra et al., 2019). This female under-representation is logically linked to a predominant male presence in sport professions additionally characterized by considerable horizontal and vertical gender segregation (Moragas, 2014; Viñas and Pérez, 2014; Pérez-Villalba et al., 2018). Women have also been found to be under-represented in coaching positions and similar professions in countries with different higher education and sports systems (Cunningham et al., 2005, 2007; Cunningham and Singer, 2010; Moran-Miller and Flores, 2011; Acosta and Carpenter, 2012; Hinojosa-Alcalde et al., 2017). A number of studies have addressed obstacles facing women interested in pursuing sporting careers, such as refereeing (Azurmendi, 2016; Kim and Hong, 2016), or occupying management and leadership positions in sporting organizations (Elling et al., 2019). This situation is not new, as in a study published over 10 years ago, Webb and Macdonald (2007) highlighted the difficulties faced by women in pursuing a successful career in physical education. In short, sport is largely characterized by gender biases, with a predominance of men and discrimination against women.

While Porto (2009) and Serra et al. (2019) have documented a downward trend in female enrollment in PASS degrees in recent years, no studies to date have explored the factors underlying the low presence of females in these degrees. To better understand the under-representation of women in this field, the aim of this study was to explore factors that influence male and female teenagers' decisions to choose or not to choose to study a degree in PASS. The ultimate aim is to identify factors that need to be corrected in order to reduce the gender gap in PASS degrees and improve women's representation in professional paths. Identification of these factors will guide corrective strategies aimed at improving female enrollment rates in this university degree and ultimately their presence in related professions.

THEORETICAL FRAMEWORK

Prior research has shown that social cognitive career theory (SCCT) (Lent et al., 1994) is a useful framework for investigating career choice processes. It has been widely applied in STEM research and is also used to investigate student intentions to enter the sports and leisure industry. As indicated by Alexander et al. (2011) and Cunningham et al. (2005, 2007), SCCT offers a social and heuristic framework for investigating academic and career choices, recognizes the social forces underpinning these choices, and helps to understand how social influences impact actions and motivations. Numerous studies have, furthermore, attempted to shed light on gender disparities in other disciplines, such as STEM (e.g., Su and Rounds, 2015; Park et al., 2018).

General Social Cognitive Career Theory Framework

Social cognitive career theory emerged in 1994 (Lent et al., 1994) as a specification of Bandura (1986) general social cognitive theory to contribute to our understanding of how people develop academic and career interests from the perspective of three core tenets: self-efficacy, outcome expectations, and goal representations (Lent et al., 1994; Bandura, 1997; Lent, 2012; Lent and Brown, 2013).

Self-efficacy refers to a person's beliefs about their ability to achieve a desired outcome (Bandura, 1987; Lent et al., 1994; Lent, 2012). These beliefs are closely linked to the nature of the actions required to achieve the outcome, the conditions required for these actions to be successful, the person's perception of their abilities, and the efforts required to overcome setbacks (Bandura, 1987). Self-efficacy partly determines outcome expectations, as a person who believes he or she is capable of performing a task successfully is likely to expect a positive outcome.

Outcome expectations refer to what a person expects will happen if they act or behave in a specific way (Lent et al., 1994; Lent, 2012). They are related to the question "If I do this, what will happen?" These expectations can be physical (e.g., monetary rewards or job opportunities), social (e.g., social approval, status), or self-evaluative (e.g., self-satisfaction) (Bandura, 1987). According to Lent et al. (1994), self-evaluative expectations are the strongest determinants of actions a person will take toward the attainment of a goal (Lent et al., 1994). People's academic or career choices tend to be governed by how they envisage the outcomes of their choices (Everhart and Chelladurai, 1998; Cunningham et al., 2005). Outcome expectations, in turn, help to establish personal goals (Lent et al., 1994).

Goal representations have an important role in self-regulating behavior, as they help a person to organize and guide their behavior in relation to the goals they have set. In brief, a person's actions are not simply the result of automatic responses to given situations or stimuli. Lent et al. (1994) stressed that personal goals were always present, but were generally implicit. Goals drive motivation when perceived as attainable (Lent et al., 1994). Individuals pursuing a given academic or career path need goals in order to plan and direct their actions (Lent, 2012). How satisfied or dissatisfied they then feel with these actions will either strengthen their resolve or prompt them to revise their goals (Lent, 2012).

People develop interest in activities that they believe they can perform competently and that they expect will have a positive effect on their personal development and social status and esteem. As their interest grows, they will set goals accordingly. People who anticipate negative outcomes, however, or who do not believe themselves capable of achieving a given goal (Blanco, 2009), are unlikely to develop this interest. People, like their environments, are constantly changing, and therefore their actions and envisaged outcomes will influence their attitudes and opinions, and may even modify their environment (Alexander et al., 2011).

The three key determinants of academic interest development according to SCCT – self-efficacy, outcome expectations, and goal representations – are also strongly linked to

social support received in relation to the pursuit of one path or another.

Social Support in Relation to the Development of Academic and Career Interest

Social cognitive career theory posits that contextual factors have an important impact on academic and career choices (Lent et al., 1994). These factors may include family aspirations, financial situation, and level of education (Lent, 2012).

Social agents can also have a major influence on teenagers navigating academic and career choices (Stake and Nickens, 2005), in particular, family and teachers (Turner and Lapan, 2002; Sáinz, 2007; Metheny et al., 2008; Sáinz and López-Sáez, 2010; Rogers and Creed, 2011; Buday et al., 2012). Having friends with similar interests positively influences outcome expectations regarding certain professions (e.g., science professions) (Stake and Nickens, 2005), and social support from teachers, family, or friends can enhance a person's self-efficacy beliefs, help them to set goals, and motivate them to pursue these goals (Buday et al., 2012).

Contextual factors also have an important effect on interest development. According to Holland (1997), people first tend to develop preferences for activities that are influenced by people they interact with in their social circles. These preferences gradually become interests as the person gains confidence in their ability to perform successfully (Nauta, 2013). Social supports can strengthen vocational interest and consequently drive motivation and goal pursuit, just as barriers can have the opposite effect (Cunningham et al., 2005).

All these contextual factors configure a strong gendered socialization process that mediate gender differences in vocational and career interests (Lent et al., 2001, 2010; Lent and Brown, 2013). According to Betz and Hackett (2006), young men and women differ in their vocational interests and goals because the opportunities presented to them from an early age also differ, and this affects self-efficacy beliefs. This theory would explain why boys and girls are generally less interested in careers that do not conform to traditional gender stereotypes (Lent, 2012).

Previous Research in Women's Career Development

Bandura (1986) self-efficacy theory was first applied to explain career choices in work by Betz and Hackett (2006) aimed at understanding career development in women. These authors hypothesized that career self-efficacy beliefs played a more powerful role than interests, values, or abilities in restricting women's career choices. Girls exposed to traditional gender-role attitudes during childhood would have limited access to the information they need to develop strong self-efficacy beliefs in relation to a wide range of occupational fields. Gender differences in academic and career self-efficacy beliefs are linked to past gender-role socialization, current gender-role pressures, and perceptions of the gender-relatedness of tasks, activities, or occupations (Betz and Hackett, 1981). Traditional gender role attitudes and sterotypes regarding "appropriate" careers can undermine women's beliefs that they can successfully pursue a non-traditional career. The stronger the perceived gender linkage of an activity or occupation, the more likely it is that gender differences in self-efficacy will arise (Bandura, 1997).

People are generally more likely to choose a particular academic or vocational path if they envision a favorable outcome (Cunningham et al., 2007). Girls and women often adopt "satisficing" strategies by choosing traditionally female occupations that are perceived to be easier to combine with home and family responsibilities rather than optimally translating their interests and abilities into career pursuits (Bandura, 1997). Furthermore, Betz and Hackett (2006) illustrated how the process of gender role socialization can bias access by both boys and girls to information they need to develop strong self-efficacy beliefs, particularly in relation to strongly gendered activities.

Research in the field of STEM has identified several factors that contribute to gender bias in academic and career choices (Morgan et al., 2001; Sáinz, 2007; Candela, 2008; Rogers et al., 2008; Eccles, 2011; Su and Rounds, 2015), with findings showing that girls largely choose a career based on personal preferences, while boys are more likely to be influenced by future prospects, such as earning a lot of money, doing or inventing new things, or becoming famous. Girls, by contrast, largely choose STEM careers where they can help others, reflecting the extent to which gender stereotypes influence career choice (Sallop and Kirby, 2007; Sáinz, 2007; Candela, 2008; López-Bonilla et al., 2012). Women thus are more likely to opt for social care or affiliated professions (Jones et al., 2000) and to gravitate away from traditionally male STEM professions (Sáinz, 2007).

The aim of the present study was to test a series of path models to detect factors that influence teenager boys' and girls' decisions to choose or not to choose to study a degree in PASS. In line with SCCT and our review of the literature, these models will be defined based on the following hypotheses: (H1) social supports will be significantly associated with interest; (H2) PASS outcome expectations will be positively related to interest; (H3) interest will partially mediate the paths from outcome expectations and social supports to goal representations; and (H4) gender differences will be observed for perceived social supports, outcome expectations, and goal representations. To test the last hypothesis, the path models were tested separately for boys and girls.

MATERIALS AND METHODS

Sample and Data Collection

We analyzed a representative sample of students from 39 randomly selected secondary schools in three regions of Spain: Catalonia, Galicia, and Madrid (95% confidence interval; ±3). The schools were representative of a wide range of socioeconomic conditions (different social classes and urban and rural settings) and school types (public and private schools with and without vocational PASS courses).

All students enrolled at these schools in their final year of junior secondary education (4° *ESO*, 15–16 years old) and in

the first of 2 years of the pre-university course (1° *Bachillerato*, 16–17 years old) were invited to participate. A total of 4146 students from 13 schools in each region took part in this study. The questionnaires were administered during class time by members of the research team. Girls accounted for 50.3% of the participants and no gender differences were observed in the distribution of the sample. Mean age was 16.82 years (SD = 0.837). Overall, 87.2% of participants were of Spanish origin; 3.37% were from other European countries (3.37%) while 9.40% were from countries in other parts of the world (e.g., Latin America and Africa). In total, 74.2% of the adolescents were from a school located in an urban area, while 28.5% were from a school in a rural area. Over two-thirds of the participants (67.7%) engaged in sport or exercise in their free time, but the rate was significantly higher for boys (76.3%) than girls (59.3%) [$\chi^2(1) = 136.825$, $p < 0.0001$]. The students had not participated in any careers guidance sessions before completing the questionnaire or received information about career opportunities in this field.

Instruments and Measures

The instrument consisted of an *ad hoc* questionnaire designed to collect demographic information and data for measuring four variables in relation to studying a degree in PASS: (a) goal representations, (b) career outcome expectations, (c) perceived social support, and (d) interest in studying the degree.

The preliminary questionnaire was evaluated and validated by six experts in the field. Based on their feedback, it was then modified for the pilot test. The resulting questionnaire was piloted among 155 students from a school that did not participate in the study to ascertain length of completion and comprehensibility. It was then further refined for administration in the 39 schools. All results reported in this article are based on data collected in June 2014.

Goal representation and outcome expectations were measured using 15 items adapted from the scales developed by Everhart and Chelladurai (1998) and by Sáinz (2007), who translated Eccles and Harold (1991). Three of the variables were based on the outcome expectations described by Bandura (1986): social (e.g., to help other people), self-evaluative (e.g., to learn new things), and physical (e.g., to obtain power, monetary rewards, or status). Drawing on the work of Sáinz (2007), we added a fourth outcome expectation variable focused on job attributes that are specific to or characteristic of most jobs in the field of sport and exercise. The questions were worded in such a way that the students' answers would provide information about their personal goals (e.g., "I would like a job that would allow me to. . .") and their outcome expectations (e.g., "If I studied a degree in PASS, I think I would be able to get a job that allowed me to. . ."). Items were rated on a 5-point Likert-type scale that ranged from 1 (strongly disagree) to 5 (strongly agree).

Social supports perceived by the students in relation to their interest in studying a degree in PASS was assessed using two variables: one based on the work of Sáinz (2007) and another based on our review of the literature. The two questions were (1) Has anybody recommended that you study PASS when you finish school? and (2) Has anybody recommended that you don't study PASS when you finish school? The options were "my father," "my mother," "my friends," "my physical education teacher," "another teacher," "a coach," and "other," and the students had to answer "yes" or "no."

Interest in studying a degree in PASS was assessed by a single item: Are you interested in studying a degree in PASS? The response options were: "yes," "maybe," "I don't know yet," and "no." The first two options were grouped as indicating interest while the second two options were grouped as indicating a lack of interest.

Data Analysis

We first performed a missing data analysis and a descriptive analysis of all study variables. Using the software package SPSS 18.0, we compared all variables between boys and girls using the *t*-test and assessed the internal consistency of the scales using Cronbach's alpha.

Prior to the mediational analysis, we calculated the correlations between all the variables to be included in the path analysis models. Correlation coefficients were interpreted according to the criteria of Safrit and Wood (1995): no correlation (score of 0–0.19), low correlation (0.20–0.39), moderate correlation (0.40–0.59), moderately high correlation (0.60–0.79), and high correlation ($\geq$0.80). We then tested a path analysis model in which the students' interest in studying PASS was hypothesized to mediate the relationship (path) between outcome expectations and goal representations. In addition, we expected that perceived social support would act only as a predictor of interest. The correlations and path analysis models are presented separately for boys and girls.

According to MacKinnon (2008), a mediating variable "is intermediate in the causal path from an independent variable to a dependent variable" (p. 8). To test for mediation, we explored three *a priori* models: Model 1 to test for partial mediation (direct and indirect effects), Model 2 to test for complete mediation (indirect effects only, i.e., interest), and Model 3 to test for absence of mediation (direct effects only). All three models were tested using the maximum likelihood estimator. Goodness of fit to the data was assessed using the following model fit indices: χ^2, root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker-Lewis index (TLI). CFI and TLI values $\geq$0.95 and RMSEA values $\geq$0.06 were considered indicators of excellent fit; the respective values of $\geq$0.90 and $\leq$0.08 were considered to indicate acceptable fit.

Model 1 was the least parsimonious model and was therefore compared to Models 2 and 3. The comparisons were based on differences in χ^2 and in CFI, TLI, and RMSEA values. The most parsimonious model was only selected when differences in CFI were <0.01 and when TLI or RMSEA values were as good as or better than those obtained for the least parsimonious model. Mediated effects were obtained using the Model Indirect command and the VIA instruction as defined in the Mplus 7.0 software (Muthén and Muthén, 2012).

TABLE 1 | Comparison between boys and girls for outcome expectations, perceived social supports, interest, and goal representations in relation to studying a degree in PASS.

	Boys, *M* (*SD*)	Girls, *M* (*SD*)	*t*-test: *t*(*df*), *p*
Outcome expectations			
1. Social	3.31 (0.58)	3.46 (0.56)	−8.456 (4079.778), <0.001
2. Self-evaluative	3.55 (0.83)	3.53 (0.84)	0.649 (4098), NS
3. Physical	3.23 (0.79)	3.10 (0.75)	5.342 (4076), <0.001
4. Specific job attributes	4.18 (0.76)	4.35 (0.80)	−6.880 (4102), <0.001
5. Perceived social supports	0.83 (1.43)	0.43 (1.06)	10.039 (3764.491), <0.001
6. Interest	1.65 (0.91)	1.31 (0.66)	13.811 (3720.206), <0.001
Goal representations			
7. Social	3.40 (0.72)	3.65 (0.71)	−10.846 (4055), <0.001
8. Self-evaluative	3.92 (0.74)	3.98 (0.69)	−2.611 (4046.626), 0.009
9. Physical	3.72 (0.75)	3.62 (0.75)	4.279 (4054), <0.001
10. Specific job attributes	2.97 (0.94)	2.53 (0.81)	15.723 (3966.968), <0.001

RESULTS

Missing Data, Descriptive Scale Statistics, and Internal Consistency

Missing data rates did not exceed 1.1% for any of the study variables and therefore, according to Graham (2009), will not have affected our data analyses because they were <5%. In subsequent analyses thus we used pairwise deletion of missing data. **Table 1** shows the descriptive statistics for each study variable. Although the differences were small, they were all statistically significant except for self-evaluative goal representations. Of particular note were the differences in goal representations in the social (M_{boys} = 3.40; M_{girls} = 3.65), physical (M_{boys} = 3.72; M_{girls} = 3.62), and specific job attribute (M_{boys} = 2.97; M_{girls} = 2.53) domains. The difference for perceived social supports was also significantly different (M_{boys} = 0.83 and M_{girls} = 0.43). **Table 2** shows Cronbach's alphas for all the variables except the interest variable.

Correlations Between Variables

Almost all the correlations were positive and statistically significant (**Table 2**), although most of them were below <0.20 (no correlation) or between 0.20 and 0.39 (low correlation). Differences between male and female students were observed for correlations between outcome expectations and perceived social supports and interest.

Mediational Models

For this study, we tested a series of mediated path models to study the predictors of interest among teenage boys and girls in studying a degree in PASS. Relationships between outcome expectations, social supports, interest, and goal representations were analyzed using three different path models. Model 1 assumed that the effect of outcome expectations on goal representations would be partially mediated by interest in studying a degree in PASS; Model 2 assumed complete mediation, while Model 3 assumed absence of mediation. This sequence of competing models was tested separately for boys and girls. The results depicting the fit of the models to the data are presented in **Table 3**.

Model 1 provided an adequate fit for both boys and girls [boys: χ^2 (*df*) = 12.567 (4), $p < 0.001$, RMSEA (90 CI) = 0.047 (0.019 –0.077), CFI = 0.995, TLI = 0.954; girls: χ^2 (*df*) = 16.455 (4), $p < 0.001$, RMSEA (90 CI) = 0.055 (0.029 –0.084), CFI = 0.990, TLI = 0.914], and outperformed Models 2 and 3, supporting thus the hypothesis that interest in studying PASS partially mediated the effect of outcome expectations on goal representations (**Figure 1**). The R^2 values for

TABLE 2 | Correlations between variables analyzed in relation studying a degree in PASS.

	1	2	3	4	5	6	7	8	9	10
Outcome expectations										
1. Social	*0.61*	0.388**	0.215**	0.541**	0.105**	0.124**	0.338**	0.294**	0.187**	0.145**
2. Self-evaluative	0.424**	*0.68*	0.572**	0.213**	0.183**	0.221**	0.371**	0.371**	0.207**	0.324**
3. Physical	0.312**	0.526**	*0.66*	0.057	0.184**	0.246**	0.360**	0.256**	0.310**	0.398**
4. Specific job attributes	0.537**	0.129**	−0.046	*0.73*	0.004	−0.007	0.134**	0.197**	0.158**	0.100**
5. Perceived social supports	0.008	0.138**	0.158**	−0.048	*0.79*	0.582	0.235**	0.024	0.069*	0.334**
6. Interest[1]	0.013	0.162**	0.176**	−0.048	0.580**		0.268**	0.015	0.056	0.438**
Goal representations										
7. Social	0.317**	0.297**	0.243**	0.110**	0.070*	0.094*	*0.63*	0.343**	0.331**	0.465**
8. Self-evaluative	0.248**	0.323**	0.174**	0.200**	0.022	0.030	0.283**	*0.59*	0.354**	0.168**
9. Physical	0.147**	0.117**	0.217**	0.090*	0.071*	0.041	0.290**	0.373**	*0.68*	0.271**
10. Specific job attributes	0.056	0.248**	0.257**	−0.026	0.330**	0.415**	0.288**	0.210**	0.148**	*0.64*

*Correlations computed using data for girls are presented in the left/bottom triangle of the table. Correlations computed using data for boys are presented in the right/upper triangle of the table. The range for all variables is 1–5, except for social supports (1–6) and interest (1–4). Cronbach's alpha coefficients are presented in the diagonal in italic. [1]Interest was measured using a single item and therefore no Cronbach's alpha coefficients are presented. *p < 0.05, **p < 0.01.*

TABLE 3 | Model fit statistics and standardized coefficient estimates for mediation path analysis models.

Model	χ^2 (*df*)	RMSEA (CI 90)	CFI	TLI	ΔRMSEA	ΔCFI	ΔTLI
Girls							
1. Partial	16.455* (4)	0.055 (0.029–0.084)	0.990	0.914			
2. Complete	318.726* (20)	0.121 (0.110–0.133)	0.763	0.585	0.066	−0.227	−0.329
3. Direct	185.569* (12)	0.119 (0.105–0.135)	0.862	0.598	0.064	−0.128	−0.316
Boys							
1. Partial	12.567* (4)	0.047 (0.019–0.077)	0.995	0.954			
2. Complete	427.946* (20)	0.144 (0.132–0.156)	0.752	0.567	0.097	−0.243	−0.387
3. Direct	227.967* (12)	0.135 (0.120–0.151)	0.869	0.618	0.088	−0.126	0.377

*1. Partial = Model 1, partial mediation model; 2. Complete = Model 2, complete mediation model; 3. Direct = Model 3, direct effects model. *p < 0.05.*

Model 1 were (a) boys – $R^2_{\text{social (goal representations)}} = 0.240$, $R^2_{\text{self−evaluative (goal representations)}} = 0.181$, $R^2_{\text{physical (goal representations)}} = 0.119$, $R^2_{\text{specific job attributes (goal representations)}} = 0.297$, and $R^2_{\text{interest}} = 0.370$; and (b) girls – $R^2_{\text{social supports (goal representations)}} = 0.138$, $R^2_{\text{self−evaluative (goal representations)}} = 0.127$, $R^2_{\text{physical (goal representations)}} = 0.057$, $R^2_{\text{specific job attributes (goal representations)}} = 0.215$, and $R^2_{\text{interest}} = 0.344$. Therefore, the boys' model explained slightly more variance than the girls' model.

The statistically significant effects observed in Model 1 (**Figures 1A,B** and **Table 4**) showed some differences between girls and boys. The boys' model contained more direct and indirect (i.e., mediated by interest) effects. The following effects, all significant, were observed in the boys' model only: (a) indirect effect of perceived support on social (0.087) and self-evaluative (−0.049) goal representations; (b) direct effect of social outcome expectations on self-evaluative goal representations (β = 0.156) and indirect effect on specific job attributes (0.022); (c) direct (β = 0.094) and indirect (−0.010) effect of physical outcome expectations on self-evaluative goal representations and indirect effect on social goal representations (0.018); (d) direct effect of specific job attribute outcome expectations on interest (β = −0.063) and specific job attribute goal representations (β = 0.083) and indirect effect on social (−0.010) and specific job attribute (−0.023) goal representations. In the girls' model, self-evaluative outcome expectations had an indirect effect on specific job attribute goal representations (0.025), while specific job attribute outcome expectations had a direct effect on self-evaluative goal representations (β = −0.134).

Some common paths were also observed for boys and girls in the form of the following effects: (a) direct effect of perceived social supports on interest ($\beta_{girls} = 0.556$, $\beta_{boys} = 0.549$) and indirect effect on specific job attributes ($\beta_{girls} = 0.201$; $\beta_{boys} = 0.199$); (b) direct effect of social outcome expectations on social goal representations ($\beta_{girls} = 0.249$, $\beta_{boys} = 0.240$); (c) direct effect of self-evaluative outcome expectations on interest ($\beta_{girls} = 0.069$, $\beta_{boys} = 0.061$) and on social ($\beta_{girls} = 0.144$, $\beta_{boys} = 0.138$), self-evaluative ($\beta_{girls} = 0.271$, $\beta_{boys} = 0.270$), and specific job attribute ($\beta_{girls} = 0.139$, $\beta_{boys} = 0.092$) goal representations; (d) direct effect of physical outcome expectations on interest ($\beta_{girls} = 0.064$, $\beta_{boys} = 0.112$) and social ($\beta_{girls} = 0.076$, $\beta_{boys} = 0.196$), physical ($\beta_{girls} = 0.216$, $\beta_{boys} = 0.302$), and specific job attribute ($\beta_{girls} = 0.136$, $\beta_{boys} = 261$) goal representations and indirect effect on specific job attribute goal representations ($\beta_{girls} = 0.023$, $\beta_{boys} = 0.040$); and (e) direct effect of specific job attribute outcome expectations on physical goal representations ($\beta_{girls} = 0.073$, $\beta_{boys} = 0.104$).

DISCUSSION

The findings of this study contribute to our understanding of why female teenagers are less interested in studying a degree in PASS than their male peers and have important theoretical and practical implications.

Perceived social support was an important predictor of interest in studying PASS in both the boys and girls analyzed. In agreement with the literature, the empirical model showed that perceived support was significantly associated with interest, confirming thus our first hypothesis (H1). As indicated by Lent et al. (2000), social context has an important role in the development of interest toward one academic track or another. Social support, however, differs for boys and girls. Therefore, the potential influence of significant others (e.g., teachers, trainers, families, and friends) on a teenagers' academic and career choices should not be overlooked (Turner and Lapan, 2002; Stake and Nickens, 2005; Sáinz, 2007; Metheny et al., 2008; Sáinz and López-Sáez, 2010; Rogers and Creed, 2011; Buday et al., 2012).

Social cognitive career theory (Lent et al., 1994) posits that outcome expectations predict academic and career interests and goal representations. Our findings show that these expectations were significantly associated with goal representations both directly and indirectly (with interest as a mediator), confirming thus our second and third hypotheses (H2 and H3). We also observed gender differences in specific outcome expectation and goal representation variables. Self-evaluative and physical outcome expectations were significant in the paths identified for both girls and boys, but the boys' model additionally featured expectations related to specific job attributes. SCCT also posits that outcome expectations will exert a direct effect on goal representations in relation to career choices (Lent et al., 2001; Lent, 2012). In our study, we observed gender differences for each of the variables in the model, and as expected, the specific job attribute outcome expectation was related to personal goal representations among boys only.

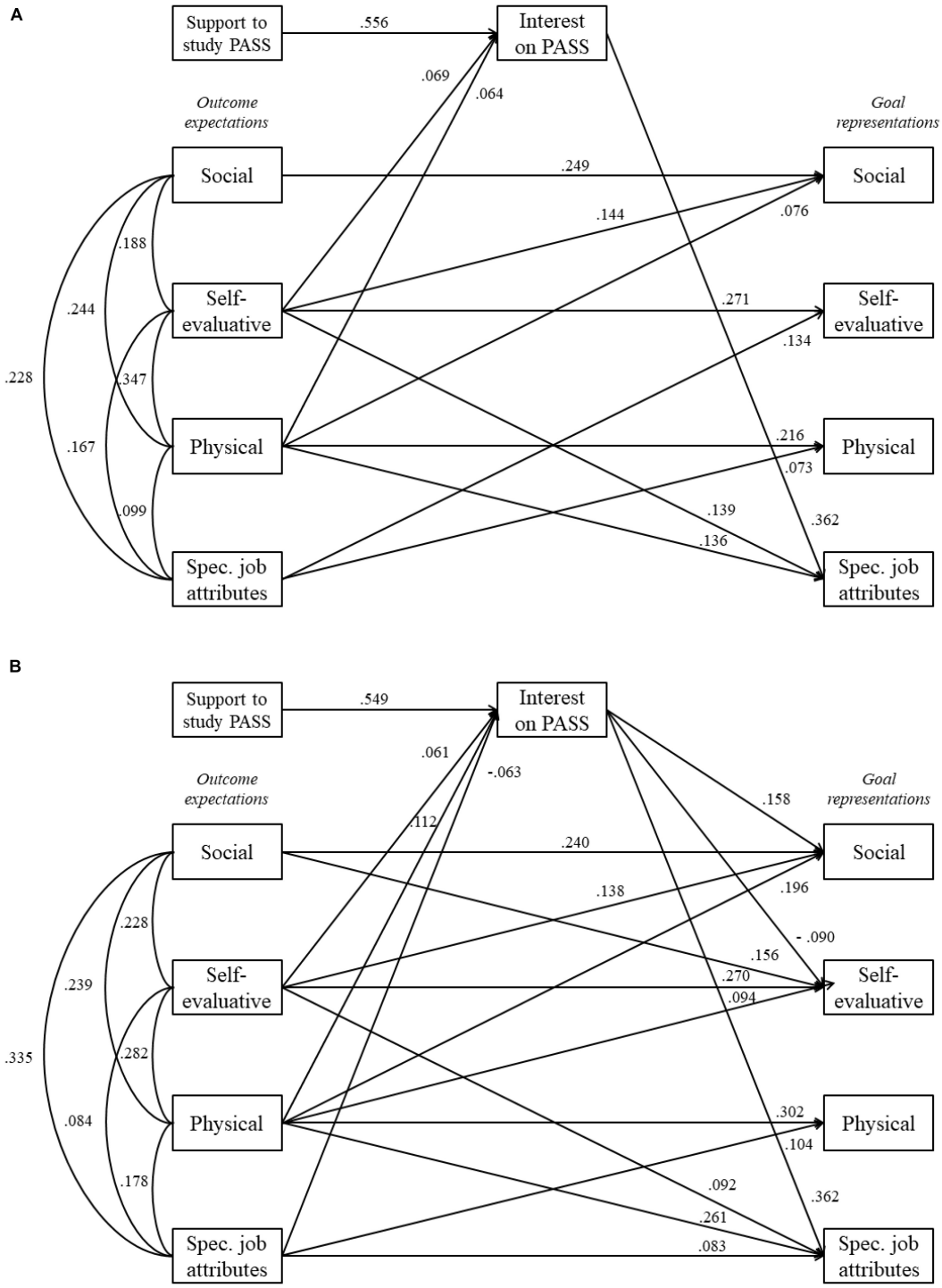

FIGURE 1 | Path analysis models showing the partial mediation of girls' **(A)** and boys' **(B)** interest in studying a degree in physical activity and sport science in the paths from perceived social supports and outcome expectations to goal representations. Only standardized statistically significant paths ($p < 0.05$) are shown. Spec. job attributes, specific job attributes.

The above findings provide insights into how teenage boys and girls establish personal goals based on the outcomes they envisage in relation to studying a degree in PASS. It has been well established that academic and career choices among both girls and boys are influenced by gender stereotypes. As observed in the literature review, female students are more likely to

TABLE 4 | Standardized indirect effects of outcome expectations on goal representations.

Independent variable	Mediator variable	Dependent variable	Boys		Girls	
			Mean indirect effect	95% CI for mean indirect effect	Mean indirect effect	95% CI for mean indirect effect
Perceived social supports	Interest	Social GRs	0.087*	0.053–0.120	0.026	−0.006–0.058
Perceived social supports	Interest	Self-evaluative GRs	−0.049*	−0.082 to −0.017	−0.003	−0.036–0.030
Perceived social supports	Interest	Physical GRs	−0.014	−0.044–0.016	0.005	−0.023–0.034
Perceived social supports	Interest	Specific job attribute GRs	0.199*	0.161–0.236	0.201*	0.149–0.253
Social OEs	Interest	Social GRs	0.010	−0.001–0.020	−0.001	−0.005–0.002
Social OEs	Interest	Self-evaluative GRs	−0.006	−0.012–0.001	0.000	−0.003–0.003
Social OEs	Interest	Physical GRs	−0.002	−0.006–0.002	0.000	−0.002–0.002
Social OEs	Interest	Specific job attribute GRs	0.022*	0.001–0.043	−0.010	−0.033–0.012
Self-evaluative OEs	Interest	Social GRs	0.008	−0.002–0.018	0.003	−0.002–0.008
Self-evaluative OEs	Interest	Self-evaluative GRs	−0.005	−0.011–0.002	0.000	−0.005–0.004
Self-evaluative OEs	Interest	Physical GRs	−0.001	−0.005–0.002	0.001	−0.003–0.005
Self-evaluative OEs	Interest	Specific job attribute GRs	0.019	−0.004–0.041	0.025*	0.005–0.045
Physical OEs	Interest	Social GRs	0.018*	0.005–0.030	0.003	−0.002–0.008
Physical OEs	Interest	Self-evaluative GRs	−0.010*	−0.018 to −0.002	0.000	−0.005–0.004
Physical OEs	Interest	Physical GRs	−0.003	−0.009–0.004	0.001	−0.003–0.004
Physical OEs	Interest	Specific job attribute GRs	0.040*	0.017–0.064	0.023*	0.001–0.045
Specific job attribute OEs	Interest	Social GRs	−0.010*	−0.020–0.000	−0.001	−0.005–0.003
Specific job attribute OEs	Interest	Self-evaluative GRs	0.006	−0.001–0.012	0.000	−0.002–0.002
Specific job attribute OEs	Interest	Physical GRs	0.002	−0.002–0.006	0.000	−0.002–0.002
Specific job attribute OEs	Interest	Specific job attribute GRs	−0.023*	−0.043 to −0.003	−0.007	−0.031–0.017

*Perceived social support, perceived supports in relation to studying a degree in sport and exercise science; Interest, interest in studying a degree in sport and exercise science; OEs, outcome expectations; GRs, goal representations. *$p < 0.05$.*

choose people-oriented careers, while male students are generally more interested in wealth and competitive positions (Sallop and Kirby, 2007; Sáinz, 2007; Candela, 2008; López-Bonilla et al., 2012). Our results also indicate that male and female teenagers are influenced by stereotyped portrayals of PASS studies and associated careers. Even though work in this field is largely people-oriented, it does not appear to be perceived as such by young people. Consequently, and in agreement with findings for STEM (Sáinz et al., 2014), misconceptions may discourage females from pursuing a career in this field.

Our results also support the theory that interest influences goal representations. SCCT predicts that interest in a given academic track or career will directly affect the setting of personal goals. In our study, goal representations were influenced by both interest and outcome expectations, confirming our third hypothesis (H3). However, again, the results for girls and boys differed. In the girls' model, interest in pursuing a degree in PASS was associated with job-specific attribute expectations only, while in the boys' model, it was associated with social, self-evaluative, and specific job attribute expectations.

Our fourth hypothesis (H4) was also confirmed, as we detected gender differences in perceived social supports, outcome expectations, and goal representations. We also found that the boy's model had greater explanatory power in relation to the SCCT than the girls'. While the girls' model provided an adequate and significant fit to the data, its paths were less elaborate than the boys'. Overall, and in support of work by Betz and Hackett (2006), our study confirms the importance of

applying gender analysis to all the components of SCCT and its respective models.

Our findings support the applicability of SCCT to PASS studies and provide new insights into associated career choices among teenage boys and girls in their final years of school. They also support claims by Betz and Hackett (1981) that gender stereotypes influence perceptions of tasks, activities, and occupations, and extend current theories on social support. Social agents are known to exert a powerful influence on academic and career choices (Turner and Lapan, 2002; Sáinz, 2007; Sáinz and López-Sáez, 2010; Buday et al., 2012; Lent, 2012).

The results of our study confirm that male and female teenagers perceive different levels of support from their social environment in relation to their intention to study PASS at university. As expected, our path analysis showed gender differences along the path from social support to interest in these studies. Consistent with findings for research in the field of STEM, the effect of perceived social supports on the development of interest in studying PASS also differed between males and females (Sáinz and López-Sáez, 2010), with girls receiving less encouragement from people in their social circles to contemplate a career in PASS.

Practical Contributions

The findings of this study are relevant to educational institutions and career counselors seeking to bridge the gender gap in the field of PASS. PASS graduates can opt for a wide range of jobs in the fields of health, education, and care delivery, and while these professions have traditionally attracted women, female enrollment in PASS degrees has steadily declined over the past 25 years (Serra et al., 2019). Strategies targeting social agents are needed to break down gender-role stereotypes and encourage more young women to contemplate a career in this field. Institutions seeking to attract more women thus need to move away from the male-centered sports culture typically transmitted to society. Awareness-raising programs highlighting the myriad of job opportunities associated with PASS could also improve outcome expectations among young women.

People already working in this field, whether in academia or industry, can also play an important role in transforming overly simplistic and gendered conceptions of PASS. By serving as role models, they can foster positive outcome expectations and inspire young women to consider pursuing a career in this field. Training of these future professionals, however, needs to integrate a gender perspective, as otherwise, they may become agents of reproduction rather than change. The inclusion of gender issues in PASS studies and training programs for physical education instructors is crucial for breaking down gender stereotypes and widening the perspectives of future trainers. Numerous other factors in the teenagers' social and school environment, including positive experiences with sport and physical activity, can also help teenagers to develop an interest in studying PASS. If this dichotomous, male-centered vision of physical education, sport, and exercise continues, these degree courses will continue to be dominated by males.

Our findings are also relevant for sports policymakers and employers as sport and exercise permeate all levels of society; offer multiple job opportunities; and are of enormous economic, social, and cultural importance. If women are not encouraged to enroll in PASS and similar degrees, their participation in the workforce will decrease even further, resulting in a loss of richness and diversity that will only perpetuate existing gender gaps. Diversity drives innovation and creativity, and applied to the field of PASS, it may also provide inspiration to young women and other people from varying sociocultural backgrounds. A key practical implication of our study is that our findings can provide institutions and practitioners with insights into how best they can tailor initiatives to attract more women to PASS degrees (Serra et al., 2018; Soler et al., 2018).

Combating the under-representation of females in PASS degrees remains a challenge that, if correctly addressed, will contribute to eliminating gendered academic and career choices among young women and men.

Limitations and Future Directions

There are several limitations that should be noted in this study. First of all, we measured interest as an intention not a behavior. It would therefore be interesting to perform a longitudinal study of the adolescents who participated in this study to monitor their academic and career paths and see how they progress toward the attainment of their goals. It would also be interesting to perform a similar study from the perspective of the SCCT performance model, which analyzes persistence in educational and occupational pursuits and level of success achieved (performance outcomes, satisfaction, and well-being) (Lent et al., 1994). Analysis of these additional factors would help better understand the career choice process from a wider perspective. It would be particularly interesting to analyze how people who set themselves specific academic or career goals persist in the pursuit of these goals, regardless of positive or negative social influences or of perceived self-efficacy in physical activity and sport. Detailed comparisons of strategies followed by male and female adolescents could shed light on how and why the few girls interested in studying a degree in PASS actually go on to study this degree, despite perceived physical and social barriers. In relation to the academic/career satisfaction/well-being SCCT model (Lent and Brown, 2006; Lent, 2012), it would be interesting to analyze similarities and differences among male and female PASS students in terms of (1) value placed on the activity chosen, (2) awareness of progress toward personal goals, (3) beliefs in their ability to perform well in necessary tasks (self-efficacy), and (4) access to resources in their environment that enhance their self-efficacy beliefs and drive them to pursue their goals with greater energy (Lent and Brown, 2006).

Based on our findings, we suggest numerous areas for future research. Of particular interest is further investigation of external factors (social supports) that directly influence the development of interest in studying PASS among girls and boys. A closer analysis of the degree of influence exerted by different social agents (parents, siblings, trainers, teachers, etc.) will provide important insights into the relevance of each agent. Qualitative research based on interviews or women-only focus groups may also shed light on perceived social supports and barriers that encourage or discourage teenage girls from pursuing a career in PASS.

To conclude, the results of this study support many of the hypothesized relationships between the SCCT variables analyzed and suggest that both perceived social supports and positive conceptions of outcome expectations are important predictors of the formulation of personal goals in relation to studying a degree in PASS. Our findings contribute to a broader understanding of the SCCT model and show that while the basic relationships are generally confirmed, the different elements have a particular influence on social supports (environmental/external factors) and outcome expectations.

We have explored factors that influence male and female teenagers' interest in pursuing a degree in PASS. Trends from recent years indicate that if the current situation continues, female enrollment in these degrees will continue to decline and with it the number of potential role models for future generations.

By better understanding how teenage girls develop interest in PASS, we will be better equipped to create strategies that will attract women to this field and in doing so contribute to bridging the gender gap.

DATA AVAILABILITY

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The study was reviewed and approved by the Research Ethics Committee of the Sports Administration of Catalonia, and ethical concerns were addressed throughout the research process. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin. Respondents and their families were provided with information about the study and were assured of confidentiality of identifiable information and were informed of their right to withdraw participation at any time without prejudice from any party. Informed signed consent was obtained from the students' parents and the school authorities prior to the study. No incentives were offered.

AUTHOR CONTRIBUTIONS

PS, SS, MC-M, AR-C, and AV: design of the study, analysis and interpretation of the data, and manuscript preparation. PS: acquisition of the data. SS: conceptualization and obtaining funding.

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Dispositional Flow and Performance in Brazilian Triathletes

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Flow is a mental state characterized by total immersion and focus in an activity; performing it pleasurably. Such a state is considered optimal for performance. The present study analyzed the relationship between dispositional flow and performance in triathletes. The sample consisted of 328 athletes (294 males and 34 females; mean age of 37.42 ± 7.18 years) competing in the Ironman Brazil – Florianópolis – South American Championship 2017. Instruments were an identification sheet, the Dispositional Flow Scale (DFS-2) and athletes' total race times. Data were analyzed using R, through the Shapiro–Wilk normality test, Mann–Whitney's *U*, Spearman Correlation, and Network Analysis [Least Absolute Shrinkage and Selection Operator (LASSO)], using strength, closeness, and betweenness as centrality measurements. Results show a positive correlation between age and practice time (r = 0.34), inverse relationship between practice time and total race time (r = −0.25), and inverse correlations between race time and 05 of the 09 flow dimensions (r between −0.17 and −0.11), suggesting better performances were related to more practice time and higher disposition to flow. Flow conditions, flow characteristics, individual characteristics, and performance were separately grouped in the network structure. Challenge–skill balance was the most influential node, with the highest closeness and betweenness values; challenge–skill balance, clear goals, control, and action-awareness merge directly influenced better race times. Sample's top 50 performers had significantly higher disposition to challenge-skill balance, clear goals, control and feedback. Practical implications of flow mechanisms are discussed. Dispositional flow was positively related to objective performance in Brazilian triathletes.

Keywords: flow, endurance, triathlon, sport psychology, athletes

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INTRODUCTION

Sports psychology strives to promote better performance to coaches and athletes within their sport's context (Weinberg and Gould, 2017). In that sense, the positive psychology approach has gained importance among researchers and professionals involved with sports and sports psychology because it seeks to understand and promote positive aspects of the human mind,

recognizes the importance of subjective experiences and well-being, and aims to go further than just repairing damage (Seligman and Csikszentmihalyi, 2000). Among the investigated aspects of positive psychology, flow state has been highlighted as a key aspect for studying and understanding athletes' peak performance (Swann et al., 2017). Flow state is a harmonious, highly positive, pleasurable, and intrinsically rewarding psychological state, characterized by intense focus, deep absorption in an activity, and a sense of things "clicking into place," despite any challenges (Csikszentmihalyi, 2002).

Flow theory (Csikszentmihalyi, 2002) describes the experience of flow in nine dimensions, being six characteristics of such a mental state: (1) intense concentration; (2) merging of awareness (what is perceived) and action (how to act/react); (3) decreased awareness of social evaluation or self-judgment (loss of self-consciousness); (4) sense of control over performing an activity and its outcomes; (5) transformation of time, seeming to either speed up or slow down; (6) the autotelic characteristic of the experience, of being pleasurable and rewarding. The other three dimensions are considered prerequisites for experiencing flow: (I) balance between challenge and skill, where there is a high challenge that the athlete feels capable of overcoming; (II) clear goals, guiding the athletes' efforts; (III) unambiguous feedback regarding one's progress toward set goals (Csikszentmihalyi, 2000).

Flow state has been linked to general sports performance and peak performance (Jackson, 1992, 1996; Jackson and Roberts, 1992; Jackson et al., 1998, 2001; Marsh and Jackson, 1999; Stavrou et al., 2007; Bakker et al., 2011; Swann et al., 2016), demonstrating that athletes feel in such a mental state during their best performances, although it is also possible to experience flow without reaching peak performance (Stavrou et al., 2007). Moreover, flow state can be rare and unpredictable (Chavez, 2008). Meanwhile, there are uncertainties regarding how flow is experienced, its exact definition, the overlapping of some of its dimensions, and its causal mechanisms (Swann et al., 2018).

Despite the contributions of flow theory to sport performance research, many studies have considered the athlete's performance as a condition for flow state (Swann et al., 2012), while its influence on performance as an outcome still requires more convincing evidence (Engeser and Rheinberg, 2008). Studies have reported a positive relationship between flow and a variety of subjective measurements of performance in a wide range of individual and team sports (Jackson and Roberts, 1992; Jackson et al., 1998, 2001; Marsh and Jackson, 1999; Stavrou et al., 2007; Bakker et al., 2011; Soulliard et al., 2019); however, when objective indicators are used, such as race time or finishing position, the evidence is less clear, and only studies with individual sports were found. Two studies found a positive relationship between performance and flow dimensions, more specifically for the autotelic dimension (Stavrou et al., 2007; 07 individual sports) and the clear goals, challenge–skill balance, and action-awareness dimensions (Jackson et al., 2001; 03 individual sports). Still, two studies with marathon runners found no significant relationship between flow and performance (Stoll and Lau, 2005; Schüler and Brunner, 2009), both adopting a global flow dimension.

In this sense, gaps still exist regarding how this psychological state, described as ideal for optimal functioning, can directly affect athletes' actual performances. To determine when and if flow state occurred during a certain activity is still a methodological challenge (Jackman et al., 2017). It is possible, however, to assess the frequency of flow experiences and its indicators, obtaining a general disposition of an athlete to experience such a mental state when performing (Jackson and Eklund, 2002). Thus, the present investigation aimed to study the relationship between dispositional flow and objective performance of Brazilian triathletes.

MATERIALS AND METHODS

Participants

The target population consisted of 1455 Brazilian triathletes (1266 males and 189 females) competing in the Ironman Brazil – Florianópolis – South American Championship 2017, considered the largest and most important ultra-endurance triathlon in South America. To represent this population, the sample size was calculated for 95% confidence level and 5% confidence interval, resulting in a required sample of 304 athletes.

Subjects were recruited according to the following inclusion criteria: (a) accept voluntary participation by signing an Informed Consent Term; (b) be registered for the 2017 Ironman Brazil; (c) have Brazilian nationality; (d) be 20–59 years of age. Answering the instruments incorrectly, having technical or health-related problems during the race, and not completing the race were adopted as exclusion criteria.

The final sample comprised 328 athletes (294 men and 34 women), with an average age of 37.42 $\pm$ 7.18 years, from all regions of Brazil. These athletes completed the event with times between 8 h 06 min and 16 h 51 min (11.49 $\pm$ 1.51).

Instruments

We used an Identification Sheet, which contained name, age, sex, and time practicing triathlon (in years and months), to characterize our subjects. Athletes' objective performance was assessed through their total race time in the competition.

Dispositional flow was measured by the Dispositional Flow Scale-2 (DFS-2) developed by Jackson and Eklund (2002) and validated to the Brazilian sport context by Gomes (2014). This instrument assesses an athlete's subjective perception of several flow state indicators. It is composed of 36 items representing the nine dimensions of flow: challenge–skill balance, action/awareness merging, clear goals, unambiguous feedback, intense concentration, control over the task at hand, loss of self-consciousness, transformation of time, and autotelic experience. Each item is answered in a 5-point Likert-type scale varying between 1-Completely disagree and 5-Completely agree. The score for each dimension is obtained through the mean value of its correspondent items, with higher values indicating higher disposition to experience a certain dimension of flow state. Cronbach's Alpha for each dimension is shown in **Table 1**.

TABLE 1 | Correlation matrix of Brazilian athletes' individual characteristics, disposition to flow, and performance.

	1	2	3	4	5	6	7	8	9	10	11	12
(1) Age (years)	–											
(2) Practice time (years)	0.31**	–										
(3) Challenge-skill balance	0.03	0.10	–									
(4) Action/awareness merging	−0.12*	−0.03	0.46**	–								
(5) Clear goals	0.03	0.08	0.55**	0.42**	–							
(6) Unambiguous feedback	0.04	0.09	0.53**	0.38**	0.65**	–						
(7) Concentration on task	0.10	0.09	0.37**	0.36**	0.54**	0.55**	–					
(8) Sense of control	0.00	0.07	0.51**	0.46**	0.56**	0.63**	0.72**	–				
(9) Loss of self-consciousness	0.01	0.03	0.12*	0.22**	0.19**	0.25**	0.24**	0.27**	–			
(10) Transformation of time	−0.08	−0.01	0.11*	0.26**	−0.02	0.04	0.07	0.06	0.24**	–		
(11) Autotelic experience	−0.05	0.08	0.35**	0.28**	0.47**	0.36**	0.27**	0.29**	0.11*	0.21**	–	
(12) Total race time (hours)	0.32**	−0.25**	−0.17**	−0.13*	−0.14**	−0.11*	−0.08	−0.14**	0.09	0.05	−0.02	–
α	N.A.	N.A.	0.61	0.75	0.74	0.76	0.81	0.79	0.83	0.68	0.71	N.A.
$\bar{x}$	37.41	6.18	4.01	3.62	4.24	3.95	3.87	3.85	3.78	3.45	4.57	11.49
SD	7.18	5.26	0.52	0.61	0.49	0.52	0.62	0.55	0.85	0.68	0.45	1.51

*N.A., Not applicable; α, Cronbach's Alpha; $\bar{x}$, mean values; SD, standard deviation. *$p < 0.05$; **$p \leq 0.01$.*

Procedures

The companies providing training and coaching for athletes competing in this event were also contacted to establish previous contact with athletes. Data collection took place during the week of the event prior to the competition. Athletes who were not being advised/trained by any company were contacted in person during the Ironman Expo and the event's accreditation, in the 3 days that preceded the race. Questionnaires were given by the researchers and answered individually by the athletes.

Data Analysis

Data were analyzed through descriptive and inferential statistics using the R software v3.5.1. Missing data were imputed through MICE package (Multiple Imputation Chained Equations). Data distribution was verified by the Shapiro–Wilk test, presenting a non-parametrical univariate distribution. Spearman correlation was used to assess the relationship between variables and Mann–Whitney's U was used to compare sample's top 50 performers with the others. Values were considered significant at $p < 0.05$.

In order to study the complex interaction between study variables, a Network Analysis technique was applied. By using the qgraph package, a Least Absolute Shrinkage and Selection Operator (LASSO) network was produced, which calculates a network of partial correlations between all variables, promoting associations between pairs while controlling for the influence of other variables. Then the LASSO network shrinks trivially small correlations to zero, plotting a network of only the largest associations, removing potentially spurious correlations (Wang et al., 2018). Networks are formed by "nodes" (circles) representing variables and "edges" connecting variables. Edges' colors indicate the direction of the relationship, and the edges' width represents the strength of the association. Nodes' positioning within the network also follows the calculated associations (Silva et al., 2006). In the present network, positive associations were represented by blue edges, while red edges indicated an inverse relationship.

Besides visual inspection of the network, the following centrality indices were used to identify the most influential nodes: strength of the connections; closeness centrality, which measures the distance between nodes and indicates how easily a node's information travels through the network; and Betweenness centrality, describing the number of times a node acts as a bridge in the shortest path between two nodes, which indicates the node's potential to affect other variables within the network (Dalege et al., 2017).

RESULTS

Analysis of the correlation matrix for the investigated variables (**Table 1**) showed significant positive correlations between athletes' age and total race time ($r = 0.32$), suggesting better performances for younger athletes. An inverse significant relationship was found for time of practice and race time ($r = -0.25$), indicating better race times for more experienced athletes. Five dimensions of disposition to flow were correlated with better race times: challenge–skill balance ($r = -0.17$), action/awareness merging ($r = -0.13$), clear goals ($r = -0.14$), feedback ($r = -0.11$), and control over task at hand ($r = -0.14$).

The resulting network (**Figure 1**) presented a noticeable grouping and separation of variables, with objective measurements (age, hours of practice, and performance) on one side and flow indicators seemingly spread on the other. Dispositional flow dimensions were positively associated with one another, showing a positive interaction between dimensions. The three dimensions representing prerequisites to flow state (challenge–skill balance, clear goals, and feedback) were closely positioned, forming a triangle, which is encompassed by five characteristics of flow state, with only loss of self-consciousness being positioned further to the side. Athletes' ages presented a positive correlation with intense concentration while being negatively linked to action/awareness merging. Furthermore, the

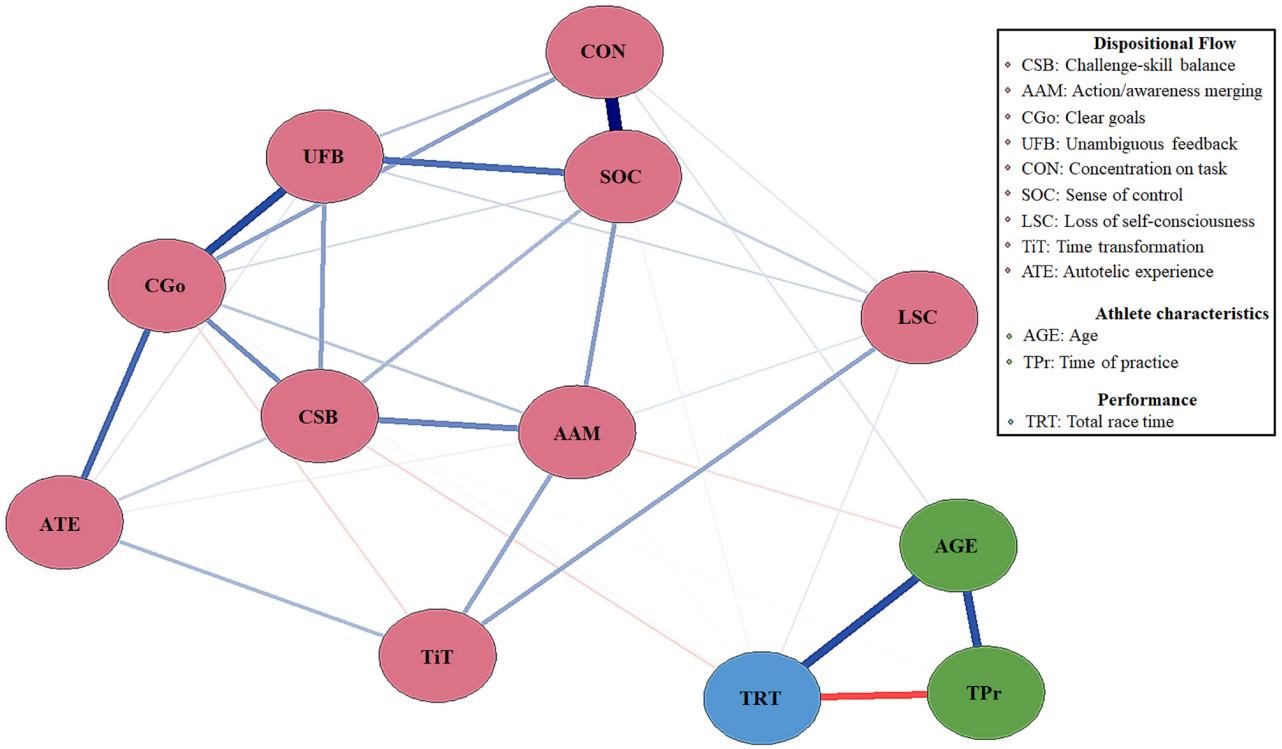

FIGURE 1 | Least Absolute Shrinkage and Selection Operator Correlation Network for athletes' characteristics, dispositional flow, and performance.

amount of triathlon practice was not related to these athletes' disposition to experience flow.

Taking a closer look at the interaction between flow dimensions within the network, we observe a strong connection between intense concentration and the sense of control over such activity (r = 0.47); such sense of control was also connected to feedback (r = 0.25), action/awareness merging (r = 0.16), and challenge–skill balance (r = 0.12). Together, these four dimensions were positioned in a square-shaped aspect at the core of all nine dimensions. Clear goals (r = 0.26) and challenge–skill balance (r = 0.07) have contributed to the autotelic characteristic of the experience. Transformation of time was positively linked to action/awareness merging (r = 0.15), loss of self-consciousness (r = 0.15) and autotelic experience (r = 0.12), on the other hand, it has presented a small but negative relationship with clear goals (r = −0.05).

Athletes' total race time has presented a positive relationship with age (r = 0.31) and loss of self-consciousness (r = 0.03), while practice time was the most relevant indicator of lower race times (r = −0.26). Four dimensions of flow have presented weak negative connections with race time, two pre-conditions to flow: challenge–skill balance (r = −0.05) and clear goals (r = −0.02); and disposition to experience two characteristics of flow: control over the task at hand (r = −0.02) and action/awareness merging (r = −0.01). Weight of all associations within the network are shown in **Table 2**.

Analyzing the network centrality indices (**Figure 2**), we observe that clear goals and sense of control were the most strongly connected variables within the network; challenge–skill balance has presented the highest closeness value, followed by action/awareness merging, sense of control, and clear goals; challenge-skill balance had the highest values of betweenness as well, thus highlighting it as the most influential node in the network.

Lastly, as a way of visualizing our results in a simpler manner, the 50 best performers in our sample were grouped and had their data compared with the other 278 subjects'. We found that these top 50 athletes were younger (p = 0.01), had practiced triathlon for longer (p = 0.02), and had higher levels of dispositional challenge–skill balance (p = 0.02), clear goals (p = 0.02), unambiguous feedback (p = 0.02), and sense of control (p = 0.03).

DISCUSSION

Flow and Performance

The present investigation aimed to study the relationship between dispositional flow and performance of Brazilian triathletes. Five of the nine flow dimensions were correlated to better race times (**Table 1**), and four of these correlations remained significant in the LASSO network analysis (**Figure 1**). Moreover, sample's top 50 performers presented higher levels of four dimensions of flow when compared to the others. Such results indicate that dispositional flow can be positively related to triathletes' performance.

TABLE 2 | Weight of associations within the Correlation Network for Brazilian.

	1	2	3	4	5	6	7	8	9	10	11	12
(1) Age (years)	–											
(2) Practice time (years)	0.30	–										
(3) Challenge-skill balance		0.01	–									
(4) Action/awareness merging	−0.05		0.21	–								
(5) Clear goals			0.19	0.09	–							
(6) Unambiguous feedback			0.16		0.31	–						
(7) Concentration on task	0.04			0.01	0.16	0.09	–					
(8) Sense of control			0.12	0.16	0.06	0.25	0.47	–				
(9) Loss of self-consciousness				0.04		0.06	0.03	0.07	–			
(10) Transformation of time				0.15	−0.05				0.15	–		
(11) Autotelic experience			0.07	0.03	0.26	0.04				0.12	–	
(12) Total race time (hours)	0.31	−0.26	−0.05	−0.01	−0.02			−0.02	0.03			–

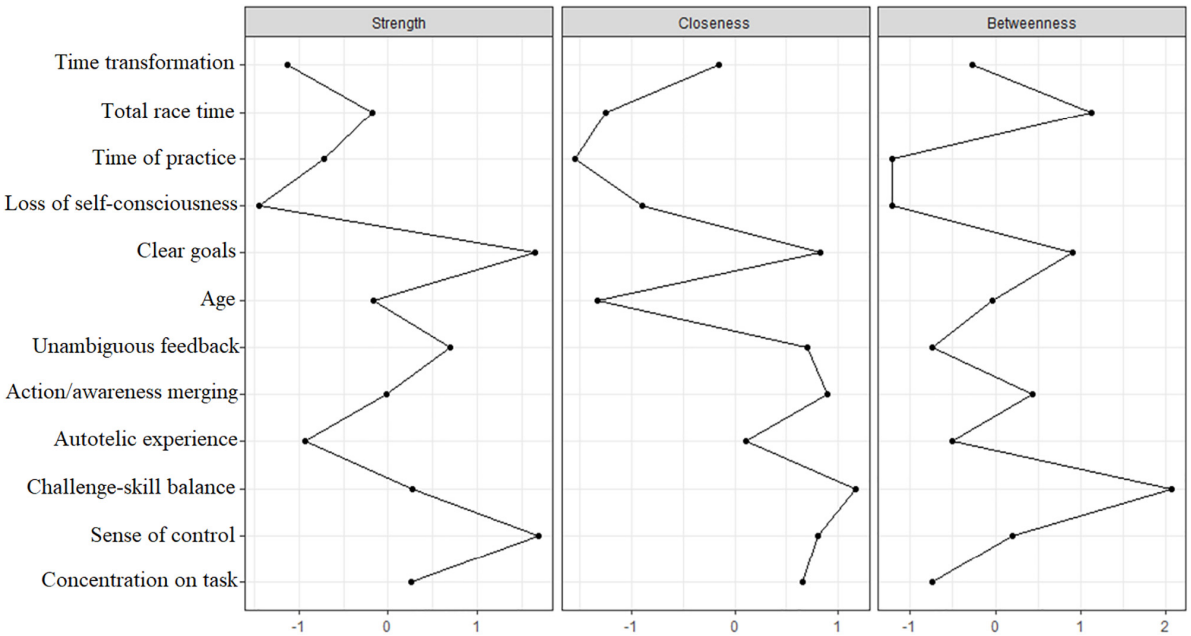

FIGURE 2 | Strength, closeness, and betweenness centrality of network's variables.

Despite the low strength of the associations, which could be attributed to the general characteristic of the DFS-2, an instrument that is not event-specific, present results are still in agreement with existing evidence. Jackson et al. (2001) have reported that clear goals (β = −0.24), challenge–skill balance (β = −0.19), and action/awareness merging (β = −0.15) were predictors of better finishing position in orienteering, surf lifesaving, and cycling athletes (n = 236, 66% male). Another study (Stavrou et al., 2007), with athletes from seven different individual sports (n = 220, 51% male), reported a positive relationship between objective performance and eight of the nine flow dimensions (r values between 0.19 and 0.52); however, only the autotelic experience dimension remained a significant predictor of performance after multiple regression analysis (β = 0.37). Both of these studies have assessed subject's flow through the Flow State Scale, an event-specific instrument (FSS, Jackson and Eklund, 2002).

Furthermore, two other studies have investigated the relationship between flow and objective performance in marathon runners. Stoll and Lau (2005) reported an inverse non-significant relationship between unidimensional flow and total race time (r = −0.11) (n = 160, 79% male), while Schüler and Brunner (2009) (n = 112, 68% male) have also found an inverse non-significant relationship between unidimensional flow and marathon race time (r = −0.12, β = −0.08). Despite presenting the same direction of relationship between flow and performance, these two studies have used not only smaller sample sizes, but they have also measured flow through another

instrument, the Flow Short-Scale (Rheinberg et al., 2003), which could explain the lack of statistical significance for the reported relationships.

A few factors must be taken in consideration when comparing these studies. Present results and literature evidence were similar in the sense that only individual sports were studied and samples were predominantly male, with the exception of one (Stavrou et al., 2007). Moreover, all of the reported results suggest that flow will positively influence objectively measured athletic performance. On the other hand, three different instruments were used to assess flow across studies. Furthermore, objective performance was measured in three different ways: race times (present study, Stoll and Lau, 2005; Schüler and Brunner, 2009), finishing position (Jackson et al., 2001), and different calculations accounting for the athletes' best performance, performance goal, and actual result (Stavrou et al., 2007). These factors, along with differences in sample sizes, could explain the different strengths and significance of associations across studies.

Flow Mechanisms

The data analysis method adopted here allows for the observation of how variables interact in a mutual and multivariate way. It is a data-driven exploratory method of analysis considered to be adequate to represent complex relationships in the form of a network graph (Wasserman and Faust, 1994). By analyzing the present network (**Figure 1**), it is possible to suggest explanations for flow mechanisms, looking at how dimensions interact with each other and how these subjective measurements are linked to these athletes' actual performance.

In this sense, the dimension of challenge–skill balance appeared as the most influential node within the network, being the closest to all other eight dimensions as well as acting as a bridge between them; in other words, changes in this dimension have the highest potential to influence other dimensions of flow and, consequently, their outcomes. Such observation is in accordance with what is proposed by the Flow Theory (Csikszentmihalyi, 2000), which recognizes the importance of having balance between challenge and skill for the experience of flow as a whole. Following this dimension and its connections, we observe a close relationship with clear goals and unambiguous feedback. Together, challenge–skill balance, clear goals, and unambiguous feedback were grouped in the shape of a triangle; coincidently, these are the three dimensions considered to be flow prerequisites (Csikszentmihalyi, 2002).

Encompassing the three flow prerequisites, we observe five characteristics of flow experience positioned between these variables and subjects' objective measurements, with only the loss of self-consciousness dimension standing further to the side. There are a series of interactions among the nine dimensions of flow. Starting from the strong connection between clear goals and unambiguous feedback, we observe two other interactions stemming from this dyad: (1) the autotelic characteristic of the experience was positioned at the side of clear goals, suggesting the importance of goal setting and achievement for pleasurable and rewarding experiences; (2) the sense of control has been positioned at the side of unambiguous feedback, indicating that it can influence, or be influenced by, progress toward set goals and knowing how to adjust in order to improve.

Athletes' sense of control has been strongly linked to the concentration on task, which highlights the importance of concentration to achieve control over an activity. Moreover, clear goals were positively related to concentration, while challenge–skill balance presented a positive association with sense of control, thus reinforcing how flow prerequisites contribute to the characteristics of flow experience. In this sense, the merging of action and awareness seems to result from the balance between challenge and skill, having clear goals in mind, being in control of the activity, and an interaction with time transformation. It is, however, beyond our reach to determine how time transformation and action/awareness merging influence one another. Still, time transformation has also been related to the sense of pleasure in the activity (autotelic experience) and being less aware of internal and external pressures (loss of self-consciousness).

One important characteristic of being in flow state is feeling "at one" with the activity (Jackson and Csikszentmihalyi, 1999). The dimensions and interactions presented above describe different aspects of being "at one" with the activity or fostering such feeling; however, action/awareness merging, loss of self-consciousness, concentration on task, and sense of control have all been criticized as being overlapping characteristics (Swann et al., 2018). While such criticism has its foundation, these dimensions appeared in our results as independent constructs interacting in a complex manner and representing distinct aspects of one mental state.

The dimensions of loss of self-consciousness and time transformation have been questioned regarding their applicability for athletes, as well as for tending to present low factor loadings for the general model of flow (Jackson and Eklund, 2002). These are the two least reported dimensions of flow in qualitative investigations with athletes (Swann et al., 2012); however, the low support for these dimensions in sports has been commonly overlooked (Swann et al., 2018). Present results have shown small contributions from both characteristics of flow along with inadequate internal consistency for time transformation ($\alpha = 0.68$). These two dimensions had the lowest degrees of strength and closeness, with only time transformation showing some level of betweenness. Moreover, loss of self-consciousness was the only dimension negatively linked to performance. Still, these flow characteristics contributed to other aspects of the experience, such as the merging of action and awareness, which suggests that, even with an overall low support, there is relevant information within these dimensions' items to be taken into consideration when studying flow.

Limitations, Future Directions, and Practical Implications

As part of any investigation, a few limitations must be presented. Our sample was predominantly male (89%), undermining our

understanding of flow and performance relationships for female athletes. Nonetheless, 87% of our target population (Brazilian competitors in the event) were male athletes. Another limitation is the assessment of only one sport, despite triathlon being composed of three different individual sports (long-distance running, cycling, and swimming); it does not mean that our results can be directly generalized to athletes from only one of these sports or even out of triathlon in general. Adopting a cross-sectional design using a memory-dependent subjective measurement of one's propensity to experience flow is an important limiting factor as well.

Future studies seeking to better understand the relationship between flow and athletic performance could benefit from the use of both dispositional and state measurements of flow to analyze how general propensity to experience flow will contribute to event-specific experiences, and how both may influence performance. Researchers should use both subjective and objective indicators of performance, since flow is an individual mental state (subjective) happening in a competitive context where objective performance is the main determinant for winning. Including physiological data, such as VO_{2max}, will also benefit performance-related studies. Furthermore, the understanding of flow state specificities as a function of sex and type of sport (e.g., short-duration × long-duration; team sports × individual sports) also requires more attention. Adopting mixed methods to obtain and analyze quantitative and qualitative data is also advised to enrich the overall understanding of this complex phenomenon.

As practical implications, athletes, coaches, sports psychologists, and other professionals working with triathletes can better understand flow and its mechanisms within this sport, with the goal of increasing the frequency and intensity of this highly desirable mental state. In this sense, we observe that some dimensions of flow can be more directly focused, such as working with the athletes' concentration and setting realistic, achievable, and motivating goals, while other dimensions seem to be a consequence of a variety of factors, such as the merging of action and awareness and the actual control over the activity being performed. Thus, directing attention toward aspects that can be more directly improved might, in turn, facilitate the occurrence of others. To develop balance between challenge and skill, the main condition for experiencing flow, we would like to highlight that both aspects go beyond improving one's actual skill and choosing adequate challenges. Therefore, it is important to positively develop how athletes perceive their own skill level, as well as how they perceive and interpret contextual demands.

DATA AVAILABILITY

All datasets generated for this study are included in the manuscript and/or the **Supplementary Files**.

ETHICS STATEMENT

The present study was approved by the Ethics Committee of Universidade Estadual de Maringá, opinion number 2.287.443. The Brazilian Triathlon Confederation (CBTri) was contacted in order to obtain approval to collect data at the event. Athletes read and signed an informed consent in order to voluntarily accept participation. Only adults were recruited. No vulnerable population was involved.

AUTHOR CONTRIBUTIONS

WG and PA contributed to the conception or design of the study. MM, AC, and MR recruited and acquired data from the participants. JV and RC analyzed and interpreted the data. WG and RC wrote the manuscript. JJ and LF critically revised the intellectual content.

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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.2019.02136/full#supplementary-material

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BRIEF RESEARCH REPORT
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The Effects of an Appropriate Behavior Program on Elementary School Children Social Skills Development in Physical Education

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The purpose of this study was to see the effects of an appropriate behavior development program in relation to the improvement of fair play and social skills behaviors of elementary school children during the physical education class. The participants of this study were 204 students from 5th and 6th grade from seven different public schools in Castilla–La Mancha, Spain. Data was collected through a questionnaire to measure students' pre and post appropriate behaviors when winning, appropriate behaviors when loosing, appropriate behaviors during the game, fair play skills and social skills, during the physical education class. Results from this study revealed that participants improved their behaviors with the implementation of the intervention (appropriate behavior program), generating positive changes in students' attitudes and social skills during physical education class. In relation to children gender, girls had better scores than boys in relation to appropriate behaviors when losing. Further, when comparing students' age, those from 10 to 11 years old scored higher in fair play behaviors and social skills. In conclusion, the intervention program was effective to improve the behaviors of the school children, generating positive changes in their attitudes and social skills during physical education.

Keywords: appropriate behaviors, social skills, games, sports, physical education, elementary education, fair play

INTRODUCTION

Focusing on the development of values and appropriate social skill during physical education and sports is extremely important (Samalot-Rivera, 2007; Samalot-Rivera and Porretta, 2012). Physical education is considered one of the school topics with the potential to develop these behaviors (Moore et al., 1995; Vidoni, 2003; Ponce, 2006; Samalot-Rivera and Porretta, 2009, 2012). For years now, physical education and sports had been considered appropriate context to develop a healthy lifestyle, including the development of appropriate behaviors, values and social skills (Hellison, 2003). Further, physical education is seen as one of the schools' subject with greater impact of mental, emotional and physical development of students (Ponce, 2006). Weinberg (2011) mentions that the participation in sports, facilitate numerous interpersonal relation situations and the development of interpersonal and social skills.

Learning to co-exist should be one of education main objectives. We must promote values like tolerance, solidarity, and mutual respect though the physical education class because is an

appropriate and ideal environment to achieve this (Eldar et al., 2006; Gil-Madrona et al., 2006). The physical education curriculum offers specific opportunities, that are not possible in other subjects (Siedentop, 1991; Laker, 2000; Siedentop et al., 2004).

Bloom and Smith (1996) and Hellison (2003) mentioned that neither teachers or coaches can assume that children will learn values and social skills by just participating in the activities without the proper planning and implementation during physical education and sports. Further, Velázquez-Callado (2004) consider that teachers who choose to teach using cooperative activities help students learn the objective of the activities and developing simultaneously social skills, auto control skills and empathy toward their peers in the physical education class.

During the last years, there had been an increasing interest to examine the effect of physical activity and sport programs on students' social development experiences during the physical education class. Cooperative learning had been one of the programs used by Fernández Río (2003), in wish he demonstrated improvements on student's social abilities like trust, enjoyment, and friendship using cooperate learning activities. Cecchini et al. (2008a) found out that physical activity offers a unique opportunity for peer interaction, respect and tolerance. For this reason, all personnel working with students or athletes, should have the proper training to implement and teach these values. This had inspired many researchers during the last decade to develop and design intervention programs to promote the moral development of students and athletes during physical education class and sport related activities (Escartí et al., 2005, 2006; Ruiz et al., 2006).

Gil-Madrona et al. (2016), examined the effectiveness of a physical education program focused on the teaching of social skills and values, fair play, social relationships, effort, self-discipline, and self-control in the social affective context on students from 6th to 8th grade. They concluded that when social abilities and values interventions are implemented, students improve their knowledge about how to positively behave in their physical education class and physical activity context. Further, Danish and Nellen (1997) who presented a model for the development of skills for life, with the objective of using physical activity and sport for the development of personal and social competencies in children and youth, defend that psychosocial acquired abilities can be transferred to other domains as long as the experiences are designed and focused with same purpose (Madrid-López et al., 2016). However, the transfer of the acquired qualities in sport to other areas of life is a controversial topic and has not been proven yet (McPherson, 1986; Heinemann, 1992; García Ferrando et al., 2017).

Some studies had focused on comparing the attitudes of males and females on sport. For example, Derry (2002) affirms that literature demonstrate boys caring more about playing and winning, and girls are more interested in learning the proper ways to play, what implies having better skill and tactic development, and social interactions. We must take this evidence in consideration when planning social skill instruction and change behaviors during the physical education class.

The purpose of this study was to know the effects of a program named Delfos (Cecchini et al., 2008a,b), in relation to the improvement of appropriate behaviors during and after physical activity or sport, fair play and social skills. The program Delfos is a pedagogical intervention program designed to develop appropriate behaviors when winning, appropriate behaviors when loosing, appropriate behaviors during the game, fair play skills and social skills, in youth during physical education class. To our knowledge, this is the first study analyzing these aspects in Castilla–La Mancha (Spain).

MATERIALS AND METHODS

Participants

Sample was composed of 204 students from 5th (21.7%) and 6th (78.9%) grade, between 10 and 13 years old (X = 11.22; SD = 0.70) with 46.1% girls and 53.9% boys. Students were from seven different public schools in Albacete Spain. Sample selection was done by convenience. All public schools from urban and disadvantage areas from Albacete Spain were taken in consideration. All subjects gave assent and their parents provided their informed consent for inclusion before they participated in the study. The protocol was approved by the University of Castilla–La Mancha Research Ethics Committee and by the Ethics Committees of the schools participating in the study.

Data Collection

A validated questionnaire titled Appropriate Behaviors in Physical Education and Sport by Samalot-Rivera and Madrona, was used to collect data in this study. This questionnaire is composed by 32 items with a 5 level Likert scale (1- Never, 2-Sometimes, 3- Occasionally, 4- Most of the Time, and All the Time). The items were grouped from a theoretical point of view and were divided in the following groups: appropriate behaviors when winning, appropriate behaviors when loosing, appropriate behaviors during the game, fair play skills and social skills. Reliability of the instrument was measured by Alpha Cronbach obtaining an adequate 0.883.

Procedures

An experimental pre and post-test with control groups was used Hernández-Sampieri et al. (2003). The Delfos program was used as the intervention of this study. The Delfos program does have an educative intervention with pedagogical teaching strategies, organization and session designed with the purpose of improving fair play, increase levels of self-control and modify inappropriate behaviors in youth. The principal values associated with Delfos program are student wellbeing, personal development, effort and self-management (Cecchini et al., 2008a,b).

There is no doubt that any program to be implemented, needs to be tested with the purpose of knowing to what extent the program is effective (Hernández-Mendo and Anguera, 2001). For this reason, we decided to test this program to see the effects that have in youth by using a questionnaire about Appropriate Behavior During Physical Education and Sport developed by

Samalot Rivera and Pedro Gil Madrona, validated by Gutiérrez-Marín et al. (2017). As part of this program, students needed to complete and sign a behavior contract where they compromise to improve and decrease their aggressive behaviors, eliminate certain conducts of putting other down and increase the capacity to avoid and solve conflicts in sport related activities and in their daily living.

Delfos program structure the physical education classes this way:

(a) Discussion of the social skill: in this phase of the program a discussion about the social skills to be worked was conducted. A discussion of the attitudes and social skills expected as part of the program objectives and values took place.
(b) Activation phase: in this phase of the program the focus was on providing students the opportunity to be physically active.
(c) Confrontation phase: in this phase, students were given constant feedback about their behaviors during class.
(d) Reflection phase: in this phase is when teachers and students analyze possible moral conflicts during the class sport or activity played and come up with solutions.
(e) Transition phase: the objective of this phase was to make sure that students understood the importance of the learned values and social skills will have in their lives. This was discussed during the reflection phase at the end when they were asked to please continue using the discussed and learned values in their communities.

The intervention program was conducted in the physical education class for a total of 20 class sessions of 45 min each. This program was designed with the purpose to help students learn appropriate sport and fair play behaviors before, during and after games.

Analysis

A 2 × 2 factorial design with pre and post-test design was used for this study. The first factor references student's gender (male and female). The second factor references the age of the participants (10 to 11 and 12 to 13 years old). Participants were measured pre and post treatment. For data analysis SPSS for Windows version 19.0 was used. With the objective to prepare data for the analysis we examined: (a) the patterns on the lost data to estimate if its respond to a random distribution (Tabachnick and Fidell, 2001), (b) the mean, standard deviation, asymmetry and kurtosis of each one of the variables considered in this study, (c) the presence of univariate and multivariate atypical cases, and (d) the presence of multicollinearity among variables (Kline, 2011). As a criterion to evaluate index of asymmetry and kurtoris it was considered to be excellent values between + 1,00 years −1,00, and as fair values inferior to + 2,00 years −2,00. Later, atypical univariate cases were identified through the standard results of each one of the variables ($z > 3.29$, $p < 0.001$).

A Mahalanobis test with $p < 0.001$ was conducted with the finality of discard multivariate atypical cases (Tabachnick and Fidell, 2001). A last analysis consisted of a multicollinearity test between the variables (Kline, 2011), this to estimate the existence of redundant variables (0.90 correlations or higher).

A variance analysis of repeated measures (ANOVA) was done. Group and independent factors were gender and age (children between 10 and 11 and 12 to 13 years old). Results obtained between pre and post-test were considered repeated measures. Box's M test was used to compare variation in multivariate samples. Partial square eta (η^2) was used to estimate the size effect and the alfa values was set on 0.05. The effects of the significant interactions given by ANOVA results were explored by a Bonferroni *post hoc*.

RESULTS

Data Preparation

The percentage of the lost cases for not responding to some of the items did not overcome the 5%. Because this was such a small percentage, it was decided to impute those by a central tendency measurement (mode) of the completed responses of one of the participants in the same scale. This method had demonstrated on lost cases to promote the conceptual attractive balance of precision and simplicity (Shrive et al., 2006). The selection of impute by was due to the fact that we tried to have the five (discrete) response options of the scale. The asymmetry and kurtosis indices of the variables under study were obtained and varied between −1.25 to −0.22 and between −0.34 to 1.84, respectively, which can be considered as acceptable. Six atypical univariate cases were detected ($z = \pm 3.29$), of which four are multivariate atypical cases. The elimination of these atypical cases improves the distribution of the variables (indices of asymmetry between −0.93 to −0.24 and of kurtosis between −0.27 to 0.71). The correlations between the variables varied between $r = 0.24$ to 0.61, which can be concluded that there are no problems of multicollinearity.

Preliminary Analyses

A t-test of mean difference was applied for independent groups in relation to the age and gender of the participants. Regarding the participants gender, it can be observed that there are significant differences in the variables Social Skills ($d = 0.37$). Female students scored higher on these variables than male students. In relation to age, it can be observed that there are significant differences in the variables Appropriate skills when losing ($d = 0.36$), Fair Play Skill ($d = 0.38$) and Social Skill ($d = 0.31$). The group of students between 10 and 11 years old scored higher on these variables than those students between 12 and 13 years old (**Table 1**).

ANOVA of Repeated Measures

Appropriate Behaviors When Loosing

Box's M test was significant ($F = 3.182$, $p \leq 0.001$), however, Box's M test has been criticized for being overly sensitive for large sample sizes, it can detect even small departures from homogeneity. In other words, it will report a statistically

TABLE 1 | Mean differences by sex and age group.

	Sex							Age group						
	Females (n = 93)		Males (n = 105)					10–11 (n = 129)		12–13 (n = 69)				
Variables	***M***	***SD***	***M***	***SD***	***t***	***p***	***d***	***M***	***SD***	***M***	***SD***	***t***	***p***	***d***
ABL	20.02	3.43	19.18	3.30	1.76	0.08	0.25	20.00	3.34	18.78	3.33	2.45	0.02	0.36
ABW	19.04	3.49	18.57	3.24	0.99	0.33	0.14	18.71	3.42	18.96	3.25	−0.50	0.62	0.07
ABDG	21.42	2.56	20.94	2.63	1.29	0.20	0.18	21.23	2.55	21.04	2.70	0.49	0.63	0.07
FPS	21.69	2.40	21.26	2.80	1.16	0.25	0.16	21.81	2.39	20.81	2.92	2.58	0.01	0.38
SK	53.18	4.45	51.27	5.67	2.62	0.01	0.37	52.73	4.72	51.12	5.92	2.09	0.04	0.31

M, Mean; SD, Standard Deviation; ABL, Appropriate behaviors when loosing; APW, Appropriate behaviors when winning; ABDG, Appropriate behaviors during game; FPS, Fair play skills; SK, Social skills.

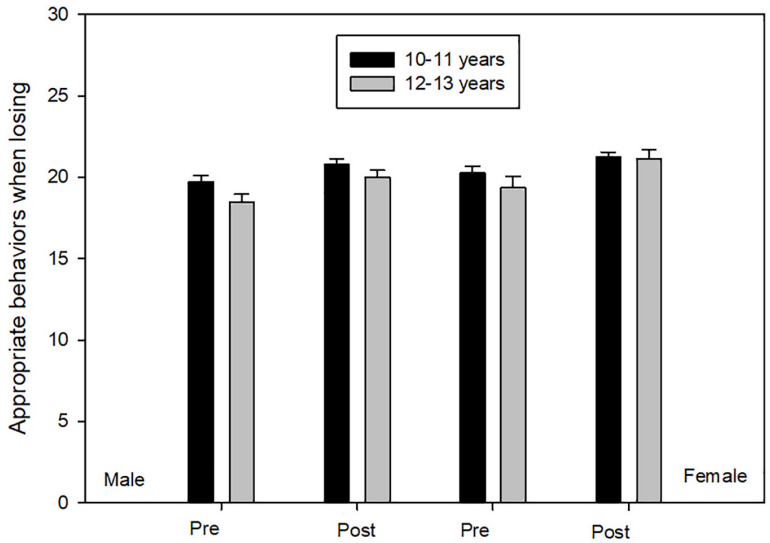

FIGURE 1 | Appropriate behaviors when loosing.

significant result when one does not exist, but they do not increase the probability of type I error (Hahs-Vaughn, 2016). ANOVA measures demonstrated the principal effects of time [$F(1,194) = 28.689$, $p \leq 0.01$, $\eta^2 = 0.13$, 1-β = 1.00] and gender [$F(1,194) = 3.83$, $p \leq 0.05$, $\eta^2 = 0.02$, 1-β = 0.50]. Female participants, when compared with male participants, scored significantly higher in appropriate behaviors when losing. In the other hand, post-test scores were significantly higher than pre-test for all four groups (**Figure 1**).

Appropriate Behaviors When Winning

Box's M test was no significant ($F = 0.424$, $p \geq 0.92$). ANOVA scores demonstrated principal effects of time [$F(1,194) = 49.095$, $p \leq 0.01$, $\eta^2 = 0.20$, 1-β = 1.00]. Participants scored significantly lower on post-test an all four groups in comparison to pre-test (**Figure 2**).

Appropriate Behaviors During Game

Box's M test was no significant ($F = 1.356$, $p \geq 0.20$). ANOVA scores demonstrated principal effects of time [$F(1,194) = 9.944$, $p \leq 0.05$, $\eta^2 = 0.05$, 1-β = 0.88]. Participants scored significantly higher on post-test on all four groups in comparison to pre-test (**Figure 3**).

Fair Play

Box's M test was no significant ($F = 1.560$, $p \geq 0.12$). ANOVA scores showed main effects of Time [$F(1,194) = 3.789$, $p \leq 0.05$, $\eta^2 = 0.02$, 1-β = 0.49] and Age [$F(1,194) = 5{,}540$, $p \leq 0.02$, $\eta^2 = 0.03$, 1-β = 0.65]. Participants aged 10 to 11, compared to their peers aged 12 to 13, scored significantly higher on fair play skills. On the other hand, in post test scores, in the four groups, were significantly higher than pre-test scores (**Figure 4**).

Social Skills

Box's M test was significant ($F = 2.865$, $p \leq 0.02$). ANOVA scores showed main effects of Time [$F(1,194) = 8{,}351$, $p \leq 0.01$, $\eta^2 = 0.04$, 1-β = 0.82], Gender [$F(1,194) = 8{,}717$, $p \leq 0.01$, $\eta^2 = 0.04$, 1-β = 0.83] and Age [$F(1,194) = 3.856$, $p \leq 0.05$, $\eta^2 = 0.02$, 1-β = 0.50]. Participants from 10 to 11 years old, compared to their peers from 12 to 13 years old, scored

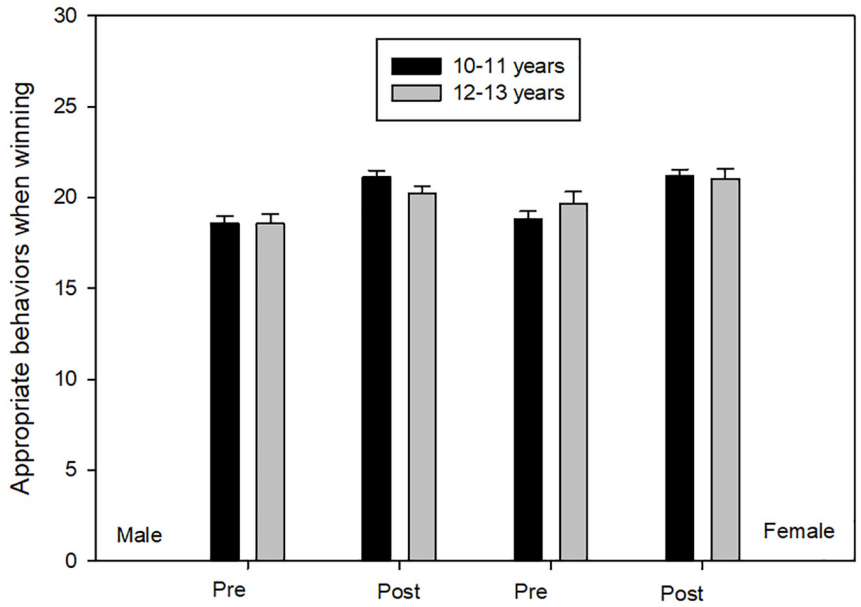

FIGURE 2 | Appropriate behaviors when winning.

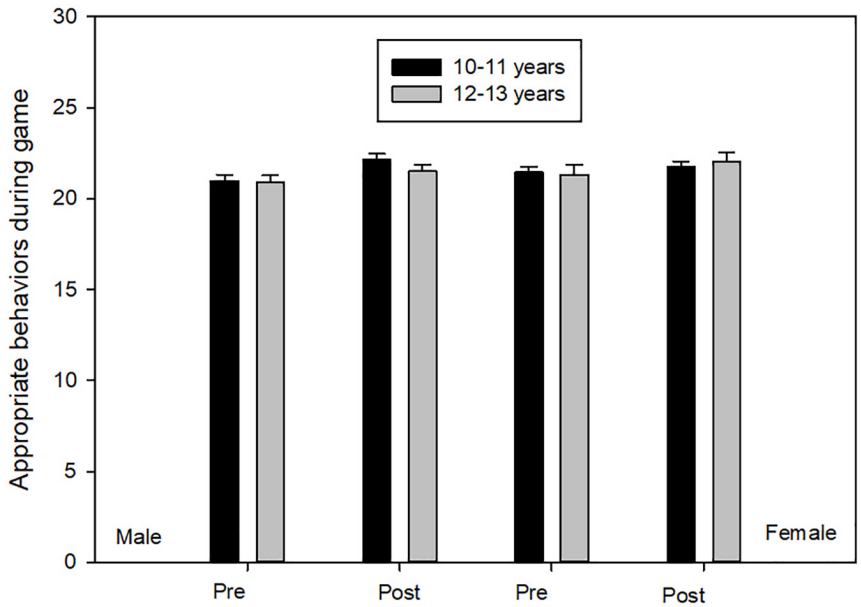

FIGURE 3 | Appropriate behaviors during game.

significantly higher in social skills. However, post test scores, in the four groups, were significantly higher than in the pre-test (**Figure 5**).

DISCUSSION

This is a novel study because, to our knowledge, this is the first study in Castilla–La Mancha (Spain) analyzing the impact of the program Delfos on students' appropriate behaviors when winning, losing and during games, fair play and social skills in the physical education class. Through this study it can be evidenced the positive impact that the implementation of the program Delfos had on the development and transfer of students' appropriate behaviors when winning, losing and during games, fair play and social skills in the physical education class. Data revealed the improvement of positive attitudes as well as their social skills and fair play versus being carried away with games

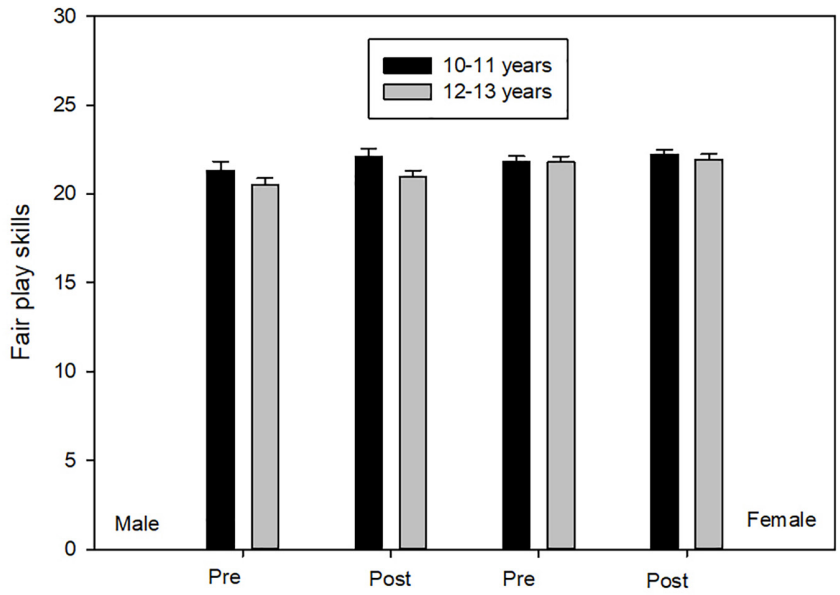

FIGURE 4 | Fair play skills.

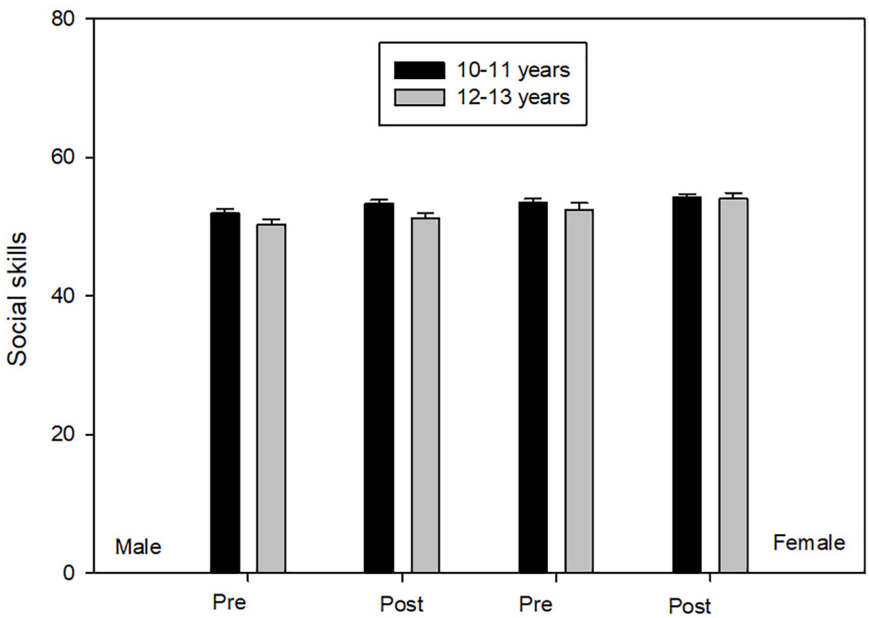

FIGURE 5 | Social skills.

difficult situations and having negative ones. Nevertheless, it is important to consider that previous studies have indicated that the transfer of the acquired qualities in sport to other areas of life is a controversial topic and has not been proven yet (McPherson, 1986; Heinemann, 1992; García Ferrando et al., 2017).

The results of this study demonstrated that students had significantly better scores after the program was implemented. This results provide evidence that playing a sport is not necessarily what help students improve on their behaviors, but rather the context or intervention during the sport activity is what make the difference, helping students to improve their behaviors, values and social skills (Cecchini et al., 2004, 2005). Cecchini et al. (2005), had similar results when they addressed youth at risk behaviors with the same objectives of this study. It is evident that literature provide enough evidence to believe that this type of program can be used as a preventive measure to address problems related to misconduct and lack of social skills and values.

Changes in attitudes and values (appropriate behaviors) will occur easier when appropriate planning to develop these behaviors in physical activity context are implemented (Samalot-Rivera and Vidoni, 2015). As mentioned many times in the literature, physical education and sports are attractive environments in which these type of interventions can be implemented creating positive behavior changes in students (Vidoni and Ulman, 2012; Samalot-Rivera and Vidoni, 2015). Further, Brustad and Arruza (2002), mentioned that sports events are a good context to develop social skills and values because it offers many opportunities for decision making and personal interaction.

The main strength of the present study is the implementation and evaluation of Delfos program in a new sample of Castilla–La Mancha (Spain), analyzing its impact on students' appropriate behaviors when winning, losing and during games, fair play, and social skills in the physical education class. This study presents also some limitations. This data does provide good improvement of results from pre and post data after the intervention, but to see the reliability of the program we could have compared to a control group or use a parallel measurement scale to control the differences between pre and post intervention. This study focused on assessing the educational possibilities of sport, but future studies should also assess the educational possibilities of other activities, such as music or art. Finally, new qualitative studies are needed to know if aspects such as class incidents, differences between teachers, or differences between types of schools might affect the implementation of the Delfos program.

CONCLUSION

Students are an important part of the teaching learning process and must be part of it by interacting with class content, peers and the established classroom rules. This way students will learn how to deal with classroom conflict resolution. In this study we were able to observe positive changes in students' target behaviors after the implementation of the program that consisted of 20 sessions of 45 min each. It was the objective of the program to help students improve in their values and social skills and not necessarily in their sport related skills. After analyzing survey data, females had higher scores than males in appropriate behavior when losing and overall social skills. On the other hand, when comparing age groups, those students from 10 to 11 years old scored significantly better on fair play and social skills, in comparison to those from 12 to 13 years old. Therefore, we suggest that these competencies may be transferred to other domains and may be maintained over time by implementing programs like this, and we also suggest to measure students' behaviors with the Appropriate Behavior Physical Education and Sport questionnaire overtime. This way teachers might reinforce the development of these competencies for students social and personal well-being (Gutiérrez-Marín et al., 2017).

DATA AVAILABILITY

The datasets generated for this study are available on request to the corresponding authors.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Research Ethics Committee of the Public School Calar Del Mundo. 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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Sport and Exercise Psychology Studies in Brazil: Performance or Health?

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The low professional insertion of psychologists in Brazilian sports teams, as well as the Sport Psychology course being seldom offered in undergraduate Psychology courses, may reflect in the current scenario of scientific research in Brazil. It is still not clear what Graduate Programs (GPs) have adopted directions regarding the development of studies in Sport and Exercise Psychology (SEP) research fields since an assessment or mapping of scientific knowledge production in this area has not yet been performed involving Exercise and Sport Science and Psychology GPs. This study aimed at investigating institutional research and their themes in SEP from these graduate programs. Studies were selected and retrieved from a national database (Sucupira Platform), that contains all registered researches from all Exercise and Sport Science (n = 31) and Psychology (n = 84) GPs in the country. Data were analyzed through R software using text mining techniques, latent semantic analysis and K-means clustering. Results revealed that research involving SEP is predominantly being developed at Exercise and Sport Science GPs (n = 171; $p < 0.01$) in comparison to psychology GPs (n = 39), mostly located in the south and southeast regions of Brazil. This research has focused on the effects of physical exercise and quality of life, while Psychology GPs have analyzed sport as associated with health and education, as a way to promote social support and to study sports' psychological aspects. It was concluded that Exercise and Sport Science GPs had the most significant contribution to SEP. Investigations were focused on the interface of exercise with quality of life, health and education, with gaps existing in programs advancing in the studies on sports and performance.

Keywords: graduate education, exercise and sport sciences, psychology, sport, exercise

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INTRODUCTION

Sport and Exercise Psychology (SEP) in Brazil dates back to about 50 years ago. Since then, this area has been seeking to organize its professional field (Queiroz et al., 2016) and experienced an expressive growth from 2010 due to the presence of SEP professionals in elite sports, as well as the increase in scientific research in Brazil (Vieira et al., 2010, 2013). However, a more pronounced

SEP practical development has been hindered by the lack of specific knowledge and difficulties to make research results available for SEP professionals (Aoyagi et al., 2012). There is a large number of sport psychology professionals that are still unaware of the benefits of scientific research as a tool to improve performance (Ucha, 2008). Besides, there is a lack of studies devoted to analyzing mental, emotional and behavioral aspects involved in sports performance (Stefanello, 2009). This is contrasting with the achievements of some athletes and teams in major international competitions.

The Brazilian SEP publications are closely related to the development of graduate programs (GPs) (Vieira et al., 2013), where the more experienced researchers are based, and the more robust studies are carried out. It is interesting to observe that most SEP studies are conducted in Exercise and Sport Science GPs rather than Psychology ones. This may be related to the lack of SEP as a formal discipline in undergraduate Psychology courses and may explain the modest scientific contribution and the reduced number of Sport Psychologists involved in high-performance sports (Vieira et al., 2010). This opposes the directions recommended by the APA's Division 47 (Exercise and Sport Psychology), which advocates in favor of research and practice unification (Aoyagi et al., 2012), as a strategy to increase the professionalization of sport psychologists.

Mapping the intellectual products related to SEP may constitute an attractive strategy to identify the way the researchers are organized and how specific academic themes advance and are structured. This may be relevant in many developing countries where SEP is a new professional field (Queiroz et al., 2016). For instance, it has been identified that Sport and Exercise Science GPs publish more SEP studies than their Psychology GP counterparts (Vieira et al., 2013). In addition, it is not clear the research emphasis or trends applied by Exercise and Sport Science and Psychology GPs regarding different SEP practical and theoretical approaches (e.g., physical activity and health; physical exercise, elderly and chronic diseases; sport, stress and motivation; sport and exercise for child and adolescent development, etc.). Thus, understanding how the scientific research is produced, organized and structured is relevant not only to the development and trends for high performance sports in Brazil but also to allow future comparisons between countries with similar academic organizations and sport's approaches.

Therefore, this study aimed to analyze the approaches applied by Exercise and Sport Science and Psychology GPs as they respond for most thesis and dissertations SEP produced in the country. The geographic distribution of these GPs was also provided.

MATERIALS AND METHODS

All studies performed at Brazilian GPs in Exercise and Sport Sciences (n = 31) and Psychology (n = 84) were included in the analysis. The studies containing words related to SEP in the title were selected for further analysis. Research titles were retrieved from the Sucupira Platform[1], which is a governmental, but public domain tool developed for the National assessment of the GPs from 2013 to 2016. Three researchers performed the analysis of all studies conducted by the Exercise and Sport Sciences (n = 2368 studies) and Psychology (n = 3566 studies) GPs. Disagreements were resolved by consensus (**Figure 1**).

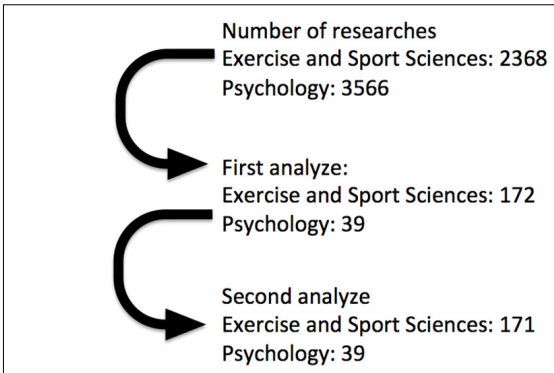

FIGURE 1 | Research selection flowchart.

All data used was obtained from publicly available data sources from documents used in research. No human subjects were enrolled and no humans subject data were used. The present study used only documental data available in Sucupira Platform, therefore, it had no human subjects, requiring no participants' consent, nor ethical approval as define by the Brazilian national research regulation CNS 196/96.

Data Analysis

The SPSS software (version 24.0) was used to verify the difference in researches' distribution across Exercise and Sport Science and Psychology GPs through the Chi-Square test. To identify the main themes appearing in the GP's research titles a combination of text mining, latent semantic analysis (LSA) and clustering techniques was used. Text mining is consisted of extracting content from text based on meaning and context; in other words, it gathers structured information from a non-structured text (Feinerer et al., 2018). This analysis comprises three steps: (a) preprocessing of the documents; (b) extracting and grouping text patterns; and (c) content evaluation (Rezende et al., 2011). The document processing step was conducted by transforming all letters to lowercase; stemming; removing stopwords, accents, punctuation, numbers and exceeding spaces. Then, each word was extracted and vectorized. The terms originated from text mining were quantified for their title frequency. With the vectorized data, a LSA was applied to identify similarities in the semantic content between titles. Similarities were generated based on a weighted score attributed to each document word, which was derived from their appearance across documents. Based on these weights, titles were scored, and similarities were defined by title association (Landauer, 1998). After calculating the similarities between titles, a K-means cluster analysis approach was used to identify the main themes arising from the titles.

[1]https://sucupira.capes.gov.br/sucupira/public/index.xhtml

The number of clusters was defined by screen plot visualization, model accuracy (AIC, BIC and EBIC statistics), class membership (classes deemed acceptable if having at least 5% of cases) and theoretical coherence.

Within each cluster, the term association was calculated from a polychoric correlation matrix and depicted as an undirected network graph. The use of an algorithm defined the networks to plot nodes (terms) according to their association. Thus, nodes with higher association were positioned closer to each other. Edges connect nodes, and the thickness (color intensity) of theses edges reflects the strength of the association between nodes. The nodes represent variables and the edges represent the connection between variables (i.e., words). Thus, central nodes have strong connections with other nodes, while peripheral nodes indicate fewer connections. The thickness of the edges reflects the associations' strength.

The main analyses were conducted using the R software (version 3.2). Text mining was conducted using the "TM" package (version 0.5.1). Latent semantic analysis was performed using the "LSA" package (version 0.73.1). Clusters were modeled using the "skmeans" (version 0.2-11). Visualizations were built using "qgraph" (version 1.6.1), wordcloud (version 2.6) and ggplot2 (version 3.0.0) packages.

RESULTS

The Scenario of the SEP Related Research

Figure 2 shows the distribution of SEP researches in all Brazilian Exercise and Sport Science and Psychology GPs. The existence of 84 psychology programs represents more than twice the number of Exercise and Sport Science programs (n = 31 programs). Despite such discrepancy, a vast majority of the studies (n = 171; 81.4%; $p < 0.01$) were conducted in the Exercise and Sport Science GPs, in comparison to the Psychology GPs (n = 39; 18.6%).

SEP Related Researches Main Themes

The geographic distribution of Exercise and Sport Science (n = 26 universities) and Psychology programs (n = 20 universities) with SEP researches are shown in **Figure 3** and indicated predominance in the south and southeast regions. The number of programs in the North region is scarce and only one Psychology GP was identified, while no GPs were identified in the country's central area. Two Exercise and Sport Science programs were based on the central region.

The cluster analysis resulted in five clusters for Exercise and Sport Science GPs (**Figure 4**) and three clusters for Psychology GPs (**Figure 5**). Following the cluster identification, a network analysis was conducted using the word groups from each cluster to reveal the main SEP research themes. The network analysis allowed the identification of each cluster's profile and a network graphing for each cluster. The categorization for the Exercise and Sport Science resulted in the following clusters: Cluster 1 = Physical activity and health in different populations; Cluster 2 = Physical exercise, elderly and chronic disease; Cluster 3 = Sport, stress and motivation; Cluster 4 = Evaluation and assessment in sport and physical exercise; Cluster 5 = Physical exercise and physical functioning. Researches from Psychology GPs were categorized as follows: Cluster 1 = Physical activity, sport and health; Cluster 2 = Psychosocial aspects of sport; Cluster 3 = Sport and physical education in child and adolescent development.

Exercise and Sport Sciences

Resulting network from cluster 1, Physical activity and health in different populations, present institutional researches involving themes associating physical activity practice to health and quality of life improvements for a variety of populations. The terms "exercise," "practice" and "health" were positioned in the center of the network, and peripheral nodes were related to the different investigated populations, such as "elderly," "women," "workers," "military/policemen" and "individuals with disabilities."

Cluster 2 network, Physical exercise, elderly and chronic disease, presented the term "physical" as a central node, being connected to terms of considerable benefits such as "cognitive," "physiological" and "functional capacities." It was also possible to identify significant associations of exercise and two groups, one involving "quality of life" and "functional capacity in elderly" research, and the other involving "physical exercise" related to the treatment of "patients with chronic disease."

Cluster 3 network, Sport, stress and motivation, represented psychological factors in sports. In this network, the theme "sport" is the central axis, connected to two main peripheral terms "base category" and "markers of cortisol." Research involving "base category" studied "anxiety at competition" and "behavioral aspects" of young athletes. For "performance," it was found connections with psychophysiological factors ("cortisol"), and a variety of psychological variables such as "coping strategies," "burnout," "stress" and "motivation." Furthermore, the term "sport" was positioned closer to the term "coaches" than "athletes," with "football" (soccer) being only highlighted sport among these studies.

Cluster 4 network, Evaluation and assessment in sport and physical exercise, comprised researches related to the "evaluation," "validation" and "development" of psychometric instruments to be used for analysis with sport and exercise. These aspects may indicate that Physical Education GPs dedicate a part of their institutional researches to the transcultural adaptation of instruments and the development of assessment tools to be used in SEP research.

Cluster 5 network, Physical exercise and physical functioning, show different factors related to health/sickness and their associations with physical activity. Significant relationships were observed in the top node that referred "exercise" as a tool for treating diseases such as a "cognitive treatment," showing positive relationships with treating of "hypoxia," better quality of "sleep," which represent the physical exercise's positive impact over mental health aspects in the treatment of "stress" and "mood state." The third group of nodes showed a "moderate training" as a tool for "breast cancer" treatment.

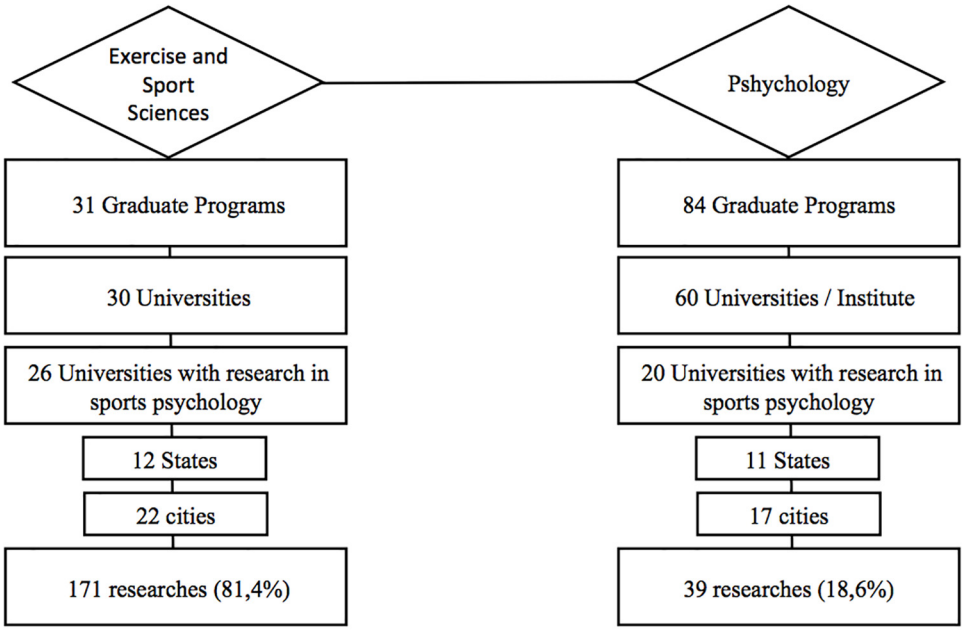

FIGURE 2 | Distribution of institutional researches in Sport and Exercise Psychology from Exercise and Sport Science and Psychology graduate programs in Brazil.

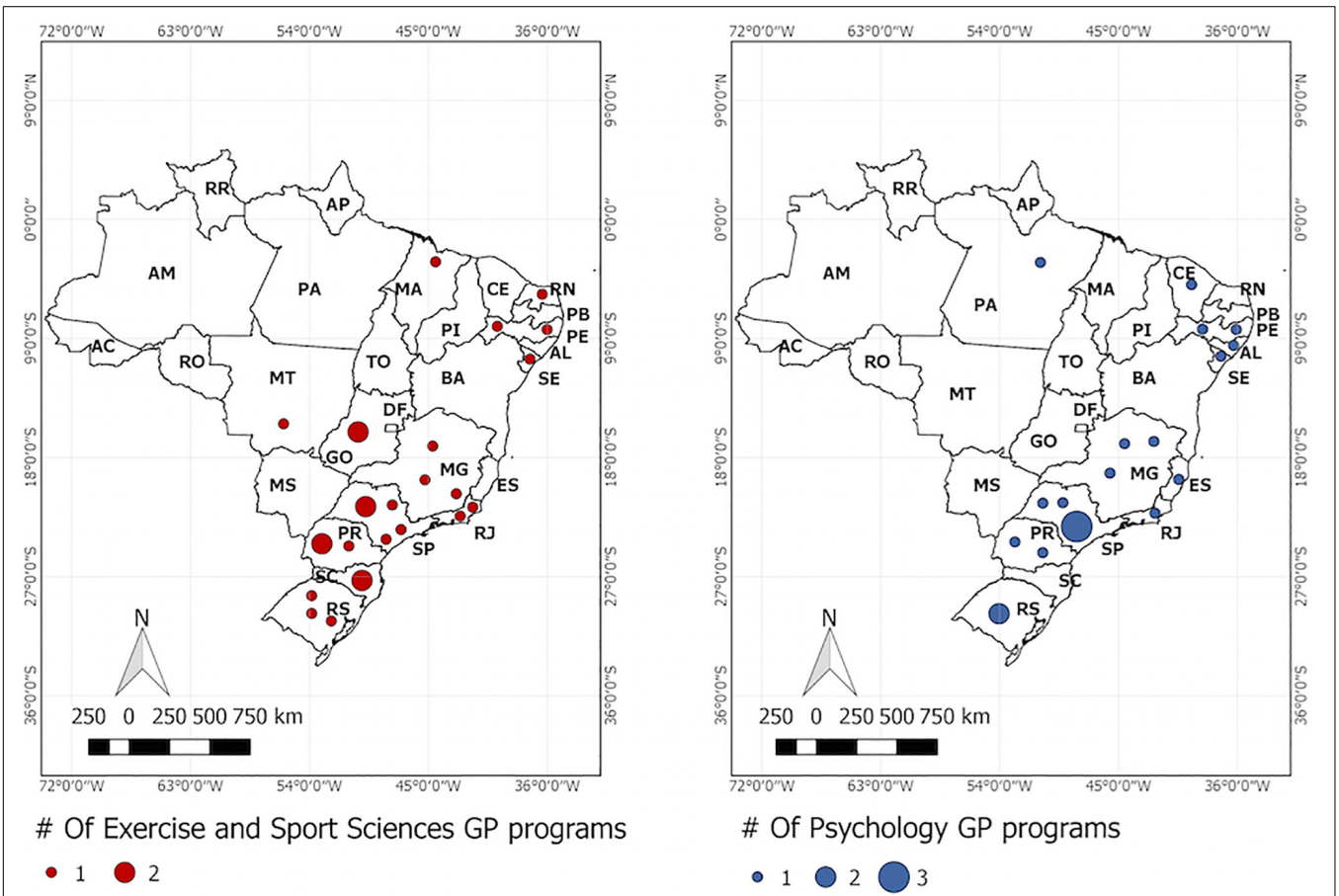

FIGURE 3 | Distribution of Exercise and Sport Science and Psychology GPs with Sport and Exercise Psychology researches in Brazilian cities.

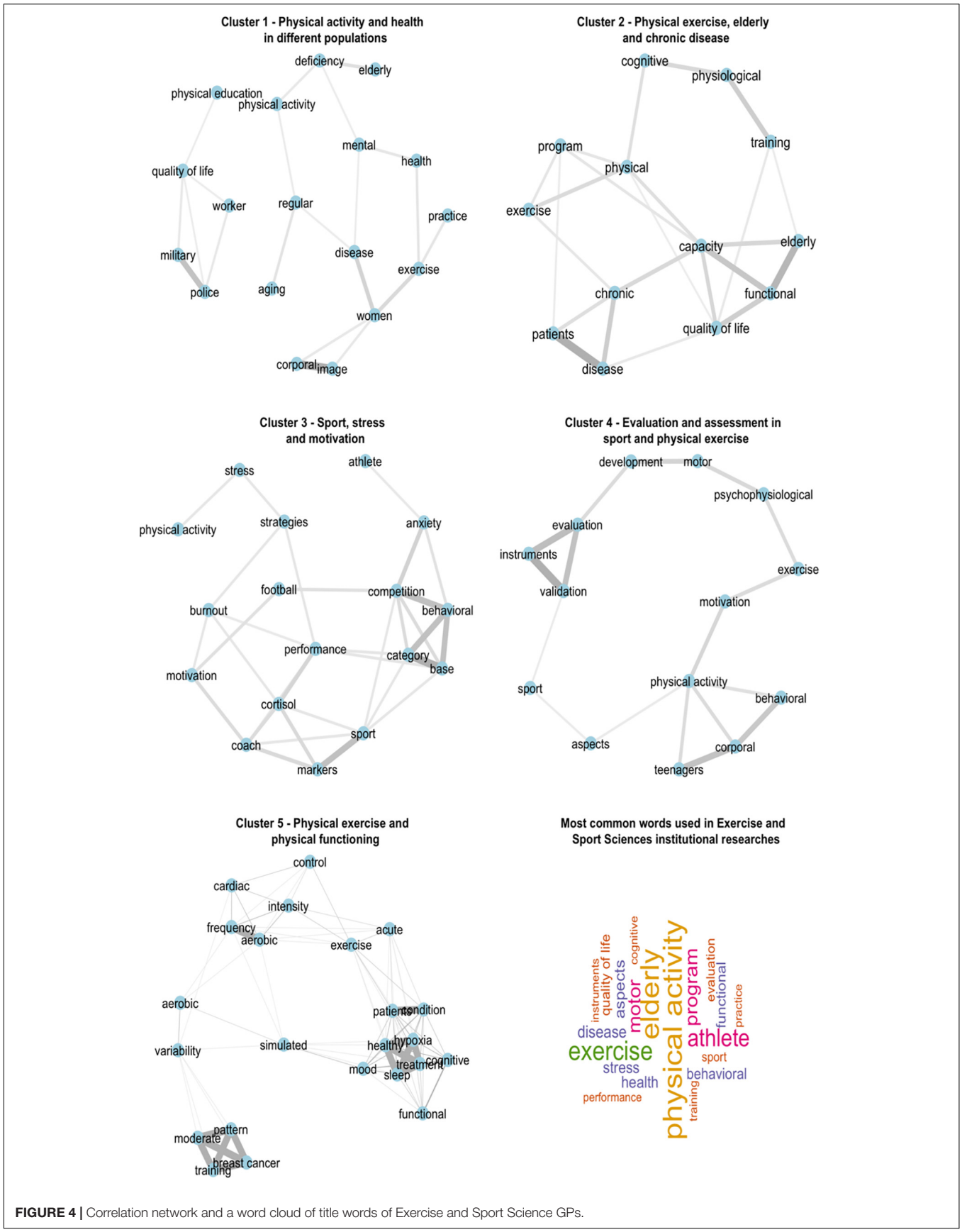

FIGURE 4 | Correlation network and a word cloud of title words of Exercise and Sport Science GPs.

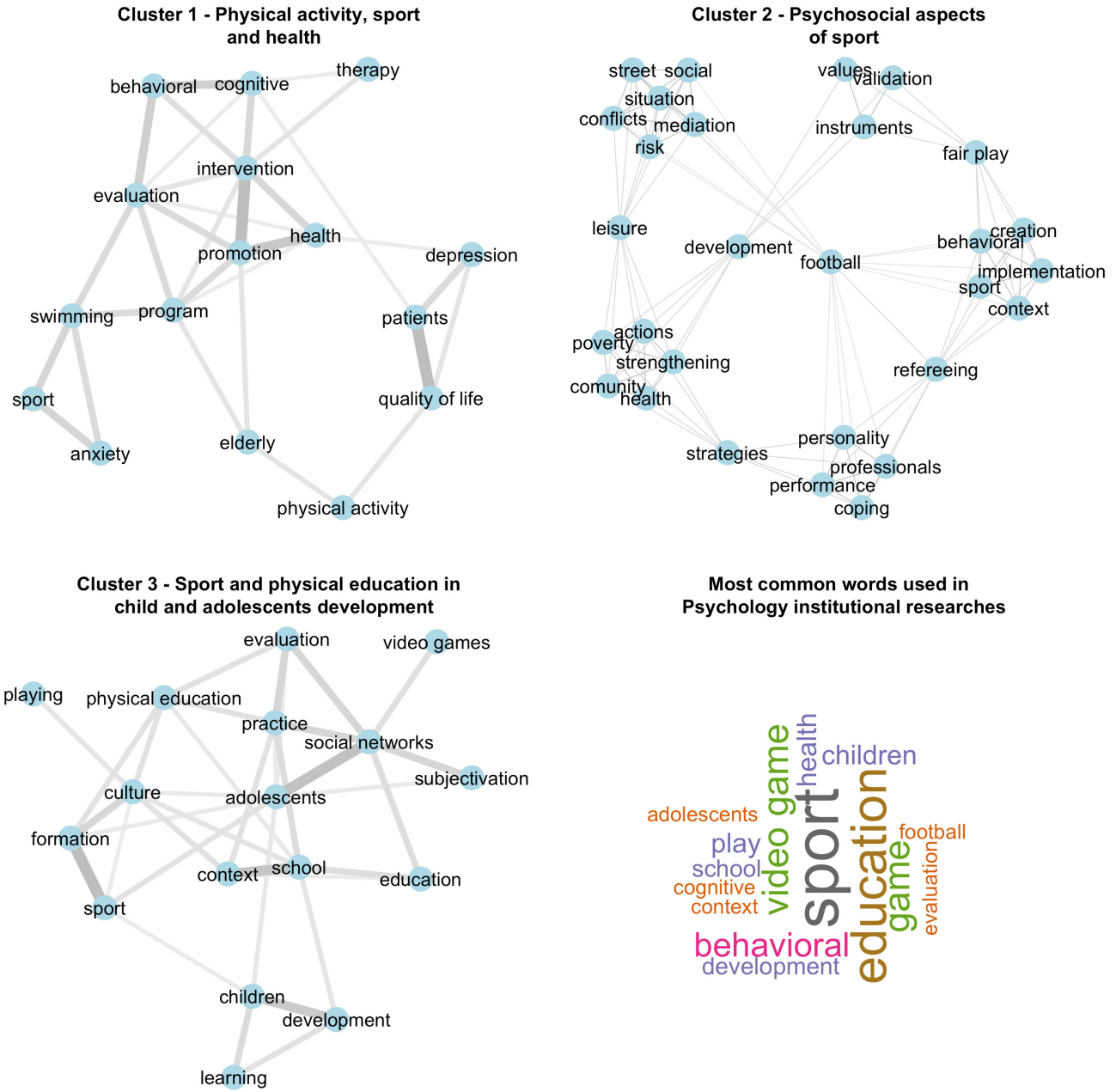

FIGURE 5 | Correlation network and a word cloud of title words of Psychology GPs.

Psychology

Cluster 1 network for programs in Psychology presents sport and exercise and its association with health. As observed, the term "health" was highlighted in the network and is related to the assessment of "behavioral" aspects of health as well as the "promotion" of health. The terms "elderly," "physical activity" and "quality of life" were connected, showing that quality of life improvement for the elderly population seems to be the focus of some of these investigations involving physical activity.

Cluster 2 network, Psychosocial aspects of the sport, it was observed that "football" has been the main focus of studies of specific sports. The association of "sport" as a "leisure" activity was seen in the close positioning of "social aspects," "conflict mediation," and "street situation" terms, these nodes were connected to "areas of risk" and social vulnerability contexts, showing the interest for these phenomena in Psychology GPs. The interest in the "development" of "validation" and "instruments" to assess psychological aspects of emotional control and performance in athletes was also observed. On the other hand, "development" has shown a connection with "strengthening," "community," "health" and "poverty" which are possibly receiving "actions" and "strategies" through "leisure"

sports. These themes indicate the importance of educating young athletes and preparing them for career transition in sport.

Cluster 3 network, Sport and physical education in child and adolescent development, presents the "educational context" that has been peripherally positioned showing the sport as a "ludic" practice used in education and "learning" to develop "children" and "adolescents" in schools. Words such as "formation," "culture" and "development" as centralized in the network reveals the interest in the interface between sports and physical education in the developmental process, primarily when related to innovative terms like "video games" or "social networks."

The distribution of the frequent title words in Exercise and Sport Science and Psychology GPs are shown in **Figure 6** and **Table 1**.

DISCUSSION

This study aimed to analyze SEP research, from Exercise and Sport Science and Psychology graduate programs in Brazil, which provided a better identification of trends and the SEP research perspectives in emerging countries and other countries using similar approaches for further comparisons. The results showed that the majority of scientific interest in SEP is developed by Exercise and Sport Science programs rather than Psychology ones. As a consequence, the most frequently studied themes are related to the relationship between physical exercise and quality of life.

The higher prevalence of Exercise and Sport Science researches in the field of SEP (**Figure 2**) may reflect a low legitimacy attributed to psychologists. Indeed, SEP is one of the youngest branches of psychological sciences, which was officially recognized in 1965 (Brandão, 2007) and regulated as a professional area only in 2000 (Vieira et al., 2013). Although it is a new area of study, no substantial changes were introduced in the curricular structure of undergraduate psychology courses and in a few cases, SEP disciplines are offered as elective. On the other hand, SEP is regularly provided in Exercise and Sport Science undergraduate programs. It is plausible that the little effort to provide a strong background in sport and physical activity may account for these differences. Therefore, it is not difficult to understand why Exercise and Sport Science graduate programs present a larger number of SEP publications than Psychology counterparts (Vieira et al., 2013).

The geographical distribution of Exercise and Sport Science and Psychology graduate programs with SEP researches indicates a large concentration in the South and Southeast regions, with a few ones located in the remaining areas (**Figure 3**). These findings are aligned with the results presented by Vilarino et al. (2017) that reported 41.4 and 31.3% of the SEP research groups are based in the Southeast and South regions, respectively. This is further reinforced as most scientific papers related to SEP are published in national journals are from these regions (Andrade et al., 2015). Therefore, theses finds contributes to identifying where the SEP is not having been studied and to indicate where new efforts and investments should must do to grow the body of researchers in SEP.

The main themes in Exercise and Sport Science programs included exercise and quality of life (**Figures 4**, **6**), followed by studies in sports. The Exercise and Sport Science programs responded by 81.4% of all studies involving SEP performed by the GPs (**Figure 2**). The main focus of these studies was related to the understanding of the association between exercise and physical activity, well-being and quality of life (Queiroz et al., 2016).

On the other hand, Psychology programs responded by 18.6% of all SEP studies (**Figure 1**). The main themes were related to sport and exercise as a tool for promoting education, social support and health (**Figures 5**, **6**). It seems that the academic studies are devoted to examining physical activity and exercise as a means to promote well-being, quality of life and the related psychological aspects (Mandolesi et al., 2018). Since the psychological benefits from exercise programs are still under dispute, a growing number of professionals are seeking to study the relationship between them.

The increasing demand for improved sports performance has directed researchers' attention to the understanding of psychological factors related to performance and success, considering that the progress in physical, technical and tactical aspects of training have fallen short of ensuring consistent successful outcomes (Stefanello, 2009). Hence, most research themes were related to football (Cluster 3, **Figure 4** and Cluster 2, **Figure 5**) (Andrade et al., 2015). It also showed a growing interest in SEP studies in some specific sports modalities such as football, indoor football, volleyball and tennis.

Nevertheless, volleyball has been identified as the most investigated sport in sports science scientific journals published in Portuguese, while football was the second most studied sport (Dominski et al., 2018). It is interesting in a country known for its football performance. On the other hand, the performance of the Brazilian volleyball teams may have driven such interest. The motivation was the most common word, as also evidenced by Vieira et al. (2013) while analyzing the SEP themes presented in Brazilian Congresses between the years 2010 and 2012. However, research involving motivation seems to be calling less attention to current sport and exercise research (**Table 1** and **Figure 4**). On the other hand, stress, anxiety, coping strategies, burnout and overtraining have gained focus as a significant number of researchers that are trying to understand how athletes face pressure and adversities in the context of sport's performance. It seems that performance-related aspects of emotional control are a promising topic (Stefanello, 2009). The use of psychophysiological markers (e.g., cortisol) may reveal the researchers' efforts toward more objective measurements and also indicate the need to integrating different areas of knowledge to promote deeper advances in science. The role of coaches for athletes' psychological aspects received far less attention.

Research involving transcultural adaptation and validation of psychometric instruments showed a growing trend (**Figure 4**, Cluster 4), as they are of scientific relevance. Indeed, these instruments were first published in English, which is a limiting factor for researchers from other non-native English speakers. The reduced number of tools specifically designed for studying

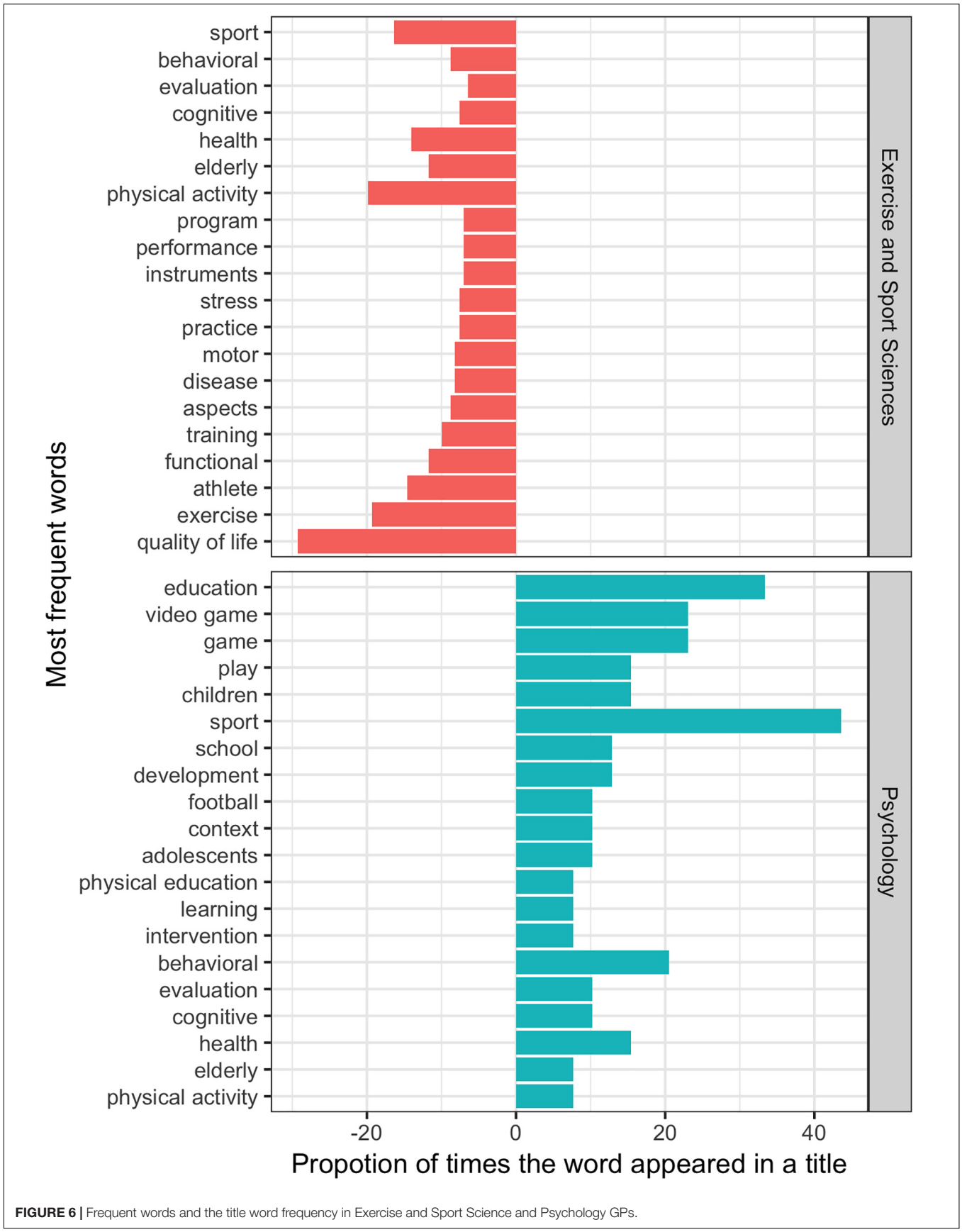

FIGURE 6 | Frequent words and the title word frequency in Exercise and Sport Science and Psychology GPs.

TABLE 1 | Keyword frequency for the Exercise and Sport Science and Psychology GPs clusters.

Exercise and sport science	Psychology
Cluster 1 – Physical activity and health in different populations (*n* = 105)	**Cluster 1 – Physical activity, sport and health (*n* = 51)**
(26) Quality of Life	(6) Sport
(24) Physical Activity	(5) Behavioral
(19) Health	(4) Cognitive – Health
(8) Elderly	(3) Elderly – Intervention – Quality of life
(5) Aging – Exercise – Military – Practice	(2) Anxiety – Depression – Evaluation –Patient – Physical activity – Program – Promotion – Swimming – Therapy
(4) Deficiency – Disease	(1) Adjuvant – Adults – Apprentices – Physical Aptitude
Cluster 2 – Physical exercise, elderly and chronic disease (*n* = 135)	**Cluster 2 – Psychosocial aspects of Sport (*n* = 28)**
(20) Quality of Life	(6) Sport
(15) Exercise	(3) Football
(11) Functional	(2) Behavioral – Development – Fair play – Leisure – Refereeing – Strategies
(9) Disease – Elderly – Training	(1) Actions – Application – Community – Conflicts – Context – Coping – Performance
(7) Patients – Program	**Cluster 3 – Sport and physical education in child and adolescents development (*n* = 65)**
(6) Capacity – Cognitive – Physical	(13) Education
(5) Chronic – Physiological	(9) Videogame
(4) Aspects – Behavioral – Mental – Stress – Women	(6) Playing
Cluster 3 – Sport, stress and motivation (*n* = 35)	(5) Children – Sport
(13) Athletes	(4) Adolescents – School
(9) Performance	(3) Context – Learning – Physical Education
(8) Football	(2) Culture – Cyber bulling – Development – Evaluation – Formation
(5) Anxiety	
Cluster 4 – Evaluation and assessment in sport and physical exercise (*n* = 168)	
(24) Sport	
(11) Aspects	
(10) Instruments – Motor	
(8) Behavioral – Evaluation – Exercise	
(7) Corporal – Physical Activity – Teenagers	
(6) Development – Motivation – Psychophysiological – Validation	
(5) Context – Image – Performance – Practice	
(4) Children – Coach – Perception – Social – Stress – Training	
Cluster 5 – Physical exercise and physical functioning (*n* = 24)	
(6) Functional	
(5) Cardiac – Exercise	
(4) Cognitive – Humor	

sport and physical activity may cause bias and increase eventual errors (Brandão, 2007). Thus, validating psychometric instruments (e.g., Albuquerque et al., 2017; Moreira et al., 2018; Contreira et al., 2019) is a critical issue for scientific progress in the field of SEP, especially in Brazil (Németh et al., 2016; Queiroz et al., 2016; Dominski et al., 2018).

The most studied SEP theme in Psychology was physical activity, sport and health (**Figure 5**). There are arguments that SEP research has been devoted to the understanding of individuals' behavior related to exercise practice and its outcomes for health, well-being and quality of life (Gouveia, 2001; Rubio, 2018) rather than sport's performance. Since the '90s, these aspects have gathered attention from psychology researchers, in an attempt to shed light on mental health, positive emotions, well-being and sense of pleasure through the practice of physical activities and exercises (Gouveia, 2001; Rubio, 2018). Hence, the present results indicate that Psychology GPs are following the trends for training methods in physical activity and its health and psychological consequences according to their particular characteristics (e.g., elderly, workers, patients, etc.).

When physical activity is considered as a tool for education (Cluster 2 and 3, **Figure 5**), sports practice has received attention for the development and teaching-learning process of children and adolescents in school environments. In these cases, psychology studies have focused on sports teaching as a ludic/playful activity, especially in team sports. Psychology programs were also concerned with constructing and validating psychometric scales to assess a variety of aspects that influence athletes' emotions and performance (**Figure 5**, Cluster 2). A study by Féres-Carneiro et al. (2010), found that research on methods and assessment tools were most evident in the areas of organizational and work psychology, with apparent gaps for legal and environmental psychology. In sports, the first studies adopted instruments from studies involving clinical psychology scenarios. The advances in the research provided by the GPs have helped a better methodological approach while studying sports performance (Rubio, 2018).

The contribution of the psychologists' in the context of the sport is related to social development (Cluster 2, **Figures 5**, **6**). Sports practice can be seen as a way to promote socialization and social engagement (Rubio, 1999). Furthermore, the use of sports in social contexts may encourage psychologists to work toward identifying formation and social transformation (Vissoci et al., 2018).

Despite the findings found in the present study, some limitations deserve attention. The first aspect of being considered is that it was impossible to include all researches involving SEP that were not registered in governmental databases (i.e., Sucupira Platform). The fact that some thesis and dissertations may have developed some aspects further than those identified in the present study (as secondary publications) cannot be ruled out. Finally, the present study is limited to the data available up to 2016, and more recent studies were not included. Large databases including updated periods are difficult to obtain. Future research is required to identify if these trends are still present in more recent years.

CONCLUSION

Analyzing the themes used in the field of SEP in Exercise and Sport Science and Psychology graduate programs revealed that the majority of SEP researches are performed in Exercise and Sport Science programs. These studies have focused on the effects of physical exercise on life quality. Psychology graduate programs have shown significant contributions to SEP by approaching the sport as a tool for promoting health, education and social support.

Practical Implications

The present findings may contribute to the understanding and the discussion of the themes being investigated in the field of SEP, showing the lack of researches guiding in this field. As practical implications, it is highlighted the need for contemporary themes should be studied in sports, in which sports practice appears to be a promising area that received much less attention than physical activity and exercise.

DATA AVAILABILITY STATEMENT

This data can be found here: https://doi.org/10.6084/m9.figshare.9883595.v1.

AUTHOR CONTRIBUTIONS

LF, AR, and JS conceived the original idea of the study. NC, CM, and JV selected the researches and contributed to data processing and analysis. JV analyzed and presented the data. LF, JS, NC, CM, AR, LSF, and AL wrote and organized the manuscript. All authors reviewed the document and approved the final version for submission.

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frontiers in Psychology

SYSTEMATIC REVIEW
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Can We Motivate Students to Practice Physical Activities and Sports Through Models-Based Practice? A Systematic Review and Meta-Analysis of Psychosocial Factors Related to Physical Education

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Adults (more than 18 years old) are likely to reproduce the habits that they acquired during childhood and adolescence (from 6 to 16 years old). For that reason, teachers and parents have the responsibility to promote an active and healthy lifestyle in children and adolescents. Even though every school subject should promote healthy activities, Physical Education (PE) is the most important subject to foster well-being habits associated to healthy lifestyle during sport practice and other kinds of active tasks. Indeed, there are many factors that influence the acquisition of healthy habits that should be taken into account when programs and activities are implemented in both educational and extracurricular context. In this sense, psychological and social factors are of utmost importance to achieve optimal experiences for an active and healthy lifestyle. However, due to the myriad of studies analyzing different factors in different contexts, there could be confusion when programs and pedagogical strategies are applied in educational or extracurricular contexts. The objective of this investigation is to analyse the state of art of the psychosocial factors which influence the engagement in physical activities and sport practice. The keywords used in this review were mainly: "Self-Determination Theory," "(intrinsic) motivation," "Psychological need satisfaction," "physical activity and sport engagement," "Elementary Education," "Secondary Education," "Physical Education." In addition, the Boolean data type "and," "or," and "not" were also used. The articles were selected according to the following criteria: (a) peer-reviewed original research published in international journals indexed in JCR or SJR, (b) published in English or Spanish, (c) about psychosocial factors which influence the physical activity and sport engagement, (d) in educational or extracurricular context. Research articles selected were found through Web of Science, Scopus, Google Scholar, SportDiscus (EBSCO-host), ERIC,

PubMed, Medline, and PsycInfo databases. It was observed that physical activities and sport practice engagement are closely related to psychological factors. In particularly, intrinsic motivation was able to determine the active participation in any activity, including physical activity and sport practice during the implementation of Small-Sided Games and other kinds of pedagogical strategies (e.g., Pedagogical Models). Motivation was also closely related to flow state. Finally, these variables should be considered in order to organize effective programs to promote an active and healthy lifestyle in Physical Education classes.

Keywords: self-determination theory, self-determined motivation, flow state, basic psychological needs (BPNs), physical education engagement, child psychological development, autonomy-supportive climate, models-based practice

INTRODUCTION

Physical inactivity is a serious worldwide problem observed in childhood and adolescence (6–18 years old), as World Health Organization (2016) highlighted in its most recent report. In this sense, it is widely investigated that inactivity is associated with serious physical diseases (e.g., overweight and obesity) and mental disorders (e.g., depression) (Knight, 2012). Although, this population shows a desire to be more active, the external (environmental) factors (e.g., the "screen culture") significantly influence the final decision to dedicate less time to healthy physical activities (Ennis, 2017).

For that reason, general public policies and specific educational policies from the Administration authorities play a determinant role in the promotion of active and healthy habits alongside the efforts of families and experts (Pate and Dowda, 2019). Regarding to educational context, Physical Education (PE) is the most important subject to achieve this mission due to its unique active and practical frameworks in contrast to the rest of the areas (Kohl and Cook, 2013). The contents of this subject are organized in several disciplines (e.g., adventure education, health-related physical activity components, sport literacy, or teaching dance) depending on the educational curriculum of each country (Kirk et al., 2006). Thus, Simone-Rychen and Hersh-Salganik (2003) proposed the development of all the subjects' contents through the *holistic model of competence* within the Definition and Selection of Competencies framework. Recently, Escalié et al. (2017) emphasized that each piece of content aims to develop a holistic students' development taking into account the *pedagogy of integration* alongside the rest of subjects.

Specifically in the educational context, one of the most established and debated content in PE curriculums around the world is the sport-based and lifestyle programs (Green et al., 2005). Hence, the sport alphabetization or sport literacy in PE is the unique content in the school curriculum aimed to develop the *sport competence*, which is the capacity to deal with a wide range of tactical/technical problems during the sport practice (Kolovelonis and Goudas, 2018). A myriad of research has investigated the best way to meaningfully acquire and develop the sport competence through sport programs using the Pedagogical Models (Haerens et al., 2011), also known as Models-Based Practice (MsBP; Casey, 2014) or Instructional Models (Metzler, 2017).

The MsBP include different pedagogical features to help practitioners to implement sport contents in a contextualized and confident way (Casey and MacPhail, 2018). For this purpose, the MsBP have been classified in several categories according to their final objectives. Hence, the Game-Centered Approach (GCA; Harvey and Jarrett, 2014) is mainly focused on the tactical/technical intelligence of the game, and it includes the Teaching Games for Understanding (TGfU; Bunker and Thorpe, 1982) and its variations around the world; the Sport Education Model (SEM; Siedentop et al., 2019) is dedicated to create an authentic sport experience; the Teaching for Personal and Social Responsibility (TPSR; Hellison, 2011) is focused on facilitating life skills through the sport practice; and finally, the Cooperative Learning (CL; Johnson and Johnson, 1994) aims to develop cooperative performance during the sport practice. In spite of the fact that these are the most implemented models around the world, this is not a complete catalog of them (Casey, 2014). For example, Constraints-Led Approach (CLA; Davids et al., 2005) is also a model of the non-linear pedagogy that aims to develop skill acquisition and motor learning of the whole spectrum of exercise and sport categories (Renshaw et al., 2015).

However, Lund and Tannehill (2010) emphasized that isolated MsBP present several limitations when they are implemented due to the fact that each model is mainly focused on a specific content area (e.g., the tactical/technical elements of the game in the case of GCA). In order to minimize this impact, a recent systematic review proposed the hybridization or combination of two or more models (González-Víllora et al., 2018).

In this context, PE is the ideal subject to promote active and healthy habits, to acquire sport competence as well as to foster active resources for the students' leisure time (Girard et al., 2019). However, according to Perlman (2012a), it is vital to implement well-designed and comprehensive PE programs which (I) take into consideration the elements of the context (e.g., educational content, students or special needs), and which (II) provide students with half of the time of each lessons in moderate-to-vigorous physical activity levels. That is to say, PE does not have intrinsic benefits if it is not adapted to the circumstances of the context where it is going to be implemented. For that reason, it is important to analyse those aspects related to the

psychological variables that are definitively able to determine a sense of enthusiasm for learning and improving new skills, and consequently, a sense of engagement for dedicating more time to do physical and sporting activities (Carrasco-Beltrán et al., 2018).

Motivation is a psychosocial process characterized by behaviors that an individual deems vital for his/her personal development (Ryan and Deci, 2000b). These behaviors might change thought time due to the fact that both internal and external factors might affect the personal interests or desires for carrying out a determinant task (Vansteenkiste et al., 2019). The research about motivation in educational contexts is rooted in the Self-Determination Theory (SDT, Deci et al., 1991). Basically, this approach analyses the reasons that students own to engage in certain kinds of activities (Gillison et al., 2019). Otherwise, several approaches have been also proposed to analyse other psychosocial determinants which similarly influence on the motivation of the students, complementing the SDT.

The Self-Determination Theory (SDT) and the Basic Psychological Needs (BPNs)

The SDT is a complex empirically-based and organismic theoretical framework of the human motivation (Deci et al., 1994; Ryan and Deci, 2017). In this sense, this theory analyses how psychosocial factors influence the human behavior. Specifically in the educational context, the SDT analyses environments and pedagogical factors which influence the students' inherent interest in learning and discovering the world (Deci et al., 1991). Additionally, Ryan and Deci (2017) highlighted that SDT is composed by six mini-theories: the *cognitive evaluation theory*, *the organismic integration theory*, *the goal content theory*, *the relationship motivation theory, the causality orientation theory,* and the *Basic Psychological Needs (BPNs) theory*.

Behaviors and motivation can change over the time, affecting on the individual's performance. For that reason, there is a necessity of categorizing the kinds of motivations that have an impact on the human behavior. Hence, Ryan and Deci (2000a) proposed a continuum of three different motivation constructs depending on the degree of self-determinance: intrinsic motivation, extrinsic motivation and amotivation. In this way, (I) the most self-determined motivation is the *intrinsic motivation*. It is present when people do an activity for inherent and personal reasons as a result of the delight and satisfaction that the practice itself implies. For instance, a student is intrinsically motivated when they enjoy practicing a specific sport because he feel pleasure, and behave in a uninhibited way when they are playing it.

(II) *External motivation* is showed when there are external or environmental factors that condition the people behavior. This construct is divided into four types or levels of regulation. (A) The first level, which is the closest to intrinsic motivation is called *integrated regulation*. It is present when people are aware by the significance of implementing certain behaviors according to the person values. For instance, when a student chose to practice a specific sport because he identified the benefits of practicing it (e.g., learning new technical skills, making friends or being more active) and, in addition, it is congruent with his/her personal values. However, in educational context, it is usual that integrated regulation was not measured (Perlman, 2011; Aelterman et al., 2012; Fernández-Río et al., 2017) due to the fact that this regulation requires a high degree of introspection and relationship with adult self-awareness (Brickell and Chatzisarantis, 2007). (B) The second level is called *identified regulation*. It is present when people's motivation comes from the beliefs that implementing certain behavior is beneficial or important. For example, when it is observed a proactive behavior, defined by the student, to practice certain sport during the schools breaks. (C) The third level is called *introjected regulation*. It is when the pleople's behavior is oriented to avoid a sense of guilty. That is to say, the activity is not accepted as a behavior. For instance, when a non-skilled students are involved in a specific skill-drill game in PE due not to disappoint their peers or teachers/coaches. Finally, (D) *external regulation* is when people practice any kind of activity in order to receive a reward or also to avoid a punishment. It is the least self-determined kind of motivation. For example, when a student always participates in a specific sport in PE, decided by the teacher or the majority of students, trying to avoid a low mark in the final results of the subject (avoidance of punishment).

Finally, (II) *amotivation* is when there is an absence of any kind of motivation in practicing any kind of activities. It is present when people act passively through an activity. For instance, when students are obligated to run around the futsal field during the first 15 min of the PE class as a warm up. In this sense, as Gillison et al. (2013) highlighted, amotivation can cause disruptive behaviors and general disagreement for the activity itself that might produce a reject for practicing similar activities in other contexts (e.g., extracurricular environments).

The Self-Determination Index (SDI; also known as Relative Autonomy Index, RAI; Vallerand, 2007) is a quantitative method that enables researchers and/or other kind of practitioners to determine the total score of the SDT continuum executing the following formula:

$$SDI \approx RAI = (2Intr.\,mot.) + Iden.\,reg. - \left(\frac{Intro.\,reg. + Ext.\,reg.}{2}\right) - (2Amo.)$$

Where *Intr. mot.* is intrinsic motivation, *Iden. reg.* is identified regulation, *Intro. reg.* is introjected regulation; *Ext. reg.* is external regulation; and *Amo.* is amotivation. The mathematical symbol ≈ means approximately equal. Recently, Ünlü (2018) proposed an adjusted of weights in the formula due to the original formula does not take into consideration whether the identified and introjected regulation types are internal and external. For that reason, he proposed to use:

$$SDIadj \approx RAIadj = mean\ internal\ motivation - mean\ external\ motivation$$

Where the means are calculated using the π weights of the identified and introjected regulations. However, educational studies tend to adapt the original formula to the characteristic of the context (e.g., Perlman, 2011 or Prusak et al., 2004).

On the other hand, it is observed that there are three basic psychological and social nutrients that are able to determine

the level of the individual's well-being and its self-determined motivation in the mentioned continuum. Hence, the BPNs comprise three innate and universally psychological needs components that have to be satisfied (and supported) in order to increase the most self-determined motivation: *autonomy* (i.e., sense of control that student interiorized on his/her behavior), *competence* (i.e., sense of mastery or ability that students perceived during a task), and *relatedness* (i.e., regarding the feeling of acceptance, belonging, and unity that the students experience with his/her peers in the same context) (Ryan and Deci, 2000b). According to Vicente et al. (2019), the BPNs are very sensitive to external factors such as the vicarious learning, which can boost or undermine the engagement and motivation to learn new things or skills. Since, the kind of motivation of the SDT are closely related to the BPNs and the external environmental factors, Vallerand (2007) proposed the Hierarchical Model of Motivation in order to relate the BPNs with the SDT continuum. Recently, Prentice et al. (2019) have proposed that the traits of the Whole Trait Theory (i.e., the link between motivational and social-cognitive elements that generate momentary enactments over the time) are an effective way to satisfy the BPNs. For that reason, these authors proposed that this theory are closely related to the SDT.

The Way to Increase Enjoyment and Adherence to Physical-Sport Activity in PE Programs

A myriad of research in PE and sport context emphasizes that students (or athletes) who perceive higher levels of autonomy, competence and relatedness exteriorize more self-determined forms of regulation and intrinsic motivation (García-Calvo et al., 2010; Vallerand and Lalande, 2011). In this sense, when a student are more engaged in PE, he/she demonstrates more enjoyment, and consequently, exteriorizes a desire to continue playing the sport in his/her leisure time (Browne et al., 2004). This fact has been widely investigated in PE observational studies (Sparks et al., 2017; Navarro-Patón et al., 2018), but also in extracurricular context such as in youth soccer (García-Mas et al., 2010) or among elite sports athletes (Keegan et al., 2014; Thomas and Güllich, 2019).

Hence, self-determined motivation can be promoted among the students designing motivational climates that support the BPNs at PE settings. In this sense, these kind of environments will consequently increase the adherence to practice sport and lifestyle activities beyond the educational context.

However, to our knowledge there is a lack of synthesis that summarize the findings of empirical interventions that aims to demonstrate that innovative MsBP and other pedagogical strategies have the potential to increase the self-determined forms of motivation among students whereas the sport competence are holistically acquired, in contrast to traditional Direct Instruction (DI) approaches, in which technical skill practice are implemented in decontextualized skill-drills forms. In fact, there is just one meta-analysis (Braithwaite et al., 2011) that analyzed the PE motivational climate using the TARGET pedagogical strategy (Epstein, 1989) around the world.

Research Question, Objectives, and Hypothesis

For all the aforementioned considerations, it is necessary to analyse the state of the art about the positive effects that pedagogical strategies and innovative MsBP applications to the sport literacy PE programs have on the students' psychosocial variables (e.g., self-determined motivation, autonomy, or sense of belonging), which directly influence on the adherence or engagement to active lifestyles.

In this sense, the following research question was formulated: "Are the innovative MsBP and the climate-supported strategies important pedagogical resources that positively impact on the self-determined motivation and the satisfaction of the BPNs to acquire lifelong active, healthy and sporty habits, in contrast to the application of traditional DI approaches in sport literacy at PE context?" Hence, the main objective of the present study was to synthetize the scientific literature findings about the impact of the most important MsBP (i.e., CL, DI, GCA, SEM, and TPSR) as well as supportive-climate strategies (e.g., TARGET) during PE sport literacy content on the students' motivation climate. The second objective of this research was to quantitatively analyse the original studies that determined the impact of the SDI between the MsBP and the traditional DI approach during PE-sport lesson plans.

The first hypothesis states that the implementation of innovative and pedagogical resources such as the MsBP or the TARGET structure are able to (I) increase the students' self-determined motivation and to (II) positive satisfy the BPNs, which directly influence on the adherence of active and sporty lifestyles. The second hypothesis states that the application of MsBP, in contrast to traditional approaches, increases the total students' rates of SDI.

METHODOLOGY

Systematic Review Protocol

In order to carry out the present systematic review and meta-analysis, the protocol was submitted to PROSPERO database (https://www.crd.york.ac.uk/prospero/) including every relevant information that will be implemented in the systematic review process. In this way, CRD42019125470 is the identification number of the protocol for the present systematic review and meta-analysis.

It was confirmed in PROSPERO that only one first search was carried out previously in the PROSPERO database (in order to corroborate there were not any other registered protocol that investigated the same topic using the same inclusion criteria). After the design of the protocol and its submission on the database were completed, the systematic review process started.

Search Strategy and Keywords

First of all, an exhaustive and systematic search about original and empirical studies which analyzed the psychosocial factors using MsBP or pedagogical strategies applied in sport or life-style activities programs at PE context was conducted using nine literature database (i.e., Web of Science, SCOPUS, Medline, Google Scholar, SportDiscus, EBSCOhost, ERIC, PsycINFO, and PubMed).

The aforementioned databases were used due to the fact that they comprise PE investigations indexed in Journal Citation Report (JCR) and Scimago Journal Rank (SJR) journals. In addition, the combination of these databases enables to obtain a faithful state of the art of the phenomenon under study using empirical evidence with high-quality standards.

Figure 1 showed the combination of the keywords and the English Boolean data types (i.e., and, or, not) used in the search equation. In this sense, keywords included important concepts and/or synonyms used in the scientific literature about the psychosocial variables and motivational outcomes (e.g., self-determined motivation, enjoyment, or adherence), the autonomy support climate (e.g., mastery supportive climate or choice), the PE environment (e.g., sport PE programs), the educational context (e.g., Secondary Education), and the pedagogical strategies (e.g., Models-Based Practice, Cooperative Learning, or Sport Education Model) implemented in each primary study.

Systematic Review and Meta-Analysis Selection Criteria

The articles selected in the present systematic review met the following selection criteria: (I) original research published in peer-reviewed online international journals indexed in JCR or SJR; (II) intervention studies that implemented one or two MsBP (i.e., CL, CLA, GCA, SEM, and TPRS), hybrid MsBP or autonomy-supportive strategies (e.g., TARGET) in PE sport units; (III) research that implemented one or more sports content (e.g., soccer, basketball, or track and field) or life-style activities (e.g., walking) intervention studies about the impact of the SDT or the BPNs satisfaction outcomes; (IV) research conducted in a PE or Physical Education Teacher Education (PETE) context; (V) original studies that included quantitative and/or qualitative designs and outcomes; and (VI) research published in English or Spanish, which are the main languages used in MsBP interventions.

In fact, the exclusion criteria included: (I) observational studies, (II) not indexed in JCR or SJR journal, (III) intervention studies published in books, thesis or conference proceedings; and (IV) opinion or pedagogical articles. When articles do not reported important methodological procedures (e.g., sport program implemented, country, or allocation of groups) the protocol of this work established to contact to the correspondence author. If the author do not respond, the article were excluded at the third level of analysis.

On the other hand, the quantitative articles selected for the meta-analysis met the following selection criteria: (I) (quantitative) studies which compare one or more MsBP with the traditional DI or skill-based approach or the comparison of two or more autonomous motivation climate with the traditional DI or skill-based approach; (II) research which included the SDT components or SDI outcomes.

Search Process, Data Extraction, and Use of Software

The search process was divided into four phrases or levels. The first one is concerned to the initial search on the databases using the aforementioned search equation, adapting it for each database. The second phrase is regarding the classification of the articles by their outcomes (e.g., findings about the satisfaction of the psychological needs or about the task- and ego-orientation), excluding those which do not fit the selection criteria. For this mission, the title, abstract, and keywords were analyzed. In this phrase, duplicated articles from different database were eliminated. The third phrase consisted of a deeper analysis of the methodology and discussion of every potential article. Finally, in the fourth level, those quantitative articles that reported the SDI from the comparison of two groups implementing MsBP or autonomous support climate and traditional DI approach, where included in an extra database for the meta-analysis.

Hence, as it is showed in **Figure 2**, the initial search comprises 13,756,419. After the second phase 781 were considered for an exhaustive analysis. Finally, 33 articles were firstly considered in the systematic review. In addition, from this number, 14 articles had fitted the meta-analysis inclusion criteria and were retrieved for being meta-analyzed.

For the purpose of this systematic review and meta-analysis, reference manager software Mendeley™ and meta-analysis software Comprehensive Meta-Analysis™ were used. In addition, quality analysis of the final included studies were evaluated using three risks of bias *ad hoc* instruments: the *Checklist for Measuring Study Quality* (Downs and Black, 1998) to assess both randomized and non-randomized studies, the *AXIS Appraisal Tool* (Downes et al., 2016) to assess the quality of cross-sectional studies, and finally, the *Cochrane Ris of Bias 2.0.* (Higgins et al., 2016) adapting several items by the *Strengthening the Reporting of Observation Studies statements* (von-Elm et al., 2008). Additionally, in order to obtain an overall quality score for each study, an exhaustive analysis were carried out based on the systematic review procedure showed in González-Víllora et al. (2018). Finally, the quality of the systematic review and meta-analysis was evaluated using the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA; Moher et al., 2009).

Meta-Analysis Procedure

The meta-analysis was executed with 14 quantitative studies from the total pool of articles included in the systematic review ($n = 33$; see **Figure 1**). In this case, the objective of the meta-analysis was to quantitatively synthesize the findings about the SDI among the studies which carried out an original analysis between the traditional DI approach and the most widely used MsBP at an educational context (i.e., CL, CLA, GCA, SEM, and TPRS). For this mission, the analyses were executed using the Comprehensive Meta-Analysis software™ (CMA™; Lipsey and Wilson, 2001).

In this context, due to the fact that fixed-effect models only calculate the error of the variation in the final analysis influenced by the sample size (Cooper, 2017), random-effects models are proposed because the effect size variation between studies assumes both true-random variance and sampling error from each study (Koutsimani et al., 2019). However, in the present study, both effect models were reported, including the weighted d-index. Additionally, the Cohen's effect size was calculated for

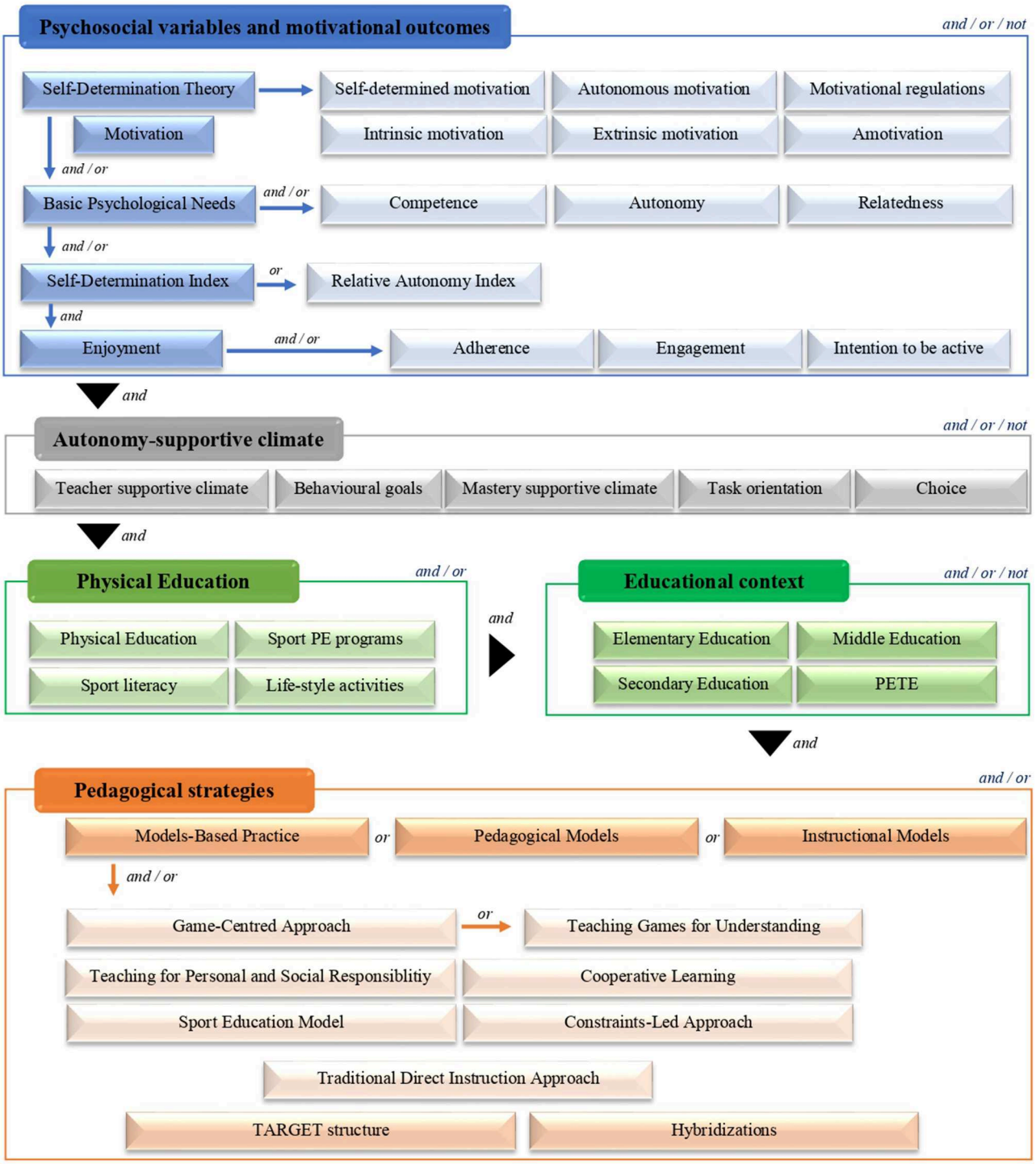


FIGURE 1 | Search equation used during the search.

every result based on the criteria of Hopkins et al. (2009), where the effect sizes were considered as trivial (<0.2), small (0.2–0.59), moderate (0.6–1.19), large (1.20–2.00), very large (2.00–3.99), and extremely large (>4.00).

Finally, the analysis was grouped by different subgroups based on the MsBP (i.e., CL, DI, GCA, Hybrid models and SEM) and the specific pedagogical strategies (i.e., TARGET structure and autonomy-supportive climate into traditional DI lessons). In this

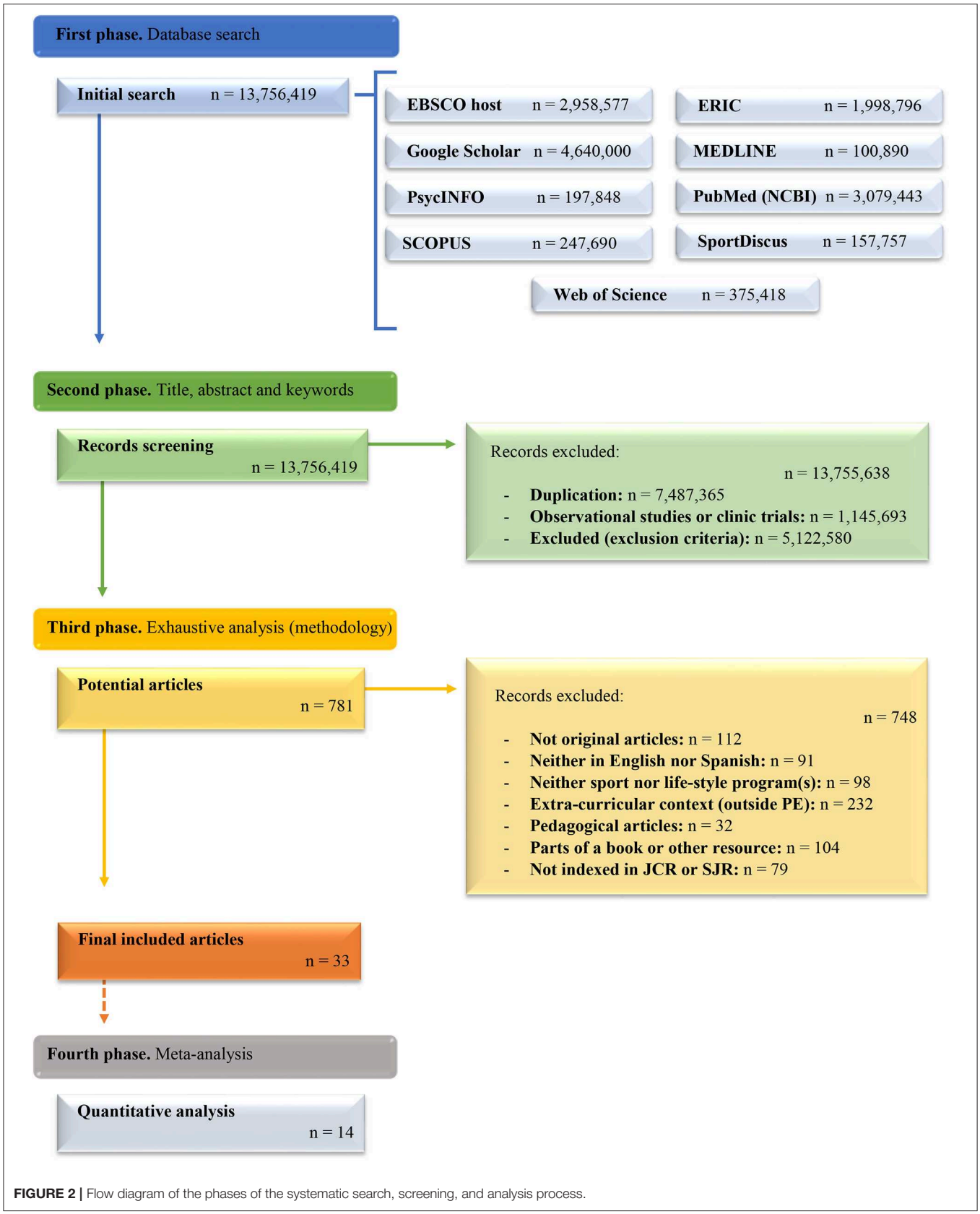


FIGURE 2 | Flow diagram of the phases of the systematic search, screening, and analysis process.

sense, the Study-Level Measure of Effect (I^2) was calculated. This statistic informs about the proportion of the total variance in the effect sizes due to the variance among the studies. According to Cooper (2017), the I^2 statistics above 75% implicate significant heterogeneity. The statistical significance was set up at $p < 0.050$ (95% confidence interval).

RESULTS

The results were divided into two sections. In the first-one (section *Systematic review findings*), the synthesis of the 33 original articles is presented. In the second-one (section *Meta-analysis findings*), the meta-analysis results of the 14 quantitative research are shown.

Systematic Review Findings

Table 1 shows the main important findings of each selected article that meets the selection criteria established in the previous section. In order to facilitate the interpretation of the results, the most important and/or relevant information of each article was classified into "Author(s) and year," "Program and content applied," "Aim of the investigation," "Intervention contextualization," "Methodology," which was divided into "Instruments" and "Variables (measured by the instruments)," and finally the "Main outcomes."

The asterisk (*) in certain references at the "Author(s) and year" column throughout **Table 1** indicates that the study has also been quantitatively analyzed during the meta-analysis process, exposed in the following section *Meta-analysis findings*.

Meta-Analysis Findings

Regarding the results of the meta-analysis, it is observed a significant overall results in fixed-effect model (d weighted effect size = 0.865; standard error = 0.062; 95% CI = 0.745, 0.986; $p < 0.001$) and random-effect model (d weighted effect size = 1.812; standard error = 0.584; 95% CI = 0.664, 2.956; $p = 0.002$). Hence, the standard difference means, and the CI of each study are showed in **Table 2**. However, the meta-analysis also showed significant heterogeneity in the I^2 statistic ($I^2 = 98.834$, $p < 0.001$).

In relation to the kind of models and pedagogical strategies implemented with the intention of comparing the impact of the motivational variables in sport content at PE or at training context (i.e., PETE), there are nine studies which applied one of the most MsBP widely used in PE classes, and five studies which implemented supportive-climate strategies in traditional sport lesson plans.

In this respect, the study which compared the CL with the DI, obtained a d weighted effect size = 0.949 (standard error = 0.134; $p < 0.001$). The two studies which compared the Hybridization of several MsBP (i.e., TGfU/SEM and CL/TGfU), showed a d weighted effect size = 0.344 (standard error = 0.171; $p = 0.044$). The five studies which analyzed the impact between the SEM and the DI, reported a d weighted effect size = 0.591 (standard error = 0.101; $p < 0.001$). The study which compared the TGfU and the DI obtained a d weighted effect size = 0.301 (standard error = 0.274; p =0.272). The studies that analyzed the impact of the traditional sport content lessons using different supportive-climate contexts obtained a d weighted effect size = 1.740 (standard error = 0.137; $p < 0.001$). Finally, the study which analyse the TARGET strategy with the DI, showed a d weighted effect size = 0.921 (standard error = 0.313; $p < 0.003$).

DISCUSSION

The main purpose of this study was to summarize the research that had analyzed the influence of the MsBP and supportive-climate tenets on the students' motivation outcomes, including the degree of self-determined motivation, the satisfaction of the BPNs and the orientation through ego and task activities during PE sport literacy programs. Additionally, the second aim of the present investigation was to quantitative analyse the students' SDI results among quantitative and quasi-experimental studies that had compared some of the MsBP with the traditional DI approach, during sport PE lesson plans.

The concerns about the impact of the PE on the students' health and the acquisition of lifelong active habits had been studied since the theories of motivation were applied to the educational (Deci et al., 1991) and sport (Duda, 1992) contexts. Indeed, the first study that analyzed the factors that might influence the American and British students' intrinsic and extrinsic motivation was carried out by Biddle and Brooke (1992). Later, Goudas et al. (1994) carried out the first observational study in PE about the students' motivational orientations. In this study, he corroborated that motivation may be influenced by the nature of the specific program or the kind of sport. One year later, Goudas et al. (1995) observed that those student-centered teaching styles could significantly influence the goal involvement during a PE introduction to track and field lessons.

However, until the research of Clarke and Quill (2003), there were no studies that analyzed the impact of the MsBP on the students' perceptions, behaviors and motivations. They observed that SEM is an ideal framework to increase the students' involvement in PE lessons, in addition to students' understanding and performance at sport (specifically at athletics, soccer, netball, and sport acrobatics). One year later, Browne et al. (2004) carried out a research that compared the SEM with the DI approach, empathizing that an increase of responsibility and significant skills improvements were achieved in the SEM context.

The increase of literature about the comparison between innovative models and the traditional ones considerably increased in the last two decades. For this reason, this section discusses the results in several subsections facilitating the synthesis of the ideas to the reader.

Implementation of Cooperative Learning and Its Impact on the Students' Motivation

CL in PE (Barrett, 2005) is a model that optimizes the learning outcomes according to five important elements (Johnson and Johnson, 1994): (I) positive interdependence, (II) positive face-to-face interaction, (III) group processing, (IV) interpersonal and small-group skills, and (V) individual accountability. On the other hand, Pujolás (2008) and Dyson et al. (2010) emphasized

TABLE 1 | Synthesis of the investigations about psychosocial outcomes in PE sport programs using MsBP and/or autonomy support.

References	Program (Content)	Aims	Intervention contextualization	Methodology		Main outcomes
				Instruments	Variables	
Clarke and Quill (2003)	PE. SEM. (Netball, soccer, sports acrobatics, and athletics)	To report the benefits of the SEM on students' motivation, involvement in practice and leadership.	England (UK). Two mixed-sex and ability classes of 8th grade (secondary education). Double (120 min) and single (60 min) classes per week during the PE course.	Qualitative; longitudinal design		Students who took the more skilled responsibilities in the model became more motivated, demonstrating a strong sense of ownership. Additionally, they enjoyed taking different roles.
				Participant observation	Field diary notes and teacher-research's diary	
				Semi-structured interviews (during the intervention)	Students perceptions	
O'Donovan (2003)	PE. Normal PE program followed by SEM. (Not reported)	To explore the effects of promoting team affiliation on social goals.	England (UK). 68 7th grade (secondary education) students. Two classes per week.	Qualitative; ethnographic design		Although, no noticeable changes in participation levels were noted, social goals were an important determinant of motivation and participation in PE.
				Participant observation	Field diary notes and video-recorded session	
				Unstructured interviews	Whole-class interview/forum	
Browne et al. (2004)	PE–2 groups. Trad. DI and SEM. (Rugby union)	To compare the effect on students' learning, enjoyment and affect between two MsBP.	Australia. 53 8th grade (secondary education) female students grouped into DI group ($n = 26$) and SEM group ($n = 27$). 10 lessons of two weekly 45-min sessions.	Mixed study; quasi-experimental design		The sense of belonging and responsibility were features that increased greater levels of autonomy at the SEM implementation. In addition, the perception of greater autonomy and organization were also observed in the SEM group.
				Declarative rugby assessment *ad hoc*	Laws and rules of the sport	
				Student self-assessment *ad hoc*	Procedural self- evaluation items	
				Teacher evaluation of skills *ad hoc*	Procedural teacher evaluation	
				Semi-structured interview	$n = 16$; enjoyment skills and affect	
Prusak et al. (2004)*	PE–2 groups. No-choice DI and TARGET strategy unit with choices. (Walking unit of instruction)	To determine students' motivational responses between autonomy and non-autonomy-supportive contexts.	USA. 42 7th and 8th grade (secondary education) students classified into DI group ($n = 21$) and TARGET group ($n = 21$). 10 sessions.	Quantitative; quasi-experimental design		Providing a free selection of activities, students experienced an increase of their situational and intrinsic motivation in contrast to the group which had to participate in imposing activities and was not autonomy-supported.
				SIMS *ad hoc* (Guay et al., 2000)	SD index (RAI) and situational motivation	
				SMSPE *ad hoc* (Briere et al., 1995)	Intrinsic motivation, extrinsic motivation, and amotivation	
Wallhead and Ntoumanis (2004)*	PE–2 groups. Trad. DI and SEM. (Basketball)	To analyse the effects of a SEM and DI interventions in fostering students' enjoyment, as well as perceived and autonomy competence.	England (UK). 51 10th grade (secondary education) students (14.3 ± 0.48), grouped into DI ($n = 25$) and SEM groups ($n = 26$). 8 lessons of one weekly 60-min (50-min real practice) session.	Quantitative; quasi-experimental design		The structure of the SEM is very similar to the TARGET strategies. Indeed, the SEM intervention facilitated the perception of task-involving climate. Additionally, perceived autonomy had a positive effect on student motivational outcome. SEM also showed better results in enjoyment and perceived efforts in contrast to the traditional approach.
				IMI (McAuley et al., 1989)	Enjoyment, effort, and perceived competence	
				TEOSQ (Duda and Nicholls, 1992)	Ego and task goal orientation	
				ASRQ *ad hoc* (Ryan and Connell, 1989) and AMS *ad hoc* (Vallerand et al., 1992)	Different degrees of perceived autonomy	
				LAPOPECQ (Papaioannou, 1995)	Ego- and task- involving climate	
				CBAS (Smoll and Schutz, 1990)	Codification of teacher behavior	

(Continued)

TABLE 1 | Continued

References	Program (Content)	Aims	Intervention contextualization	Methodology		Main outcomes
				Instruments	Variables	
Hastie and Sinelnikov (2006)	PE. SEM giving special attention to the TARGET strategy. (Basketball)	To examine the students' participation and perception of an innovative SEM.	Russia. 37 6th grade (primary education) students. 18 lessons of three weekly 40-min sessions.	Mixed study; quasi-experimental design		Traditional PE in Russia had been following the DI approach. In this context, the implementation of SEM produced an increase of the students' involvement, autonomy, enjoyment, and engagement throughout the whole season.
				Systematic observation and BEST (Sharpe and Koperwas, 1999)	Teacher behavior and students lesson participation	
				PESS (Mohr et al., 2003)	SEM components and features	
				Semi-structured interviews	$n = 4$; students' perceptions	
Mandigo et al. (2008)	PE. TASG. (Target, Striking, Net/Wall, and Invasion games)	To (I) investigate students' motivational experience across different sports, and to (II) compare the gender differences.	Canada. 759 students from 4th to 7th grade (primary education), divided into 9 classes for the Target unit, 11 for the Striking unit, 7 for the Net/Wall unit, and 10 for the Invasion games unit.	Quantitative; quasi-experimental design		Lower impact on students' motivation at the Invasion games unit was observed because it is the most tactical-complex category. The use of TASG is an effective way to foster students' intrinsic motivation.
				IMI *ad hoc* (McAuley et al., 1989) including open-ended responses	Perceptions of the BPNs and intrinsic motivation	
				CPOCI (Mandigo and Sheppard, 2003)	Perception of the optimal challenge	
Gray et al. (2009)	PE−2 groups. Trad. DI and TIG using the TARGET strategy. (Basketball)	To determine the teacher behaviors and the students' motivational climate across two models using the TARGET structure.	Scotland (UK). 51 8th grade (secondary education) students (12.5 ± 0.30), grouped into DI ($n = 25$) and TIG-TARGET groups ($n = 27$), including the two teachers. 5 lessons of one weekly session from 60 to 80 min.	Mixed study; quasi-experimental des		The TIG group teacher showed more mastery behavior. On the contrary, the DI lessons negatively affected the pupil feeling of autonomy, enjoyment effort, and learning based on problem-solving or cooperative context, as it was applied in the TIG.
				Video recording data BEST (Sharpe and Koperwas, 1999)	Effectiveness of application of TARGET	
				Semi-structured teacher	Teachers' experience	
				Semi-structured student interviews and/or focus group	$n = 4$; students' learning experience	
Lonsdale et al. (2009)	PE. Trad. DI including free-choice periods. (Basketball)	To compare the relationship between students' SD motivation and PA level during teacher structured part of the sessions, and free-choice portion of them.	Hong Kong (China). 296 female and 232 male 10th grade (secondary education) students (15.78 ± 0.91 years). 18 lessons of 40 min, divided in 20 min of structured lessons led by the teacher and 20 min of free-choice activity.	Quantitative; quasi-experimental design		Students' motivation were related to high levels of steps in both structured and free-choice part of the lessons. Besides, need-supportive contexts were also related to greater self-determined motivation. It is recommend to integrate free-choice periods into PE.
				SIMS (Guay et al., 2000)	SD index (RAI)	
				Yamax Digi-Walker DW-700^{TM} pedometers	Students' steps per minutes	
Spittle and Byrne (2009)	PE−2 groups. Trad. DI and SEM. (Soccer, hockey, and football codes)	To (I) compare the impact of two models on the students' intrinsic and/or extrinsic motivation, goal orientation and perceived motivational climate.	Australia. 115 8th grade (secondary education) students grouped into DI ($n = 74$) and SEM groups ($n = 41$). 10 lessons of one weekly session.	Quantitative; quasi-experimental design		Although. there was no significant difference in enjoyment and perceived effort between both models; perceived competence, task orientation, and mastery climate are significantly higher in the SEM group in contrast to the DI group. For that reason, SEM enhance student motivation.
				IMI (McAuley et al., 1989)	Interest/enjoyment, effort/importance, pressure/tension and perceived competence	
				TEOSQ (Duda and Nicholls, 1992)	Ego and task goal orientation	
				PMCSQ (Walling et al., 1993)	Performance and mastery climate	

(Continued)

TABLE 1 | Continued

References	Program (Content)	Aims	Intervention contextualization	Methodology		Main outcomes
				Instruments	Variables	
Jones et al. (2010)	PE–2 groups. Trad. DI and TGfU. (Invasion games)	To determine the students' intrinsic motivation between the implementation of two models.	England (UK). 202 7th–9th grades (Key Stage three) students and their two teachers. 6 weeks.	Quantitative; quasi-experimental design		Students from the TGfU group showed significantly greater levels of intrinsic motivation. Enjoyment can be engaged using TGfU.
				IMI *ad hoc* (McAuley et al., 1989)	Enjoyment, Pressure/tension, effort, choice and value/usefulness	
Perlman (2010)	PE–2 groups. Trad. DI and SEM. (Basketball, Volleyball, soccer, and lacrosse)	To investigate the affect and needs satisfaction of amotivated students using the SEM and the DI approaches.	USA. 78 9th–12th grades amotivated students from a pool of 1,176, divided into DI ($n = 16$ classes of 40 students) and SEM groups ($n = 16$ classes of 38 students). 15 lessons of three/four weekly 60-min sessions.	Quantitative; quasi-experimental design		The SEM students showed significantly higher levels of enjoyment and relatedness satisfaction, rather than DI students. SEM features such as peer leadership enable more students' engagement into their learning experiences.
				SRQ-PE *ad hoc* and AMS-PE *ad hoc* (Goudas et al., 1994)	Identification of amotivated students	
				IMI *ad hoc* (McAuley et al., 1989)	Enjoyment subscale	
				BPNS-PE *ad hoc* (Ntoumanis, 2005)	BPNs components	
Perlman and Goc-Karp (2010)	PE. SEM. (Flag football and soccer)	To understand the psychosocial variables related to the SDT in a class using the SEM.	USA. 24 secondary education students. Two seasons of three weekly 72-min sessions.	Qualitative; case of study		It was confirmed that the psychosocial needs of both students and teachers could be supported by implementing SEM.
				Interviews	Students and teacher perceptions	
				Field notes	Students and teacher behaviors	
González-Cutre et al. (2011)*	PE–2 groups. Trad. DI and TARGET strategy unit. (Invasion game and sport acrobatics)	To compare the effects of the task-involving climate, 2 × 2 achievement goals and the self-determined motivation by means of a TARGET unit.	Spain. 46 8th grade (secondary education) students (13.39 ± 0.57) divided into DI group ($n = 20$) and TARGET group ($n = 26$). 26 lessons of two weekly 50-min sessions.	Quantitative; quasi-experimental design		It was observed that the TARGET-group students achieved more self-determined motivation, in contrast to the traditional-group students. Hence, the mastery-approach can be supported by programs which priories the students' effort and personal growth. This fact, alongside other psychological variables, can determine the amount and time of extracurricular physical and sport activities practiced by the students.
				PMCSQ-2 *ad hoc* (Newton et al., 2000)	Ego and task-involving climate	
				PSPP *ad hoc* (Fox and Corbin, 1989)	Perceived competence	
				2 × 2 -AGF *ad hoc* (Elliot and McGregor, 2001)	Achievement-goals components	
				SGS-PE *ad hoc* (Guan et al., 2006)	Responsibility and relationship goals.	
				PLOCS *ad hoc* (Goudas et al., 1994)	SDT components	
				DFS-2 *ad hoc* (Jackson and Eklund, 2002)	Flow state	
Perlman (2011)*	PE–2 groups. Trad. DI and SEM. (Volleyball)	To examine the impact of a SEM season on students' self-determination and BPNs variables.	USA. 182 9th grade (secondary education) students (14.3 ± 0.48), grouped into DI ($n = 88$) and SEM groups ($n = 94$). 20 lessons of four weekly 60-min sessions.	Quantitative; quasi-experimental design		SEM students were significantly more self-motivated and reported higher levels of relatedness in contrast to DI students. This fact allows social connections between peers and students.
				SMS *ad hoc* (Pelletier et al., 1995)	SDT components, including Intrinsic motivation to know and SDI.	
				BPNS-PE (Ntoumanis, 2005)	BPNs components	

(Continued)

TABLE 1 | Continued

References	Program (Content)	Aims	Intervention contextualization	Methodology		Main outcomes
				Instruments	Variables	
Perlman (2012b)*	PETE—2 groups. Trad. DI and SEM.	To assess the influence of using the SEM on the teachers' autonomous instruction.	Australia. 50 pre-service secondary PE teachers randomly assigned to a traditional DI group ($n = 25$) and SEM group ($n = 25$). 15 lessons of 60-min sessions during 16 weeks.	Quantitative; quasi-experimental design		Pre-service teachers whom participated in the SEM group showed better autonomous behaviors in contrast to the traditional model group. Significant changes in perception of autonomy-support were found in SEM in contrast to the traditional group.
				Coding and observational autonomous instruction method (Sarrazin et al., 2006)	Teacher's instruction style (autonomous, controlling, or neutral)	
				LCQ (Williams and Deci, 1996)	Perception of autonomy-support	
				SMS *ad hoc* (Pelletier et al., 1995)	SDT components	
Gillison et al. (2013)	PE—4 groups. Trad. DI using different autonomy- or controlling- supportive climate instructions. (Fitness-based circuits)	To evaluate the students' motivational level and intention to be active on different autonomy- and controlling-supportive climate lessons of fitness.	England (UK). 592 9th grade (secondary education) students. One experimental lesson. After the teacher demonstration of each activity, the lesson began with a warm-up, followed by a circuit of 10 fitness activities with 30 s of duration, including 2 min of break at the middle of the lesson.	Quantitative; quasi-experimental design		On the one hand, the students whom were autonomously supported by their teacher significantly increased their self-determined motivation and their positive intention to exercise in contrast to those students whom received a controlling supportive climate. On the other hand, this study highlighted the difficulty of manipulating social and goal contexts to engage active students.
				PLOCS (Goudas et al., 1994) and SIMS (Guay et al., 2000)	SDT and behavioral regulations components	
				IMI *ad hoc* (McAuley et al., 1989)	Interest, effort, and enjoyment of the lesson and activity value	
				LCQ *ad hoc* (Williams and Deci, 1996)	Perception of autonomy support	
				EFI (Gauvin and Rejeski, 1993)	Change in mood and vitality after the activity	
Amado et al. (2014)	PE—2 groups. Trad. DI and multi-dimensional intervention. (Dance)	To analyse the students' self-determined motivation as well as the satisfaction of the BPNs through dance.	Spain. 47 10th grade (secondary education) students (14.84 ± 0.84 years), divided into DI group ($n = 27$) and multi-dimensional intervention group ($n = 20$). 12 lessons of two weekly 50-min sessions.	Quantitative; quasi-experimental design		A significant difference was observed in the need for autonomy among participants in the multi-dimensional intervention. This kind of programs, focused on supporting the BPNs, shows a positive effect among children adherence to physical activity.
				BPNMS *ad hoc* (Vlachopoulos and Michailidou, 2006)	BPNs components	
				MDCEQ *ad hoc* (Amado et al., 2012)	SDT components except integrated and introjected regulation	
Báguena-Mainar et al. (2014)*	PE-2 groups. Trad. DI and TGfU with TARGET. (Volleyball)	To investigate the impact of a GCA program using the TARGET strategy in the students' motivation.	Spain. 61 10th grade (secondary education) students (15.88 ± 0.84) grouped in DI ($n = 20$) and TGfU with TARGET structure ($n = 41$) group. 10 lessons of two weekly 50-min sessions.	Quantitative; quasi-experimental design		The use of TGfU alongside the TARGET strategy significantly fostered the students' task-orientation and the autonomy support, engaging them to be more active, in contrast to traditional PE frameworks. Controlling environmental models (i.e., DI) are likely to produce a decrease in the students' enjoyment.
				PPECCS *ad hoc* (Biddle et al., 1995)	Ego and task involving climate	
				ASCQ *ad hoc* (Conroy and Coatsworth, 2007)	Autonomous behavior and students' opinion	
				BPNES *ad hoc* (Vlachopoulos and Michailidou, 2006)	BPNs components	
				SIMS-14 *ad hoc* (Guay et al., 2000)	SDT components except integrated and introjected	
Goodyear et al. (2014)	PE. CL. (Basketball)	To analyse the implementation of a model to increase responsibility for the students' self-learning and engagement with the PE contents.	England (UK). Two classes of 10th grade (secondary education) female students. Eight lessons for a minimum of 2 h per week.	Qualitative; quasi-experimental design		CL (with the use of flip cameras during the unit) was reported as a beneficial model to empower female students' responsibility, cooperation and collaboration with their peers. Hence, students' engagement is enhanced with the CL approach.
				Reflexible teacher journal, PLTA (Casey et al., 2009) and videorecordings produced by the students Student team semi-structured interviews	Evaluation of CL learning elements. Students' behaviors, participation, and engagement. Students' participation	

(Continued)

TABLE 1 | Continued

References	Program (Content)	Aims	Intervention contextualization	Methodology		Main outcomes
				Instruments	Variables	
Hastie et al. (2014)	PE. SEM using the TARGET strategy. (Handball)	To analyse the implementation of SEM that emphasizes the mastery-involving climate among students' motivation.	USA. 21 secondary education male students and one teacher. 12 lessons of one weekly of 90-min sessions.	Quantitative; quasi-experimental design Videorecording sessions and BEST (Sharpe and Koperwas, 1999) TEGQ (Papaioannou et al., 2007)	 Teaching behavior related to motivational climate Motivational climate students' perception	SEM features can be oriented to a mastery-oriented climate throughout the season. In this context, the TARGET structure was an additive to the students' motivation and mastery-oriented climate.
Smith et al. (2014)	PE–2 groups. Trad. DI and TGM. (Netball and football for girls; plus rugby and football for boys)	To examine the levels of moderate-to-vigorous physical activity and the self-determined motivation among female and male students using two models.	England (UK). 72 7th grade (secondary education) students (11.31 ± 0.45) from two schools, divided into DI groups (girls class = 17, boys class = 19) and TGM groups (girls class = 13, boys class = 23). 12 lessons for each model.	Quantitative; quasi-experimental design SOFIT (McKenzie, 2012) and RT2^{TM} triaxial acceleromenter Self-Determination Questionnaire (Standage et al., 2005) IMI *ad hoc* (McAuley et al., 1989)	 Quantification of the activity level Intrinsic motivation and BPNs components Enjoyment subscale	Although physical activity levels were higher in the female TGM class; it is significantly higher in the male TGM class, in contrast to both DI and TGM classes. However, there were no significant differences in self-determined motivation between TGM and DI.
Wallhead et al. (2014)*	PE–2 groups. Multi-activity DI and SEM. (Floor hockey, volleyball, handball, basketball, badminton, cooperative games, and soccer)	To investigate the impact of the SEM using different sports on the students' motivation, and their influence on the leisure-time physical activity.	USA. 568 secondary education students (14.75 ± 0.48 years) from two schools. 25 lessons of SEM (first school) and from four- to nine-block lessons of DI (second school). SEM benchmark observation instrument were used (Ko et al., 2006).	Mixed study; quasi-experimental design PLOCS (Goudas et al., 1994) AMS-PE *ad hoc* (Goudas et al., 1994) IMI *ad hoc* (McAuley et al., 1989) PAIS (Ajzen, 2003) and LTEQ (Godin and Shephard, 1985)	 SDT components except integrated regulation Amotivation subscale Enjoyment subscale Intention to be physically active	SEM students reported greater interest due to an increase of enjoyment and self-determined motivation, in contrast to multi-activity DI program students. However, the results showed a small increase over time in the intention to practice leisure-time physical activity among SEM students.
Chatzipanteli et al. (2015)*	PE–2 groups. Trad. DI and teaching style program. (Basketball, volleyball, soccer, fitness, track and field, and gymnastics)	To compare the effects of different student-centered teaching styles on the student self-regulation, motivation and lesson satisfaction from a PE program.	Greece. 601 7th grade students (secondary education), assigned into Trad. DI group (n = 285) and supportive climate group using different teaching styles (n = 316). 38 lesson of three weekly 45-min sessions.	Quantitative; quasi-experimental design MPPEQ *ad hoc* (Theodosiou and Papaioannou, 2006) SIMS *ad hoc* (Guay et al., 2000) LSSCL *ad hoc* (Duda and Nicholls, 1992)	 Students' metacognition about the sports SDT components except integrated and integrated regulation. Lesson satisfaction	Student-centered teaching style group showed significantly higher marks on the metacognitive outcomes. Additionally, this group also reported significantly higher levels of self-determined motivation, in contrast to the traditional one.
Moy et al. (2016)	PETE–2 groups. Trad. DI and CLA. (Hurdles unit)	To corroborate that the CLA model can effectively orient students toward the positive satisfaction of the three BPNs.	Australia. 54 second-year pre-service PETE students, divided into two groups who experience DI firstly and CLA secondly; and vice versa. 2 lessons of 50-min.	Quantitative; quasi-experimental design IMI *ad hoc* (McAuley et al., 1989)	 Enjoyment, effort, and BPNs components.	The BPNs, effort and enjoyment were significantly better in both CLA groups, reporting more self-determined motivated behaviors than in both DI groups.

(Continued)

TABLE 1 | Continued

References	Program (Content)	Aims	Intervention contextualization	Methodology		Main outcomes
				Instruments	Variables	
Chang et al. (2016)*	PE−2 groups. Trad. DI and Trad. DI using autonomy-support strategy. (PE program of multiple sports)	To assess the impact of changing the teaching style in a traditional PE program (including running, jumping, vaulting boxes, badminton, Chinese yo-yo, and basketball) on students' motivation.	Taiwan. 126 6th grade (elementary education) students, assigned to DI ($n = 65$) and autonomy-supportive groups ($n = 61$). 12 lessons of two weekly 40-min sessions. Each sport was taught twice per week.	Quantitative; quasi-experimental design		PE lessons manipulated by supporting students' autonomy reported an increase of their intrinsic motivation. In this sense, the students from the autonomy-supportive group showed greater levels of perceived autonomy when students had more choices in selecting partners, contents, and/or learning tasks.
				Perceived teacher autonomy questionnaire *ad hoc* (Standage et al., 2006)	Students' perceived autonomy by the teacher	
				Perceived autonomy questionnaire *ad hoc* (Standage et al., 2006)	Students' perceived autonomy in PE	
				Self-determined motivation scale *ad hoc* Ntoumanis (2001)	SDT components except integrated regulation	
Cuevas et al. (2016)*	PE−2 groups. Trad. DI and SEM. (Volleyball)	To compare the effect of the traditional model and the SEM on the students' motivational outcomes.	Spain. 86 10th grade (secondary education) students (15.65 ± 0.78 years) grouped into DI team ($n =$ 43) and SEM team ($n =$13). 19 lessons of two weekly 55-min sessions.	Quantitative; quasi-experimental design		Although, it was observed slight improvements in the SDI and identified regulation among SEM students, intrinsic motivation significantly improved in contrast to DI students. Otherwise, no changes were observed in the perceptions of the thwarting autonomy and relatedness at SEM students.
				QEMPE (Sánchez-Oliva et al., 2012)	SD components expect integrated regulation	
				PNTS *ad hoc* (Bartholomew et al., 2011)	Thwarting of autonomy, competence, and relatedness	
				SSI *ad hoc* (Balaguer et al., 1997)	Satisfaction-enjoyment and boredom	
				IPAS *ad hoc* (Hein et al., 2004)	Intention to be physically active	
Burgueño et al. (2017)*	PE−2 groups. Trad. DI and SEM. (Basketball)	To compare the impact of the students' motivational regulation between the implementation of traditional DI unit and SEM.	Spain. 44 11th grade (secondary education) students (16.32 ± 0.57 years) assigned to DI team ($n = 22$) and CL team ($n = 22$). 12 lessons of two weekly 55-min sessions.	Mixed study; quasi-experimental design		The SEM season significantly produced an increase of the intrinsic motivation and identified regulation, including a decrease of external regulation and amotivation in contrast to the DI group.
				SMS *ad hoc* (Guay et al., 2000)	SDI; Identified motivation, identified regulation, external regulation, and amotivation	
Fernández-Río et al. (2017)**	PE−2 groups. Trad. DI and CL. (Cooperative physical challenges *ad hoc*, Coop fitness *ad hoc,* and Cooperative parkour *ad hoc*)	To (I) determine the impact of students' motivation across the CL approach, (II) assessing the students' perception, as well as (III) feelings and thoughts about this model.	Spain. 249 from 8th to 11th grades (secondary education) students (13.41 ± 1.25 years) and their four teachers assigned to DI ($n = 112$) and CL groups ($n = 137$). 16 weeks of 2 h every week. Each unit (Cooperative physical challenges, Coop fitness and Cooperative parkour *ad hoc*) has a duration of 10 sessions.	Mixed study; quasi-experimental design		It is demonstrated that the application of the CL approach increases the students' most self-determined kinds of motivation. Indeed, students' perceptions showed the ideas of cooperation, relatedness, enjoyment and novelty, which produced a positive impact during the CL intervention.
				PLOCS *ad hoc* (Goudas et al., 1994)	SDT components except integrated regulation	
				PMCSQ-2 *ad hoc* (Newton et al., 2000)	Cooperative learning subscale	
				Students' perceptions open-ended question (Qualitative approach)	Students' perceptions about the CL experience particularly, and the whole experience generally.	
Gil-Arias et al. (2017)*	PE−2 groups. Trad. DI and Hybrid TGfU/SEM. (Volleyball and Ultimate Frisbee™)	To assess the effect between a hybrid TGfU/SEM and a traditional DI unit on students' self-determined motivation, as well as on their adherence in PE programs.	Spain. 55 9th−10th grades (secondary education) students (15.45 ± 0.41), divided into group A ($n = 27$; Hybrid firstly and DI secondly) and group B ($n = 28$; DI firstly and Hybrid secondly). 16 lessons of two weekly 50-min sessions. Each model lasted 8 lessons.	Mixed study; quasi-experimental design		When students participated in the Hybrid TGfU/SEM unit, they showed greater levels of autonomy and competence, in contrast to DI units. In addition, group A (i.e., hybrid unit first) obtained higher scores on self-determined motivational variables than group B (i.e., DI unit first).
				PLOCS *ad hoc* (Goudas et al., 1994)	Autonomous motivation and SDT components	
				BPNES *ad hoc* (Vlachopoulos and Michailidou, 2006)	BPNs components	
				EBSS *ad hoc* (Duda and Nicholls, 1992)	Enjoyment	

(Continued)

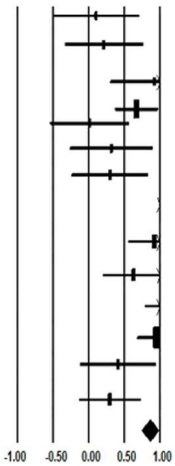
TABLE 1 | Continued

References	Program (Content)	Aims	Intervention contextualization	Methodology		Main outcomes
				Instruments	Variables	
				IPAS (Arias-Estero et al., 2013)	Intention to be physically active	
Harvey et al. (2017)	PE. CGA-TGM. (Basketball)	To examine the students' perceptions of BPNs and self-determined motivation applying a CGA-TGM unit.	USA. 94 elementary students and 79 middle school students. 33 lesson of one weekly 40-min sessions at elementary school, and 32 lessons of four weekly 43–49 min at middle school. Application of the model benchmark to ensure an optimal implementation of the models.	Quantitative; quasi-experimental design		This model showed a significant increase of the relatedness perception in elementary and middle students. Indeed, the implementation of this model enables students to first learn the tactical aspects of the game in a contextualized situation using modified and/or Small-Sided Games. Besides, longer-term TGM implementation enhances the reduction of controlling teacher behaviors.
				BPNs and SDT questionnaire protocol (Standage et al., 2005)	Three BPNs components and the SDT components except integrated regulation	
				SOFIT (McKenzie, 2012)	Lesson context evaluation	
				WVUTES (Hawkins and Wiegand, 1989)	11 teacher behavior patterns evaluation (e.g., positive feedback or physical guidance)	
Chiva-Bartoll et al. (2018)*	PE-2 groups. Trad. DI and hybrid CL/TGfU. (Handball)	To examine and compare the students' motivational climate between a hybrid CL/TGfU model and a traditional approach.	Spain. 96 10th grade (secondary education) students (15.00 ± 0.7 years), divided into 31 students in the traditional approach group, and 65 in the hybrid approach group. 8 lessons of two weekly 55–60-min sessions.	Quantitative; quasi-experimental design		The evolution of the motivational climate did not show significant differences among groups. However, the hybrid model contributed to the increase of task-involvement, as well as the decrease of ego-involvement.
				PMCSQ-2 (Newton et al., 2000)	Motivational climate divided into (I) task-involvement and (II) ego-involvement subscales.	
Vazou et al. (2019)	PE-2 groups. Trad. fitness unit and BPNs supportive-climate fitness-practice lesson (Fitness: running, curl-ups, and push-ups).	To investigate the motivational factors that could be fostered by the PE teacher introducing supportive-climate elements in PE fitness-practice lessons.	USA. 148 4th−6th grade (elementary education) students (10.39 ± 0.98 years) divided into traditional and supportive-climate groups. Two lessons (one for each group) of 30 min.	Quantitative; quasi-experimental design		Since physical fitness could be considered an unenjoyable activity, the implementation of play-like elements in the supportive climate group, prevented the declined of affective valence, and increase of enjoyment, in contrast to the traditional fitness group.
				SenseWear Armband™ monitor	Physical activity level	
				FS (Hardy and Rejeski, 1989)	Affective valence	
				S-PACES (Paxton et al., 2008)	Enjoyment	
				AFSS (Reeve and Sickenius, 1994)	BPNs components	

In order of appearance: PE, Physical Education; SEM, Sport Education Model; UK, United Kingdom; Trad. DI, Traditional Direct Instruction; MsBP, Models-Based Practice; TARGET, Task, Authority, Recognition, Grouping, Evaluation, and Time; USA, United States of America; SIMS, Situational Intrinsic Motivation Scale; SD, Self-Determined; RAI, Relative Autonomy Index; SMSPE, Sport Motivation Scale for Physical Education; IMI, Intrinsic Motivation Inventory; TEOSQ, Task and Ego Orientation in Sport Questionnaire; ASRQ, Academic Self-Regulation Questionnaire; AMS, Academic Motivation Scale; LAPOPECQ, Learning and Performance Orientations in Physical Education Classes Questionnaire; CBAS, Coach Behavior Assessment System; BEST, Behavioral Evaluation Strategies and Taxonomies; PESS, Physical Education Season Survey; TASG, Teaching-Autonomy-Supportive Games; BPNs, Basic Psychological Needs; CPOCI, Children's Perception of Optimal Challenge Inventory; TIG, Team Invasion Games; PA, Physical Activity; PMCSQ, Perceived Motivational Climate in Sport Questionnaire; TGfU, Teaching Games for Understanding; SRQ-PE, Self-Regulation Questionnaire for Physical Education; AMS-PE, Academic Motivation Scale for Physical Education; BPNS-PE, Basic Psychological Needs for Physical Education; PSPP, Physical Self-Perception Profile; 2 × 2-AGF, 2 × 2 Achievement Goal Framework; SGS-PE, Social Goal Scale for Physical Education; PLOCS, Perceived Locus of Causality Scale; SDT, Self-Determination Theory; DFS-2, Dispositional Flow State; SMS, Sport Motivation Scale; PETE, Physical Education Teacher Education; LCQ, Learning Climate Questionnaire; EFI, Exercise Induced Feelings Inventory; BPNMS, Basic Psychological Needs Measurement Scale; MDCEQ, Motivation in Dance and Corporal Expression Questionnaire; PPECCS, Perceived Physical Education Class Climate Scale; ASCQ, Autonomy-Supportive Coaching Strategies Questionnaire; BPNES, Basic Psychological Needs in Exercise Scale; CL, Cooperative Learning; PLTA, Post-Lesson Teacher Analysis; TEGQ, Teacher's Emphasis on Goals Questionnaire; GCA, Games-Centered Approach; TGM, Tactical Games Model; SOFIT, System for Observing Fitness Instruction Time; PAIS, Physical Activity Intention Scale; LTEQ, Leisure-Time Exercise Questionnaire; MPPEQ, Metacognitive Process in Physical Education Questionnaire; LSSCL, Lesson Satisfaction Scale at the Contextual Level; CLA, Constraints-Led Approach; QEMPE, Questionnaire for Evaluating Motivation in Physical Education; PNTS, Psychological Need Thwarting Scale; SSI, Sport Satisfaction Instrument; IPAS, Intention to be Physically Active Scale; EBSS, Enjoyment/Boredom in Sport Scale; WVUTES, West Virginia Teaching Evaluation System; FS, Feeling Scale; S-PACES, Simplified Physical Activity Enjoyment Scale; AFSS, Activity Feelings State Scale.

TABLE 2 | SDI meta-analysis about the comparison of DI approach and innovative MsBP in sport literacy at PE or formal educational context.

References	*d* effect size	SE	CI		*p*-value	Forest plot
			Lower	Upper		
Prusak et al. (2004)	0.104	0.309	−0.502	0.709	<0.737	
Wallhead and Ntoumanis (2004)	0.217	0.281	−0.334	0.767	0.441	
González-Cutre et al. (2011)	0.921	0.313	0.309	1.534	0.003	
Perlman (2011)	0.674	0.152	0.375	0.973	<0.001	
Perlman (2012b)	0.017	0.283	−0.537	0.572	0.952	
Amado et al. (2014)	0.321	0.297	−0.61	0.902	0.280	
Báguena-Mainar et al. (2014)	0.301	0.274	−0.236	0.838	0.272	
Chatzipanteli et al. (2015)	18.945	0.552	17.862	20.027	<0.001	
Chang et al. (2016)	0.927	0.188	0.560	1.295	<0.001	
Cuevas et al. (2016)	0.632	0.221	0.199	1.065	0.004	
Burgueño et al. (2017)	1.459	0.339	0.794	2.124	<0.001	
Fernández-Río et al. (2017)	0.949	0.134	0.685	1.212	<0.001	
Gil-Arias et al. (2017)	0.414	0.273	−0.120	0.948	0.129	
Chiva-Bartoll et al. (2018)	0.298	0.219	−0.132	0.728	0.174	
Overall	0.865	0.062	0.745	0.986	<0.001	



SE, Standard error; CI, Confidence interval.

that time is also a very important factor to bear in mind when CL is implemented because it is observed that the degree of cooperation in a team is directly related to the quantity of time dedicating in working together. Regarding the psychosocial outcomes using this model, two studies (i.e., Goodyear et al., 2014; Fernández-Río et al., 2017) have investigated qualitative and quantitatively the effects of the CL among secondary PE students.

After implementing a CL unit using flip cameras, Goodyear et al. (2014) observed positive learning environments where the students' responsibility, collaboration, and cooperation were reinforced. As it is also observed in the adult population (Wang, 2012), CL creates more successful experiences that increase the self-determined motivation. In addition, Goodyear et al. (2014) reinforced the idea of implementing this model using roles (as in SEM) because non-sporty participants can be more engaged in PE.

Most recently, Fernández-Río et al. (2017) compared the impact of different life-style activities and sports units using CL and DI in a mixed study (i.e., both quantitative and qualitative). In this research, it was observed a significant cooperative class climate among the students who participated in the CL group. Otherwise, novelty was a positive variable that influenced the students' self-determined motivation. However, students also reported certain disappointment when sometimes several students did not work cooperatively in the CL group. Indeed, in spite of the fact that CL could be difficult to apply in certain contexts, teachers should be aware of the benefits that produce (Goodyear and Casey, 2015) in conceptual, attitudinal and procedural content. For those reasons, it is confirmed the idea that pedagogical and social factors have an impact on psychological mediators that determined the different types of motivation.

Implementation of Constraint-Led Approach and Its Impact on the Students' Motivation

CLA is also situated in the non-linear pedagogy framework (Davids et al., 2005). This model is based on the ecological dynamics theory. It establishes that movement patterns are organized under the interaction of constraints (Renshaw and Chow, 2019). In this sense, this model emphasizes the necessity of creating environments to promote movement patterns according to the unique individual physical and psychological characteristics or profiles. According to Chow et al. (2011), CLA is very similar to the application of the Modify Games or Small-Sided (and Conditioned) Games at TGfU [encompassed in the GCA]. However, the main difference between CLA and TGfU is that this approach is theoretically developed in the ecological dynamics of the non-linear pedagogy (Renshaw et al., 2015).

Although, there is no research that analyzed the benefits of the CLA on the students' motivation or the BPNs satisfaction in the educational context (Tan et al., 2012; Moy et al., 2016) analyzed this approach comparing the psychological effects with the traditional DI approach in pre-service PE teachers. They reported that the use of CLA increased the pre-service teacher students' tactical/technical intelligence, as well as the intrinsic motivation. In this sense, it was confirmed that perceived competence is positively associated with the intrinsic motivation. Additionally, the study concluded that the implementation of non-linear pedagogy through CLA alongside effective verbal instruction and positive feedback promote not only the acquisition of determinant skills, but also it can produce an increase of personal effort, enjoyment, interest, and excitement among students. Indeed these outcomes might determine a positive effect on students' task engagement and persistence for practice both in educational and extracurricular context.

Implementation of Games-Centered Approach and Its Impact on the Students' Motivation

CGA is a "great" framework that reinforces the game understanding and the technical skills (i.e., tactical/technical intelligence) via implementing Modify Games or Small-Sided (and Conditioned) Games adapted to the characteristics of the students (Harvey and Jarrett, 2014). That is to say, technical abilities (prioritized in the DI approach) are developed when a tactical problem arises in the game (Werner et al., 1996). In this way, those models which provide and facilitate the sport content understanding through games are encompassed in this approach. Hence, in the present study, four different types of models (i.e., TIG, TGfU, TASG, and TGM) encompassed in this approach were identified.

Gray et al. (2009) showed that the implementation of the TIG, in contrast to the traditional approaches, increases the opportunities to play the game, and consequently, improves the students' decision-making intelligence. Similarly, Smith et al. (2014) observed an increase in the amount of moderate-to-vigorous physical activity among TGM students in contrast to DI students. However, when these results are divided by gender, discrepancies are observed: female TGM students do not meet the 50% of physical activity level recommended for PE sessions (Hartwig et al., 2019).

On the other hand, Jones et al. (2010) highlighted that using TGfU, in contrast to the traditional skill-based approach, also produces an increase of fun and enjoyment due to the fact that students perceive more autonomous environments. Similar results had been highlighted by Mandigo et al. (2008), who reported an increase in students' intrinsic motivation using the TASG. Indeed, Báguena-Mainar et al. (2014) emphasized that participants perceived more responsibility when the pedagogical frameworks based on the student-centered approach were implemented, producing greater levels of autonomy and satisfaction. Recently, Harvey et al. (2017) also observed that the implementation of contextualized games situations determined the enjoyment and motivation of the students. On the contrary, Smith et al. (2014) did not found significant differences in the students' intrinsic motivation when they compared several sports using the TGM, suggesting that the teacher behaviors and the time of instruction might influence these results.

In this respect, Mandigo et al. (2008) proposed to reinforce the autonomy-supportive climate when TGfU is going to be implemented in PE classes. In addition, their findings supported the idea that the intrinsic motivational levels among girls could significantly increase when they experience autonomy-supportive environments. On the other hand, taking into account the teacher behavior and the teaching style, Gray et al. (2009) suggested implementing the Epstein's (1989) TARGET structure alongside the MsBP. Finally, Harvey et al. (2017) corroborated the idea that providing choices during the implementation of the model reduced the teachers' controlling behaviors.

Finally, every study (Mandigo et al., 2008; Gray et al., 2009; Jones et al., 2010; Báguena-Mainar et al., 2014; Harvey et al., 2017) coincides in the idea that CGA is beneficial to increase the most self-determined form of motivation taking into account the autonomy support climate. However, as Harvey et al. (2017) indicated, it is necessary to increase the commitment to this approach to reduce the controlling teacher behaviors that influence negatively on the students' motivation.

Implementation of Sport Education Model and Its Impact on the Students' Motivation

The SEM is a pedagogical framework with seven features (i.e., seasons, formal competition, affiliation to a unique team, data recording, festivity, application of roles, and final competition) aims to produce an authentic sport experience simulating the real aspects of the game, but adapting every element related to the sport itself to the educational context (Siedentop et al., 2019).

SEM has been the most widely used model for analyzing the impact on the students' psychological variables and their effects on the students' sport adherence and lifelong active habits. Clarke and Quill (2003) observed positive perceptions among students after experience a SEM season. In this sense, they identified that the sense of belonging to a team, as well as the increase of the responsibility, produced an increase in the motivation to practice games. Similarly, Browne et al. (2004), Perlman (2010), as well as Wallhead and Ntoumanis (2004), highlighted that the affiliation (to a unique team) is an important feature to deliver supportive and mastery-climate. In the same line, O'Donovan (2003) also confirmed that the implementation of SEM increases the students' motivation and task-climate.

On the other hand, Wallhead and Ntoumanis (2004) found that one feature of the SEM was that formal competition can negatively influence the students' self-determined motivation and the ego-involving climate. They proposed several teaching strategies to counteract those negative effects (e.g., seasons related to tasks such as choreographies or fair-play assessment). However, as Hastie and Sinelnikov (2006) explained, the aforementioned feature can be considered as a key element of how to improve skills. They reported the fact that training to improve the skills of the team in order to win games produced enjoyment. In their study, they also observed that other features such as the roles and the affiliation to a team also produced an increase of enjoyment and intrinsic motivation.

When SEM is compared with traditional approaches, some authors (Spittle and Byrne, 2009; Perlman, 2010, 2011) have reported an increase of enjoyment and the BPNs satisfaction when students experienced the SEM. Specifically, Perlman (2010) spotlighted that amotivated PE students increased their engagement and enjoyment to PE classes during the SEM season. In this regard, these students reported an increase in relatedness, fostered by the features of the model itself. In the same year, Perlman and Goc-Karp (2010) qualitatively reported that the three psychological needs can be also satisfied using the SEM. However, in a posterior study, Perlman (2011) did not observe significant changes in the perception of autonomy and competence, possibly because of the prescription of learning experiences implemented in that season.

The SEM can also be implemented with the TARGET structure (Epstein, 1989), as Hastie et al. (2014) demonstrated. In

this case, it is demonstrated that the teacher has to manipulate the SEM to orientate the needs of each student to create a mastery-oriented climate, and consequently, to produce more self-determined forms of motivation. In this sense, Medina-Casaubón and Burgueño (2017) also confirmed that SEM helps students to develop their holistic emotional, psychological and social intelligence, together with the acquisition of the sport competence (i.e., tactical/technical skills).

Recently, Cuevas et al. (2016) confirmed that the intrinsic motivation was significantly higher in the students who experienced the SEM in contrast with the students who participated in the DI, verifying the idea that SEM can produce enjoyment, pleasure, and well-being. These factors can determine the way in which the effort variable increases. This was the first study that analyzed empirically the thwarting of the BPNs, that is to say, the negative effect due to a hostile context (Bartholomew et al., 2011). However, they observed a slight decrease in thwarting competence among SEM students. On the other hand, it is also be confirmed that SEM produces high levels of self-determined motivation that directly and positively impacts on the adherence to continue practicing a sport or a healthy activity.

Implementation of Hybridizations and Its Impact on the Students' Motivation

Hybridizations of MsBP might be the solution to extend the benefits of implementing single MsBP (González-Víllora et al., 2018). However, it is also supported the idea of combining single MsBP or parts of them.

In the present study, there were identified two comparisons between the hybridization of two models with the traditional DI approach. Thus, Gil-Arias et al. (2017) investigated the impact of the hybridization of the TGM/SEM on the most self-determined motivation as well as the satisfaction of the BPNs. Their methodology was a cross over or counterbalance design (i.e., one group participated in the hybridization unit whereas the other group participated in the DI unit, later the first group experienced the DI unit and the second one the hybridization unit), which demonstrated that using the hybrid TGfU/SEM increased the students tactical/technical intelligence. In addition, the authors found that the sense of belonging or unit (a feature of the SEM; affiliation) was higher in the first group (which experienced the hybridization first). Regarding the motivational variables, it could not be confirmed that students from group one significantly improved their self-determined motivation. In this sense, it was also observed that group one obtained lower BPNs when they experienced DI after the hybridization.

Otherwise, the recent study of Chiva-Bartoll et al. (2018) also confirmed that hybridizations (in this case TGfU/CL hybridization) can impact on the task-involving climate. In addition, this study also confirmed the idea of Smith et al. (2014) who proposed that the teacher behavior and pedagogical strategies could provide a mastery-oriented climate, because statistical differences were not found in the progression of the motivational climate between hybridization and traditional approaches. In this sense, Chiva-Bartoll et al. (2018) reinforced the idea of applying reciprocal and guided discovery teaching styles to optimize the student self-determined motivation, autonomy and mastery-climate alongside innovative approaches.

Both studies (Gil-Arias et al., 2017; Chiva-Bartoll et al., 2018) suggested that hybridizations have a positive impact on the self-determined motivation and the BPNs satisfaction, in contrast to traditional approaches that prioritizes the decontextualized technical skills learning.

Implementation of Autonomy-Supportive Climate and Its Impact on the Students' Motivation

Although MsBP are an ideal context to obtain more self-determined forms of motivation, it is observed that the teacher behavior and climate could definitely impact on the students' psychological outcomes (Gray et al., 2009; Hastie et al., 2014). In this sense, there are eight researches (Prusak et al., 2004; Lonsdale et al., 2009; González-Cutre et al., 2011; Gillison et al., 2013; Amado et al., 2014; Chatzipanteli et al., 2015; Chang et al., 2016; and Vazou et al., 2019) that analyses the impact of the support-climate on the self-determined motivation, enjoyment and BPNs satisfaction during a traditional sport and/or life-style activities units.

The first idea that Prusak et al. (2004), Lonsdale et al. (2009) and Chang et al. (2016) observed was that students are more self-determined motivated when options to choice (e.g., activity, duration, or classmate) are given to them. In this sense, Lonsdale et al. (2009) highlighted that in this kind of autonomy-supportive climates, the self-determined motivation increases in contrast to teacher-centered approaches. However, as Gillison et al. (2013) indicated, some kinds of choice with null structure may undermine the positive forms of motivations. Otherwise, implementing reciprocal and inclusion teaching styles in traditional sessions can produce a significant increase of declarative and procedural knowledge whereas the students' intrinsic motivation also increases (Chatzipanteli et al., 2015). Finally, Chang et al. (2016) demonstrated that autonomy-supportive sessions can be adapted to the circumstances of the context to optimize the students' self-determined motivation.

On the other hand, González-Cutre et al. (2011) highlighted that the TARGET structure in PE units enables to increase the task-involving climates, and consequently, the desire to continue practicing physical and sport activities with an increase of motivation in PE. Recently, Vazou et al. (2019) emphasized the importance of providing contexts where the students perceive enjoyment and competence that engage them to be continuously involved in physical activities. With this purpose, they proposed using a wide range of resources (e.g., music or videos), as well as an increase of the student-centered pedagogy programs even when the lesson plans are related to a fitness program or any other health-life activity.

PRACTICAL APPLICATION

It is important to analyse the content and the pedagogical strategies which pursuit an optimal and holistic children's affective, cognitive, and physical development to be applied in

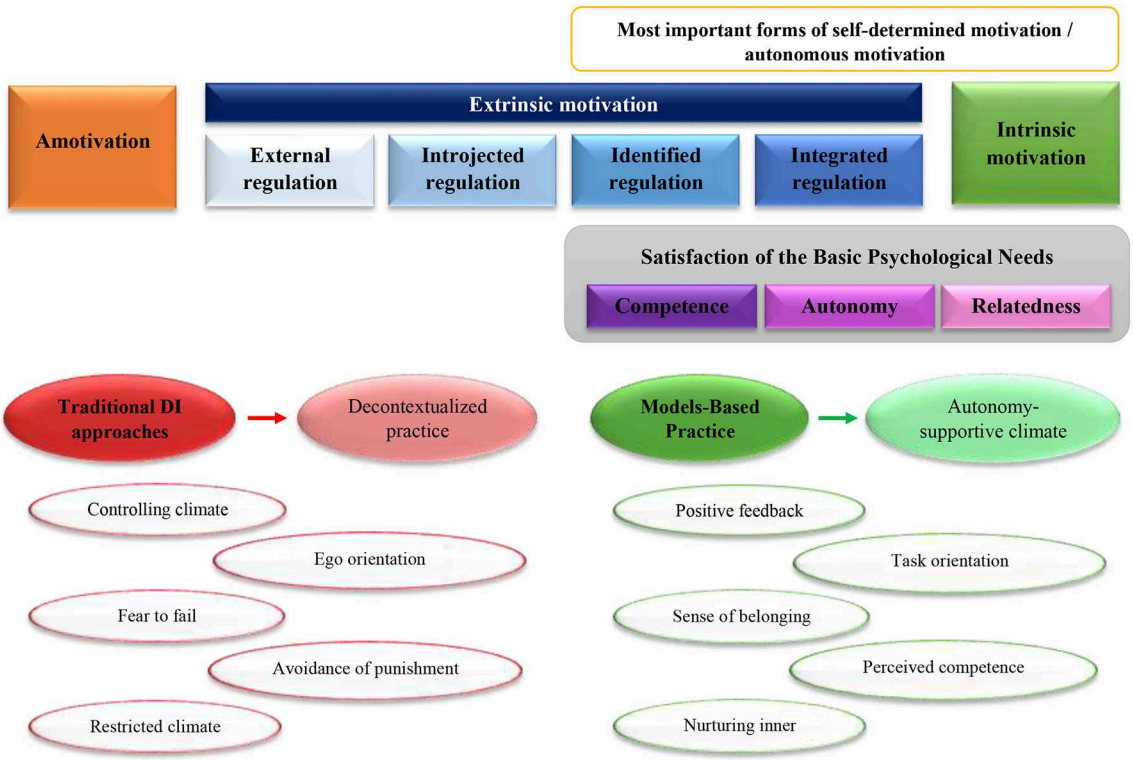


FIGURE 3 | How to promote motivation in PE context? Applying the SDT and the BPNs frameworks.

PE classes. In this sense, it was recently observed that MsBP, and specifically, GCA maximize the acquisition of the motor and sport competence among PE programs during sport literacy contents (González-Víllora et al., 2019). In this study, it was demonstrated that MsBP and autonomy-supportive classes also foster the self-determined motivation in children. This fact impacts directly on the engagement and adherence to maintain active lifestyle habits, e.g., go walking or joining to a futsal club because the student perceived a positive enjoyment when the futsal PE unit was implemented (Morgan et al., 2005).

As it is showed in **Figure 3**, the motivation continuum is not a stable characteristic of the human behavior (Ryan and Deci, 2017). It is influenced by external factors and can be changed positively or negatively over time.

In the continuum the most self-determined or autonomous types of motivation are (I) identified regulation, (II) integrated regulation and finally, (III) intrinsic motivation (please, see subsection *The Self-Determination Theory (SDT) and Basic Psychological Needs (BPNs)* to read one example of these kinds of regulation in an educational context). In this systematic review, it is observed how this kind of motivation can be supported by the implementation of MsBP. However, as Hastie et al. (2014) it is important to incorporate an autonomous supportive environment which surrounded the application of the MsBP. Indeed, as Gillison et al. (2013) highlighted, it is very important to satisfy the BPNs of the students giving informational feedback using a positive intonation, showing empathy and engage students to be involved in a game or activity, or provided a credible rationale of why the targeted activity or game is important (i.e., identified regulation).

On the other hand, every comparative study analyzed in this work highlighted that traditional DI approaches impact negatively on the most self-determined forms of motivation, that is to say, influence positively on the less self-determined forms of motivation (i.e., amotivation, external regulation and introjected regulation). Indeed, Ntoumanis et al. (2004) and Huhtiniemi et al. (2019) observed that students who do not perceive enjoyment in the PE classes (normally in traditional classes) are more likely to be amotivated. This fact would be worsened if students perceived less competence when they are involved in skill-based drills. For that reason, Mandigo et al. (2019) has recently observed that physical literacy and sport competence can be increased if both primary and secondary education students are engaged and exposed to multiple forms of physical and sport activities through MsBP such as TGfU in contrast to traditional sport specialization or stimulation of isolated and repeated games.

In summary, teachers (or coaches) should select the best pedagogical strategy according to the main features of the students, content, curriculum and contest. In this sense, PE teachers should focus on developing comprehensive students' physical literacy and *sport competence* through MsBP, but also they should be aware about the positive influence of this kind of strategies on the psychosocial variables that directly impact on

the students' self-determined motivation, and consequently on the adherence of active lifestyle.

CONCLUSIONS

This secondary research examines the impact of MsBP programs and autonomous supportive climates in PE on the student's psychosocial outcomes, including the level of motivation. Although more scientific literature is needed in this field, it is clearly observed that students' self-determined motivation increased when MsBP are implemented or when traditional DI sessions are carried out using a plethora of autonomous supportive pedagogical resources. What is more, MsBP are ideal pedagogical frameworks to produce significant increases of (I) the *sport competence* and (II) the self-determined motivation among PE students in contrast to traditional DI environments.

On the contrary, it is also observed that MsBP are not intrinsically pedagogical strategies to engage the practice of physical activities or sports beyond the PE classes. In this sense, models need (I) to be adapted to the characteristics and necessities of each context (including students, materials, contents, curricular elements, specific contexts, and teachers), and (II) to incorporate autonomous supportive pedagogical strategies to promote students self-determined motivation alongside the development of an optimal level of motor and sport competence, which enables students to have an active lifelong habits.

DATA AVAILABILITY STATEMENT

All datasets generated for this study are included in the manuscript/supplementary files.

AUTHOR CONTRIBUTIONS

MS-D and SG-V were involved in the conception and design of the systematic review and executed the meta-analysis. Firstly, MS-D elaborated the protocol registering in PROSPERO (https://www.crd.york.ac.uk/prospero/), once the rest of the authors (SG-V, JP-V, and GL-S) had reviewed and improved it. Finally, the four authors carried out the systematic search and write the article.

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*The following references marked with one asterisk (*) have been analyzed in **Table 1**. Additionally, the articles marked with two asterisks (**) have been quantitatively meta-analyzed in **Table 2**.

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frontiers in Psychology

BRIEF RESEARCH REPORT
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The Hardiness of Adolescents in Various Social Groups

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Hardiness is considered as one of the adaptation resources of personality to stressful situations, responsible for the mental health preservation. Adolescents as an age group is one of most susceptible to stress factors, so conducting research on the development of hardiness in adolescents becomes necessary. Due to difference in social conditions under which development of hardiness of adolescents takes place, the purpose of our research was to study the hardiness of adolescents included in different social groups: first group – athletes, students of sports schools, second – students of specialized schools for intellectually gifted individuals, third– students of regular schools. In total, 239 adolescents of 14–16 years old participated. The study revealed significant differences in the development of hardiness among all three groups of adolescents. The general and specific patterns of the development of hardiness components of adolescents in different social groups were identified. The article describes the main types of manifestation of hardiness and its components under different social conditions of activity and development in modern adolescents.

Keywords: hardiness, adolescents, social environment, activities, development

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INTRODUCTION

The problem of adaptation to the requirements of the social environment is particularly acute in adolescence, which is traditionally regarded as a crisis age (Kalashnikova and Petrova, 2017; Benzi et al., 2019; Morinaj and Hascher, 2019). The desire of adolescents to experience their own strength, to succeed and to assert themselves in the peer group is associated with various kinds of difficulties that can lead to inappropriate forms of behavior (Sobkin et al., 2005; Echazu and Nocetti, 2018). Because of this, more and more research is connected with the study of factors that ensure the development of hardiness, which is considered as the main adaptation resource of a person responsible for preserving the mental health and well-being of adolescents (Kiva et al., 2016; Oschepkov, 2017; Mishina, 2018).

According to the studied literature, various interrelated factors (genetic, social, age) of the controversial development of adolescents' hardiness are distinguished (Ivanova, 2013; Kormushina, 2016; Gorkovaya and Miklyaeva, 2017; Bezgodova et al., 2018). At the same time, most authors believe that the development of the hardiness of adolescents is determined to a greater degree by the social environment (Shvareva, 2010; Gorkovaya et al., 2015; Casagrande et al., 2018; Fokina et al., 2018; Guerra et al., 2019, etc.).

This is confirmed by a number of studies that prove the positive or negative impact of various social groups on the development of hardiness (Borzilova and Solonchenko, 2017; Kalashnikova and Nikitina, 2017; Nikitina, 2017; Melisbek and Bodnar, 2018). In particular, it proves the positive role of a happy family in the development of hardiness compared with the unfavorable one (Archakova, 2016; Gulyaeva and Myagkaya, 2017).

In a number of works it has been revealed that hardiness is more pronounced among adolescents involved in sports, creative, intellectual, or vocal activities, compared to ordinary schoolchildren (Sultanbaeva and Chertykov, 2014; Chernyavskaya and Shabanova, 2016; Plotnikov et al., 2017; Shumakova and Shamardina, 2018). Without disputing the significance of these studies it should be noted that they were conducted on a small sample and are rather local.

We believe that to study the role of the influence of the social environment on the development of the hardiness of adolescents, it is necessary, first of all, to determine the methodological position. In our opinion, this approach can be the social activity approach of the Russian psychologists – classics such as Ananyev (2007) and Rubinstein (2015), as well as the works of foreign researchers – Deci and Ryan (2000), Bandura (2004), and Seligman (2013).

The essence of this approach is that the influence of the social environment on the development of adolescents is always mediated by the type of activity that is leading for them and the conditions in which this activity is carried out. In the course of mastering activities and adapting to social conditions adolescents will develop the qualities that will be more necessary for carrying out activities and adapting to a specific environment. This methodological approach was the basis of our research presented in this article.

In determining hardiness, we rely on the work of Kobasa (1979) and Leontiev and Rasskazova (2006), who understand hardiness as the measure of personality's ability to withstand a stressful situation, maintaining internal balance without reducing success. It includes three autonomous components: commitment, control and challenge.

Commitment includes interest in their activities. The opposite phenomenon is detachment from social interests and life in general. Control implies the presence of their own beliefs, ideas, even in case of unwarranted success. The opposite phenomenon of control is helplessness, inability to defend one's opinion, to deny or insist on it. Challenge is based on a person's ability to be aware of his/her actions and decisions, being aware of the degree of risk in a given case at the same time (Leontiev and Rasskazova, 2006).

Based on the foregoing, it is possible to consider the above presented approach in the form of a scheme, according to which the development of the hardiness of adolescents to a greater extent is determined by activity (**Figure 1**).

The methodological basis of the study allowed us to identify three social groups of adolescents, who, due to a certain specificity of the performing activity may differ in terms of the level of development and components of hardiness. The number of such groups included adolescents involved in sports schools and schools of the Olympic reserve, making up the first group, students of gymnasiums, lyceums as the second group, students of secondary schools made up the third group.

The specificity of each group is determined by the dominant orientation of the activity in which they are included. In the first and second group there were either achievements in sports activities or academic achievements, in the third group students were more focused on their individual needs. The purpose of the study was to identify the similarities and differences, the influence of various social environments on the development of hardiness of adolescents and its components (commitment, control, and challenge).

General Hypothesis

It is assumed that the inclusion of adolescents in different social conditions of life can affect the development of their level and components of hardiness (commitment, control, challenge).

It is assumed that obtaining objective knowledge on the impact of social conditions and activities on the development of hardiness may be helpful for the development of more effective strategies for working with adolescents and improving their well-being and mental health.

Particular Hypotheses

Sporting activity takes place in conditions of real competition, aiming at both immediate and distant goals, therefore it is associated with stress-competitive situations, with the need to overcome difficulties, so it can be assumed that the existence of hardiness, on the one hand, is one of their main conditions of success, and therefore all components of hardiness are of high importance and must be developed at a sufficiently high level.

Learning activity in gymnasiums, lyceums and specialized research centers is focused on high academic achievements with orientation on future perspectives, it seems to be impossible without self-control, and therefore we can assume that this component must be high.

At regular school adolescents are in more natural conditions of life, they are more left to themselves, have fewer commitments and more free time to meet their individual needs. At the same time lack of sufficiently clear and long-term goals, peculiar for the other two groups of adolescents, will affect the development of hardiness components. So, the specificity of each group is determined by the dominant orientation of the activity in which they are included. In the first group these are sports results, in the second group the main is orientation is academic knowledge, while in the third group students are more focused on meeting their individual needs.

MATERIALS AND METHODS

Research Design

The study was conducted on the basis of the Olympic Reserve School, the "Yunost" Children and Youth Sports School, the Specialized Educational and Specialized Educational and Scientific Center (lyceum) for Gifted Schoolchildren, the Gymnasium with in-depth study of English and several secondary schools in Yekaterinburg. The research Ethics Committee of the Ural Federal University of Yekaterinburg approved this study. Written informed consent was obtained from the parents/legal guardians of all participants. The distribution of participants by gender is, in our opinion, very important in terms of its significance for determining behavior and readiness to overcome stress in the social environment

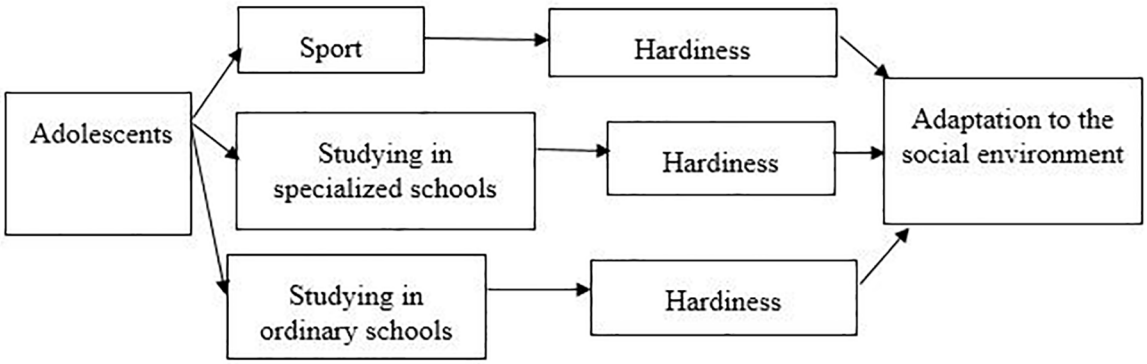

FIGURE 1 | Model of the influence of the social environment on the development of hardiness of adolescents.

(Gorkovaya et al., 2015; Kalashnikova and Petrova, 2017). The study involved 239 adolescents aged from 14 to 16 years, 80 adolescents-sportsmen (44 male and 36 female), 79 adolescents – lyceum students (39 male and 40 female), 80 adolescents- schoolchildren (37 male and 43 female).

Measures and Statistical Analysis

As a research method, we selected testing of adolescents from different social groups of 14–16 years old. To study hardiness, we used a questionnaire developed by the American psychologist Salvatore Maddy and adapted by Leontiev and Rasskazova (2006). The questionnaire consists of 45 questions, allow you to assess the level of hardiness, as well as indicators of 3 subscales (commitment, control, and challenge). The reliability determined for this investigation was $\alpha = 0.90$.

To compare hardiness indicators the SPSS-23 program (Students *t*-test and the Kruskal–Wallis test) was used.

TABLE 1 | The level of development of hardiness of adolescents of different social groups.

Samples parameters	Number of participants with different level of hardiness (%)		
	Low level	Middle level	High level
For the sample as whole	14.2%	52.9%	32.9%
Adolescents girls	20.3%	54.3%	25.4%
Adolescents boys	7.3%	52.6%	40.1%
Adolescents- sportsmen	2%	53,5%	44.5%
Adolescents Lyceum students	15%	60%	25%
Adolescents-schoolchildren	23%	46%	31%
Boys athletes	2.2%	55.6%	42.2%
Lyceum students boys	5.1%	66.7%	28.2%
School boys	16.2%	32.5%	51.3%
Girls athletes	2.7%	54%	43.3%
Lyceum students girls	25%	52.5%	22.5%
Schoolgirls	31.7%	56.3%	12%

RESULTS

In the course of the study, we identified differences in the level of development of hardiness in adolescents of different social groups. The levels of development of resilience were determined in accordance with the data from the Leontiev and Rasskazova (2006), according to which the low level is less than 60 points, the average level is between 60 and 90 points, and the high level is above 90 points. The results of the study are presented in **Table 1**.

According to the data in **Table 1**, it is possible to note the differences in the indices of the development of hardiness both between three social groups and in the gender indicators within each group. First of all, talking about each group as a whole, we can conclude that 44.5% of adolescent -sportsmen have high level of hardiness, and only 2% have low rates. At the same time, if we talk about gender indicators, then indicators of the level of development of hardiness are almost the same in girls and boys.

The data obtained show that the competitive environment with a focus on achievement and a specific result, ensures the development of hardiness of adolescent- sportsmen at a sufficiently high level. In the group of lyceum students and schoolchildren the data obtained show similar to adolescent-sportsmen average indicators of hardiness. Number of adolescents with a high level (25%) is reduced and there is a clear increase in adolescents with a low level (15%). Moreover, the low values of hardiness are more pronounced in female lyceum students.

The analysis of the questionnaires of schoolchildren with high indicators of hardiness revealed interesting facts, in particular, young students of physical and mathematical classes, winners of scientific competitions, and young men of gymnasiums, but successfully combining sports with educational achievements, have high rates.

Thus, the findings confirm the fact that the competitive environment and focus on future achievements will increasingly develop the hardiness of adolescents. Relating the difficulties of adaptation in the gender aspect, it is obvious that in the academic environment girls find it harder to adapt.

There is a significant difference in the manifestation of hardiness in the two groups: only 22.5% of lyceum girls' students

have high values vs. 43.3% in female athletes, 25% of them have low values vs. 2.7% in female athletes.

Thus, it can be concluded that the development of hardiness in the groups of adolescents of lyceum students differs from the group of adolescents-sportsmen.

In the third social group of adolescents –schoolchildren, the peculiarities of manifestation of hardiness are also noted, compared with the first and second groups. First, the level of high development of hardiness in this sample is lower (31%) than in the sample of adolescents sportsmen (44.5%), but slightly higher than that of adolescents lyceum students (25%).

At the same time, these high values are provided primarily by data on boys schoolchildren (51, 3%), which is higher than in other groups. The data obtained can be explained on the basis of questionnaires of adolescents with high rates, so they all have hobbies, in particular, go in for sports (recreational sports), but for them it's more a type of free leisure, not a focus on results, and secondly, they are quite independent in choosing activities and achieving their short-term goals, thirdly, they do not bear the burden of high responsibility imposed by adults.

Along with the pluses, we see that the number of adolescents schoolchildren with low values is also quite large (23%). This means that a fairly large group of adolescent schoolchildren do not develop hardiness, most likely due to the fact that these students are not involved in active forms of creative and sports activities. Low values throughout the sample were observed in 13.5% of adolescents, while it can be noted that the number of girls with a low level of hardiness exceeds boys, respectively 20, 3% and 7, 3%.

The group with low values includes not only girls schoolchildren (31.7%), but also boys schoolchildren (16.2%), and this means that a fairly large group of adolescents schoolchildren does not develop hardiness due to the fact that there are no conditions for its manifestation, these schoolchildren are not involved in active forms of creative and sports activities. Thus, the obtained data confirm the fact that a competitive environment and a focus on sporting achievements will contribute more to the development of the hardiness of adolescents than the academic environment focused on academic achievements, even if they are quite high. Thus, it can be concluded that all social groups

TABLE 2 | Data on hardiness and its components (commitment, control, challenge) in the group of adolescents-sportsmen and adolescents-lyceum students.

	Mean value		Standard deviation			
	Adolescents-sportsmen	Adolescents-lyceum students	Adolescents-sportsmen	Adolescents-lyceum students	*t*	Cohen coefficient
Commitment	35,4875	29,0127	7,23388	7,70530	5,461**	0.86
Control	33,0000	31,4684	7,30528	8,12693	1,250	0.27
Challenge	18,7375	17,4177	3,94180	5,17293	1,811	0.24
Hardiness	87,0250	77,5063	15,38862	18,34560	3,542**	0.60

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

TABLE 3 | Data on hardiness and its components (commitment, control, challenge) in the group of adolescents lyceum students and adolescents schoolchildren.

	Mean value		Standard deviation			
	Adolescents-lyceyists	Adolescents-schoolchildren	Adolescents-lyceyists	Adolescents-schoolchildren	*t*	Cohen coefficient
Commitment	29,0127	33,3500	7,70530	8,73535	–3,321**	0.53
Control	31,4684	27,8500	8,12693	10,43254	2,441**	0.44
Challenge	17,4177	13,2125	5,17293	4,68959	5,368**	0.88
Hardiness	77,5063	74,4625	18,34560	19,97020	1,001	0.16

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

TABLE 4 | Gender differences on hardiness and its components (commitment, control, challenge).

	Mean value		Standard deviation			Cohen coefficient
	Boys	Girls	Boys	Girls	*t*	
Commitment	33,9832	31,2231	8,15733	8,31914	2,595**	0.48
Control	32,6050	28,8926	8,20316	9,30663	3,276**	0.50
Challenge	16,8487	16,0000	5,31490	5,05140	1,268	0.24
Hardiness	83,7479	75,4545	17,82695	18,78874	3,507**	0.59

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

have conditions for the development of the hardiness of adolescents, but it is the sports environment that has the most significant influence on its development. The presented results can be supplemented with data on the study of the development of components of hardiness, such as commitment, control, and challenge. To identify differences in the development of components of hardiness among adolescents from different social groups, mathematical data processing methods were used.

Analysis of the development of components of hardiness in the groups of adolescents – sportsmen and adolescents – lyceum students, presented in **Table 2**, suggests that there are significant differences in the component of commitment and general hardiness in these groups.

There are no significant differences in the components of control and challenge, this fact indicates that academic activities, as well as sports activities, contribute to the development of these components of hardiness. Cohen coefficient shows high effect for commitment (0.86) and middle effect for hardiness (0.60).

We can see in **Table 3** significant differences in control and challenge components in the studied groups. The indicator of hardiness, "control," is the conviction of adolescents that their efforts depend on personal results and they can influence the outcome of what is happening, even if this influence is not absolute and success is not guaranteed. Adolescents with a developed component of control feel that they choose their own activity, their own way. Thus, this suggests that in the framework of sports and academic activities, the development of control and challenge is higher than in the framework of general academic activities, whereby the development of hardiness is higher among adolescents-sportsmen and adolescents-lyceum students. Most likely, this is due to the fact that competition and a focus on achieving high sports or academic results require a greater manifestation of effort and readiness to work in conditions of both success and non-success. Cohen coefficient shows middle effect for commitment and control (0.53, 0.44) and high effect for challenge (0.88).

The obtained data confirmed the hypothesis put forward by us that in conditions of sports activity in adolescents the level of development of hardiness is higher than that of adolescents lyceum students and adolescents schoolchildren. At the same time, it can be noted that the influence of the academic environment and educational activities on the development of control and challenge in adolescents is quite high. Regarding adolescent schoolchildren, it can be said that in this environment there are conditions for developing the hardiness of adolescents, but only if they are included in active forms of leisure (sports, social, and creative groups).

Significant gender differences in commitment, control and general hardiness have been revealed. Boys in general have priority in **Table 4**. It can be concluded that it is the academic environment that is less conducive to the development of the hardiness of girls, while in the sports environment conditions are almost equal. Cohen coefficient shows middle effect for commitment and control (0.48, 0.50) and high effect for hardiness (0.59).

In fact, our data confirm studies indicating the important role of the social environment in the development of endurance of adolescents (Sultanbaeva and Chertykov, 2014; Archakova, 2016; Chernyavskaya and Shabanova, 2016; Malkin and Rogaleva, 2016; Borzilova and Solonchenko, 2017; Gulyaeva and Myagkaya, 2017; Plotnikov et al., 2017; Shumakova and Shamardina, 2018; Straub, 2019).

In our opinion, this can be explained that different types of activities do not equally affect the satisfaction of the needs for autonomy, competence and for relatedness (Deci and Ryan, 2000) and the achievement of self-efficacy (Bandura, 2004; Rubinstein, 2015; Nikitina, 2018; Rogaleva et al., 2018).

The data obtained can be used to develop strategies for educational programs for the correction of social conditions for the development of hardiness in adolescents of different social groups, ensuring their well-being. In particular, for adolescents of all social groups, one of the main conditions for increasing hardiness is the presence of involvement and interest in the implementation of activities or social interaction.

The second important aspect is the need to set short and long-range goals, which is typical for sports activities, and academic orientation schools and that are not sufficiently present in regular schools. Target attitudes and action to achieve them, can contribute to the development of self-control, risk-taking, acceptance of success and failure as an important experience that can increase adolescent confidence.

The third important component of the strategy for working with adolescents is to develop risk preparedness or the desire to actively acquire knowledge from experience for later use, this is achieved only if the substantive component of programs provides for linking activities with future professional activities, or with those skills which may be useful in mastering a particular profession, or have some real practical result that a teenager can be proud of and perceive it as kind of achievement significant for the future.

CONCLUSION

Thus, our study confirms the hypotheses put forward, according to which the development of the hardiness of adolescents depends on the activity they perform and the conditions in which the activity is carried out. The obtained new data can contribute to the construction of a strategy for working with adolescents and various social groups to achieve their well-being. In this regard, further studies may be aimed at studying the hardiness of adolescents in the context of availability of conditions for satisfying their needs in autonomy, competence and significant relationships, which are considered as factors of their well-being.

DATA AVAILABILITY STATEMENT

All datasets generated for this study are included in the article/supplementary material.

ETHICS STATEMENT

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

AUTHOR CONTRIBUTIONS

VM, LR, AK, and NK conceived the hypothesis of this study, and wrote the manuscript with significant input from VM. VM and LR participated in data collection. All authors analyzed the data, contributed to data interpretation of the statistical analysis, and read and approved the final manuscript.

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Basic Psychological Needs and Sports Satisfaction Among Brazilian Athletes and Coaches: The Mediating Role of the Dyadic Relationship

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Even though sport satisfaction has proved an important element for youngsters to keep practicing sports, little is known on the sport satisfaction of coaches. Moreover, the coach-athlete relationship is acknowledged as a key element for sport success, but whether its importance is the same for coaches and athletes is yet to be investigated. Our study analyzed the mediating role of the coach-athlete relationship in associating the satisfaction of basic psychological needs and sport satisfaction of Brazilian coaches and athletes. 364 coaches and athletes participated in the study representing 182 dyads from different sports according to the following instruments: Basic Needs Satisfaction Sport Scale (BNSSS), Coach-Athlete Relationship Questionnaire, athlete and coach versions (CART-Q), and the Athletic Satisfaction Questionnaire (ASQ). Data analysis followed a Structural Equation Modeling (SEM) with a significance level of $p < 0.05$, generating results in which the mediating model for coaches was not adequately fit, while the direct model, without mediation, was adequately fit and explained 48% of sport satisfaction variance. For athletes, the mediating model has shown adequate fit and explained 81% of the sport satisfaction variance, leading us to conclude that the quality of the coach-athlete relationship can be considered a determining factor for the satisfaction of young Brazilian athletes' basic psychological needs as well as sport satisfaction, but proved not as relevant to their coaches.

Keywords: interpersonal relationships, satisfaction, motivation, sport, psychological need

INTRODUCTION

Studies in the high-performance sport context have intensively focused on factors to contribute to the well-being of athletes considering that the environment favors tense situations and emotional alterations (Balaguer et al., 2012). In this context, the Theory of Self-determination (TAD) points out to the satisfaction of basic psychological needs (autonomy, competence, and relationships) as key factors to achieve well-being by encompassing universally essential elements to the integrity

of human development (Deci and Ryan, 2012). Recent studies have indicated that when feeling independent to control emotions and truly connected to a social environment through the support of their coaches, athletes are more likely to reach self-determined motivation and consequently feel satisfied with their sports (Deci et al., 2013; Reynoulds and Mcdonough, 2015; Gurrola et al., 2016).

Such evidence is supported by the micro theory of Basic Psychological Needs (Deci and Ryan, 2012), which states that social environments conducted by significant persons (such as teachers, coaches, parents) favor the satisfaction of athletes' basic needs for providing them with psychological experiences that positively affect their motivation and performance (Balaguer et al., 2012; Deci et al., 2013; González et al., 2015). In contrast, poorly adapted environments can frustrate the need of youngsters and consequently lower their participation in sports and sense of personal fulfilment, in addition to generate both emotional and physical fatigue (Bartholomew et al., 2011; Gurrola et al., 2016).

Recent studies have pointed out that athletes' satisfaction with team structural and procedural aspects, such as group environment and sport experiences, is associated with the optimization of both cognitive and emotional performance (Riemer and Chelladurai, 1998; Jowett and Poczwardowski, 2007; Lee et al., 2017; Ntomali et al., 2017; Rocchi and Pelletier, 2018). Additionally, athletes' satisfaction favors the development of group cohesion (García-Calvo et al., 2014; Kim and Cruz, 2016), intrinsic motivation (Mageau and Vallerand, 2003; Cranmer and Sollitto, 2015), establishment of effective communication (Sullivan and Gee, 2007; Kao and Tsai, 2016), and well-being (Kim and Cruz, 2016; Jowett et al., 2017).

In this perspective, we highlight the relevance of sport satisfaction to the well-being and performance of athletes, which has been explained according to variables such as leadership styles (Kao and Tsai, 2016; Kim and Cruz, 2016; Ntomali et al., 2017), social support (Cranmer and Sollitto, 2015), and motivational environment (Bekiari and Syrmpas, 2015). The behavior of sport leaders has proved a determinant role in athletes' satisfaction (Kao and Tsai, 2016) and social support is important when transmitting information from coaches for contributing to the emotional support of athletes (Cranmer and Sollitto, 2015). In addition, a motivational environment acts as catalyst for athletes' motivation regarding their engagement in sports and consequently their satisfaction with sport experiences (Bekiari and Syrmpas, 2015).

In an effort to understand how motivation and sport satisfaction relate to positive experiences and the optimization of athletes' performance (Vallerand, 2000; Kao and Tsai, 2016; Lee et al., 2017), our study bases on the TAD to investigate natural or intrinsic human tendencies to behave in an efficient, healthy manner. The TAD remains one of the most commonly used theoretical approaches and approaches the reasons leading an individual to initiate, remain or quit their activities (Ryan and Deci, 2017). The micro theory of Basic Psychological Needs predicts universally essential elements for human development, motivation, integrity, and general well-being emerging upon the satisfaction of basic psychological needs regarding autonomy, competence, and personal relationships (Ryan and Deci, 2017).

Specifically, autonomy corresponds to the individual's ability to feel in control of their actions and decisions. Competence refers to the need of an individual to feel efficient enough to reach their desired results. Personal relationships are based on an innate capacity of individuals to perceive themselves truly connected to a social environment (Deci and Ryan, 2012; Reynoulds and Mcdonough, 2015). Researches indicate that athletes who see themselves as able to manage their actions within the sport context feel physically and psychologically able to performe their functions and feel accepted in their teams, in addition to being more likely to feel intrinsically motivated, thus facilitating the perception of sport satisfaction (Deci et al., 2013; Bekiari and Syrmpas, 2015; Reynoulds and Mcdonough, 2015; Gurrola et al., 2016; Monteiro et al., 2018; Vieira et al., 2018).

However, despite the important impact that motivation can have on athletes' satisfaction (Mageau and Vallerand, 2003; Bekiari and Syrmpas, 2015; Lee et al., 2017), most studies have focused on athletes (Cranmer and Sollitto, 2015; Kao and Tsai, 2016; Kim and Cruz, 2016; Ntomali et al., 2017) rather than the perspective of sport coaches (Lorimer, 2009; Lorimer and Jowett, 2009; Kim and Cruz, 2016). It is known that even more important than the isolate perception of athletes or coaches, their combined views, characterized as dyads, can provide more efficient and thorough information on sport experiences (Lorimer and Jowett, 2009; Jowett, 2017).

The quality of the coach-athlete relationship is considered a central axis in the sport context defined as a combination of inter-relations involving thoughts, feelings, and behaviors of coaches and athletes (Jowett and Poczwardowski, 2007; Jowett, 2017). Such relationship has been studied from the integrated model 3+1Cs (Jowett and Poczwardowski, 2007) incorporating affective (closeness), cognitive (commitment), and behavior (complementarity) components of the dyad, in addition to the degree to which athletes' and coaches' perceptions interconnect (co-orientation) (Rhind and Jowett, 2012).

Studies have reported that close dyadic relationships based on respect, affection, and commitment benefit the development of athlete excellence contributing to the personal growth of both athletes and coaches (Cheuczuk et al., 2016; Davis et al., 2018; Avci et al., 2018). In contrast, dyads characterized by distance and absence of commitment imply interpersonal conflicts, exhaustion, dissatisfaction, and lack of interest inside and outside the sport context (Jowett and Lavalee, 2007; Antonini et al., 2011; Li et al., 2015; Jowett and Shanmugam, 2016; Davis et al., 2018).

Our study considers the importance of motivational aspects for athletes' satisfaction and the impact of social psychology in the sport context (Jowett and Poczwardowski, 2007) and seeks to improve the scientific knowledge discussing the implications in the dyadic relationships to promote positive psychological aspects for coaches and young Brazilian athletes taking into account affective, cognitive, and behavior aspects, representing the gap investigated in our study *per se*. The fostering of harmonious sport environments generates potential literature evidence regarding athletes' development (Jowett, 2017;

Ryan and Deci, 2017); however, it is yet to be clarified whether such development is also applicable to coaches (Lorimer, 2009; Lorimer and Jowett, 2009; Kao and Tsai, 2016).

Thus, the analysis of positive psychological variables in the perspective of the main social actors in the sport context (coach and athlete) enables a larger view on the personal and interpersonal factors that focus on their well-being and performance beyond the perspective of isolated influences from coaches' behavior. Considering these remarks, our goal was to investigate the mediating impact of the coach-athlete relationship on the association between basic psychological needs and athletes' satisfaction of coaches and young Brazilian athletes.

Hypothesis

Our first hypothesis involves a positive association between sport motivation, characterized by the satisfaction of basic psychological needs, and sport satisfaction for both coaches and athletes considering that autonomous and competent individuals who also feel connected to their peers are more likely to feel satisfied (González et al., 2015). Our second hypothesis considers that coach-athlete relationship will increase the impact of motivation over sport satisfaction since positive coach-athlete relationships may improve these individuals' physical and psychological well-being providing them with better performance and satisfaction with the sport (Jowett and Shanmugam, 2016).

MATERIALS AND METHODS

Participants

Aiming at representing the dyadic relationships, we calculated the sample size by considering the limiting number of coaches participating in the competition, which was performed for finite samples with a 95-confidence level and a five-percent confidence interval (Richardson et al., 2012). We included a total of 540 coaches to insure the participation of at least 159 dyads (n = 159 coaches; n = 159 athletes). Inclusion criteria as follows: (1) having qualified for the national stage of the main youth sporting event in Brazil, the Youth School Games; (2) a coach-athlete relationship of over 3 months (Hampson and Jowett, 2014; Sagar and Jowett, 2015; Nicholls and Perry, 2016). We selected the athletes intentionally after sampling the coaches. Based on the inclusion criteria for the coaches – team and individual sport types – coaches were requested to indicate an athlete who met criterion 3 (a 3-month old relationship) to constitute the dyad.

A total of 189 dyads participated in the study (378 subjects), however, seven pairs were excluded for having answered the questionnaires incorrectly, which generated a final total of 364 individuals representing 182 dyads. The average age in the samples was 40.47 ± 9.7 years old for coaches and 16.24 ± 0.81 years old for athletes. The individuals represented all five regions of Brazil and 13 different sports: volleyball (n = 30; 16.5%), judo (n = 30; 16.5%), basketball (n = 29; 15.9%), handball (n = 23; 12.6%), track and field (n = 22; 12.1%), futsal (n = 12; 6.6%), swimming (n = 12; 6.6%), Olympic wrestling (n = 7; 3.8%), table tennis (n = 5; 2.7%), chess (n = 5; 2.7%), cycling (n = 3; 1.6%), rhythmic gymnastics (n = 3; 1.6%), and beach volleyball (n = 1; 0.5%).

Measures

We used the Brazilian version of the Basic Needs Satisfaction in Sport Scale (Nascimento Junior et al., 2018), originally developed by Ng et al. (2011), to investigate the satisfaction of basic psychological needs of coaches and athletes. Differently from the original scale (which has five dimensions: competence, choice, internal perceived locus of causality, volition, and relatedness), the Brazilian scale is constituted of only one general dimension of autonomy. It was pointed out as a necessary change during the various phases of the instrument adaptation to the Portuguese language, such as at the content analysis phase and factor structure analysis (EFA and CFA). In the EFA, the authors tested different models in order to find the best fit since the content analysis revealed inconsistencies. Thus, the instrument is composed of 12 items distributed in three dimensions: competence (item 6 "I feel that I am good at my sport"), autonomy (item 1 "In my sport, I fell that I am pursuing my personal goals") and relatedness (item 4 "There are people in my sport who care about me"), which is available for reader consultation (Nascimento Junior et al., 2018). Answers are given in a 7-point Likert scale ranging from 1– "Not true at all" to 7– "Very true." Scale Confirmatory Factor Analysis (CFA) presented acceptable fit for athletes [$X^2(51) = 82.137$; $p = 0.004$; $X^2/df = 1.611$; CFI = 0.94; GFI = 0.93; TLI = 0.93; RMSEA = 0.06; $P(\text{rmsea} < 0.05) = 0.268$]. We submitted the scale to a process of content validation in order to adjust its items for coaches, which generated acceptable Content Validity Coefficient (CVC = 0.91). CFA analysis for coaches also revealed acceptable fit [$X^2(51) = 104.208$; $p = 0.001$; $X^2/df = 2.043$; CFI = 0.93; GFI = 0.92; TLI = 0.90; RMSEA = 0.07; $P(\text{rmsea} < 0.05) = 0.023$].

To measure coaches' and athletes' direct perspective of their social relationships, we adopted the Portuguese version of the Coach-Athlete Relationship Questionnaire (Vieira et al., 2015 athlete version – $\alpha > 0.70$; Contreira et al., 2019 coach version – $\alpha = 0.86$). The scale was originally developed by Jowett and Ntoumanis (2004) and comprises 11 items assessing the following three dimensions: closeness (item 3 "I like my coach/athlete"), commitment (item 2 "I am committed to my coach/athlete"), and complementarity (item 10 "In my training with my coach/athlete, I am willing to do my best") Items answered in a seven-point Likert scale ranging from 1-"Strongly disagree" to 7-"Strongly agree." CFA revealed instrument's acceptable fit for athletes [$X^2(39) = 93.926$; $p = 0.001$; $X^2/df = 2.408$; CFI = 0.90; GFI = 0.92; TLI = 0.87; RMSEA = 0.08; $P(\text{rmsea} < 0.05) = 0.04$] and coaches [$X^2(37) = 76.284$; $p = 0.001$; $X^2/df = 2.062$; CFI = 0.90; GFI = 0.94; TLI = 0.88; RMSEA = 0.07; $P(\text{rmsea} < 0.05) = 0.04$].

We used the version of the (Borrego et al., 2010) Athlete Satisfaction Questionnaire (Riemer and Chelladurai, 1998) validated for the Portuguese language. This instrument assesses the level of athletes' satisfaction with their sport experiences and is composed of 53 statements answered in a Likert scale ranging from 1-"Not at all satisfied" to 7-"Extremely satisfied," encompassing a 15-level scale of satisfaction. In this study, we used a shorter 11-item version that assesses only the

following three dimensions: training and instruction (item 7 "The training that I receive/give from/to my coach/athlete regarding technique and tactics of my position"), individual performance (item 1 "The level on which my performance goals were reached during the season"), and personal treatment (item 11 "How my coach/athlete supports me"), regarded as directly relevant for the coach-athlete relationship study (Jowett and Don Carolis, 2003; Jowett, 2008; Lorimer, 2009; Lorimer and Jowett, 2009). This same short version of the questionnaire had been used in a previous research involving coaches and athletes (Jowett, 2008; Lorimer, 2009; Jowett and Nezlek, 2011). The scale CFA showed acceptable fit for athletes [$X^2(41) = 69.852$; $p = 0.003$; $X^2/df = 1.704$; CFI = 0.95; GFI = 0.94; TLI = 0.93; RMSEA = 0.06; P(rmsea < 0.05) = 0.198]. With the help of a specialists committee, a version of the instrument was adapted for coaches and generated a satisfactory content validity (CVC > 0.80). Coach-version CFA also revealed acceptable fit indices [$X^2(32) = 98.184$; $p = 0.001$; X^2/df = 3.068; CFI = 0.92; GFI = 0.90; TLI = 0.90; RMSEA = 0.09; P(rmsea < 0.05) = 0.001].

Procedure

This study was approved by the Ethics Committee of a Brazilian university under statement number 1.324.411/2015. All participants and legal representatives had read and signed an Informed Consent Term. Data gathering occurred during the Youth School Games, regarded as the most important competition for athletes at this age group in the country. We collected the data at the locations where the competitions were being held as well as in individuals' accommodations according to their availability. The individuals answered the questions in group, but filling the questionnaire individually, averaging 20 min per person. Data collection with athletes and coaches occurred throughout the competition held in November 2015.

Data Analysis

Preliminary Analysis

We performed an exploratory data analysis with descriptive statistics as mean (x), standard deviation (sd). We compared the BPN satisfaction, athletics satisfaction and CAR between athletes and coaches through an independent student t-test ($p < 0.05$). All analyses were performed using Amos 22.0.

Main Analysis

Our main goal was to verify whether CAR mediated the relationship between BPN satisfaction (independent variable) and athlete's satisfaction (dependent variable) using a Structural Equation Modeling (SEM) on software Amos 22.0, following the two-step model building approach recommend by Anderson and Gerbing (1988). The first step involves testing the measurement model through a Confirmatory Factor Analysis (CFA), while in the second step the hypothesized structural model is tested.

The internal consistency of the measurement model (Step 1) was assessed by composite reliability (CR) (Hair et al., 2005), while average variance extracted (AVE) were estimated to assess convergent validity (Fornell and Larcker, 1981). A CR equal or higher than 0.7 and an AVE equal or higher than 0.5 are considered reliable and valid constructs (Fornell and Larcker, 1981). Discriminant validity was established whenever AVE for each construct exceeded the squared correlations between the construct in question and any other construct (Fornell and Larcker, 1981).

Before the main analysis, we verified the data for normality, missing values, and outliers for all study variables following the procedure outlined by Tabachnick and Fidell (2013). Examination of skewness and kurtosis for all variables indicated univariate normality based on the cut-off values of skewness < 3.0 and kurtosis < 10.0 (Kline, 2016). Analysis of Mardia's multivariate coefficient (Athletes = 38.62; Coaches = 52.35) indicated that the data distribution derived from multivariate normality, which justified the use of the Bollen-Stine bootstrap procedure to obtain a corrected Chi-squared value (Athletes – $p = 0.194$; Coaches – $p = 0.005$) of the estimated coefficients for the Maximum Likelihood Estimator (Bollen and Stine, 1993). After excluding seven pairs (coaches and athletes), no missing data was identified. We verified the occurrence of outliers using the Square Mahalanobis distance (D^2) since the absence of such cases is a prerequisite for this analysis.

We used several fit indices to assess the model fit according to Hu and Bentler (1999) recommendations: chi square ($\chi 2$), Normalized Chi-Square ($\chi 2$/df), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and its associated ninety-percent Confidence Interval (CI). CFI and TLI values close to or above 0.95, RMSEA values close to or below 0.08, and the lower end of 90% CI of the RMSEA containing the value of 0.05 represent an excellent fit to the data for the hypothesized model (Hu and Bentler, 1999). Furthermore, we used these indices for both Step 1 and Step 2. Fit quality for the structural model (Step 2) was also assessed through its factor loadings (FL) and items individual reliability (Marôco, 2010). Based on Kline's recommendation (2016), the reference for path interpretation included small effect below 0.20; medium effect between 0.20 and 0.49; and large effect above 0.50 ($p < 0.05$).

Mediation Analysis

In order to test the theoretical model proposed for the study, the mediation effects were verified by the indirect effects (Williams and MacKinnon, 2008). Bias-corrected bootstrapped point estimates for the indirect effects of the independent variable on the dependent variable were estimated, considering 95% confidence intervals. Significant indirect effects were considered (at alfa = 0.05) if its 95% confidence intervals does not include zero. Bias corrected and accelerated intervals supported by a 1000 samples bootstrapping were used to make inferences. Bootstrapping procedures have been recommended Williams and MacKinnon (2008) as more efficient and powerful detecting indirect effects in smaller samples.

RESULTS

Descriptive Results

The brazilian coach and athlete sociodemographic profile are shown in **Table 1**. Most of the coaches were male (82.4%),

TABLE 1 | Sociodemographic profile of Brazilian coaches and athletes (n = 182 dyads).

Variables	*F*	(%)
Gender		
Coaches		
Male	150	82.4
Female	32	17.6
Athletes		
Male	88	48.4
Female	94	51.6
Type of Sport		
Individual	87	47.8
Teams	95	52.2
Coach-athlete dyads		
<1 year	07	3.8
1–5 years	114	62.6
>5 years	51	28.0
Years experience		
Coaches		
<5 years	08	4.4
5 a 10 years	36	19.8
>10 years	135	74.2
Athletes		
<1 year	02	1.1
1 a 5 years	87	48.1
>5 years	84	46.4
Region of Brazil		
South	23	12.6
Southeast	25	13.7
West center	28	15.4
Northeast	62	34.1
North	43	23.6

Source: the authors.

TABLE 2 | Coach-athlete relationship, basic psychological needs and sport satisfaction comparison between coaches and athletes (n = 182 dyads).

Variables	Coaches *X* (SD)	Athletes *X* (SD)	*P*
CAR			
Closeness	6.54 (0.84)	6.69 (0.56)	**0.03***
Commitment	6.24 (0.81)	6.16 (0.84)	0.54
Complementarity	6.54 (0.61)	6.52 (0.58)	0.08
BPN			
Competence	6.17 (0.76)	5.97 (0.80)	**0.01***
Autonomy	6.52 (0.63)	6.66 (0.55)	**0.01***
Relatedness	5.84 (0.95)	6.30 (0.82)	**0.01***
ST			
Training-instruction	6.18 (0.74)	6.41 (0.77)	**0.01***
Individual performance	5.88 (0.77)	5.81 (0.83)	0.58
Personal treatment	6.31 (0.67)	6.47 (0.63)	**0.01***

*Independent sample t-test (*p < 0.05). CAR (Coach-athlete relationship); BPN (basic psychological needs); ST (sport satisfaction). Source: the authors. The values in bold correspond to the significance level of the comparisons made. These values showed statistically significant differences between the groups.*

whereas most of athletes were female (51.6%). Over half of coach-athletes dyades (62.6%) had one to 5 years of relationship. The majority of coaches has more than 10 years in the field (74.2%), while most athlete showed 1–5 years experience (48.1%).

Table 2 shows the descriptive data for the main variables in the study. Athletes and coaches had different perceptions only for closeness, with athletes (6.69 ± 0.56) perceiving higher levels than coaches (6.54 ± 0.84) (p = 0.03). Regarding the basic needs =, we found that coaches (6.17 ± 0.76) felt more competent than athletes (5.97 ± 0.80) ($p < 0.01$), while athletes presented higher autonomy (6.66 ± 0.55) and relatedness (6.30 ± 0.82) than coaches (6.52 ± 0.63 and 5.84 ± 0.95, respectively) ($p < 0.01$). Athletes have also shown higher levels of satisfaction with training and instruction (6.41 ± 0.77) and personal treatment (6.47 ± 0.63) than coaches (6.18 ± 0.74 and 6.31 ± 0.67, respectively) ($p < 0.01$).

Table 3 shows the correlations between basic needs satisfaction, coach-athlete relationship and sport satisfaction. Coach data are displayed in the upper triangle and correlation values for athletes in the lower triangle. Significant correlations were obtained for most variables for coaches, while athletes presented correlations among all variables ($p < 0.05$). The strongest correlation between different constructs for coaches occurred between BPN's competence and ST's training and instruction (r = 0.57) as well as between CAR complementarity and ST personal treatment (r = 0.52).

Measurement Model (Step 1)

Initially, we tested a three-factor measurement model through CFA (SEM Step 1) by assessing the relationship of the items analyzed with their respective latent factors. Acceptable fit indices were obtained for both coaches [$X^2(24) = 55.17$; $p = 0.001$; $X^2/df = 2.51$; CFI = 0.94; GFI = 0.94; TLI = 0.90; NFI = 0.90; RMSEA = 0.08; P(rmsea < 0.05) = 0.014] and athletes [$X^2(24) = 47.35$; $p = 0.003$; $X^2/df = 1.97$; CFI = 0.94; GFI = 0.95; TLI = 0.91; NFI = 0.90; RMSEA = 0.07; P(rmsea < 0.05) = 0.103]. Moreover, local adjustment and the internal reliability of items also proved adequate, since all paths had significant FL > 0.50. In this sense, the latent model was confirmed and enabled for SEM Step 2. In order to assess the convergent validity, AVE was computed. The AVE values were as follows for athletes and coaches, respectively,: BPN = 0.45/0.53; CAR = 0.47/0.50; and ST = 0.53/0.51. Only two variables showed AVE lower the cut-off, however, these values were very close to 0.50. We observed that the BPN revealed to be discriminant to the others (AVE > SC) for both athletes and coaches. CAR and ST revealed to be discriminant to the others (AVE > SC) just for coaches, while, for athletes, CAR and ST showed higher SC (0.76) than their AVE. This result can be related to the association between these variables, which assess similar constructs (Jowett and Don Carolis, 2003; Jowett, 2008; Lorimer, 2009). The composite reliability values were as follows for athletes and coaches: BPN = 0.65/0.78; CAR = 0.71/0.74; and ST = 0.78/0.75.

Structural Equation Modeling (Step 2)

Direct Effect

Firstly, we tested a model with direct paths between BPN and ST (**Figure 1**), which had adequate fit (**Table 4**) with

TABLE 3 | Correlation matrix for study variables.

Variables	CAR			BPN			Athletic satisfaction		
	1	2	3	4	5	6	7	8	9
1. Closeness	–	**0.49***	**0.42***	**0.21***	0.12	**0.15***	**0.24***	**0.43***	**0.47***
2. Commitment	**0.43***	–	**0.53***	**0.30***	**0.37***	**0.22***	**0.43***	**0.40***	**0.53***
3. Complementarity	**0.55***	**0.55***	–	**0.43***	**0.41***	**0.34***	**0.40***	**0.36***	**0.35***
4. Competence	**0.19***	**0.27***	**0.30***	–	**0.52***	**0.43***	**0.57***	**0.31***	**0.33***
5. Autonomy	**0.27***	**0.34***	**0.33***	**0.40***	–	**0.32***	**0.42***	**0.39***	**0.46***
6. Relatedness	**0.23***	**0.32***	**0.29***	**0.17***	**0.25***	–	**0.28***	**0.17***	**0.31***
7. Training-instruction	**0.42***	**0.42***	**0.46***	**0.25***	**0.25***	**0.32***	–	**0.63***	**0.51***
8. Individual performance	**0.24***	**0.36***	**0.29***	**0.35***	**0.28***	**0.22***	**0.48***	–	0.52
9. Personal treatment	**0.45***	**0.50***	**0.52***	**0.36***	**0.30***	**0.25***	**0.55***	**0.43***	–

**Pearson correlations, significant values for $p < 0.05$. Upper triangle (Correlation coefficients for coaches) – Lower triangle (Correlation coefficients for athletes). CART (1. Closeness; 2.Commitment; 3. Complementarity); BPN (4. Competence; 5. Autonomy; 6. Relatedness); ST (7. Training-instruction; 8. Individual performance; 9. Personal treatment). CAR: coach-athlete relationship subscales; BPN: Basic Psychological needs subscale. Source: the authors. Bold values correspond to statistically significant correlations between variables.*

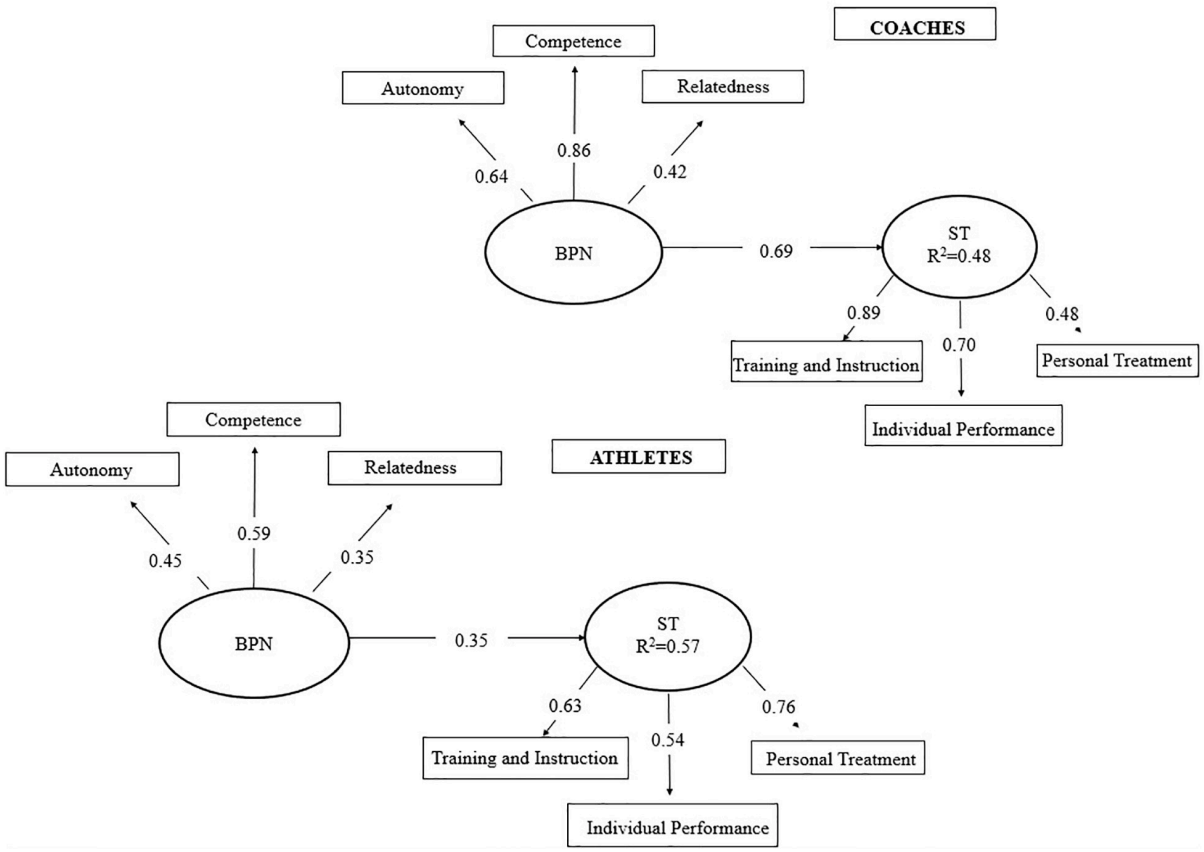

FIGURE 1 | Structural equation model of BPN impact over coaches and athletes satisfaction (n = 182 dyads).

BPN explaining 48% and 57% of ST variance for coaches and athletes, respectively.

Indirect Effect

We tested a second model including CAR as a mediating variable over the BPN effect on satisfaction. The model for coaches did not show adequate fit (**Table 4**), still, model paths and shared variance indicated the CAR mediating role (**Figure 2**). Meanwhile, the model for athletes presented acceptable fit (**Table 4**) and evidenced a significant mild-strength mediating positive effect of CAR suggesting the importance of young athletes attributing it to the relationship with their coaches (**Figure 2**).

By analyzing Bootstrapped parameter estimates for coaches (**Table 5**), we found that their satisfaction (ST) had a 54%

TABLE 4 | Fit indices comparison with and without mediation for coaches and athletes' structural equation model (n = 182).

Models	B/Sχ^2	χ^2/df	RMSEA [95% C.I.]	CFI	TLI
Coaches					
No mediation	23.34	2.92	0.10 [0.09–0.12]	0.95	0.90
CAR mediation	90.17	3.76	0.12 [0.10–0.13]	0.87	0.81
Athletes					
No mediation	14.37	2.05	0.08 [0.06–0.08]	0.95	0.90
CAR mediation	34.97	1.52	0.05 [0.04–0.06]	0.97	0.95

B/SX^2 = Bollen-stine Chi-Square; df = Degrees of freedom; X^2/df = Normalized chi-square; RMSEA = Root mean square error of approximation; TLI = Tucker-lewis index; CFI = Comparative fitness index. Source: the authors.

explained variance from BPN + CAR and CAR shared 47% of its variance with BPN. A strong positive effect occurred from BPN to ST (β = 0.56; $p < 0.05$) as well as a mild positive effect from CAR to ST (β = 0.22; $p < 0.05$). The impact of BPN over ST increased when mediated by the independent indirect CAR effect (β = 0.15) (total effect β = 0.71).

When analyzing the mediating Bootstrapped parameter estimates for athletes (**Table 5**), we observe that 81% of the variance in their satisfaction levels (ST) could be predicted by BPN + CAR and CAR was explained in 49% by the BPN. The direct path between BPN and ST had a weak positive effect (β = 0.17; $p < 0.05$) and a strong positive effect emerged from CAR to ST (β = 0.77; $p < 0.05$). CAR mediation revealed an independent and high indirect effect (β = 0.54) in the association ($p < 0.05$) (total effect β = 0.71).

DISCUSSION

Our aim was to examine the mediating role of coach-athlete relationship in the association between basic needs satisfaction and sport satisfaction of Brazilian coaches and athletes. Our

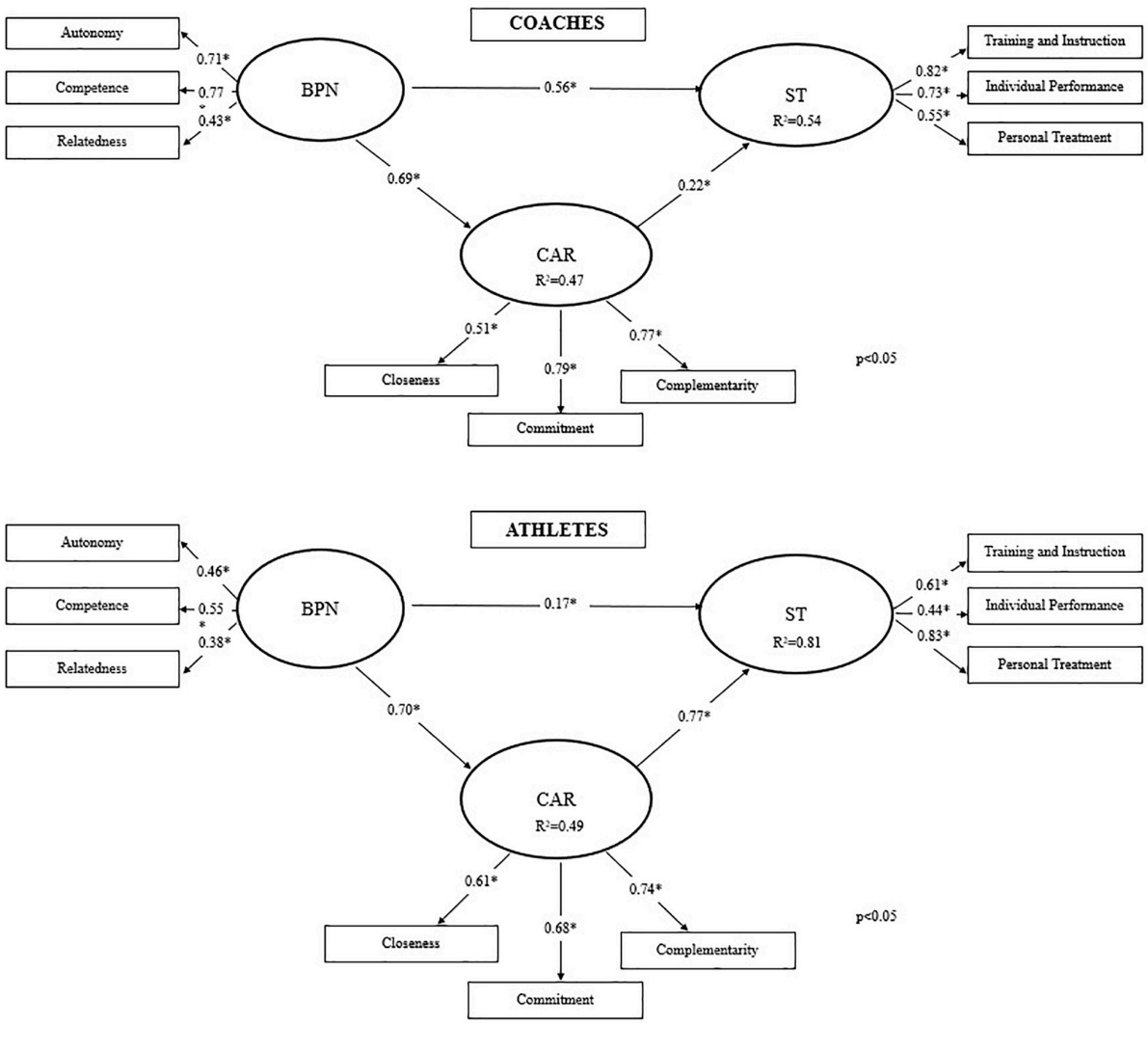

FIGURE 2 | Structural equation modeling of the CAR mediating role over the BPN impact on coaches and athletes satisfaction (n = 182 dyads).

TABLE 5 | Standardized direct and indirect effects for the structural model (M2) for coaches and athletes (n = 182 dyads).

Parameter			Effect	95% CI
Coaches				
Direct effects				
BPN	→	CAR	0.69	0.46–0.85
	→	ST	0.56	0.29–0.89
CAR	→	ST	0.22	0.08–0.48
Indirect effect of BPN via				
CAR	→	ST	0.15	0.04–0.29
Total effect			0.71	
Athletes				
Direct effects				
BPN	→	CAR	0.70	0.40–0.93
	→	ST	0.17	0.02–0.89
CAR	→	ST	0.77	0.33–1.46
Indirect effect of BPN via				
CAR	→	ST	0.54	0.31–0.76
Total effect			0.71	

*CI – Confidence interval; CAR (coach-athlete relationship); BPN (basic psychological needs); ST (sport satisfaction). *$p < 0.05$. Source: the authors.*

Hypothesis 1 was confirmed: BPN had a positive impact over both coaches (48%) and athletes (57%) satisfaction with slightly more relevant impact for athletes. In contrast, our Hypothesis 2 was only partially supported since such mediating model presented acceptable fit exclusively for athletes. In this model, variance of athletes' satisfaction was predicted in 81%. Although adequate fit indices were not reached, the model for coaches offered evidence regarding the role coach-athlete relationship in coach satisfaction.

Effects of Basic Psychological Needs on Athletes' Satisfaction

According to the literature, the impact of basic needs satisfaction over sport satisfaction revealed in the results confirm the predictions (**Figure 1**). According to the SDT, basic needs of autonomy, competence and relatedness are universal elements essential for human development, its integrity, and general well-being (Deci and Ryan, 2012) mainly due to their contribution to intrinsic motivation (Costa et al., 2016). A more autonomous motivation is known to be related to higher levels of satisfaction with performance, as found in a longitudinal study by Blecharz et al. (2015) involving professional Polish athletes. The study found a model explaining 57% of performance satisfaction variance and highlighted the significant indirect effect of intrinsic motivation mediating the association between self-efficacy and performance satisfaction for those athletes.

Another study approached collegiate athletes and found that those who receive support from had higher levels of satisfaction regarding their sports (Hoffmann and Loughead, 2016). Such evidence strengthen our findings by showing that when athletes feel engaged and connected to their social environment, they are more likely to present higher levels of satisfaction with their sport, which reveals how interpersonal relationships stablished in sport practices are intervening factors for athletic satisfaction.

Regarding the BPN impact over satisfaction of Brazilian coaches (**Figure 1**), our findings contribute to current knowledge on the subject with important advances considering that the field of sport psychology is yet to be further explored since most studies have focused only on athletes' satisfaction (Lorimer, 2009; Kim and Cruz, 2016). Our results revealed that coaches' BPN explained 48% of their sport satisfaction, similarly to the findings of Jowett (2008) when studying the impact of intrinsic and extrinsic motivation of coaches on their satisfaction. The author found positive effects from motivation to satisfaction upon the presence of self-determined intrinsic motivation. Rocchi and Pelletier (2018) found that coaches whose training contexts enable the satisfaction of their basic psychological needs tend to have an autonomous regulation of motivation as well as an interpersonal support attitude. In contrast, the frustration of such needs contributes to the controlled regulation of motivation and the absence of interpersonal support.

According to SDT, it is possible to state that coaches who have their basic needs met, especially regarding competence (**Table 1**), tend to reach greater satisfaction in their sport practice. Such positive evaluation of processes and outcomes regarding their experience can be explained by the SDT mini-theory of Cognitive Evaluation, which addresses the effects of social contexts on intrinsic motivation since contextual events have control aspects that influence competence perception (Lorimer, 2009; Ryan and Deci, 2017). Therefore, we understand that sport represents a social context in which a coach needs to feel capable of performing their tasks and responsibilities when coaching athletes and teams including effort and involvement in activities.

The Mediating Role of the Coach-Athlete Relationship in Sport Motivation and Satisfaction

Our mediating model indicated that the study on coach-athlete relationship led to a higher degree of explained variance for sport satisfaction suggesting that it is important for athletes to establish a good relationship with their coaches in order to feel satisfied with the sport (**Figure 2**). Our results emphasize the relevance of a positive relationship between coaches and young athletes, especially regarding their perception of closeness (affective component), as well as the dimensions of training and instruction, and personal treatment (**Table 1**). A study by Cranmer and Sollitto (2015) supports our findings by demonstrating that social support from coaches predicted better satisfaction of college athletes with their sport experiences. Coaches are considered vital for the entire process of involvement in a sport for allowing athletes to reach their maximum potential (Kim and Cruz, 2016; Ramazanoğlu, 2018) and having the potential to shape athletes' experiences in their sport context (Cranmer and Sollitto, 2015). Jowett et al. (2017) add that athletes who share a good-quality relationship with their coaches experience high levels of satisfaction of their basic needs, which establishes a positive prediction of self-determined motivation and well-being.

Considering our participants' age group, our findings are supported by evidences in the literature that show how young athletes need experienced and well-qualified coaches who offer support and orientation to help them overcome challenges and adversities in their sport (Jackson et al., 2010). In this context, the strong mediation of CAR in athletic satisfaction agrees with SDT's assumptions, which understands human behavior in interaction with the environment and how motivation will be influenced by athletes' social contexts in which a positive participation of social agents, such as teachers, colleagues, family, and coaches, can make individuals more self-determined (Ryan and Deci, 2017).

Model 3+1C's model corroborates such aspects and reveals that the relationship quality intensifies individual feelings of happiness and satisfaction upon affection reciprocity along with cognitive and behavioral aspects between coaches and athletes (Jowett and Shanmugam, 2016). Jowett and Nezlek (2011) add that close relationships of British coaches and athletes benefit satisfaction, especially for aspects of formation, training and instruction, and personal treatment, similarly to our findings.

Despite not having reached adequate fit, the mediating model for coaches presented significant paths between latent variables (**Figure 2**) indicating a potential of CAR to mediate the BPN association with coaches' satisfaction, which is regarded as deriving from a positive affective condition based on the processes and outcomes of sport experiences (Lorimer, 2009; Kim and Cruz, 2016). Thus, we consider that even though important, CAR did not prove a determining factor for these Brazilian coaches to feel satisfied with their experience of coaching young athletes.

According to our findings, Lorimer (2009) found a model in which CAR predicted 32% of British coaches' satisfaction, but with a major proportion of unexplained variance resulting from the multifaceted nature of CAR, which also varies according to specific goals and professionalism. According to Jowett (2008), complex extrinsic factors will dictate coaches' satisfaction beyond their relationships with athletes alone, such as monetary rewards, contracts, need for recognition, competition level, organizational pressure, and the technical level of the team.

Other aspects intervening in the association between CAR and coaches' satisfaction may result from the fact that some coaches base their sport experiences almost exclusively on training and instruction aspects, dedicating little time to social relationships (Lorimer, 2009). In this perspective, there is growing evidence in the literature highlighting the importance of developing positive interpersonal environments between coaches and athletes (Jowett and Poczwardowski, 2007; Jowett, 2017), which might reflect on harmonious relationships, satisfaction, psychological well-being, and improved performance for both sides. Therefore, we emphasized the need to foster social interactions between coaches and their young athletes.

CONCLUSION AND LIMITATIONS

Our study revealed that young athletes and coaches' sport satisfaction is strongly influenced by the satisfaction of their basic psychological needs. For athletes, such relationship is much stronger when mediated by the coach-athlete relationship. Our findings contribute to coaches, sport psychologists, and other professionals involved with youth sports regarding their understanding on the importance of social relationships to motivate and provide young athletes with satisfaction; in addition, it is important to promote closeness, commitment along with training and instruction. It is important for coaches to include psychological aspects and social relationships in their training and competition atmospheres to overcome mere technical and tactical aspects. In this sense, it is important for athletes to feel motivated to persist in their sport that they also feel close to their coaches in an affective relationship involving respect and trust.

Even though our study provides empirical evidence on the importance of CAR as mediator in the relationships between the BPN and the satisfaction of coaches and young Brazilian athletes, it is important to point out some limitations. Among such limitations, we highlight language adequacy in the ASQ and BNSSS for coaches since these scales originally assessed sport satisfaction and BPN satisfaction in the perspective of athletes. Aiming at verifying the validity of such adequacy, the instruments were assessed by Ph.D. professors in Sport Psychology regarding the clarity of language and practical relevance to be later applied to a reduced sample of coaches before being used in the total sample of the research. Still, the CFA indicated acceptable indices of the factorial structure of the instruments adapted to coaches. We also highlight that despite such limitation, the adequacy (adaptation) of scales allows to advance in the scientific knowledge on satisfaction and the BPN for coaches, which becomes restrict due to the lack of instruments for this population. Finally, the transversal format of study enabled significant predictions on the relationships among the variables, but did not allow causal relations whereas a longitudinal would enable more robust inferences. In this context, further studies are suggested to use a longitudinal design to monitor the variables since the perceptions of the coaches and athletes modify throughout the sport season, or even during training and competitions. We also highlight that some variables, such as personality traits, competitive level, and significant achievements by coaches, may influence the CAR mediator effect. Furthermore, our study limits to verify associations focusing on a positive perspective and does not investigate the need frustration as a negative affective condition determined by a complex evaluation of the structures, processes, and results related to sports experience influencing the CAR. Considering the importance of analyzing these variables, we suggest that further studies should include such investigation.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this manuscript will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of Standing Committee on Ethics in Research with Humans, from the State University of Maringa with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the Standing Committee on Ethics in Research with Humans, under opinion 1.324.411/2015.

AUTHOR CONTRIBUTIONS

AC, LF, and JN provided the study with design and idea. AC, NC, PG, SM, and LC recruited and acquired data from participants. JN, AC, and PG analyzed and interpreted the data. AC, LF, NC, PG, LC, SM, and JN have contributed to the manuscript drafting. All authors have contributed to the study critical review and submission approval.

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Effect of Acute Physical Exercise on Executive Functions and Emotional Recognition: Analysis of Moderate to High Intensity in Young Adults

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Physical exercise (PE) is associated with cognitive changes and brain function. However, it is required to clarify the effect of PE in different intensities, population groups conditions and the EF duration over different cognitive domains. Besides, no studies are known to have evaluated the contextual emotional recognition. Therefore, we studied the effect of acute PE of moderate intensities up to higher ones to the executive functions and the contextual emotional recognition. The participants were evaluated and classified in two experiments according to the IPAQ short form self-report and control measures. In both experiments, the groups were randomized, controlled, and exposed to one session of indoor cycling through intervals of high measure intensity (75–85% HRmax). Experiment 1 comprised young adults who were physically active (PA) and healthy, apparently ($n = 54$, $M_{age} = 20.7$, $SD = 2.5$). Experiment 2 involved young adults who were physically inactive (IP) and healthy, apparently ($n = 36$, $M_{age} = 21.6$, $SD = 1.8$). The duration was the only factor that varied: 45 min for PA and 30 min for PI. The executive functions were evaluated by the Stroop, TMT A/B, and verbal fluency, and the emotional recognition through a task that includes body and facial emotions in context, simultaneously. The analysis of factorial mixed ANOVA showed effects on the right choices of the indoor cycling groups in the PA, and the time response in PI. Also, other effects were observed in the controlled groups. TMT-A/B measures showed changes in the pre-test–post-test measures for both experiments. Verbal fluency performance favored the control group in both experiments. Meanwhile, the emotional recognition showed an effect of the PE in error-reduction and enhanced the scores in the right choices of body emotions. These results suggest that the EF with intensities favored cognitive processes such as inhibitory control and emotional recognition in context. We took into account the importance of

high-complexity tasks design that avoid a ceiling effect. This study is the first on reporting a positive effect of PE over the emotional contextual recognition. Important clinical and educational implications are presented implications which highlight the modulatory role of EF with moderate to high intensities.

Keywords: physical exercise, cognitive neuroscience, cognitive performance, executive functions, emotional recognition, exercise psychology

INTRODUCTION

Physical exercise (PE) is an important environmental factor with positive effects on the brain and healthy behavior along different life stages (Herting et al., 2014; Hillman et al., 2014; Etnier et al., 2019), mainly when considering that less than 60% of world population does not do required PE (World Health Organization [WHO], 2018, World Health Organization [WHO], 2007). Such data, nowadays, are increasing and associated with sedentary lifestyles and low PE involvement (Guthold et al., 2018; Päivärinne et al., 2018). Thus, PE is considered a non-pharmacological strategy that has direct effects in functional and cognitive brain structures (Herting et al., 2014; Erickson et al., 2015; Prakash et al., 2015; Voss et al., 2015; Hagger, 2019). Researchers have addressed the questionings of the effect of EF on cognition from two perspectives. On the one hand, chronic effects in PE (e.g., weeks, months, and/or years). On the other hand, the immediate effect of the acute PE (e.g., one session). This study focuses on the second perspective, treating the effect of acute PE on cognitive processes and emotional recognition.

Most of the reviewed literature matches on observing positive changes of cognition after PE (Reed and Ones, 2006; Lambourne and Tomporowski, 2010; Chang et al., 2012; Donnelly et al., 2016; Ludyga et al., 2016; Sáez de Asteasu et al., 2017; Esteban-Cornejo et al., 2019; Etnier et al., 2019; Hillman et al., 2019; McSween et al., 2019). Likewise, it has been demonstrated that an acute PE brings benefits for some ways of performance on cognitive tasks after exercise. By the same token, executive functions improve after PE (Wu et al., 2019). Recent studies, however, affirm that there is not enough evidence that PE is positive for cognition or brain function and structure in child and young samples (Gunnell et al., 2018). What explains these possible contradictions is the huge methodological variety, and therefore, new investigative contributions might clarify and provide evidence of the relation of PE on cognition (Pontifex et al., 2019).

The relation between PE, cognition, brain functions, and structures seem to rest upon several factors (Chang et al., 2012, 2015; Erickson et al., 2015; Gunnell et al., 2018). For instance, duration, intensity, and PE modality, as well as the vital cycle, the type of cognitive performance and physical condition of the participant. Even the effect of PE can vary depending on the cognitive domain (Pontifex et al., 2009, 2019). These factors are relevant in questioning the relation between PE, brain and cognition. Hence, further research is required that identifies its modulating role (Labelle et al., 2013; Ludyga et al., 2016).

Addressing the related factors of PE (e.g., type, intensity, and duration), some contributions have pointed out that aerobic PE can improve cognitive performance in both young and old adults (Chang et al., 2012; Joyce et al., 2014; Tsukamoto et al., 2016). Specifically, Physiological changes have been observed by activating circuits of the prefrontal and occipital cortex in tasks that include a great cognitive effort (e.g., attention and executive control) (Chen and Chang, 2012; Basso et al., 2015). Other studies have reported that aerobic PE can enhance cognitive and neurological function (Armstrong and Welsman, 2007; Herting et al., 2014; Li et al., 2014; Reiter et al., 2015). Likewise, aerobic PE is associated with improved memory efficiency (Herting and Nagel, 2013; Voss et al., 2019) and inhibitory control performance (Pontifex et al., 2019). Even participants who were exposed to the multimodal combination (training of aerobic PE followed by cognitive training) showed improvement in cognitive performance as compared to those who only had a cognitive training (Wang et al., 2019a).

The immediate effects of PE on cognitive performance seem to be conditional on intensity of PE. Inverted U hypothesis (Gutin, 1973) supports that cognitive performance tends to have more benefits after a moderate intensity of aerobic PE (>64% Maximum heart rate – HRmax) in contrast to low ones (<50% HRmax) or high intensities (>80% HRmax). In this regard, the evidence which supports the inverted U hypothesis is wide (Pontifex et al., 2009; Hillman et al., 2014; Li et al., 2014; De Souto Barreto et al., 2016; Ludyga et al., 2016). Nonetheless, current studies inform that high intensities of PE allow to have benefits in cognitive domains as inhibitory control (Quintero et al., 2018), memory and metacognition (Zuniga et al., 2019). Further, it is important to underscore that the number of studies of PE interventions of moderate intensity is actually small compared to interventions of moderate or low intensities (Browne et al., 2017). There are even more limited studies that address the transition of moderate and high intensities.

As a matter of fact, there is no agreement on the effect of duration, type or intensity of PE on cognition and the different types of cognitive domains (Vazou et al., 2019). A line of research suggested by other authors consists of clarifying the effects of PE in people who are physically active (PA), inactive and/or sedentary. Moreover, it associates more cognitive domains (Sink et al., 2015; Tsukamoto et al., 2016; Vieira et al., 2016; Browne et al., 2017; Peruyero et al., 2017; Silva et al., 2019). Based on the above-mentioned, narrative, systematic, and meta-analytic revisions have suggested an improvement of cognitive performance after an acute session of PE (Lambourne and Tomporowski, 2010; Chang et al., 2012; Ludyga et al., 2016; Basso and Suzuki, 2017; McSween et al., 2019); yet, constructs such as emotional recognition must be studied in relation to acute PE.

In that way, understanding how environmental factors, such as PE, contribute to the performance of emotional recognition in

context, and in ecological situations, is a novel area that answers to current questionings of social and cognitive neuroscience (Aviezer et al., 2008; Kumfor et al., 2018). We assumed that acute PE has positive effects on emotional recognition. Especially, whenever the aerobic exercise is combined with the demands of coordination seems that it gets more benefits on facial emotion recognition (Brand et al., 2019). In fact, the capacity of information processing, which links body movements with body-face recognition (Kumfor et al., 2018), is associated with brain regions such as motor areas, cerebellum, and fusiform gyrus (Committeri et al., 2007; Yogev-Seligmann et al., 2008), that are connected with the acute PE (Li et al., 2014; Esteban-Cornejo et al., 2019; Won et al., 2019). Recent paradigms on emotional recognition have located body information as contextual keys, taking away attention from facial recognition processing (Aviezer et al., 2008, 2012).

Based on the described evidence, that the dose-response relation in terms of intensity, duration and the type of acute PE over cognitive performance, specifically with executive functional tasks and emotional recognition, is an issue that needs to be studied. By solving the previous matter, we would contribute with knowledge about the strategy of PE, which can be a potent and promising environmental source that allows to adjust cognitive processes (executive performance to be precise) and emotional recognition. Among other scopes, it would facilitate the capacity of social human interactions in clinical and academic activities that improve the mental health of people. Thus, the main objective is to study the effect of acute PE of indoor cycling with a range of moderate and high intensity (75–85% HRmax) in regard to executive functions and emotional recognition in PA and inactive people and high apparently.

MATERIALS AND METHODS

Design and Participants

Two experiments were designed, controlled and randomized with pre-test–post-test measures, for an indoor cycling session. The process of choosing, randomizing, and selecting is shown in **Figure 1**. Initially, (n = 140) were recruited, and 90 university students were analyzed (M_{age} = 21.0, DE = 2.3). In both experiments, people were randomized by a computer-generated list through Excel (function RANDBETWEEN) from 1 to 60 in PA participants, and between 1 and 53 in physically inactive. The first experiment was carried out in young adults who were PA, and apparently healthy (n = 54). La They were randomly assigned to the experimental group and were exposed to a 45 min-session of indoor cycling, whereas the control group had no PE. The second experiment involved physically inactive young adults (n = 36) who were randomly selected for the control and experimental groups. The indoor cycling session in the second experiment lasted 30 min. The intensity of a session of PE was moderate-high ranging between 75 and 85% HRmax. The intensity ranges are: moderate between 64 and 76% HRmax, and High 76–96% HRmax (ACSM, 2018) The HRmax was calculated by Karvonen et al. (1957) 220-age (see section "Procedure").

Measure

General Characteristics

The participants answered a battery of instruments according to pre-experimental protocol (see section "Procedure"). **Table 1** provides data such as age, body mass, resting heart rate (supine position for 10 min), cognitive screening *(MoCA)*, self-report of physical activity *(IAPQ)*, and Depression *(BID)*. As expected, significative differences in the IPAQ self-report were observed ($p < 0.000$).

Measurement Screening

Cognitive screening

The MoCA: *Montreal Cognitive Assessment* measures 10 cognitive domains with satisfactory results of sensitivity and specificity, which fluctuate between 82–90% and 75–87%, respectively (Nasreddine et al., 2005). The MoCA is one of the most used instruments in clinics and research that identifies early cognitive changes. Cut-off points vary depending on educational and cultural level (O'Driscoll and Shaikh, 2017). Hence and having in mind Colombian population, one cut-off and exclusion point was assumed <24 (Pedraza et al., 2014, 2016; Gil et al., 2015).

The BDI – II: Beck Depression Inventory tests the existence or severity of depressive symptoms with 21 items. Spanish version was used (Sanz and García-Vera, 2013). The BID-II supports satisfactory psychometric evidence (Wang and Gorenstein, 2013). It was excluded such individuals whose score was >30 were excluded. The observation of depressive symptomatology can constitute a confusing factor, and thereupon, it was relevant to consider this control measure.

Physical exercise measure

The IPAQ-SF: The International Physical Activity Questionnaire – Short Form is used to facilitate a measurement and monitoring of physical activity (Craig et al., 2003), and seven questions about the last 7 days in relation to duration, minutes, hours, and days. A total measured score in METs (metabolic equivalent of task minutes per week) is recorded. The three classification levels are the following; low (e.g., walking), moderate (e.g., recreational cycling), and strong (e.g., intense aerobic activity). It is recognized as one of the most used questionnaires to determine AF level (Forsén et al., 2010; Van Poppel et al., 2010). The evidence of consistency and validity of the scores has been reported in several psychometric revisions (Sanda et al., 2017). The prior measurements are in line with the World Health Organization's global recommendations for physical activity (World Health Organization [WHO], 2007, 2010). IPAQ-SF was used with the aim of classifying active and inactive physically groups.

PARQ & You: The Physical Activity Readiness Questionnaire has been an easy-to-use tool for people between 15 and 69 years of age. The PARQ & You identifies health and cardiovascular problems from seven questions. It is usually applied to apparently healthy individuals, who have the willingness to take part in PE programs (Warburton et al., 2011). A participant's self-report which was associated with a cardiovascular problem was excluded from the study.

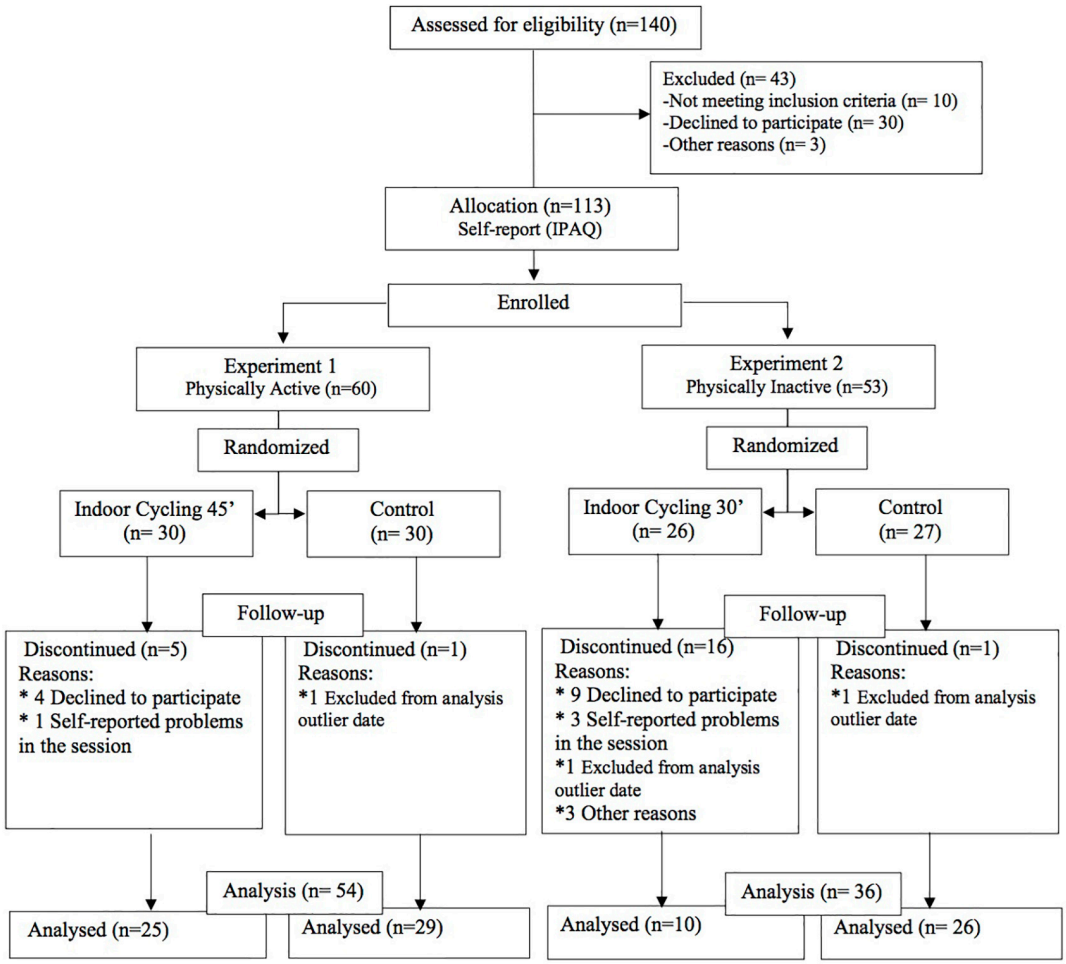

FIGURE 1 | Flow of participants throughout the study.

Task of Executive Functions

An executive functioning battery was registered, which is composed of three tasks; Stroop, TMT, and Verbal Fluency. These tasks are widely used in executive function measurement (Strauss et al., 2007). Moreover, other revisions have dealt with the PE effect on cognitive processes (Chang et al., 2012; Ludyga et al., 2016; McSween et al., 2019; Pontifex et al., 2019).

(a) Stroop: it evaluates the inhibitory control as executive process and it is associated with function in the anterior cingular cortex. An adapted version of the Stroop test version was performed in pencil and paper format by manipulating two conditions (Florez et al., 2012). In Stroop-A, the person reads written words, and as soon as it is highlighted, he/she must mention the color and avoid saying the word. In the Stroop-B, the evaluator points to the columns of words that are in color, and the individual reads what is written, but when the evaluator says the word "color," the person should mention the ink's color without naming the word. In both conditions, 84 stimuli were found. The response and the percentage of the right choices as well as answer time of the execution in both conditions was measured.

(b) The Trail Making Test (TMT) evaluates attention processes, visual scanning, mental processing, and flexibility (Reitan, 1958). It consists of two assessed parts in paper – pencil format. TMT-A deals with the sequence of ascending numbers from 1 to 25. The individuals must match the locked-numbers. The TMT-B is used for the estimation of executive functions (e.g., attention, planning, cognitive flexibility, and response inhibition). The individual has to match the aligned circles randomly by alternating between upward numbers (1–3) and the letters (A–L) (1-A-2-B, etc.). Normally, the TMT-A and the TMT-B are valid and reliable measures (Rabin et al., 2005).

(c) Verbal Fluency (Phonemic and Semantic): It evaluates the capacity to access lexicon and recover semantic information under limited conditions, and its psychometric properties are satisfactory (Borkowski et al., 1967; Strauss et al., 2007). The individual must mention as many words as he/she can, that start with the letter "S" (phonological fluency). Regarding phonological fluency, he must mention as many

TABLE 1 | Characteristics of participants.

Characteristics	Physically active (n = 54)		Physically inactive (n = 36)		t	p
	Experiment 1		Experiment 2			
	M	*SD*	*M*	*SD*		
Age (years)	20.7	2.5	21.6	1.8	−0.029	0.977
Body mass (kg)	65.5	13.8	64.3	10.6	0.325	0.746
Resting heart rate (bpm)	63.9	11.0	70.8	8.3	−1.83	0.73
Physical activity – IPAQ (METs)	6190.8	5087.1	176.8	195.6	7.07**	0.000
Depression – BDI	7.3	5.9	9.94	6.7	−1.89	0.062
Cognitive screening – MoCA	26.57	1.2	26.06	2.2	1.36	0.176

*BPM, Beat per minute; IPAQ, International physical activity questionnaire; METs, Caloric expenditure; BDI, Beck depression inventory; MoCA, Montreal cognitive assessment. **$p < 0.01$.*

words as possible in relation to a category or a common interest. We tested the "animals" category. In both tasks, 60 s were timed. Words from the same morphology or proper names were excluded. The total score is the sum of all the right words that are produced in each category.

Task Emotional Recognition

The experimental task of recognition of body-face emotions was used in context (see **Figure 2**). This paradigm was originally developed by Aviezer et al. (2008), and used in subsequent studies (Aviezer et al., 2011, 2012; Santamaría-García et al., 2019). This task consists of the representation of four basic emotions (anger, sadness, fear, and displeasure), involving body context. Each emotion is represented by the facial expression along with the body context. In the same way, the facial and corporal emotions can be either congruent or incongruent (e.g., consistent, sadness-face, and sadness-body; inconsistent, sadness-face, and anger-body). We submitted a total of 80 stimuli (Height 11.4 cm × Width 15.2 cm) which were assigned randomly in a 14" computer screen Microsoft Power Point. The task's command is "You have to select the emotional option that best describes the facial expression." Each participant had to choose the right answer from six options of basic emotions (sadness, anger, fear, disgust, happiness, and surprise). There is no time limit on task execution. The precision of correct response of the facial emotional expression was scored. The assigned scoring for the correct match of facial emotion =2 points. If the contextual influence matches the body emotion =1 point. When the person neither got the facial emotion, nor the body context right (0 points). The total score turned into a response rate (Response Accuracy = Sum of score/84 × 100).

Procedure

The volunteers participated in three stages (pre-experimental session, experimental session, and post-experimental session). To maximize transparency and replicability, the indoor Cycling program described in this manuscript follows the Consensus on Exercise Reporting Template (CERT) (Slade et al., 2016) (see **Supplementary Table S1**).

Pre-experimental Session

In the pre-experimental session, the objectives and the scope were presented. In addition to the signature of the informed consent, information about the age, weight, HR at rest, MoCA, BDI-II, IAPQ-SF, and PARQ (see **Table 1**) was collected. All of these measures were obtained in the days before the indoor cycling PE session. According to the IAPQ-SF results, the participants were classified into one of the two experiments: Experiment 1 – PA volunteers whose physical activity report was moderate and intense. Experiment 2 – physically inactive volunteers whose physical activity was in low category. The participants were instructed regarding clothing, hydration, and feeding before the PE session. The protocol of cognitive measures and emotional recognition from the pretest was executed from 45 up to 60 min before the experimental session in the fitness center. After the evaluation protocol, the instructor informed about the basic concepts, techniques and commands executed in the indoor cycling session. The instructor has a degree in Physical Education with international certification in Indoor Cycle and 10 years of experience in sports training.

Experimental Manipulation

Each experiment controlled the HR through Polar-M200, whose HR register is obtained by sensors from the wrist. The intensities of PE were moderates (64–76% HRmax), and high (76–96% HRmax) (ACSM, 2018). Data were gathered through easy connectivity between the device and the computer. The HRmax was calculated by the 220-Age formula. During the experimental session, a research assistant monitored HR behavior and the RPMs that corresponds to the training zone of each participant. The bicycles were standard and relevant to the indoor cycling aims.

Experiment 1 – Physically active group: The participants were randomly assigned to the experimental and control group (see **Figure 1**). The experimental group performed an indoor cycling session with intensities between 75 and 85% HRmax for 45 min (see **Supplementary Figure S1**). The PE protocol had three phases. Phase 1, warming up and muscle activation (10 min) 60–65% HRmax between 60 and 90 RPM (revolutions per minute). Phase 2, main work (35 min) which had six sections of 4 min with six peaks of 85% HRmax between 90

FIGURE 2 | Examples of stimuli of task face-body context. **(A)** Trial congruent face-anger and body-anger. **(B)** Trial incongruent face-anger and body-sadness. Permission obtained from Aviezer et al. (2008).

and 100 RPM, and active recovery at 75% HRmax. Phase 3, Final recovery (5 min) 60% HRmax between 50 and 70 RPM (See examples of the planimetry – additional material). The group control stayed at rest for 45 min in the facilities of the fitness center. HR measures were the following, HRrest (M = 65.4, DE = 9.8), HRmean (M = 136.8, DE = 12.3), HRmax (M = 186.1 DE = 9.5).

Experiment 2 – Sedentary group: The participants were selected randomly to the experimental and control group (see **Figure 1**). The experimental group performed an indoor cycling session of 35 min duration with intensities of 75 and 85% HRmax (see **Supplementary Figure S1**). The protocol had three phases. Phase 1, warming up and muscle activation (7 min) 65–75%HRmax between 70 and 90RPM. Phase 2, main work (17 min) with four sections of 4 min with peaks of 85%HRmax between 50 and 100RPM. Phase 3, final recovery (5 min) 75–65%HRmax between 90 and 70RPM. The control group remained at rest for 30 min after the post-test. HR measures were, HRrest (M = 63.1, DE = 10.1), HRmean (M = 143.1, DE = 5.7), HRmax (M = 185.4, DE = 9.5). In both experimental groups, the musical track was according to the RPM, intensity, intervals, and commands of the instructor (e.g., position three, sitting, etc.).

Post-experimental Session

The participants from both experiments had an individual recovery with the monitoring of resting HR. Further, each of them got hydrated during and after PE session. The post-test measure protocols were obtained after getting the resting HR.

Data Analysis

Both experiments were subjected to the following statistic procedure. The intention-to-treat principle was not carried out, therefore, per-protocol analysis was performed with those who completed the indoor cycling session (see **Figure 1**). An exploratory analysis of data was executed by calculating tendency central measures (M), of dispersion (SD) and Confidence interval (95% from the mean). *Outliers* that were observed in the box diagram and located below or above from the interquartile range *(Q3–Q1)*. In these cases, each datum was analyzed by identifying the information gathering process. To some of them, we applied Winsorizing technique, which consists of adjusting cognitive measures and emotional recognition. Three extreme cases were excluded. Each experiment analysis was executed separately in order to estimate and control the effect of every physical condition (active and inactive). Normality Kolmogorov–Smirnov assumptions were confirmed ($n > 50$) for experiment 1, PA ($p > 0.05$), and Shapiro Wilk ($n < 50$) in experiment 2, physically inactive ($p > 0.05$). The comparison of demographic, cognitive, physical activity, HR, anxiety, and depression variables were estimated with the T student test for independent samples. The contrast of the acute PE effect was performed by a Mixed Factorial ANOVA or by partially repeated measures. The dependent variables were treated separately due to the levels and conditions of analysis, which each one of these measures has (e.g., execution time, right choices). Finally, four factorial models were estimated.

(i) The first model was 4 × 2 × 2 for the stroop: four Stroop conditions (Stroop-A right choices, Stroop-A time, Stroop-B right choices, Stroop-B time) × 2 measures (pre-test–post-test) × two groups (Experimental and control).
(ii) The second model 2 × 2 × 2 analyzed TMT measures: two TMT conditions (parts A and B), × two measures (pre-test–post-test) × two groups (Experimental and Control).
(iii) The third model 2 × 2 × 2 analyzed fluency measures with verbal fluency: (phonological "S" and semantic "animals").
(iv) The fourth model 3 × 2 × 2 analyzed emotional recognition hits: three responses rate (face, body, and errors) × two measures (pre-test – post-test) × two groups (Experimental and Control).

The sphericity of each model was corrected through Greenhouse–Geisser. The meaning of interactions and principal effects were analyzed with the *post hoc* Bonferroni test. The size of the effect was estimated with Eta to the partial square.

Ethics Statement

We followed the Helsinki's declaration (WMA, 2013) and the Universal Declaration of Ethic Principles for Psychologist regulations (IUPS, 2008). The evaluation and intervention protocol was approved by the Ethics' Committee of Health Sciences Department of Universidad de Caldas (CBCS-048 Code, Record 015 of 2017) which is coherent with the rules of the Republic of Colombia (Ministerio de Salud - República de Colombia, 1993). All the participants signed the informed consent acknowledging the purposes, phases, and possible risks of the research. During the phase of experimental manipulation, there were specialized professionals for medical attention if needed.

RESULTS

Descriptive data of the PA participants (experiment 1) can be observed in **Table 2**, and for the physically inactive participants (experiment 2) in **Table 3**.

Performance Stroop Task

The Mix Anova 4 × 2 × 2 (Stroop, time, and group conditions) was not significant in the interaction, [$F(1.54,80.5) = 452$, $p = 0.588$, $\eta p^2 = 0.009$]. The stroop and time conditions (pretest and posttest) were significant [$F(1.54,80.5) = 452$, $p = 0.000$, $\eta p^2 = 0.33$]. The post-hoc analysis (See **Figure 3**) showed favorable significant differences for the indoor cycling group in the percentage of right answers of the Stroop-A condition between the pretest and the posttest ($p = 0.002$). In the same way, for the control group, significant changes were observed in the response time of the Stroop-A condition between pretest and posttest ($p = 0.009$), also the answering time of the condition of the Stroop-B, the control group was faster compared to the indoor cycling group ($p = 0.001$).

On the other hand, in the experiment 2 of the PI, the interaction conditions of the stroop, time and group was not significant [$F(1.00,57.4) = 1.44$, $p = 0.245$, $\eta p^2 = 0.041$]. The time and stroop conditions showed significant differences [$F(1.00,57.4) = 5.15$, $p = 0.004$, $\eta p^2 = 0.121$]. The post-hoc median comparison, indicated that the indoor cycling group reduced the answering time of stroop-A between the pretest and posttest ($p = 0.014$). On the other side, the control group showed better right answer percentage of stroop-B between the pretest and posttest ($p = 0.014$) (possibly due to an instrumentation effect).

Performance TMT-A/B

Task performance of TMT A/B, measures (pre-test and post-test) and the group were not significant [$F(1.00,52.0) = 0.709$, $p = 0.403$, $\eta p^2 = 0.013$]. Mean comparison indicated that the indoor-cycling group obtained a better average performance than the control group. However, these data were not significant (see **Figure 4**). The *post hoc* analysis of means Bonferroni comparison showed differences in the pre-test and post-test measures in both TMT-A/B conditions, and in both groups ($p < 0.000$, see **Figures 4A,B**).

In experiment 2, significant differences in the interaction between TMT-A/B conditions, measures, and the group were identified [$F(1.00,34.0) = 0.199$, $p = 0.658$, $\eta p^2 = 0.006$]. The interaction between the TMT-A/B conditions and the measures was significant [$F(1.00,34.0) = 6.182$, $p = 0.018$, $\eta p^2 = 0.154$] (see **Figures 4E,F**). Although the response time averages were better in the indoor-cycling than the control group, these averages were not significant in both TMT-A/B conditions ($p < 0.5$). The *post hoc* comparison identifies differences of

TABLE 2 | Descriptive dates physically active (PA) – Experiment 1.

Variable	Indoor cycling PA *n* = 25				Control PA *n* = 29			
	Pre-test		Post-test		Pre-test		Post-test	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Stroop condition A								
Accuracy response (%)	95.0	4.0	97.5	2.2	97.1	3.6	97.6	2.4
Response time (seg)	80.4	14.9	73.8	11.4	78.7	24.5	69.4	20.8
Stroop condition B								
Accuracy response (%)	98.7	1.9	97.1	8.7	98.6	1.7	99.0	1.5
Response time	73.4	14.3	68.7	11.8	67.0	12.3	58.8	8.8
Trail making test								
TMT-A time (seg)	51.6	15.9	36.7	16.2	55.6	21.7	44.0	21.8
TMT-B time (seg)	91.1	43.2	66.1	22.3	90.7	30.6	77.1	27.3
Verbal fluency								
Phonemic word "S"	11.6	3.0	13.0	3.4	11.9	3.1	13.9	3.7
Semantic animal	18.6	4.5	19.6	4.3	20.8	4.5	22.0	4.2
Emotional recognition								
% Response face	42.3	12.7	44.9	14.5	44.5	11.0	46.1	12.9
% Response body	16.75	10.3	15.4	6.1	18.7	11.5	14.0	5.0
% Error	40.6	12.9	36.2	11.7	39.8	10.9	39.	10.7

TABLE 3 | Descriptive dates physically inactive (PI) – Experiment 2.

Variable	Indoor cycling PI *n* = 10				Control group PI *n* = 26			
	Pre-test		Post-test		Pre-test		Post-test	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Stroop condition A								
Accuracy response (%)	95.1	4.7	98.6	1.4	94.7	7.7	97.8	2.8
Response time (seg)	81.9	19.1	68.2	17.4	70.0	14.8	66.9	12.5
Stroop condition B								
Accuracy response (%)	98.2	2.5	98.3	1.6	98.7	1.9	98.9	2.4
Response time (seg)	67.7	16.5	64.0	8.4	67.9	14.5	62.2	16.1
Trail making test								
TMT-A time (seg)	46.3	10.9	31.7	10.7	45.7	18.8	38.5	17.4
TMT-B time (seg)	85.6	44.6	73.5	36.9	98.2	47.9	88.2	37.7
Verbal fluency								
Phonemic word "S"	9.1	6.1	12.0	2.7	11.8	4.4	17.9	4.4
Semantic animal	20.6	2.9	20.8	3.0	12.1	4.0	19.2	4.8
Emotional recognition								
% Response face	48.4	9.7	52.9	14.3	41.2	13.8	41.7	15.0
% Response body	20.8	12.4	16.1	8.1	22.6	9.8	20.9	12.2
% Error	30.9	7.4	31.0	10.2	36.3	13.4	37.3	17.2

improvement in the execution of time between the pre-test and post-test measures in TMT-A/B conditions ($p < 0.001$, see **Figures 4E,F**).

Verbal Fluency

For experiment 1, verbal fluency conditions (greater number of words with the letter "S" and semantic category of animals), measures and the group were not significant [$F(1,52) = 0.057$, $p = 0.812$, $\eta p^2 = 0.001$]. The *post hoc* analysis indicated that the control group mentioned a greater number of the semantic animals category than the indoor-cycling group in the post-test ($p < 0.042$, see **Figure 4D**). The group control showed differences in the pre-test and post-test measures in relation to the "S" letter ($p < 0.010$, see **Figure 4C**).

Interaction between verbal fluency, time (pre-test and post-test) and group was not significant in the physically inactive participants [$F(1.00,4.0) = 6.182$, $p = 0.018$, $\eta p^2 = 0.154$]. Although the descriptive data show changes in the times, the *post hoc* analysis did not identify.

Emotional Recognition

Experiment 1 indicated that three emotional recognition conditions (% response face, body and error), measures and the group, were not significant [$F(1,52) = 0.553$, $p = 0.547$, $\eta p^2 = 0.011$] (**Figures 5A,B,F**). Measures comparison, with the *post hoc* Bonferroni showed significant differences in pre-test and post-test measures ($p < 0.32$) in error percentage reduction in the indoor cycling group (see, **Figure 5C**).

For experiment 2, the interaction effect between the responses of emotional recognition, measures and the group was not significant [$F(1,34) = 0.444$, $p = 0.643$, $\eta p^2 = 0.013$] (**Figures 5A,B,F**). The main effect of response percentage of emotional recognition in three conditions was significant [$F(1,34) = 8.816$, $p = 0.005$, $\eta p^2 = 0.206$]. Mean *post hoc* comparison pointed out that the indoor-cycling group had a significant reduction of the percentage of body emotion recognition in pre-test and post-test measures ($p = 0.028$, see **Figure 5E**). Descriptively, averages indicate that the right choices percentage of facial recognition favored the indoor cycling group (*pre-test,* $M = 48.4$, $DE = 9.7$; *post-test,* $M = 52.9$, $DE = 14.3$, see **Figure 5D**).

DISCUSSION

Our main objective was to study the effect of acute PE of indoor cycling with a moderate-high intensity range (75–85% HRmax) on executive function, and the emotional recognition in healthy people who are PA and inactive. We have outlined two experiments, each one of them for two conditions, PA (Experiment 1) and inactive (Experiment 2). Overall, we highlight two main results. First, we observed some effects of acute PE on executive functions with a specific PE tendency of indoor-cycling on physically inactive participants. Second, regarding emotional recognition, the group that was exposed to PE indoor-cycling from PA participants (Experiment 1) reduced errors significantly. Similarly, the PE indoor-cycling group from physically inactive participants had a higher percentage of right choices in facial recognition.

These findings provide evidence of the differential effect of demographic conditions (physically active and inactive), and experimental manipulations considering the type, intensity, acute PE, duration on executive functions and emotional recognition. Below, we mention main results.

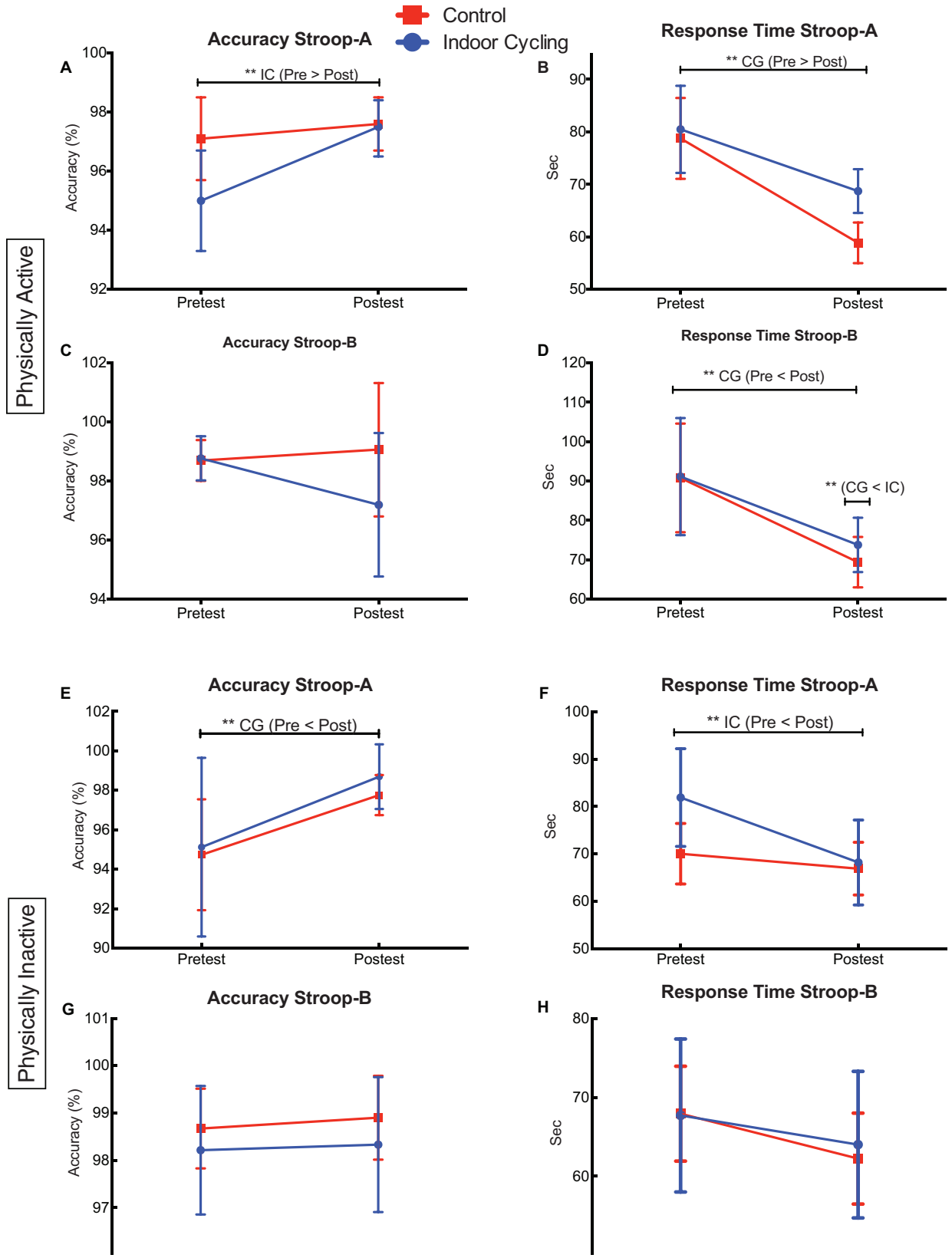

FIGURE 3 | Performance stroop task. Physically active **(A–D)** and physically inactive **(E–H)**. Means and 95% confidence interval of pre-test to post-test of stroop condition **(A,B)**. IC, indoor cycling (Experimental Group); CG, control group. $^{**}p < 0.01$.

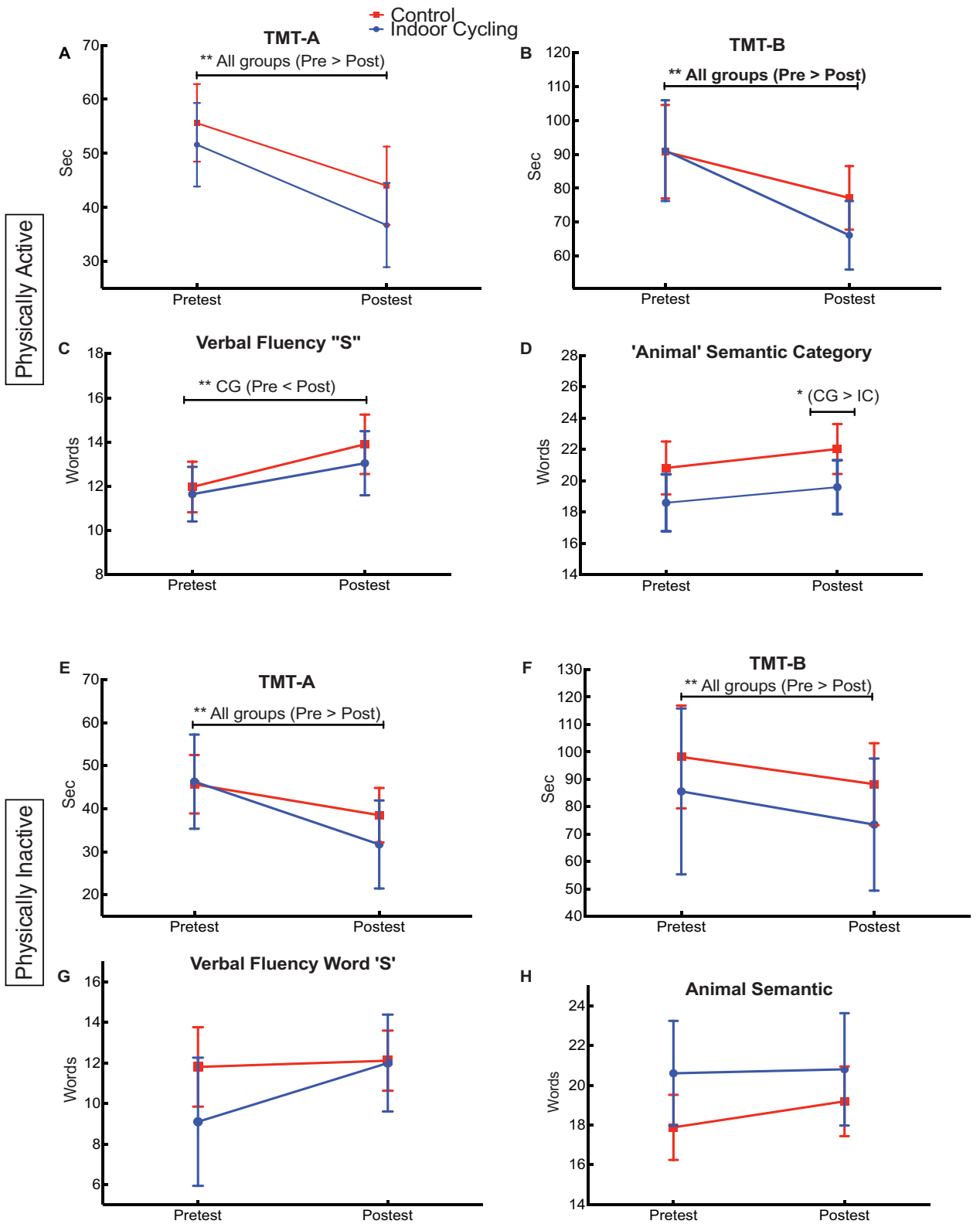

FIGURE 4 | Physically active **(A–D)** and physically inactive **(E–H)**. Means and 95% confidence interval of pre-test to post-test of TMT A/B – verbal fluency. IC, Indoor Cycling (Experimental Group); CG, control group. Physically, *$p < 0.05$ and **$p < 0.01$.

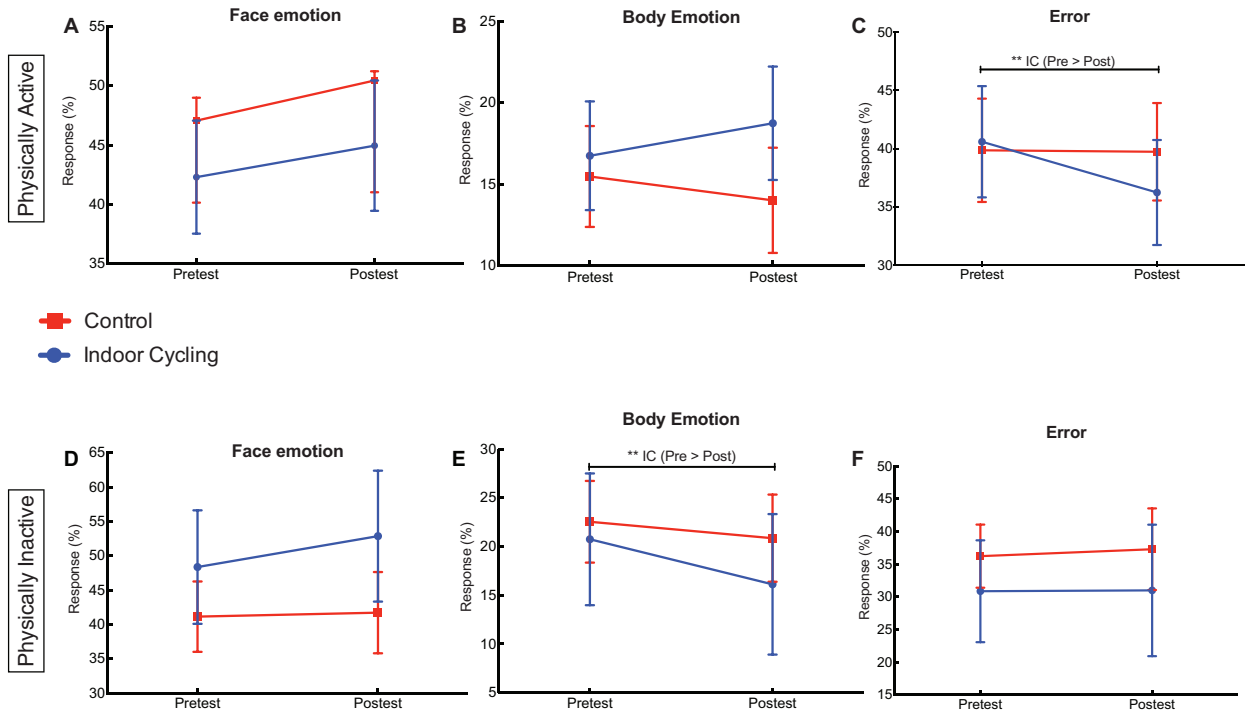

FIGURE 5 | Physically active **(A–C)** and physically inactive **(D–F)**. Means and 95% confidence interval of pre-test to post-test of emotional recognition. IC, indoor cycling (Experimental Group); CG, control group.

Executive Performance and Physical Exercise (Acute PE)

The literature that has dealt with the issues of the effect of acute PE on cognitive processes is wide (Tsukamoto et al., 2016; Akram et al., 2018; Quintero et al., 2018; Leyland et al., 2019; Wang et al., 2019b). In both experiments, we worked with a widely used battery on the executive function evaluation at clinic and research level: Stroop, TMT, and Verbal Fluency.

In this way, Experiment 1 data (PA) indicated that the group, which was subjected to PE indoor cycling, improved significantly in the Stroop-A right choices between pre and post compared to the control group. On the other hand, in the second experiment (physically inactive), the indoor cycling group improved response time in the post-test Stroop-A after the 30-min session (75–85%HRmax). Regarding the control group, Stroop-A right choices in pre-test and post-test measures and response time improved significantly compared to the indoor-cycling group.

In respect of TMT-A/B execution, significant changes enhanced for both groups, which can be explained more by a learning effect of the task than an acute differentiating effect of PE. Regarding phonological and semantic fluency, effects of PE were not observed, but the control group was significantly better. This result must be assumed with reservation on the grounds that this study only presented behavioral measures. Other types of measures and with greater precision can shed light on executive functions and semantic processing. For instance, current contributions point out that the acute PE is associated with greater neuron activation in older adults (Won et al., 2019). The neuron activation and underlying process activation of semantic memory, which is useful for the task performance of semantic processes, which constitutes a promising line of research for future studies (Szepietowska, 2019).

The prior findings are considered from three perspectives. (i) The best performance of the control group, which is PA in the performance of some executive tasks after acute PE, can be explained by a possible physical-cognitive reserve. Thus, optimum cognitive resources would be involved at execution time of the post-test task (Gajewski and Falkenstein, 2015), whereas the indoor cycling group could experiment tiredness due to moderate-high intensities of the HRmax. (ii) From a life cycle perspective, young adults tend to have a relatively stable an executive performance, different from other populations such as children and older adults. Hence, in childhood and old age greater sensibility of executive functions and toward stimuli such as the PE can be evidenced (Ludyga et al., 2016). The prior motive can explain that direct effects are not estimated. (iii) Lastly, the assumption of the hypothesis of the inverted U (Gutin, 1973) indicates that cognitive performance is diminished under high intensities of PE. Some effects of our data could provide evidence to the statement of the inverted U. Another part of our significant outcomes, however, provided evidence that transition of moderate-high intensities has also positive effects on cognitive performance.

Therefore, current studies have reported that high intensities of PE have a positive effect on executive functions in the

performance of tasks such as the Stroop and attentional tasks of cancelation (Tsukamoto et al., 2016; Quintero et al., 2018). Additionally, the effect of strong acute PE may last from 30 min to 2 h after EP session (Basso et al., 2015). While it is true that the hypothesis of inverted U has a wide scientific evidence (Pontifex et al., 2009; Chang et al., 2014; De Souto Barreto et al., 2016; Ludyga et al., 2016), the discussion is still open in order to have more solid evidence.

Considering the above-mentioned, studying cognitive processes with great complexity tasks and that are coherent with the postulates of *embodied cognition* sets up a research line to explore. Specifically, simple tasks of cognitive evaluation such as the ones we implemented, and despite being widely used, have some limitations. The ceiling effect has a high rate of right choices with no variability measures, which is characteristic of a healthy neurologically population (McMorris et al., 2016; Mora-Gonzalez et al., 2019). This is a possible cause that justifies why high intensities of PE and healthy population are not sensitive to the performance of simple cognitive tasks.

Thereupon, qualification of tasks with higher complexity, which can underlie motor and cognitive processes, is an important challenge (e.g., Paradigms of Cognitive Motor Interference by using dual tasks). In such way, if the precision with tasks is evaluated, which involve all the body, similar to sport performance, those conditions can generate an intense effect of PE on cognitive processes (McMorris et al., 2016; Browne et al., 2017). In other words, associating tasks of cognitive complexity that involve the body, such as tasks that have an *embodied cognition* perspective, is a methodological and scientific challenge to be explored.

Emotional Recognition: Hypothesis of Physical Exercise as a Modulator of Social Cognition

In accordance with our revision, the studies that deal with the modulating effect of PE on emotional recognition are limited. In this sense, such issue has been addressed in our study. The found data proved that groups exposed to in one indoor-cycling sessions, from both experiments with moderate-high intensities (HRmax), had an effect on the right choices of emotional recognition in context. Thus, this finding suggests that the acute PE, apart from having cognitive benefits, which were previously mentioned, seems to have a direct effect on recognition emotional processing, and mainly, on tasks that require processing of contextual information.

Studies, which are carried out by magnetic functional resonance (fMRI), have demonstrated that body emotional posture influence in facial expression processing (Poyo-Solanas et al., 2018). Moreover, it has been suggested that the regions that are in charge of processing dynamic body movements are linked to emotional and body recognition (Kumfor et al., 2018). Using tasks of the same kind of our study, emotional recognition patterns in context in teenagers with criminal conduct have been explored (Santamaría-García et al., 2019), and with patients who suffer from frontotemporal dementia (Kumfor et al., 2018). These processes of body-face recognition are related to brain regions, as the fusiform gyrus (Committeri et al., 2007; Yogev-Seligmann et al., 2008), cingulate cortex, superior temporal gyrus, motor areas, and cerebellum. The identification of body and contextual information is very relevant for emotional recognition (De Gelder, 2006; Aviezer et al., 2012; Poyo-Solanas et al., 2018).

To sum up, our results are evidence that supports the modulator role hypothesis of PE in social cognition processes. Also, they let us put in perspective a path for new research lines, which result promising and hopeful so as to enhance the quality of life of people.

Implications, Limitation, and Future Research Directions

In agreement with the aforementioned, our results have practical implications, which are directly related to the quality of life of people. They are also pertinent for how the real world functions due to the easy access to PE in relation to its cost-benefit and non-invasiveness. The inclusion of programs of health promotion through the PE in school ages, and preventions of diseases in adulthood as a strategy to possible neurodegenerative disease emergence, hence, potential strategies of intervention at a preventive and psychoeducational level (Aguirre-Loaiza et al., 2019). Likewise, instructors and practitioners can train PA and inactive people through intervals of moderate-high intensities as part of a conditioning program as well as parallel purposes that are related with the objective of improving their cognitive processes.

On the other hand, and from a theoretical perspective, our results contribute to the increasing body of knowledge that studies modulator effect comprehension of acute PE on cognitive processes (Pontifex et al., 2019). Additionally, this study considered for the first time the immediate effect of PE in the assessment of emotional-context recognition, its huge scope and potential benefits in social human relationships. In this way, the path for future works in the line of social cognition is marked, modulating the cognitive and brain processes through PE.

This study, however, had some limitations. Firstly, physical activity measures were self-reported. The instruments use, such as the IPAQ-SF in the valoration and allocations to the experiments, was the first limitation. Therefore, more objective evaluations through aerobic conditions will allow a higher control, which is an important criterion for future studies. Secondly, our study kept isolated analysis between two experiments so as to identify a direct effect of duration and PE session intensities. Thus, it would be interesting that both sample conditions are compared (physically active and inactive) in a further analysis. Although it seems that physical condition is not a conditional requirement for temporary improvements and PE benefits (Ludyga et al., 2016). Other works, though, insist on considering physical (Labelle et al., 2013). Finally, our study worked with a single conditional capacity; there

are other capacities to be studied (e.g., strength, coordination, among others). Indeed, it is possible the combination of these capacities pose an important work line yet to be studied. Likewise, manipulating a chronic PE program and linking cognitive tasks with complex paradigms is a limitation that if addressed in new proposals, it may clarify of the modulating role of PE. These results should be considered with caution due to the sample size, therefore new work is encouraged (Slade et al., 2016).

After mentioning the limitations, we deem that future studies can address: (i) research that demonstrates the role of EP with different intensities. (ii) Apart from the prior, the assessment and design of other measures of cognitive domains, which are associated to the social cognition and embodied *cognition* with greater complexity, allowing higher sensibility and specificity. For instance, dual tasks in which the body performance is linked. (iii) Effect exploration of other conditional capacities (e.g., coordination). (iv) Motor expertise exploration and analysis of the cognitive-physical reserve relation regarding the cognitive-emotional performance in context.

CONCLUSION

In summary, our findings add evidence in which the acute PE with moderate-high intensities of HRmax (75–85%) has positive effects on executive functions, and mainly, in the emotional-contextual recognition.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The research was approved by the Ethics Committee of the School of Health Sciences, Caldas University (Code CBCS-048, Acta015 from 2017). All the participants signed the informed agreement and knew the purposes of the investigation and its respective phases. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

HA-L, JA, IA, AF-J, SR-B, and FA-Z conceived and designed the experiments. JA, IA, SB-G, and H-AL collected data. HA-L and JA performed the statistical analysis. AF-J, CN, SB-G, HA-L, and AG-M interpreted the data. HA-L, AF-J, and SB-G wrote the original draft. HA-L, JA, IA, AF-J, SB-G, SR-B, FA-Z, CN, and AG-M reviewed, edited and drafted the manuscript, and approved the final 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.2019.02774/full#supplementary-material

FIGURE S1 | Session Indoor Cycling – Planimetry.

TABLE S1 | Consensus on Exercise Reporting Template.

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