1828
AKADÉMIAI KIADÓ

Exercise addiction and psychosocial health risks among adolescent athletes: Focus on sport type and performance level

CARMEN MAYOLAS-PI[1,2*], SEBASTIAN SITKO[1,2], ALVARO PANO-RODRIGUEZ[3], ISAAC LOPEZ-LAVAL[1,2], JOAQUIN REVERTER-MASIA[2,3] and ALEJANDRO LEGAZ-ARRESE[1,2]

[1] Faculty of Health and Sport Sciences, University of Zaragoza, Zaragoza, Spain

[2] Human Movement Research Group, Zaragoza, Spain

[3] Faculty of Education, Psychology and Social Work, University of Lleida, Lleida, Spain

Journal of Behavioral Addictions

DOI: 10.1556/2006.2025.00024

Received: June 25, 2024 • Revised manuscript received: December 16, 2024; February 27, 2025 • Accepted: March 8, 2025

FULL-LENGTH REPORT

ABSTRACT

Aim: Exercise addiction is a compulsive need to engage in physical activity despite potential negative consequences. This study aims to analyze adolescents' psychosocial health in relation to the risk of exercise addiction, focusing on competition levels, sport types, gender, and age. *Methods:* A cross-sectional study was conducted with 7,596 participants (44.2% girls) aged 11–19. Data on physical activity (PAQ-C and PAQ-A), sleep quality (PSQI), anxiety (SAS), depression symptoms (BDI-II), eating disorders (EDI-3), and health-related quality of life (KIDSCREEN-52) were collected via validated questionnaires. The prevalence of exercise addiction risk (EAI) was assessed, and differences based on competition level, sport type, gender, and age were analyzed. Gamma GLMs factors-adjusted were used for statistical comparisons. *Results:* 6.4% of adolescents in non-competitive sports and 15.6% in competitive sports showed a risk of exercise addiction. The risk was higher in boys, but the difference diminished at higher competition levels. The risk of addiction increased notably in late adolescence. Competitive athletes, especially at high levels, were at greater risk compared to noncompetitive athletes. Those in individual sports were at higher risk than those in team sports. Adolescents at risk of exercise addiction reported poorer mental health, including sleep quality ($\beta = 1.62$, $p < 0.001$), anxiety ($\beta = 3.58$, $p < 0.001$), depression ($\beta = 2.283$, $p < 0.001$), and eating disorders ($\beta = 3.101$, $p < 0.001$). *Conclusions:* Exercise addiction is a significant concern among adolescents, especially in competitive and individual sports. It is associated with poorer mental health outcomes, emphasizing the need for targeted interventions to reduce the risk of addiction and promote holistic health in adolescent athletes.

KEYWORDS

risk of exercise addiction, adolescents, competitive sports, individual sports, team sports, psychosocial health

INTRODUCTION

Exercise addiction (EA) is an emerging concern in sports psychology and public health, particularly among adolescents, a population undergoing critical phases of physical and psychological development. While regular physical activity is universally recognized for its profound benefits, including improved cardiovascular health, enhanced mental well-being, and reduced risk of chronic diseases (Kumar, Robinson, & Till, 2015), excessive physical activity can transition into compulsive behavior with detrimental outcomes (Berczik et al., 2012). Multiple terminologies have been proposed to describe the same phenomenon, such as

*Corresponding author.
E-mail: carmayo@unizar.es

exercise addiction, exercise dependence, obligatory exercise, compulsive exercise, and excessive exercise (Hausenblas, Schreiber & Smoliga, 2017). In this research, the term addiction was considered to be the most appropriate because it incorporates both dependence and compulsion and thus defines EA as a compulsive need to engage in physical activity despite negative consequences, leading to physical injuries, psychological distress, and social impairments (Lichtenstein & Hinze, 2020).

Adolescence represents a pivotal period for fostering healthy habits, yet it also increases vulnerability to harmful behaviors. During this developmental stage, heightened autonomy and decision-making intersect with societal pressures and performance expectations, potentially exacerbating the risk of EA (Alcaraz-Ibañez, Chiminazzo, Sicilia, & Fernandes, 2021). The duality of physical activity—as both a promoter of health and a potential source of addiction—necessitates a nuanced understanding of factors influencing this risk. To provide a cohesive framework, this study adopts a biopsychosocial model to examine EA, considering the interplay of biological, psychological, and social factors. Biological influences include pubertal development and physical maturation, while psychological dimensions encompass personality traits such as perfectionism and compulsivity. Social components include competition level, peer influences, and societal expectations (Telzer, Van Hoorn, Rogers, & Do, 2018).

Existing literature suggests that the prevalence of EA varies across populations and contexts. Competitive athletes, particularly those engaged in high-level competitions, face heightened risks due to the intense demands and pressures associated with their activities (Trott et al., 2020). Gender differences in EA are also documented, with males often exhibiting higher prevalence rates, though these differences diminish at elite competition levels (Dumitru, Dumitru, & Maher, 2018). Additionally, sport type plays a significant role, with individual sports often associated with greater EA risk than team sports due to the solitary nature of training and competition (Di Lodovico, Poulnais, & Gorwood, 2019).

Problematic exercise behaviors are not only associated with psychological distress but also with significant physical health risks for athletes, such as relative energy deficiency in sport (RED-S), overuse injuries, and impaired recovery (Fahrenholtz et al., 2022; Torstveit, Fahrenholtz, Lichtenstein, Stenqvist, & Melin, 2019). RED-S, characterized by energy imbalance due to excessive training and inadequate nutrition, has been linked to hormonal dysfunction, reduced bone density, and decreased performance. Furthermore, athletes exhibiting compulsive exercise behaviors are more likely to suffer from overtraining syndrome, which includes chronic fatigue, sleep disturbances, and a heightened risk of musculoskeletal injuries (Lichtenstein, Griffiths, Hemmingsen, & Støving, 2018). These physical consequences are compounded by mental health challenges, such as anxiety and depression (Mayolas-Pi et al., 2017), and body image disturbances, highlighting the multifaceted impact of EA on athletes' overall well-being. Despite these known risks, limited research has comprehensively examined the intersection of psychosocial health, competition level, and sport type in adolescent populations.

This study addresses these gaps by analyzing the psychosocial health implications associated with the risk of EA among adolescents participating in diverse sport types and competition levels. Building on prior research, it explores how the physical and psychological impacts of EA observed in adult athletes manifest in younger populations. By adopting a biopsychosocial framework, this study seeks to unravel the complex interrelationships influencing EA risk, providing actionable insights for stakeholders in youth sports and public health. Accordingly, the objectives of the current study were to examine the demographic factors that might increase EA risk and the potential health implications associated with EA risk.

METHODS

Participants and procedure

A total of 7,596 participants (44.2% girls) aged 11–19 completed the baseline assessment with valid data for physical activity, sleep quality, symptoms of anxiety and depression, eating disorders, and health-related quality of life. Participants were classified in 5 different categories: noncompetitive athletes, locally, regionally, nationally and internationally competitive athletes (Table 1). National and international athletes were recruited through the Spanish and Regional Sports Federations, High Performance Sports Centers, Sports Technique Centers, and the 20 clubs of each sports discipline with the highest level of performance according to gender. Each club and sports institution were contacted by e-mail, letter and telephone. The invitation included a brief introduction to the study and an explanation of its anonymous nature and a link to the online questionnaire. To be included in the study, athletes had to train at least 2 days/week and competitive athletes had to report at least 6 months of experience in training and competing in a sporting discipline included in the Summer Olympic Games program.

To recruit noncompetitive and locally and regionally competitive athletes, all students from all secondary education centers in three representative provinces of Spain were invited to participate in the study. Noncompetitive athletes had to express that they did sports at least twice a week, but that they did not compete in any sport.

For all study subjects the exclusion criteria were: 1) chronic illness, or any physical or psychological limitation that may limit physical activity levels; 2) presence of an injury that may affect participation in their respective sports and/or in any variable considered in the present study. Data were recovered from January 15 to March 15 of the years 2018, 2019 and 2020. Choosing this timeframe guaranteed that athletes were in an advanced phase of the training season and the time limitation also allowed the possible seasonal effect to be controlled. In addition, by analyzing only the sports disciplines included in the Summer Olympic

Table 1. Participant characteristics according to performance level and gender

	Noncompetitive		Locally/regionally competitive		Nationally/internationally competitive	
	Boys	Girls	Boys	Girls	Boys	Girls
n	1,359	1,806	1,826	770	1,052	783
EA score	16.6 (4.7)	15.4 (4.9)	18.6 (4.5)	18.0 (4.9)	19.4 (4.4)	19.4 (4.6)
Age (y)	15.1 (1.7)	14.9 (1.7)	14.8 (1.7)	14.7 (1.8)	15.7 (1.9)	15.3 (2.0)
BMI (kg/m^2)	21.1 (3.9)	20.3 (3.2)	20.2 (3.0)	20.0 (2.9)	21.0 (3.0)	20.1 (2.9)
PA level (1–5)	2.6 (0.6)	2.4 (0.6)	2.9 (0.6)	2.6 (0.6)	2.9 (0.6)	2.8 (0.6)
Sport training						
Years (y)	4.2 (3.3)	3.7 (3.1)	6.8 (3.3)	5.3 (3.2)	7.2 (3.4)	6.9 (3.3)
Hours week (h/wk)	4.1 (2.8)	3.2 (2.4)	6.2 (3.6)	5.7 (3.6)	11.1 (6.0)	12.1 (6.8)
Days week (d/wk)	3.3 (1.6)	2.8 (1.5)	3.7 (1.2)	3.4 (1.2)	4.8 (1.3)	4.8 (1.3)

Values are the mean (standard deviation). EA exercise addiction; Y years; BMI body mass index; PA physical activity.

Games program, athletes were in the same phase of the training season, away from the main competitions that take place at the end of the academic school year and during the summer. Tables 1 and 2 represent the main characteristics of the participants according to gender, age, sport type and performance level.

Measures

Physical activity and sport. To obtain contextual information about physical activity, participants completed the Spanish version of the Physical Activity Questionnaire for Children and Adolescents (PAQ-C and PAQ-A) (Martínez-Gómez et al., 2009). Participants were asked to evaluate the level of physical activity in their free time, in physical education classes and at different times (lunchtime, afternoon and evening) on school days and weekends during the last 7 days. Nine (PAQ-C) and eight (PAQ-A) items were rated on a 5-point Likert-type scale, with lower scores indicative of lower levels of physical activity. Physical activity was also assessed using a modified version of the PACE questionnaire for adolescents (Prochaska, Sallis, & Long, 2001). This adaptation has been used in epidemiological studies with European adolescents and involves asking the days on which subjects accumulate at least 60 min of moderate and vigorous physical activity during the last 14 days (McMahon et al., 2017).

Other questions included their priority sport, the years of practice at the competition level and the current number of sessions/week and hours/week. Finally, they were asked questions related to their performance level, season objective and competitive allocation. The national level was considered when a participant competed in the highest competitive category at the national level for their age, gender and sport.

A traditional classification was adapted to differentiate between technical, power, gymnastic, combat, racket, team and endurance sports (Belz, Kleinert, Ohlert, Rau, & Allroggen, 2018) (Table 2) (Appendix Table A1). Sports were coded as team or individual based on whether they involved three or more athletes on each team competing simultaneously (Zhou, Heim, & O'Brien, 2015). Team sports were differentiated into those with opponents and those without opponents depending on whether the practitioners competed simultaneously on the same competition field. Additionally, the study identified a group of athletes who indicated that they primarily competed both individually and in a team sport without an opponent.

Risk of exercise addiction. The Spanish version of the Exercise Addiction Inventory (EAI) was used to establish the risk of EA after the adolescent adaptation of Lichtenstein et al. (2018) (e.g., the word "partner" was changed to "friends"). The EAI Spanish version shown satisfactory psychometric properties (Sicilia, Alías-García, Ferriz, & Moreno-Murcia, 2013). The internal reliability of the sample was appropriate ($\alpha = 0.767$).

Table 2. Weekly training hours according to sport type, gender and performance level

	Technical (n = 164)		Power (n = 126)		Gymnastic (n = 314)		Combat (n = 193)		Racket (n = 212)		Team (n = 2,596)		Endurance (n = 769)	
	n		n		n		n		n		n		n	
Locally/regionally competitive														
Boys	15	7.5 (3.2)	10	5.4 (2.4)	7	6.3 (4.6)	33	6.9 (5.1)	90	5.4 (3.3)	1,535	6.0 (3.3)	127	8.8 (5.6)
Girls	19	4.8 (3.9)	13	5.4 (2.9)	140	6.9 (4.2)	20	4.8 (2.4)	55	4.8 (3.2)	406	5.0 (2.6)	113	7.6 (5.0)
Nationally/internationally competitive														
Boys	66	15.2 (7.8)	57	10.2 (4.8)	16	10.2 (6.0)	92	10.4 (5.8)	40	12.7 (7.3)	457	9.4 (5.0)	301	12.9 (6.2)
Girls	64	12.4 (7.5)	46	9.5 (4.1)	151	17.8 (6.9)	48	9.3 (5.7)	27	9.7 (5.1)	198	9.6 (4.8)	228	12.1 (6.5)

Values are the mean (standard deviation).

The EAI consists of six questions based on six general components of addiction: salience, mood modification, tolerance, withdrawal symptoms, social conflict, and relapse (Terry, Szabo, & Griffiths, 2004). The responses are rated on a 5-point Likert scale. The EAI classifies subjects as having a high risk of EA (score: 24–30) or a low risk of EA (score: 0–23). This instrument has also been validated in adolescent populations (Lichtenstein et al., 2018).

Sleep quality. The Pittsburgh Sleep Quality Index (PSQI) is a reliable and valid screening tool used to assess sleep dysfunction in both clinical and non-clinical samples (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). It has been found to have moderate structural validity across various populations, indicating that it is effective in fulfilling its intended purpose (Mollayeva et al., 2016). The PSQI consists of 19 questions which cover 7 components of sleep quality, including subjective sleep quality, sleep duration, sleep latency, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. Each of these components is rated on a 3-point scale, with higher scores indicating poorer sleep quality. The total score, which ranges from 0 to 21, is the sum of all component scores. This tool has been validated for use in assessing the sleep quality of adolescents as well (de la Vega et al., 2015). The internal reliability of the sample was appropriate ($\alpha = 0.729$).

Symptoms of anxiety. The Self-Rating Anxiety Scale (SAS) (Zung, 1971) was used to assess anxiety levels. Its Spanish version has shown good internal reliability (Hernández-Pozo, Macías, Calleja, Cerezo, & del Valle Chauvet, 2008) and has been previously used in large samples of European adolescents (McMahon et al., 2017). The survey comprises 20 items employing a 4-point Likert scale where respondents indicate the frequency with which they have experienced each symptom (never or rarely, sometimes, quite frequently, almost always or always). This scale provides a total score (20–80), reflecting the frequency of somatic anxiety symptoms. The internal reliability of the sample was appropriate ($\alpha = 0.808$).

Symptoms of depression. Depression scores were measured using the Spanish version of the Beck Depression Inventory (BDI-II) (Wang & Gorenstein, 2013). The 21 items of this instrument evaluate specific symptoms of depression experienced during the last two weeks, such as mood, pessimism, feelings of failure, and dissatisfaction. The reliability and validity of the BDI-II have been confirmed in clinical and community samples of adolescents (Osman, Kopper, Barrios, Gutierrez, & Bagge, 2004). The internal reliability of the sample was appropriate ($\alpha = 0.922$).

Eating disorders. The Spanish version of the Eating Disorders Inventory (EDI-3) was used to measure levels of eating disorder psychopathology (Garner, Elosua, López-Jáuregui, & Sánchez-Sánchez, 2010), validated for clinical and non-clinical populations (Elosua & López-Jáuregui, 2012; Rutsztein et al., 2013). The EDI-3 consists of 91 items across 12 main scales and 6 indices. Three of the main scales are risk scales: drive for thinness, bulimia, and body dissatisfaction. The remaining nine scales assess psychological aspects associated with the development and maintenance of eating disorders, including low self-esteem, personal alienation, interpersonal insecurity, interpersonal alienation, interoceptive deficits, emotional dysregulation, perfectionism, asceticism, and maturity fears. Higher scores indicate a greater presence of symptoms. The EDI-3 also groups some scales into six indices: Risk of Eating Disorders, Ineffectiveness, Interpersonal Problems, Affective Problems, Excessive Control and General Psychological Maladjustment (sum of all psychological scales). These indices help predict treatment outcomes and measure levels of psychopathology. The internal reliability of the sample was appropriate ($\alpha = 0.836$).

Health-related quality of life. The Spanish version of the KIDSCREEN-52 was used to measure health-related quality of life (HRQoL). This generic HRQoL instrument is based on a multidimensional construct and was developed as part of a European collaboration to provide a cross-cultural measure for children and young people aged 8–18 years (Ravens-Sieberer et al., 2001). It assesses physical, mental, and social dimensions of well-being from the perspective of the child or adolescent in the past week. It assess 10 dimensions: Physical well-being, Psychological well-being, Moods and emotions, Self-perception, Autonomy, Parent relations, Social support and peers, School environment, Social acceptance/bullying and Financial resources. The questionnaire includes 52 items, rated on a five-point Likert scale, with higher scores indicating better HRQoL. KIDSCREEN dimensions have acceptable psychometric properties and reliability (Ravens-Sieberer et al., 2005). The internal reliability of the sample was appropriate ($\alpha = 0.874$).

Socioeconomic status. Socioeconomically disadvantaged children and adolescents are more likely to develop mental health problems (Reiss et al., 2019) and experience a lower quality of life (Gomes et al., 2020). Subjective socioeconomic status or perceived family wealth was accordingly assessed using the question *"How well-off do you think your family is?"*. This question was originally used in the international study "The Health Behavior in School-aged Children (HBSC)" in 1994 as an indicator of the subjective socioeconomic status of adolescents (Roberts et al., 2009). The 5 response options were classified into 4 categories: 1 (poor), 2 (not very poor), 3 (normal) and 4 (rich or very rich).

Physical evaluation. The body mass index was calculated according to the reported values of mass and height. Pubertal status was evaluated using the Puberal Development Scale, which has shown acceptable levels of validity and reliability (Bond et al., 2006). For girls, the questionnaire asks about five aspects: body hair, accelerated growth, skin changes, menarche and breast development. For boys, the first three questions are similar, and changes in facial hair and voice are also assessed. Additionally, girls were asked about the onset and age of menstruation. Finally, a 5-level categorical scale designed to be comparable to Tanner's stages of pubertal development was calculated (Carskadon & Acebo, 1993).

Other variables. Participants were categorized according to the geographical area of Spain (north-south) and the number of inhabitants of the place of residence (range 1–5).

Statistical analysis

All analyses were conducted using IBM SPSS Statistics v.26 software (IBM Corp. USA). Descriptive statistics for the sample included means and standard deviations for continuous variables, and percentages for categorical variables. The normality of the dependent variable was tested using the Kolmogorov–Smirnov test and by examining the skewness coefficient. To examine the influence of independent factors on the risk of exercise addiction, generalized linear models (GLMs) were employed. Since the dependent variables did not adhere to a normal distribution, a Gamma GLM was utilized. The independent factors analysed included gender, age group (11–13, 14–16, 17–19 years), maturation stage (stages 1–5), competition level (noncompetitive, locally/regionally and nationally/internationally competitive), and type of sport (technical, power, gymnastic, combat, racket, team, endurance). Further analysis assessed the effect of on the type of competition (individual, team, team without opponent, individual and team without opponent). Post hoc analysis with Bonferroni adjustment was performed when necessary. Additionally, Gamma GLMs were used to assess the impact of high risk of exercise addiction (high risk vs. low risk) on the health variables analyzed, including symptoms of anxiety and depression, sleep quality, eating disorders, and health-related quality of life (HRQoL) scores. Confounding variables positively associated with physical activity participation were used as covariates. These included maturational development, family socioeconomic level, place of residence, municipality size, and weekly training hours in the competition group comparisons. A p value of <0.05 was considered statistically significant.

Ethics

The study was designed as a cross-sectional investigation based on self-reported data and was conducted following the principles of the Declaration of Helsinki. The study protocol was reviewed and approved by the Clinical Research Ethics Committee of Aragón (CEICA-PI/0339).

RESULTS

6.4% of adolescents who engaged in non-competitive sports and 15.6% of those who participated in competitive sports exhibited a risk of EA. The risk of EA was higher in boys than in girls, with similar values observed at high levels of competition: non-competitive $\beta = 2.737$ (SE $= 0.007$, $p < 0.001$); locally/regionally $\beta = 2.891$ (SE $= 0.010$, $p = 0.004$); nationally/internationally competitive $\beta = 2.968$ (SE $= 0.009$, $p = 0.755$). For both genders, the risk of EA increased with age, this increase was noticeable from the age of 17 onwards, boys $\beta = 2.933$ (SE $= 0.011$, $p < 0.001$); girls $\beta = 2.917$ (SE $= 0.015$, $p < 0.001$). Significant differences in the risk of EA between boys and girls were found at Tanner stages 2, 3, 4, and 5, but not at Tanner stage 1 (T1 $\beta = 2.771$, SE $= 0.037$, $p = 0.227$). Adolescents with greater risk of EA completed more weekly activity hours than those without risk ($p < 0.001$), independently of gender, age and competition level.

For both genders, athletes who competed had a higher risk of EA than those who did not compete ($\beta = 2.936$, SE $= 0.004$, $p < 0.001$). Additionally, the risk of EA increased with the level of competition for both genders (boys $\beta = 2.964$, SE $= 0.008$, $p < 0.001$; girls $\beta = 2.968$, SE $= 0.011$, $p < 0.001$) (Table 1). Athletes who competed in individual sports showed a higher risk of EA than those who competed in team sports ($\beta = 2.925$, SE $= 0.005$, $p < 0.001$). In boys, there were no differences in the risk of EA based on the type of sport practiced ($\beta = 2.959$, SE $= 0.012$, $p = 0.111$). In girls, the differences were small ($\beta = 2.953$, SE $= 0.015$, $p < 0.01$) and no significant differences were observed after adjusting for Bonferroni (Table 3).

Regardless of whether the athletes competed or the level of competition, adolescents at risk of EA showed poorer values in sleep quality (4.6 vs. 5.1, $\beta = 1.62$, SE $= 0.02$, $p < 0.001$), anxiety (33.9 vs. 36.0, $\beta = 3.58$, SE < 0.01, $p < 0.001$), depression (8.1 vs. 9.8, $\beta = 2.283$, SE $= 0.03$, $p < 0.001$), symptoms of eating disorders (18.0 vs. 22.2, $\beta = 3.101$, SE $= 0.03$, $p < 0.001$), with minor differences in social variables. Adolescents at risk of EA showed better physical well-being than adolescents without risk of EA. These differences were independent of sex and level of competition (Tables 4 and 5).

DISCUSSION

To the best of the authors' knowledge, this is the first study to analyze psychosocial health in relation to the risk of EA in a wide range of sport disciplines and adolescents characterized by different performance level. The main findings of this study were: 1) Approximately 6% of adolescents who participate in non-competitive sports and 16% of those who participate in competitive sports exhibited a risk of EA. In particular, athletes who compete, especially at high levels of competition, have a higher risk of EA than those who do not compete 2) The gender differences in the risk of EA are non-existent at higher levels of competition. 3) The risk of EA is higher in late adolescence. 4) Athletes who compete in individual sports have a higher risk of EA than those who compete in team sports. 5) Athletes at risk of EA have poorer mental health compared to those not at risk, with minor differences in social indicators, and better values in physical well-being.

Table 3. Exercise addiction score according to sport type, gender and performance level

	Technical (n = 164)		Power (n = 126)		Gymnastic (n = 314)		Combat (n = 193)		Racket (n = 212)		Team (n = 2,596)		Endurance (n = 769)		p value
	n		n		n		n		n		n		n		
Locally/regionally competitive															
Boys	15	18.8 (4.1)	10	19.3 (3.9)	7	20.9 (2.2)	33	18.3 (4.3)	90	18.6 (4.6)	1,535	18.6 (4.5)	127	18.2 (4.9)	0.786
Girls	19	19.7 (4.5)	13	18.0 (4.9)	140	18.7 (4.8)	20	19.2 (5.2)	55	18.5 (5.3)	406	17.3 (4.9)	113	18.7 (4.2)	0.014
Nationally/internationally competitive															
Boys	66	17.9 (4.0)	57	20.2 (3.8)	16	18.3 (6.2)	92	19.6 (5.3)	40	19.0 (5.1)	457	19.3 (4.2)	301	19.7 (4.6)	0.077
Girls	64	18.3 (5.1)	46	19.6 (4.5)	151	19.2 (4.7)	48	20.5 (4.4)	27	20.7 (3.9)	198	19.6 (4.6)	228	19.3 (4.5)	0.197

Values are the mean (standard deviation).
Generalized Linear Model, factors-adjusted: socioeconomic level, maturational development, place of residence and size of municipality of residence. Bonferroni adjustment.

First, our study found that 6% of noncompetitive adolescents and 16% of competitive adolescents showed a higher risk of EA. This finding contrasts with the results of a recent meta-analysis involving adults without disordered eating, which identified EA as a risk factor. In that study, the rates of EA in competitive athletes (5%) were lower than in general exercisers (8.1%) (Trott et al., 2020). However, caution is warranted when interpreting these results, as some questions in the EAI may be more likely to receive affirmative responses from high-performance athletes. For instance, items such as "I have increased my training time per session" or "After a pause, I try to return to the sport with the same training volume" might naturally elicit more positive responses from this group. In fact, adolescents with EA risk showed greater physical well-being and performed more weekly activity hours than those without risk. This was independent of gender, competition level and participation in competitive sport. Thus, a higher risk of EA could be related to a greater passion for sport.

Second, gender differences in the risk of EA were very small and non-existent at the highest competition levels. This finding aligns with previous research, including a recent meta-analysis of studies assessing gender differences in EA risk, which found that men had slightly higher EA scores but overall differences were trivial (Dumitru et al., 2018). However, caution is warranted in interpreting these results. As Szabo, Griffiths, De La Vega, Mervó, and Demetrovics (2015) noted, none of the theoretical models in the existing literature can fully explain EA, as the causes of this behavior vary among individuals, with particular attention to gender differences. This author proposed a collaborative model between researchers and clinicians known as the "Pyramid Approach" (Szabo., 2024). In this model, researchers begin with broad population-level screening using questionnaires (the base of the pyramid). Individuals identified with high REA can then be referred to clinical practitioners for further assessment (the middle layer), though this step is not feasible in anonymous studies. At this stage, health professionals with clinical or medical expertise can conduct in-depth interviews to distinguish between those who engage in high-volume exercise while maintaining control and those exhibiting maladaptive, uncontrolled exercise behaviors. The latter group can be evaluated for co-morbidities and offered established treatment (the top of the pyramid). With patient consent, cases may be published under pseudonyms, contributing to a growing body of documented instances. This approach could help clarify underlying dysfunctions and refine the conceptualization of exercise addiction, potentially informing its inclusion in future clinical reference manuals.

The higher risk of EA during late adolescence reported by the current study could be attributed to various factors, such as heightened performance expectations, critical periods of physical and psychological development, and increased autonomy in training decisions during this life period (Alcaraz-Ibañez et al., 2021). This underscores the importance of monitoring adolescents closely as they progress in their athletic careers, providing education on healthy

Table 4. Exercise addiction and psychosocial health according to performance level in boys

	Noncompetitive		Cohen's d	Locally/regionally competitive		Cohen's d	Nationally/ internationally competitive		Cohen's d	All		Cohen's d
	REA	LEA		REA	LEA		REA	LEA		REA	LEA	
n	96	1,263		256	1,570		187	865		539	3,698	
EA score	25.7 (1.7)	15.9 (4.1)*	3.12	25.4 (1.6)	17.5 (3.8)*	2.71	25.7 (1.7)	18.0 (3.6)*	2.74	25.6 (1.6)	17.1 (4.0)*	2.79
Sleep quality	5.1 (2.3)	4.6 (2.7)	0.20	4.5 (2.8)	4.0 (2.6)*	0.19	4.3 (2.5)	3.7 (2.4)*	0.24	4.5 (2.6)	4.1 (2.6)*	0.15
Anxiety symptoms	36.5 (8.1)	34.1 (7.2)*	0.31	34.8 (7.6)	32.8 (6.8)*	0.28	33.0 (6.3)	31.1 (6.0)*	0.31	34.5 (7.4)	32.9 (6.9)*	0.22
Depression symptoms	8.9 (9.5)	7.1 (8.4)*	0.20	6.2 (8.4)	5.2 (7.4)*	0.13	6.3 (6.7)	4.2 (5.8)*	0.34	6.7 (8.1)	5.6 (7.5)*	0.14
Eating disorders scores												
Eating disorder	22.5 (13.9)	17.3 (12.4)*	0.39	18.6 (12.6)	14.7 (11.1)*	0.33	16.4 (11.5)	12.5 (9.9)*	0.36	18.5 (12.6)	15.1 (11.4)*	0.28
Inefficiency	10.3 (8.9)	9.0 (8.5)	0.15	7.9 (7.8)	7.1 (6.9)	0.11	7.2 (6.9)	6.2 (6.6)	0.15	8.1 (7.8)	7.5 (7.5)	0.08
Interpersonal problems	15.9 (9.5)	14.3 (9.4)	0.17	12.6 (8.1)	11.7 (8.0)	0.11	12.4 (8.5)	10.6 (7.8)*	0.22	13.1 (8.6)	12.3 (8.6)	0.09
Emotional problems	15.4 (11.0)	11.9 (9.2)*	0.35	14.2 (10.5)	10.3 (8.1)*	0.42	11.2 (8.6)	7.7 (7.1)*	0.44	13.4 (10.1)	10.2 (8.4)*	0.34
Excess control	18.9 (9.2)	13.4 (7.8)*	0.64	16.8 (8.2)	13.1 (7.1)*	0.48	17.7 (7.6)	13.0 (7.0)*	0.64	17.5 (8.2)	13.2 (7.3)*	0.55
Global index of psychological maladjustment	72.4 (29.1)	60.5 (27.5)*	0.58	64.1 (26.7)	54.4 (22.9)*	0.39	59.5 (24.5)	48.2 (21.0)*	0.50	64.9 (26.7)	55.0 (24.6)*	0.39
HRQoL scores												
Physical well-being	52.2 (12.6)	47.5 (11.0)*	0.40	57.1 (10.1)	52.7 (11.1)*	0.41	56.7 (10.2)	54.2 (10.8)*	0.24	56.2 (10.7)	51.3 (11.3)*	0.44
Psychological well-being	50.5 (12.6)	49.7 (12.4)	0.06	54.3 (11.6)	52.6 (11.3)	0.15	51.8 (10.7)	52.5 (10.3)	0.07	52.7 (11.6)	51.6 (11.5)	0.09
Moods and emotions	45.0 (14.2)	48.7 (12.6)*	0.28	48.9 (13.8)	51.6 (12.6)*	0.20	49.3 (11.5)	52.9 (12.0)*	0.31	48.4 (13.2)	51.0 (12.5)*	0.20
Self-perception	46.5 (8.9)	49.1 (9.6)*	0.28	48.2 (9.4)	49.7 (9.3)*	0.16	49.3 (8.7)	50.5 (8.9)	0.14	48.3 (9.1)	49.7 (9.3)*	0.15
Autonomy	46.2 (12.7)	47.1 (11.4)	0.07	50.2 (12.5)	49.0 (11.0)	0.10	46.1 (11.1)	47.8 (10.2)	0.16	48.0 (12.2)	48.1 (11.0)	0.01
Parent relations	45.9 (11.2)	47.8 (12.2)	0.16	50.7 (12.2)	50.0 (11.3)	0.06	49.9 (11.3)	51.7 (10.2)	0.17	49.7 (11.5)	49.6 (11.8)	0.01
Social support and peers	51.5 (12.1)	51.7 (12.7)	0.02	55.3 (13.2)	53.9 (12.3)	0.11	51.4 (12.1)	52.6 (11.0)	0.10	52.8 (12.2)	53.2 (12.7)	0.03
School environment	48.9 (11.2)	49.1 (11.2)	0.02	49.5 (11.4)	49.7 (10.4)	0.02	47.0 (11.1)	49.4 (9.9)*	0.23	49.5 (10.6)	48.5 (11.3)	0.09
Social acceptance/bullying	42.7 (14.0)	45.4 (11.6)*	0.21	45.2 (13.8)	47.7 (11.3)*	0.20	49.5 (10.5)	49.7 (10.6)	0.02	47.4 (11.4)	46.3 (12.9)	0.09
Financial resources	49.5 (11.4)	49.8 (9.8)	0.03	51.9 (9.6)	51.5 (9.1)	0.04	51.4 (9.1)	52.6 (8.7)	0.13	51.2 (9.3)	51.3 (9.8)	0.01

Values are the mean (standard deviation). REA risk of exercise addiction; LEA low risk of exercise addiction; EA exercise addiction; HRQoL Health-related quality of life.
Higher values are indicative of a worse score, except for the HRQoL variables.
Generalized Linear Model, factors-adjusted: socioeconomic level, maturational development, place of residence and size of municipality of residence.
*$p < 0.05$ vs. REA group.

Table 5. Exercise addiction and psychosocial health according to performance level in girls

	Noncompetitive		Cohen's d	Locally/regionally competitive		Cohen's d	Nationally/ internationally competitive		Cohen's d	All		Cohen's d
	REA	LEA		REA	LEA		REA	LEA		REA	LEA	
n	106	1,700		105	665		145	638		356	3,003	
EAI score	25.4 (1.6)	14.8 (4.3)*	3.27	25.5 (1.6)	16.8 (4.1)*	2.80	25.9 (1.8)	17.9 (3.7)*	2.75	25.6 (1.7)	15.9 (4.3)*	3.00
Sleep quality	6.1 (3.1)	5.4 (3.1)*	0.23	5.5 (3.2)	4.5 (2.8)*	0.33	5.6 (3.0)	4.3 (2.8)*	0.49	5.7 (3.1)	4.9 (3.0)*	0.26
Anxiety symptoms	41.8 (9.7)	36.6 (7.5)*	0.60	37.2 (9.2)	34.2 (7.3)*	0.36	36.6 (7.9)	33.4 (7.2)*	0.42	38.3 (9.1)	35.4 (7.5)*	0.35
Depression symptoms	14.3 (11.9)	8.8 (8.9)*	0.52	9.7 (10.7)	7.0 (8.3)*	0.28	9.6 (8.8)	6.0 (6.9)*	0.46	11.0 (10.6)	7.8 (8.5)*	0.33
Eating disorders scores												
Eating disorder	33.8 (18.2)	23.2 (16.2)*	0.62	25.4 (19.8)	19.2 (15.9)*	0.35	24.8 (18.0)	17.9 (15.2)*	0.41	27.7 (19.0)	21.2 (16.1)*	0.37
Inefficiency	14.8 (12.3)	10.2 (9.4)*	0.42	11.1 (10.7)	8.9 (8.7)*	0.23	10.0 (8.5)	7.9 (8.1)*	0.25	11.8 (10.6)	9.5 (9.0)*	0.23
Interpersonal problems	18.1 (10.9)	13.7 (9.0)*	0.44	14.0 (9.9)	12.0 (8.4)*	0.22	13.4 (8.4)	11.7 (8.7)*	0.20	15.0 (9.9)	12.9 (8.9)*	0.22
Emotional problems	21.3 (13.9)	15.0 (10.8)*	0.51	16.4 (12.4)	12.4 (9.7)*	0.36	15.1 (10.7)	10.8 (9.6)*	0.42	17.3 (12.5)	13.5 (10.5)*	0.33
Excess control	18.1 (8.7)	12.7 (7.4)*	0.67	17.6 (9.2)	12.6 (7.3)*	0.60	18.2 (8.4)	12.5 (6.9)*	0.74	18.0 (8.7)	12.7 (7.3)*	0.66
Global index of psychological maladjustment	84.8 (39.5)	64.1 (30.1)*	0.59	72.8 (36.7)	58.7 (28.3)*	0.43	68.5 (29.7)	54.6 (27.9)*	0.48	74.6 (35.5)	60.9 (29.5)*	0.42
HRQoL scores												
Physical well-being	47.4 (10.6)	44.4 (10.2)*	0.29	53.0 (10.7)	50.0 (10.6)*	0.28	52.3 (10.0)	51.8 (10.0)	0.05	51.1 (10.6)	47.4 (10.7)*	0.35
Psychological well-being	44.3 (11.6)	49.3 (11.2)*	0.44	50.9 (11.9)	51.4 (11.1)	0.04	49.3 (11.0)	51.3 (10.6)*	0.19	48.4 (11.7)	50.2 (11.1)	0.16
Moods and emotions	39.9 (10.8)	46.0 (11.9)*	0.54	45.4 (14.2)	48.7 (12.4)*	0.25	45.8 (11.3)	49.4 (11.7)*	0.31	44.0 (12.4)	47.4 (12.0)*	0.28
Self-perception	43.3 (9.4)	46.5 (9.2)*	0.34	46.3 (10.4)	47.8 (9.7)	0.15	46.3 (8.2)	49.6 (9.5)*	0.37	45.5 (9.3)	47.5 (9.5)*	0.21
Autonomy	42.6 (10.6)	45.7 (10.9)*	0.29	47.8 (11.9)	46.8 (11.0)	0.09	42.0 (12.0)	44.4 (9.6)*	0.22	43.9 (11.8)	45.6 (10.7)*	0.15
Parent relations	43.0 (12.0)	49.3 (11.7)*	0.53	49.2 (11.1)	50.2 (11.0)	0.09	48.4 (11.3)	52.1 (10.7)*	0.34	47.1 (11.7)	50.1 (11.4)*	0.26
Social support and peers	50.1 (12.1)	54.0 (12.2)*	0.32	55.5 (13.0)	54.0 (11.9)	0.12	52.5 (10.6)	53.0 (10.7)	0.05	52.7 (11.9)	53.8 (11.8)	0.09
School environment	47.2 (9.8)	49.8 (10.3)*	0.26	51.6 (11.7)	51.2 (10.8)	0.04	48.7 (10.9)	51.2 (10.3)*	0.26	49.2 (11.0)	50.5 (10.4)	0.12
Social acceptance/bullying	45.8 (11.5)	47.1 (11.4)	0.11	46.9 (12.1)	48.6 (10.9)	0.15	48.6 (10.5)	50.8 (9.9)*	0.22	47.3 (11.3)	48.3 (11.1)	0.09
Financial resources	48.5 (10.1)	51.8 (9.3)*	0.34	53.4 (9.4)	53.1 (8.4)	0.03	53.7 (8.8)	53.2 (8.2)	0.06	52.2 (9.6)	52.4 (8.9)	0.02

Values are the mean (standard deviation). REA risk of exercise addiction; LEA low risk of exercise addiction; EA exercise addiction; HRQoL Health-related quality of life.
Higher values are indicative of a worse score, except for the HRQoL variables.
Generalized Linear Model, factors-adjusted: socioeconomic level, maturational development, place of residence and size of municipality of residence.
*$p < 0.05$ vs. REA group.

training practices and offering psychological support during this vulnerable period.

One of the most interesting findings of the present study is the higher EA risk in individual versus team sports participants. Previous literature on this topic is very conflicting. For instance, Lichtenstein, Larsen, Christiansen, Støving, and Bredahl (2014) compared the prevalence of exercise addiction in adult men participating in either football or individual fitness activities. Curiously, the prevalence of EA was statistically equal in the two groups (7.1% in football and 9.7% in fitness). However, a systematic review aimed to assess EA risk in different sport types showed that individual sports participants in general, and endurance sports athletes in particular are at the highest risk (Di Lodovico et al., 2019). To further complicate this topic, a recent systematic review reported conflicting results, with two studies showing higher incidence in EA in team sports, another two in individual sports and the last one stating no differences between groups (Chhabra, Nazlıgül, & Szabo, 2024). These disparities in the findings reported by previous literature regarding the risk of exercise addiction between team and individual sports stem from a complex interplay of competitive pressures, social dynamics, psychological characteristics, and environmental factors. Further, as none of the previous studies assessed these differences in adolescent populations of mixed genders, these disparities could be potentially attributed to our sample's characteristics.

Finally, adolescents with EA risk reported significantly worse mental health compared to their peers without such risk, despite there being no notable differences in social indicators. Again, this finding has been previously reported in the literature but mainly in adult populations. For example, a cross-sectional study performed by Meyer et al. (2021) reported that as many as 75% of adults with EA fulfill the criteria for at least one psychiatric disorder. Further, a meta-analysis of 20 studies reported lower mental health and general health values in adults with EA (Simon-Grima, Estrada-Marcén, & Montero-Marín, 2019). These findings are, as reported, no different to adolescent populations and highlight the profound impact of exercise addiction on overall well-being, independent of external social factors such as socioeconomic status, family support, or peer relationships. It suggests that the compulsive nature of exercise addiction and its associated psychological stressors play a critical role in deteriorating health outcomes among adolescents. These results underscore the necessity for targeted interventions focusing on healthy exercise habits and mental health support to mitigate these adverse effects. By addressing exercise addiction issues early on, it may be possible to improve the long-term mental health trajectories of at-risk adolescents, promoting a healthier, more balanced approach to physical activity.

The study presents several strengths that enhance its credibility and contribution to the understanding of the risk of exercise addiction among adolescent athletes. Firstly, the inclusion of a large sample size comprising 7,596 participants across various performance levels provides robust statistical power and allows for meaningful subgroup analyses. Additionally, the use of validated assessment tools and standardized questionnaires for physical activity and socio-demographic variables, ensures the reliability and validity of the data collected. Moreover, the comprehensive examination of multiple domains, including gender differences, age effects, and the influence of sports participation, enriches the findings and offers valuable insights for targeted interventions. However, certain limitations should be acknowledged. The cross-sectional design of the study precludes causal inferences, and longitudinal research would be beneficial to elucidate the temporal relationships between sports participation, psychosocial health, and the risk of exercise addiction over time. Furthermore, the reliance on self-reported measures introduces the possibility of response biases and social desirability effects, which may impact the accuracy of the reported data. Additionally, while efforts were made to recruit participants across diverse geographical regions and sports disciplines, the generalizability of the findings may be limited to the specific context of the study population. The study sample was assessed during a specific timeframe of their annual training cycle, which may have influenced the results. For example, assessments performed close to the competition periods may have resulted in different scores across the questionnaires.

A critical consideration in interpreting the findings of the current study is the inherent limitations of using self-reported questionnaires to assess the "risk" of EA. While tools such as the Exercise Addiction Inventory (EAI) offer valuable insights, they are not diagnostic instruments and are prone to measurement inaccuracies. Questions related to behaviors like "increased training time" or "resuming training volume after a pause" may reflect normative practices among high-performing athletes rather than pathological tendencies. Consequently, categorizing athletes as being "at risk" for EA without supplementary evaluation can result in overestimations or misclassifications.

These inaccuracies highlight the need for a more specific approach to EA assessment. Complementing self-reported measures with clinical interviews could significantly improve diagnostic precision. Such interviews allow for a deeper exploration of the underlying motivations and psychological states associated with compulsive exercise behaviors, distinguishing between adaptive dedication and maladaptive addiction.

Despite these limitations, the study significantly advances our understanding of the complex interplay between sports participation and exercise addiction in adolescent athletes, highlighting avenues for future research and targeted interventions to promote their well-being.

CONCLUSIONS

Exercise addiction poses a significant risk to adolescent athletes, particularly those engaged in competitive and individual sports, and is linked to poorer mental health outcomes. To promote holistic well-being in this vulnerable group, it is crucial to implement targeted interventions.

Policymakers and sports organizations should prioritize prevention, detection, and treatment strategies aimed at reducing the risk of exercise addiction among adolescents.

Funding sources: This work was supported by the Government of Aragon, Spain (Grant Number S25_23R).

Authors' contribution: ALA and CMP: study desing. CMP, SS and ALA: writing, reviewing & editing. CMP, APS, ILL, JRM and ALA: data collection. SS visualization, investigation. ILL and JRM: methodology. APR: software, data curation. ALA: conceptualization, methodology and supervision. All authors have read and agreed to the final version of the manuscript.

Conflict of interest: The authors report there are no competing interests to declare.

Acknowledgement: We are grateful for the contributions of the members of the Human Movement Research Group.

REFERENCES

Alcaraz-Ibañez, M., Chiminazzo, J. G. C., Sicilia, A., & Fernandes, P. T. (2021). Body and appearance-related self-conscious emotions and exercise addiction in Brazilian adolescents: A person-centred study. *Journal of Sports Sciences*, *39*(13), 1528–1536. https://doi.org/10.1080/02640414.2021.1883290.

Belz, J., Kleinert, J., Ohlert, J., Rau, T., & Allroggen, M. (2018). Risk for depression and psychological well-being in German national and state team athletes—associations with age, gender, and performance level. *Journal of Clinical Sport Psychology*, *12*(2), 160–178. https://doi.org/10.1123/jcsp.2016-0024.

Berczik, K., Szabó, A., Griffiths, M., Kurimay, T., Kun, B., Urbán, R., & Demetrovics, Z. (2012). Exercise addiction: Symptoms, diagnosis, epidemiology, and etiology. *Substance Use & Misuse*, *47*, 403–417. https://doi.org/10.3109/10826084.2011.639120.

Bond, L., Clements, J., Bertalli, N., Evans-Whipp, T., McMorris, B. J., Patton, G. C., … Catalano, R. F. (2006). A comparison of self-reported puberty using the Pubertal Development Scale and the Sexual Maturation Scale in a school-based epidemiologic survey. *Journal of Adolescence*, *29*(5), 709–720. https://doi.org/10.1016/j.adolescence.2005.10.001.

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193–213. https://doi.org/10.1016/0165-1781(89)90047-4.

Carskadon, M. A., & Acebo, C. (1993). A self-administered rating scale for pubertal development. *Journal of Adolescence*, *14*(3), 190–195. https://doi.org/10.1016/1054-139X(93)90004-9.

Chhabra, B., Nazlıgül, M. D., & Szabo, A. (2024). Exercise addiction in team sports: A systematic literature review. *Scandinavian Journal of Psychology*, *65*(5), 846–857. https://doi.org/10.1111/sjop.13026.

de la Vega, R., Tomé-Pires, C., Solé, E., Racine, M., Castarlenas, E., Jensen, M., & Miró, J. (2015). The Pittsburgh Sleep Quality Index: Validity and factor structure in young people. *Psychological Assessment*, *27*(4), e22–e27. https://doi.org/10.1037/pas0000128.

Di Lodovico, L., Poulnais, S., & Gorwood, P. (2019). Which sports are more at risk of physical exercise addiction: A systematic review. *Addictive Behaviors*, *93*, 257–262. https://doi.org/10.1016/j.addbeh.2018.12.030.

Dumitru, D. C., Dumitru, T., & Maher, A. J. (2018). A systematic review of exercise addiction: Examining gender differences. *Journal of Physical Education and Sport*, *18*(3), 1738–1747. https://doi.org/10.7752/jpes.2018.0325.

Elosua, P., & López-Jáuregui, A. (2012). Internal structure of the Spanish adaptation of the eating disorder inventory-3. *European Journal of Psychological Assessment*, *28*(1), 25–31. https://doi.org/10.1027/1015-5759/a000087.

Fahrenholtz, I., Melin, A., Wasserfurth, P., Stenling, A., Logue, D., Garthe, I., … Torstveit, M. (2022). Risk of low energy availability, disordered eating, exercise addiction, and food intolerances in female endurance athletes. *Frontiers in Sports and Active Living*, *4*, 869594. https://doi.org/10.3389/fspor.2022.869594.

Garner, D., Elosua, P., López-Jáuregui, A., & Sánchez-Sánchez, F. (2010). *EDI 3. Inventario de Trastornos de la Conducta Alimentaria-3*. Manual. TEA Ediciones.

Gomes, A. C., Rebelo, M. A. B., de Queiroz, A. C., de Queiroz, A. P. C., Herkrath, F. J., Rebelo Vieira, J. M., … Vettore, M. V. (2020). Socioeconomic status, social support, oral health beliefs, psychosocial factors, health behaviours and health-related quality of life in adolescents. *Quality of Life Research*, *29*(1), 141–151. https://doi.org/10.1007/s11136-019-02279-6.

Hausenblas, H., Schreiber, K., & Smoliga, J. (2017). Addiction to exercise. *British Medical Journal*, *357*. https://doi.org/10.1136/bmj.j1745.

Hernández-Pozo, M., Macías, D., Calleja, N., Cerezo, S., & del Valle Chauvet, C. (2008). Propiedades psicométricas del inventario Zung del estado de ansiedad con mexicanos. *Psychologia*, *2*(2), 19–46.

Kumar, B., Robinson, R., & Till, S. (2015). Physical activity and health in adolescence. *Clinical Medicine*, *15*(3), 267. https://doi.org/10.7861/clinmedicine.

Lichtenstein, M. B., Griffiths, M. D., Hemmingsen, S. D., & Støving, R. K. (2018). Exercise addiction in adolescents and emerging adults - validation of a youth version of the Exercise Addiction Inventory. *Journal of Behavioural Addiction*, *7*(1), 117–125. https://doi.org/10.1556/2006.7.2018.01.

Lichtenstein, M. B., & Hinze, C. J. (2020). *Exercise addiction: Epidemiology, assessment, and treatment*. Academic Press. https://doi.org/10.1016/B978-0-12-818626-8.00010-4.

Lichtenstein, M. B., Larsen, K. S., Christiansen, E., Støving, R. K., & Bredahl, T. V. G. (2014). Exercise addiction in team sport and individual sport: Prevalences and validation of the Exercise Addiction Inventory. *Addiction Research & Theory*, *22*(5), 431–437. https://doi.org/10.3109/16066359.2013.875537.

Martínez-Gómez, D., Martínez-de-Haro, V., Pozo, T., Welk, G. J., Villagra, A., Calle, M. E., … Veiga, O. L. (2009). Reliability and validity of the PAQ-A questionnaire to assess physical activity in

Spanish adolescents. *Revista Española de Salud Pública*, *83*(3), 427–439. https://doi.org/10.1590/s1135-57272009000300008.

Mayolas-Pi, C., Simon-Grima, J., Penarrubia-Lozano, C., Munguia-Izquierdo, D., Moliner-Urdiales, D., & Legaz-Arrese, A. (2017). Exercise addiction risk and health in male and female amateur endurance cyclists. *Journal of Behavioral Addictions*, *6*(1), 74–83. https://doi.org/10.1556/2006.6.2017.018.

McMahon, E. M., Corcoran, P., O'Regan, G., Keeley, H., Cannon, M., Carli, V., … Wasserman, D. (2017). Physical activity in European adolescents and associations with anxiety, depression, and well-being. *European Childhood and Adolescence Psychiatry*, *26*(1), 111–122. https://doi.org/10.1007/s00787-016-0875-9.

Meyer, M., Sattler, I., Schilling, H., Lang, U. E., Schmidt, A., Colledge, F., & Walter, M. (2021). Mental disorders in individuals with exercise addiction—a cross-sectional study. *Frontiers in Psychiatry*, *12*, 751550. https://doi.org/10.3389/fpsyt.2021.751550.

Mollayeva, T., Thurairajah, P., Burton, K., Mollayeva, S., Shapiro, C. M., & Colantonio, A. (2016). The Pittsburgh Sleep quality index as a screening tool for sleep dysfunction in clinical and non-clinical samples: A systematic review and meta-analysis. *Sleep Medicine Reviews*, *25*, 52–73. https://doi.org/10.1016/j.smrv.2015.01.009.

Osman, A., Kopper, B. A., Barrios, F., Gutierrez, P. M., & Bagge, C. L. (2004). Reliability and validity of the Beck Depression Inventory-II with adolescent psychiatric inpatients. *Psychological Assessment*, *16*(2), 120–132. https://doi.org/10.1037/1040-3590.16.2.120.

Prochaska, J., Sallis, J., & Long, B. (2001). A physical activity screening measure for use with adolescents in primary care. *Archives of Pediatric and Adolescent Medicine*, *155*(5), 554–559. https://doi.org/10.1001/archpedi.155.5.554.

Ravens-Sieberer, U., Gosch, A., Abel, T., Auquier, P., Bellach, B. M., Bruil, J., … European KIDSCREEN Group (2001). Quality of life in children and adolescents: A European public health perspective. *Sozial- und Präventivmedizin*, *46*(5), 294–302. https://doi.org/10.1007/BF01321080.

Ravens-Sieberer, U., Gosch, A., Rajmil, L., Erhart, M., Bruil, J., Duer, W., … the Kidscreen Group, E. (2005). KIDSCREEN-52 quality-of-life measure for children and adolescents. *Expert Review of Pharmacoeconomics & Outcomes Research*, *5*(3), 353–364. https://doi.org/10.1586/14737167.5.3.353.

Reiss, F., Meyrose, A. K., Otto, C., Lampert, T., Klasen, F., & Ravens-Sieberer, U. (2019). Socioeconomic status, stressful life situations and mental health problems in children and adolescents: Results of the German BELLA cohort-study. *PLoS One*, *14*(3), e0213700. https://doi.org/10.1371/journal.pone.0213700.

Roberts, C., Freeman, J., Samdal, O., Schnohr, C. W., de Looze, M. E., Nic Gabhainn, S., … International HBSC Study Group (2009). The health behaviour in school-aged children (HBSC) study: Methodological developments and current tensions. *International Journal of Public Health*, *54*(2), 140–150. https://doi.org/10.1007/s00038-009-5405-9.

Rutsztein, G., Leonardelli, E., Scappatura, M. L., Murawski, B., Elizathe, L., & Maglio, A. L. (2013). Psychometric properties of the Eating Disorders Inventory-3 (EDI-3) among female adolescents from Argentina. *Revista Mexicana de Trastornos Alimentarios*, *4*(1), 1–14. https://doi.org/10.1016/S2007-1523(13)71987-6.

Sicilia, Á., Alías-García, A., Ferriz, R., & Moreno-Murcia, J. A. (2013). Spanish adaptation and validation of the exercise addiction inventory (EAI). *Psicothema*, *25*(3), 377–383. https://doi.org/10.7334/psicothema2013.21.

Simon-Grima, J. S., Estrada-Marcén, N., & Montero-Marín, J. (2019). Exercise addiction measure through the exercise addiction inventory (EAI) and health in habitual exercisers: A systematic review and meta-analysis. *Adicciones*, *31*(3), 233–249. https://doi.org/10.20882/adicciones.990.

Szabo, A. (2024). Chasing a phantom dysfunction: A position paper on current methods in exercise addiction research. *International Journal of Mental Health and Addiction*. https://doi.org/10.1007/s11469-024-01372-3.

Szabo, A., Griffiths, M. D., De La Vega, R. M., Mervó, B., & Demetrovics, Z. (2015). Methodological and conceptual limitations in exercise addiction research. *Yale Journal of Biology and Medicine*, *88*(3), 303–308. https://pmc.ncbi.nlm.nih.gov/articles/PMC4553651/.

Telzer, E., Van Hoorn, J., & Rogers, C., & Do, K. T. (2018). Social influence on positive youth development: A developmental neuroscience perspective. *Advances in Child Development and Behavior*, *54*, 215–258. https://doi.org/10.1016/bs.acdb.2017.10.003.

Terry, A., Szabo, A., & Griffiths, M. (2004). The exercise addiction inventory: A new brief screening tool. *Addiction Research & Theory*, *12*(5), 489–499. https://doi.org/10.1080/16066350310001637363.

Torstveit, M., Fahrenholtz, I., Lichtenstein, M., Stenqvist, T., & Melin, A. (2019). Exercise dependence, eating disorder symptoms, and biomarkers of Relative Energy Deficiency in Sports (RED-S) among male endurance athletes. *BMJ Open Sport & Exercise Medicine*, *5*, e000439. https://doi.org/10.1136/bmjsem-2018-000439.

Trott, M., Jackson, S. E., Firth, J., Fisher, A., Johnstone, J., Mistry, A., … Smith, L. (2020). Exercise addiction prevalence and correlates in the absence of eating disorder symptomology: A systematic review and meta-analysis. *Journal of Addiction Medicine*, *14*(6), e321–e329. https://doi.org/10.1097/ADM.0000000000000664.

Wang, Y. P., & Gorenstein, C. (2013). Psychometric properties of the Beck depression inventory-II: A comprehensive review. *Brazilian Journal of Psychiatry*, *35*(4), 416–431. https://doi.org/10.1590/1516-4446-2012-1048.

Zhou, J., Heim, D., & O'Brien, K. (2015). Alcohol consumption, athlete identity, and happiness among student sportspeople as a function of sport-type. *Alcohol and Alcoholism*, *50*(5), 617–623. https://doi.org/10.1093/alcalc/agv030.

Zung, W. (1971). A rating instrument for anxiety disorders. *Psychosomatics*, *12*(6), 371–379. https://doi.org/10.1016/S0033-3182(71)71479-0.

Appendix

Appendix Table A1. Classification of sports according to sport type

Technical (n = 164)	Archery, equestrian, golf, shooting, surfing.
Power (n = 126)	Athletics combined events, athletics jumping events, athletics sprints (<15 s), athletics throwing events, weightlifting.
Gymnastic (n = 314)	Artistic gymnastics, artistic swimming, rhythmic gymnastics, trampoline gymnastics.
Combat (n = 193)	Boxing, fencing, judo, taekwondo, wrestling.
Racket (n = 212)	Badminton, table tennis, tennis.
Team (n = 2.596)	Baseball, basketball, beach volleyball, field hockey, football, handball, rugby, volleyball, water polo.
Endurance (n = 769)	Calm water canoeing, cycling, long distance athletics running, middle-distance athletics running, race athletics walking, rowing, swimming, triathlon.