

PERSPECTIVE

Physical Activity's Impact on Anxiety Management: A Systematic Review

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Abstract

Anxiety is a prevalent mental health concern among adolescents, which has prompted an increase in research examining the potential benefits of physical activity (PA) interventions. While PA has been explored as a potentially efficacious approach, research findings remain fragmented. The findings from 12 studies, analysed using the PRISMA framework, highlight the significant role of PA in managing anxiety among adolescents. Notably, higher levels of PA were linked to lower anxiety levels and a lower prevalence of anxiety-related symptoms. Despite the fact that some studies revealed gender and age-dependent differences in anxiety outcomes, a consistent trend highlighted the overall beneficial effects of PA. Thus, these studies demonstrate that PA interventions may effectively reduce anxiety in adolescents. Encouragement of PA, particularly in school and community contexts, emerges as an effective and accessible strategy for promoting the mental health of adolescents. These results support incorporating PA initiatives into larger mental health promotion and management programmes for this vulnerable population, offering valuable insights for policymakers and educators.

Keywords:

mental disorder, mental health, public health, health & well-being, education, inclusion

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Introduction

Mental health is fundamental for development and well-being [World Health Organization (WHO), 2021]. Approximately one billion individuals globally experience some kind of mental disorder, with anxiety and depressive disorders being the most common [United Nations (UN), 2022]. These figures increased by more than 25% during the COVID-19 pandemic (UN, 2022). It is

further estimated that one out of every two people will develop a mental disorder in their lifetime (McGrath et al., 2023). Like most mental health problems, anxiety disorder typically originates during childhood or adolescence (Merikangas et al., 2009). There is evidence, however, that mental health disorders are prevalent during the adolescent phase, when young people enter a pivotal period during which they are especially vulnerable to adverse social influences and health consequences

(Castelpietra et al., 2022; WHO, 2017), and when fluctuations in health can establish health trajectories that will be felt for many years.

Anxiety disorders, which entail excessive perceptions of fear or threat, evident, for instance, in social and generalised anxiety disorders, are among the most common mental disorders among adolescents, often beginning during childhood and following a chronic course (Antony et al., 2009). The most recent Global Burden of Health project (Institute for Health Metrics and Evaluation 2019) estimates anxiety disorders to be the most prevalent mental health problem globally. There is, however, substantial variation, with reported figures for anxiety among adolescents ranging from 17.0% (Eastern Mediterranean Region) to 4.0% (European Region). Considering the prevalence of mental disorders, it is important to identify activities and interventions that support adolescent mental health.

Anxiety is a sensation that is characterised by stress, worry, tension, nervousness, and unease (Munir et al., 2022). It is a normal response to stress and a typical human emotion characterised by various responses (e.g., behavioural, affective, and cognitive) to perceived threats. The purpose of the physical symptoms of anxiety is primarily to prepare the body to cope with the threat (Steimer, 2002). Hence, the anxious sensation is one of our body's natural defence mechanisms, alerting us to threats and preparing our bodies to fight back or flee a dangerous situation, also known as the 'fight, flight, or freeze' response. However, it can be considered excessive or pathological when such responses cause significant distress or are out of proportion to the perceived source of stress (Bhatia & Goyal, 2018). In other words, when anxiety becomes unmanageable to the point where it affects one's quality of life, it may lead to anxiety disorder. Usually, the feeling of anxiousness is reduced as the stressor is removed (Chu et al., 2024). However, with

anxiety disorders, eliminating the stressor or trigger does not necessarily reduce or remove the anxiousness (Schneiderman et al., 2005). The most common anxiety disorders include panic disorder (panic attacks), generalised anxiety disorder (excessive worry), social anxiety disorder (excessive fear in social situations), specific phobias (excessive fear of an object or situation), and separation anxiety disorder (excessive fear about separation from a certain individual) (Bandelow & Michaelis, 2015).

A growing evidence base supports the claim that sporting activities may help manage distress, including anxiety (D'Angelantonio et al., 2022; McMahon et al., 2017; Panza et al., 2020). In addition, adolescents who participate in the WHO-recommended 60 minutes or more of moderate-to-vigorous PA can significantly benefit from engaging in sporting activities (Bailey, 2018), as well as experiencing fewer anxiety and depression symptoms (Biddle et al., 2019; Hale et al., 2021; Rodriguez-Ayllon et al., 2019). For example, a meta-analysis investigating the association between PA and panic/anxiety demonstrated a small but significant effect of PA interventions in reducing panic disorder while also reducing anxiety (Wang & Liu, 2023). A systematic review and meta-analysis concluded that PA might be a useful approach to address anxiety symptoms in children and young people based on a moderate improvement in state anxiety, compared to no intervention or minimal intervention control conditions and significantly superior effects on state anxiety when compared to a time- and attention-controlled group (Carter et al., 2021). Physical activity (PA) (D'Angelantonio et al., 2022) and social connectivity (Eime et al., 2013) are two aspects that have been independently established to be protective against anxiety. It has been argued that organised sports and other types of PA offer a mix of these factors, which are potentially helpful and have been studied independently as

protective factors for anxiety. Furthermore, these activities are typically low-cost, easily adapted, and without significant side-effects or stigma (Vancampfort et al., 2017).

PA enhances the synthesis of anti-anxiety neurochemicals, including serotonin, gamma-aminobutyric acid, brain-derived neurotrophic factor, and endocannabinoids (Ratey, 2019). Moreover, PA stimulates the frontal lobe, which is linked to executive function, aiding in regulating the amygdala, the brain's mechanism for responding to perceived or actual dangers (Ratey, 2019). Physical activities can serve as a distraction, allowing individuals to break free from the cycle of negative thoughts that exacerbate anxiety. Participating in PA alleviates muscle tension, a prevalent sign of numerous anxiety disorders. Furthermore, regular PA fosters social connection and enhances self-esteem. Bartolomeo and Papa (2017) posited that participation in team sports enhances prosocial behaviours and fosters social identity and a sense of belonging among team members.

This review examines the relationship between sports participation and anxiety. Participation is understood here in terms used by the Council of Europe's European Sports Charter (CoE, 2001): "all forms of PA which, through casual or organised participation, aim at expressing or improving physical fitness and mental well-being, forming relationships, or obtaining results in competitions at all levels" (Bailey et al., 2023). In other words, sport is regarded as a communal and/or recreational pursuit accessible to many young individuals. Our usage excludes elite or sub-elite youth populations, which we propose should be considered a distinct sub-population. Athletes frequently encounter significant expectations, such as elevated training demands, competitive stress, and inadequate recovery (Küttel & Larsen, 2020; Nicholls et al., 2020). Several systematic reviews and meta-analyses have reported that playing top-level youth sports

is associated with heightened symptoms of mental ill-health, including anxiety, depression, and eating disorders (Kegelaers et al., 2022; Rice et al., 2019; Walter et al., 2022).

Adolescent anxiety is a public health concern, with prevalence rates increasing globally (UN, 2022). Given the limited accessibility and stigma associated with pharmacological and psychological interventions, non-pharmacological approaches, such as PA, have gained attention. While previous reviews have explored this relationship, few have systematically examined the contextual factors mediating its effects, such as social interaction and resilience. This review contributes to the literature by synthesizing studies from 2018 to 2023 and offering a broader perspective, including various study designs and contexts.

Methods

This research methodology is based on rapid reviewing principles, integrating established systematic review strategies with modifications to provide faster and more varied insights (Tricco et al., 2015). This methodology is influenced by prior research conducted by Public Health England on PA assessments (Chalkley et al., 2015). It involves a deliberate search, thorough integration, and systematic translation of relevant literature on Active Schools. An advantage of this approach lies in its ability to maintain the rigour of established research procedures while affording the flexibility to prioritise our project's core question: 'What works?' This careful balance ensures both thorough data gathering and the pursuit of practical outcomes. It also provides timely evidence to inform policy and practice. Studies predating 2018 were excluded to ensure relevance to current adolescent experiences, particularly considering recent socio-environmental factors such as the COVID-19 pandemic.

Data Collection

Our data collection technique involved searching three specialised databases: Google Scholar, SPORTDiscus, and the Psychology & Behavioural Sciences Collection. We focused on peer-reviewed journal publications published between January 2018 and March 2023. To thoroughly address our subject, we employed the following search terms: sport* OR physical activity* AND adolescent* OR youth OR teenage* AND anxiety. The search phrases were optimised through several trials to ensure acquisition of the most pertinent results on anxiety management via physical activities.

Exclusion Criteria

Given the anticipated volume of documents, all records were meticulously organised using a specialised referencing system. Duplicates were eliminated by our research team. The ensuing list of documents underwent scrutiny based on the exclusion criteria: (a) not peer-reviewed journal articles; (b) languages other than English; (c) not related to sports and mental health; (d) not an intervention, trial, evaluation, or 'what works' study; (e) not related to adolescents (ages 10 to 19); (f) not involving adolescents diagnosed with severe mental disorders; (g) not policy-related articles; (h) not review/conceptual articles; (i) excluded articles with only formative research; and (j) excluded articles published before 2018.

The checking process unfolds as follows:

- i. Documents are randomly allocated to team members
- ii. Each document undergoes a blind and independent assessment (keep, reject, or unsure)
- iii. A third member resolves discrepancies and reviews unsure' ratings

These studies were summarised based on their sample size, age, objectives, methods, key findings, and quality rating. In terms of quality assurance, research evidence was analysed in two ways. First,

we applied the Active Living by Design (ALBD) Community Action Model (Bors et al., 2009), featuring five components: Preparation, Promotion, Programme, Policy, and Physical Projects. This framework helps categorise studies and identify research gaps. Additionally, studies were assessed for research quality according to the following rubric (Hill et al., 2018):

- Study design
- Longitudinal design
- Cross-sectional (adequately matched)
- Cross-sectional (limited information)
- Frequency of measurements
- Objective measures
- Previous validation/reliability noted

Quality was scored on a scale of 0 to 8, categorising studies as low (0-2), moderate (3-6), or high (7-8) quality. Inter-rater reliability is established using Cohen's kappa values. Our methodology aligns with the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement (Moher et al., 2009), and our research is registered with the PROSPERO international database for systematic reviews.

Results

Twelve studies were chosen from the databases (refer to Figure 1). A thorough examination of the complex interplay between PA and anxiety across various contexts and populations was conducted. This research examined PA and anxiety-related sleep disruptions, PA and premenstrual syndrome in adolescent females, as well as screen-related sedentary behaviours and anxiety in adolescents. Various studies examined the psychological aspects of anxiety, particularly competitive anxiety in young athletes, as well as the influence of resilience, coping mechanisms, and motivation on the complex link between PA and anxiety.

A study conducted in Spain indicated that PA-related anxiety exerted a minimal effect on sports commitment but worry positively influenced sports commitment among adolescent athletes (Pons et al., 2018). Similarly, a Spanish study indicated that anxiety negatively correlated with resilience in its accepting dimension among adolescent athletes (Hernandez et al., 2020). The findings revealed a positive correlation between sports experience and resilience while demonstrating a negative correlation with anxiety. Additionally, Navarro et al. (2021) created the Behavioural Regulation in Exercise Questionnaire-2. During the validation of the questionnaire, it was determined that intrinsic and identified behavioural regulation correlated with increased satisfaction in physical exercise and reduced social anxiety, as well as diminished social and bodily anxiety among Spanish adolescents.

An experimental study in Lithuania showed that an eight-month exercise intervention programme effectively enhanced PA and fitness while reducing anxiety in adolescents (Klizienė et al., 2018). An Indian experimental study similarly demonstrated that both PA and music therapy effectively reduced anxiety and tension in teenagers (George et al., 2020). This research investigated the impact of exercise and music therapy on stress and anxiety, offering pragmatic anxiety treatment techniques.

A Turkish study indicated that a nutritious diet and increased PA may mitigate obesity and social anxiety in teenagers (Muftuoglu & Bayram, 2020). Examining nutritional habits and PA revealed the significance of a balanced diet in reducing social anxiety. A further Turkish study demonstrated that PA significantly influenced hyper-focus and mood fluctuations in young adults (Celik et al., 2021). The postponement of personal social obligations and conflicts adversely affected anxiety, fatigue, hunger, and nausea. A Turkish study among young adults (Aktaş

& Celebi, 2018) unexpectedly revealed no significant correlation between social appearance concern and leisure time exercise. Nevertheless, the latter study indicated that levels of concern for social appearance were elevated in males.

Indries et al. (2019) identified a positive correlation between sports-related anxiety and exam anxiety, alongside a negative correlation with the academic achievement of Romanian children. The degree of anxiety experienced during academic evaluations and examinations affects the anxiety levels in athletics and competitive sports. Consequently, inadequate academic achievement adversely affects sports anxiety. A Brazilian study indicated that elevated PA during physical education classes correlated with reduced anxiety-related sleep disturbances in both genders, whereas post-school PA was linked to diminished anxiety-related sleep disturbances, specifically in male adolescents (Werneck et al., 2020). PA facilitates quicker onset of sleep and enhances sleep quality due to the elevated synthesis of melatonin, a hormone that governs sleep-wake cycles. These studies illuminate the nuances of PA and anxiety relationships and their applicability across demographic groups and environments.

An Indonesian study investigating the correlation between physical activity and anxiety with premenstrual syndrome in adolescents found no significant association between physical activity and premenstrual syndrome but identified a strong relationship between anxiety and premenstrual syndrome (Armini et al., 2022). In summary, increased anxiety levels correlate with exacerbated PMS symptoms in female teenagers. The hormonal fluctuations during PMS might influence neurotransmitters in the brain, such as serotonin and dopamine, associated with mood control. A Chinese study indicated that elevated screen-related sedentary behaviours were associated with increased anxiety levels in teenagers (Wen et al., 2022).

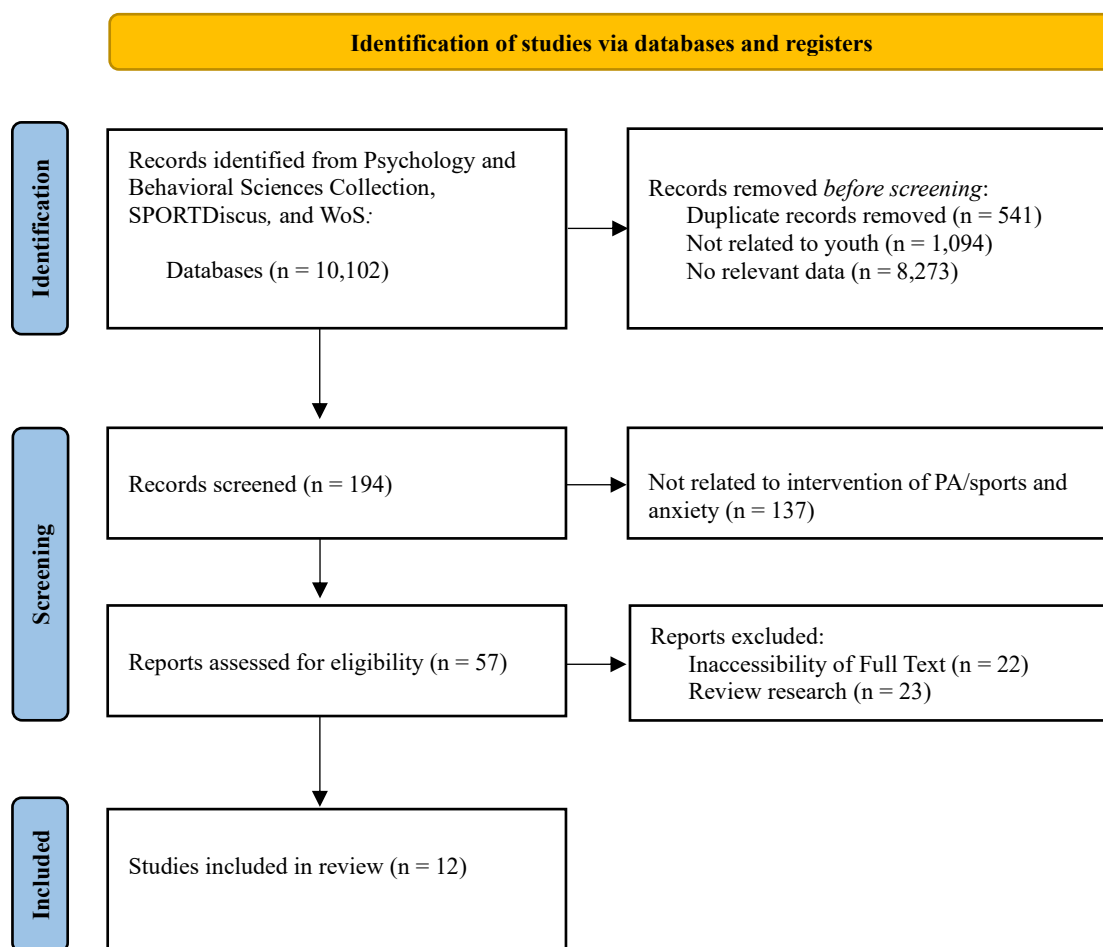


Figure 1. PRISMA output

The majority of the studies were conducted among adolescents. As a whole, these studies show that PA boosts resilience and reduces anxiety. Nevertheless, there is a dearth of research that looks into the influence of PA on anxiety or anxiety disorders. Perhaps the COVID-19 pandemic made engagement in physical activities more difficult, thus limiting the possibilities of researching this facet in the context of anxiety. Most of the effort in the past three years has been focused on the exacerbation of mental health during COVID-19. Consequently, examining the role of PA in reducing anxiety was made more complicated by the movement control order as a result of COVID-19.

Surprisingly, none of the studies used a qualitative or mixed-methods approach. Most used cross-sectional surveys, followed by experimental designs. Qualitative studies can provide a rich and nuanced understanding of individuals' perspectives, emotions, beliefs, and, most importantly, motivations when engaging in PA. Mixed-methods studies can provide a comprehensive understanding and enable corroboration of the findings from various sources, thus increasing the reliability and validity of the studies.

Table 1. Characteristics and quality assessment of eligible studies

Source / Country	Type of Study / Design	Objective / Sample	Methods / Measures	Key Findings	Rating Score
Aktağ, & Çelebi (2019) / Turkey	Survey / cross-sectional study	To analyse the relationship between leisure time exercise and social appearance. 247 students aged 18-30 years	The SAAS scale assessed social appearance and anxiety. A Turkish adaptation of LTEQ was found valid and a reliable instrument to determine leisure time PA levels.	- No significant correlations among social appearance anxiety, anxiety and leisure time exercise duration were found.	Low
Armini, Zahriya, Hidayati et al. (2022) / Indonesia	Survey / cross-sectional study	To analyse the relationship between PA and anxiety with PMS. 143 adolescent girls aged 13-14 years	PA was assessed using the PAQ-A questionnaire. Anxiety was measured using the Z-SAS questionnaire (anxiety characteristics, attitudes, and somatic symptoms).	- No significant association between PA and PMS was found. - A significant correlation between anxiety and PMS was discovered.	Moderate
Çelik, Demirel, & Şam (2021) / Turkey	Survey / cross-sectional study	To analyse the relationship between anxiety levels and exercise addiction during Covid-19 pandemic period. 184 students of sport science degree aged more than 18 years	To assess anxiety and exercise addiction levels of students, CAS and EAS scales were used.	- Regular exercise and active sports and their duration influenced hyper-focus and mood swings. - The postponement of individual social needs and conflict had negative impacts on the individuals' anxiety levels, drowsiness, loss of appetite, and nausea.	Low
George, Haritha, Jincy et al. (2020) / India	Intervention/ Pre-test-post-test experimental design	To assess the effect of aerobic exercise in reducing stress and anxiety. Experimental group and control group of 15 students each, aged 14-19 years	Experimental group received an exercise programme including 10 minutes of warm-up and cool-down exercise and 20 minutes of aerobic dance programme. Music therapy was given for 15 minutes. The control group was given only music therapy programme lasting 30 minutes.	- Both groups showed reductions in stress and anxiety. While comparing between the groups in case of stress and anxiety, there was significant stress reduction only. - Both aerobic exercise and music therapy are effective in reducing stress and anxiety	Moderate
González-Hernández, Gomariz-Gea, Valero-Valenzuela et al. (2021) / Spain	Survey / cross-sectional study	To examine the levels of resilience and competitive anxiety by sex and years of sports experience. To analyse the relationship between resilience resources	Differential and multivariate descriptive, correlation and multiple regression analyses were performed. The Spanish version of the RS-14 scale was used to assess the level of individual resilience.	- Anxiety was negatively related to resilience in its dimension of acceptance. - Girls showed higher levels of somatic anxiety, while boys had higher levels of acceptance. - Statistically significant differences were found in the acceptance resources in favour	Moderate

		and competitive anxiety, and the variables that predict resiliency resources and self-confidence.	An abbreviated version of the CSAI-2R questionnaire was employed to assess competitive state anxiety.	of boys, while significantly different indicators in somatic anxiety and self-confidence in favour of girls were found.	
		241 handball and basketball players aged 14-17 years		- Sports experience was positively related to resilience and negatively to anxiety.	
Indrieş & Bochiş (2019) / Romania	Survey / descriptive cross-sectional study	To identify the levels of anxiety and test anxiety in sports. To investigate the influences of academic performances and test anxiety on anxiety in sports. 65 students aged 9-11 years	The 30-item CTAS scale assessed students' <i>thoughts</i> (e.g. I think I will get a lower score), <i>distracting behaviour</i> (e.g. I move my legs under the bench) and <i>automatic reactions</i> . Additionally, SAS-2 was used to measure anxiety in sports.	- The results showed an average level of anxiety in sports. The above-average levels for the whole group were obtained from the global score of the CTAS. - A direct or positive relationship between sports anxiety and test anxiety and a negative association with the academic performance of the students in the disciplines of Romanian language and literature and sport, but not mathematics, was found.	Moderate
Klizienė et al. (2022) / Lithuania	Survey/pre-test/post-test experimental design	To analyse the effects of an 8-month exercise intervention program on PA and decrease anxiety. Experimental group of 70 students aged 6-7 years control group of 68 students aged 6-7 years	8 months intervention: A pre-test/post-test experimental design was used to avoid interference with educational activities due to the random selection of children into the groups. Children's PA was assessed using the CPAQ scale. The RCMAS scale was used to measure anxiety and children's defensiveness.	- The exercise intervention program led to statistically significant changes in the dependent variables: increased PA and decreased anxiety for the experimental group.	Moderate
Muftuoğlu & Bayram (2020) / Turkey	Survey / descriptive cross-sectional study	To analyse the relationship between nutritional habits, social anxiety and PA levels. 300 students aged 14-18 years	The KIDMED Index assessed the students' healthy eating habits. The IPAQ questionnaire collected PA levels. The SPAS inventory assessed social anxiety levels.	- No statistically significant differences between KIDMED, IPAQ, or SPAS were found by sex. - Students reporting a healthy diet showed higher KIDMED scores and lower SPAS scores than those with an unhealthy diet. - A positive correlation was found between KIDMED and IPAQ, and a negative correlation between KIDMED and SPAS and BMI for age.	Moderate

				<ul style="list-style-type: none"> - A negative but insignificant correlation was shown between IPAQ and SPAS scores. 	
Navarro et al. (2023) / Spain	Survey / cross-sectional study	<p>To validate the psychometric structure of the BREQ-2 scale to confirm the existence of five levels of motivation toward physical exercise.</p> <p>To examine the differences in motivation according to sex and age and the role of age and sex in the relationship between motivation and enjoyment.</p> <p>666 students aged 10-16 years</p>	<p>BREQ-2 questionnaire was used to assess the different types of motivations.</p> <p>PASAS evaluated social anxiety in sports.</p> <p>PACES assessed enjoyment of PE.</p> <p>SPAS measures the degree of anxiety a person experiences when they perceive that others are or may be negatively evaluating their physical aspect.</p>	<ul style="list-style-type: none"> - The CFA of the BREQ-2 showed a five-factor structure. A more parsimonious four-factor structure with a single intrinsic-identified regulation was identified through EFA. - The more self-determined types of motivation were positively associated with enjoyment and negatively associated with anxiety. - The type of physical exercise motivation fluctuated depending on age and sex, and age moderated the relationship between motivation and enjoyment. 	Moderate
Pons, Viladrich, Ramis et al. (2020) / Spain	Survey / cross-sectional study	<p>To examine how coping mediates the relationship between competitive anxiety and sports commitment.</p> <p>500 team athletes aged 13-21 years (basketball, soccer, volleyball, handball, roller hockey and water polo)</p>	<p>The measurement model was defined using CFA and exploratory SEM, and two different mediation models (total and partial) were compared using SEM.</p> <p>The 15-item Spanish version of the SAS-2 scale assessed competitive anxiety.</p> <p>Coping was assessed through the 31-item Spanish version of ISCCS scale.</p> <p>Sport commitment was measured using the commitment subscale of the SCQ questionnaire.</p>	<ul style="list-style-type: none"> - Cognitive anxiety factors predicted sports commitment. - Somatic anxiety had a weak influence on sports commitment. Worry showed a positive influence on sports commitment. - Concentration disruption negatively impacted sports commitment through mediating effects only, showing a negative path to task-oriented coping and a positive path to disengagement-oriented coping. - Task coping efforts undertaken by adolescent athletes were identified as a key element in the relationship between competitive anxiety and sports commitment. 	High
Wen, Zhu, Yuan et al. (2019) / China	Survey / cross-sectional study	<p>To investigate the association between PA, screen-related sedentary behaviours, and anxiety.</p> <p>900 adolescents aged 12-16 years</p>	<p>LPA was employed to identify homogeneous subtypes of anxiety.</p> <p>The 100-item MHT scale was used to assess mental health (learning and interpersonal anxieties, loneliness and remorse tendencies, allergic tendencies, physical symptoms, terror, and impulsive tendencies).</p>	<ul style="list-style-type: none"> - High screen-related sedentary behaviours were associated with higher odds of anxiety. - High prevalence of moderate and severe anxiety accounted for 56% and 24.78%, respectively. 	Low

			The YRBSS questionnaire items assessed PA and screen-related sedentary behaviours.		
Werneck, Schuch, Ferrari, et al. (2020) / Brazil	Survey / multi-stage, stratified, clustered probability design	To analyse the association between different contexts of PA and anxiety-induced sleep disturbance. 100,648 students aged 11-18 years	Anxiety-induced sleep disturbance was assessed using the GSHS survey. An adaptation of GSHS was used to assess PA, including nine questions about PE classes, school transportation, and after school exercise/sports practice. A self-report questionnaire assessed the total time watching TV per day and the consumption of ultra-processed food over the previous 7 days.	<ul style="list-style-type: none"> - Higher PA during transportation was associated with higher AISD. - PA during PE classes showed lower odds for AISD. - Outside school, PA was associated with reduced AISD among boys. - The association between PA and AISD seems to be context dependent. 	High

Note: PA = Physical Activity; PE = Physical Education; GSHS = Global School-Based Student Health; AISD = Anxiety-Induced Sleep Disturbance; PMS = Premenstrual syndrome; PAQ-A = Physical Activity Questionnaire for Adolescents; Z-SAS = Zung Self-Rating Anxiety Score Questionnaire; LPA = Latent Profile Analysis; MHT = Mental Health Test; YRBSS = Youth Risk Behavior Surveillance System; RS-14 = Resilience Scale; CSAI-2R = Competitive State Anxiety Inventory-2R; SAS-2 = Sport Anxiety Scale-2; ISCCS = Inventaire des Stratégies de Coping en Compétition Sportive [Coping Inventory for Competitive Sport]; SCQ = Sport Commitment Questionnaire; CFA = Confirmatory Factorial Analysis; SEM = Structural Equation Modeling; KIDMED = Mediterranean Diet Quality Index; IPAQ = International Physical Activity Questionnaire; SPAS = Social Physique Anxiety Inventory; BMI = Body Mass Index; CTAS = Child Test Anxiety Scale; BREQ-2 = Behavioral Regulation in Exercise Questionnaire; PASAS = Physical Activity and Sport Anxiety Scale; PACES = Physical Activity Enjoyment Scale-Short Version; RCMAS = Revised Children's Manifest Anxiety Scale; CPAQ = Children's Physical Activity Questionnaire; SAAS = Social Appearance Anxiety Scale; LTEQ = Leisure Time Exercise Questionnaire; CAS = Coronavirus Anxiety Scale; EAS = Exercise Addiction Scale.

Discussion

The identified studies in this rapid review were still somewhat heterogeneous, often examining anxiety in connection with other health concerns, such as premenstrual syndrome (Armini et al., 2022), sleep disturbance (Werneck et al., 2020), and appearance anxiety (Aktağ & Çelebi, 2018). The quality of the publications, as a whole, was relatively low, with the credibility of some articles somewhat questionable (e.g., Aktağ & Çelebi, 2018; George et al., 2021; Klizienė et al., 2018). Only one paper directly researched the relationship between PA and anxiety (as well as screen-related sedentary behaviours; Wen et al., 2022). PA was measured based on the days participants engaged in 60 minutes or per day over the past week. The result was somewhat ambiguous, with statistical significance reported among different subgroups of PA when the χ^2 statistic method was used, but no significance emerged following multivariate logistic regression. Perhaps shared variance between self-reports of sedentariness and PA might explain this finding, which was found to be the case in a Canadian study with adolescents' screen time anxiety (Kim et al., 2020), highlighting the limitations of self-report measures. It certainly stands in contrast with earlier studies, which have indicated a negative association between PA and anxiety (McMahon et al., 2017; Stubbs et al., 2017).

Two papers reported relatively simple quasi-experimental studies in which some form of physical intervention was tested against a control (George et al., 2021; Klizienė et al., 2018). One study based in India (George et al., 2021) examined the effectiveness of aerobic exercise in reducing stress and anxiety among high school students who attended a boarding (residential) school.

The intervention group was given what was described as “aerobic exercise (dance)” (p. 1) (and also music therapy); the control group was given music therapy (listening to relaxing music). After 3 days per week for 4 weeks, stress and anxiety levels among the students in the intervention group reduced significantly compared with the control group. The authors of this study conclude that their results show the effectiveness of aerobic exercise in reducing stress and anxiety. This conclusion can be questioned on at least one issue. It is claimed that “The aerobic exercise included basic muscle stretching, walking, jogging and aerobic dance moves like hip roll, squatting, calf raises, side knee crunches, kickbacks, overhead reaches, body twists, bicycle crunches etc.”.

However, most of these exercises are not aerobically good. In addition, it is not clear how most of them counter as “dance” either. Therefore, the authors' description of their intervention seems inaccurate. A more accurate label is 'a variety of exercises'. A more robust study came from Lithuania (Klizienė et al., 2018). It involved eight months of exercises (dynamic exercise, intense motor skill repetition, differentiation, and PA in the classroom) with elementary-aged students. PA was measured using validated questionnaires. Findings show that the students in the intervention group experienced statistically significant changes in the dependent variables: increased PA and decreased anxiety. Insofar as these studies add to a surprisingly limited evidence base for the effects of PA interventions to combat childhood and adolescent anxiety, they have some value. However, their methodological and quality limitations highlight the need for further research.

Moreover, appearance anxiety (fixation with one's appearance and fear that others will negatively evaluate one's appearance) is a potentially relevant topic for researchers of PA. On one hand, exercise is frequently proposed to enhance physical appearance (Corazza et al., 2019); on the other, appearance norms can exclude young people who fall outside of socially acceptable standards (Scotto di Luzio et al., 2023). A study in Turkey (Aktağ & Çelebi 2018) examined this phenomenon, finding that students' gender was not a significant variable, which is somewhat surprising in light of earlier research findings. However, differences between females and males did emerge when PA levels were considered, especially membership in sports clubs. Those students associated with sports clubs had both higher levels of PA and lower social appearance anxiety than those who were not. The fact that the participants in this study attended a physical education college is potentially relevant.

A second study from Turkey (Muftuoglu & Bayram, 2020) explored relationships between PA and social physique anxiety (as well as nutritional behaviour). Social physique anxiety (the anxiety experienced when a person believes they are being observed or judged on their appearance) is related to appearance anxiety (Aktağ & Çelebi, 2018) as they both refer to concerns about physical appearance and other body characteristics that are central to adolescents' sense of self-worth. Consistent with earlier studies (e.g., Deshmukh-Taskar et al., 2010), a negative correlation between PA and social physique anxiety was reported. In other words, when PA is performed in a social setting or with others, appearance anxiety tends to increase due to the individual's fear of negative peer evaluation.

Another anxiety-related condition included in the sample of publications discussed PA and anxiety-induced sleep disturbance (Werneck et al., 2020). This study drew on a substantial sample of more than 100,000 individuals aged 11–18 years and found that PA was associated with reduced anxiety among adolescents. Interestingly, the reported effects seemed to be context-dependent. There was a negative correlation between PA and anxiety when that activity took place during physical education lessons or PA practice outside school. However, there was a positive association between PA and anxiety during physically active transport. It might be the case that PA intensity levels are lower during active travel than in team sports (Bailey et al., 2023).

It is difficult to generalise such claims. The authors argue persuasively that a plausible explanation for these differences is that physical education lessons and out-of-school activities are more likely to take place in social groups rather than during transport and socially situated sporting activities are a protective factor for mental health indicators (Doré, Sylvester et al., 2020; Rastogi et al., 2023). Social activities are typically associated with social connectedness, competence, and autonomy, indicative of intrinsic motivation and associated with mental health (Stanley & Schutte, 2023). Social connectedness and support are often characteristic of sporting activities (Samsudin et al., 2024) and can act as buffers against the stresses and strains of adolescent lives (Singh et al., 2020).

The buffering function of social connectedness and support which is often characteristic of sporting activities is one of the most widely endorsed hypotheses for explaining why much of the empirical literature corroborates the claim that PA supports mental health

(Arat & Wong, 2017; Bang et al., 2020; Biddle et al., 2019). An alternative hypothesis is that PA develops psychological competencies that support mental health. One study in our collection tested this hypothesis, focusing on resilience (González-Hernández et al., 2020). The results showed that anxiety was negatively related to resilience, and participation in sports was positively related to resilience and negatively related to anxiety. There were statistically significant differences by gender, with girls reporting higher levels of somatic anxiety (the physiological activation that a person perceives when faced with a stressful situation) and boys reporting higher levels of acceptance.

These findings support the role of PA in anxiety management through multiple mechanisms, including neurochemical effects and social connectedness (Ratey, 2019). The observed context-dependent effects highlight the need for structured programmes that encourage social engagement. Theoretical frameworks, such as Self-Determination Theory (Deci & Ryan, 2000), may help explain these benefits. Practical implications include the need for integrating PA into school curricula and public health initiatives.

Conclusion

PA is associated with reduced anxiety symptoms among adolescents (D'Angelantonio et al., 2022). Extrapolating from studies with adults, we might hypothesise that the observed pattern might be related to the body's production and regulation of anti-anxiety neurochemicals during PA. However, a more plausible (but not mutually exclusive) explanation comes from findings suggesting that associations between PA and mental health are dependent on context and highlight

social and contextual potential mechanisms. In other words, and with a due sense of caution that reflects the small number and relatively low quality of the identified studies in this review, our findings highlight the value of the inherently social nature of most sporting and physical activities. We do not rule out other mechanisms. Nevertheless, based on the available evidence, it seems reasonable to emphasise the social dimension of sport in any program aspiring to support young people's mental health.

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Data Availability Statement

The datasets generated and analyzed during the current study are available upon reasonable request from the corresponding author.

Conflicts of Interest

The authors declare no conflict of interest.

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