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Impact of physical activity on school-related stress in children and adolescents before COVID-19: a systematic review

Impacto de la actividad física en el estrés escolar en niños y adolescentes antes del COVID-19: una revisión sistemática

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Abstract. Background: This systematic review aimed to explore the relationship between physical activity (PA) and school-related stress in children and adolescents. The study examined how PA interventions, sports, and exercise affect mental health outcomes, particularly stress reduction in school-aged populations. Methods: A comprehensive literature search was conducted in Web of Science, Scopus, PubMed, SPORTDiscus, and PsycINFO, covering studies published up to February 2023. Inclusion criteria were based on the PICO framework, focusing on school-aged participants (6-18 years) and PA-related interventions targeting stress or mental health. The GRADE system was used to evaluate the quality of the evidence, and PRISMA guidelines were followed. Results: A total of 20 studies met the inclusion criteria. Thirteen studies focused on PA and its impact on stress and mental health, consistently showing a negative relationship between regular PA and academic stress. Five studies assessed the effects of organized sports, with mixed results regarding their ability to reduce stress. Three studies investigated exercise interventions, highlighting the importance of exercise frequency in improving mental health outcomes. One study reported positive results from behavior-change interventions like workshops on PA benefits. Conclusion: This review confirms the association between PA, sports, and improved mental health in school-aged students. However, more high-quality experimental research is needed to clarify the specific characteristics (intensity, type, and duration) of PA that provide the most benefits for stress reduction in adolescents.
Keywords: physical activity, school-related stress, mental health, adolescents, exercise, sports.

Resumen. Antecedentes: Esta revisión sistemática tuvo como objetivo explorar la relación entre la actividad física (AF) y el estrés escolar en niños y adolescentes. El estudio examinó cómo las intervenciones de AF, los deportes y el ejercicio afectan los resultados de salud mental, particularmente la reducción del estrés en poblaciones escolares. Métodos: Se realizó una búsqueda exhaustiva de literatura en Web of Science, Scopus, PubMed, SPORTDiscus y PsycINFO, cubriendo estudios publicados hasta febrero de 2023. Los criterios de inclusión se basaron en el marco PICO, centrándose en participantes en edad escolar (6-18 años) y en intervenciones relacionadas con la AF dirigidas al estrés o la salud mental. Se utilizó el sistema GRADE para evaluar la calidad de la evidencia, y se siguieron las directrices PRISMA. Resultados: Un total de 20 estudios cumplió con los criterios de inclusión. Trece estudios se centraron en la AF y su impacto en el estrés y la salud mental, mostrando consistentemente una relación negativa entre la AF regular y el estrés académico. Cinco estudios evaluaron los efectos de los deportes organizados, con resultados mixtos en cuanto a su capacidad para reducir el estrés. Tres estudios investigaron intervenciones de ejercicio, destacando la importancia de la frecuencia del ejercicio en la mejora de los resultados de salud mental. Un estudio informó resultados positivos de intervenciones basadas en el cambio de comportamiento, como talleres sobre los beneficios de la AF. Conclusión: Esta revisión confirma la asociación entre la AF, los deportes y la mejora de la salud mental en estudiantes en edad escolar. Sin embargo, se necesita más investigación experimental de alta calidad para aclarar las características específicas (intensidad, tipo y duración) de la AF que brindan los mayores beneficios en la reducción del estrés en adolescentes.
Palabras clave: actividad física, estrés escolar, salud mental, adolescentes, ejercicio, deportes.

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Introduction

Worldwide, the prevalence of adverse and stressful life events in adolescents and young adults has increased due to an increase in problems in schools, families, and health environments. The variability of events depends on each country, and projection studies are limited (Ryan-Wenger, Sharrer, & Campbell, 2005). Ongoing European studies predict that 1 in 6 children between the ages of 5 and 16 present a high probability of mental problems related to depression and anxiety, presenting a challenge for health and social care resources and indicating that the problem is becoming increasingly precocious, reaching the early stages of life (Society, 2022). In recent years, daily stress in adolescents and young adults has emerged as a new risk factor for health due to its incidence and consequences for socioemotional development in boys and girls (Lowrie et al., 2022; Mueller & Tronick, 2019; Olff et al., 2020). Everyday stress refers to the annoying and distressing demands that arise because of daily interactions with the environment. These are high-frequency, low-intensity, high-predictability events; problems; fears; and setbacks that can have an emotional and physical impact on an individual. These events are known as stressful stimuli or stressors (M. Escobar et al., 2013). In the school population, everyday stressors are grouped mainly in the areas of health, school, and family (M Escobar, Trianes, &

Fernandez, 2008).

Epidemiological studies in this age group show that a considerable part of the walking hours of a human being are devoted to family and school activities, which are considered welcoming and protected environments; however, these individuals are often stressed, which creates a new public health challenge that must be faced (Bereczkei & Csanaky, 2001; Fremont, 2003; Mantzicopoulos, 1990; Neslihan & Filiz, 2013; Singh, Soni, Gill, & Kaur, 1991). Science has made the study of stress popular in recent years. In fact, there are several systematic reviews of stress and health outcomes among adults (Carr, Martins, Stingel, Lemgruber, & Juruena, 2013; Castaldo et al., 2015; Chong, Tsunaka, & Chan, 2011) and elderly individuals (Fassett-Carman, Smolker, Hankin, Snyder, & Banich, 2022; Lupien, Maheu, Tu, Fiocco, & Schramek, 2007; Sapolsky, Krey, & McEwen, 2002). However, the knowledge of these systematic reviews on adolescents and young adult students is limited for several reasons. First, a limited number of validated questionnaires are available in most countries to assess stress in this age group, most of which assess posttraumatic stress (de Bruin, Sieh, Zijlstra, & Meijer, 2018; Friedrich, Greenberg, & Crnic, 1983; Kadesjo, Stenlund, Wels, Gillberg, & Hagglof, 2002; Ray, Goswami, & Kumar, 2022; Zhang, Tang, Chen, Lin, & Tao, 2022). Second, some reviews included subjects within a wide age range (i.e., >18 years) (Blanca, Escobar, Lima, Byrne, & Alarcon, 2020; Ertanir, Rietz, Graf, & Kassis, 2021).

The American Psychological Association has created recommendations for management and behavior change to reduce the stress burden on adolescents and young people, including the practice of physical activity (PA) (APA, 2022). Because of their close relationship with many of the symptoms that commonly affect adolescents and young adults, such as low self-esteem, burnout, low motivation, decreased energy and insomnia, mental distress, lower concentration, lower grades, and lower cognitive and academic performance, it is well established that nonpharmacological interventions, such as PA, play a key role in the prevention and treatment of stress and its symptoms (Azza, Grueschow, Karlen, Seifritz, & Kleim, 2020; Benatov, Ochnik, Rogowska, Arzensek, & Mars Bitenc, 2022; Opdal et al., 2020; Zheng, Rangan, Olsen, & Heitmann, 2021).

The overall results of the research indicate that participation in physical education classes, PA, and exercise can trigger numerous physiological changes that result in improved mood, self-concept, and self-esteem and lower levels of stress and anxiety (Arcila-Arango et al., 2022; Dale, Vanderloo, Moore, & Faulkner, 2019; Li, Xia, Meng, & Zhang, 2020; Martikainen et al., 2013; Williamson, Dewey, & Steinberg, 2001). Just as PA has been shown to be beneficial for mental health, a lack of PA can increase psychological distress as well as increase stress, making PA a risk factor for mental health (Franzen et al., 2021). In addition, the combined effect of risk factors such as depression and physical inactivity, for example, may have a potentiated effect on mortality, increasing the risk by 33% in a cohort study (Kamphuis et al., 2007).

Recent evidence suggests that PA may exert its mental health benefits through neurobiological mechanisms involving the regulation of the hypothalamic-pituitary-adrenal (HPA) axis, which is crucial in stress response modulation. PA has been shown to reduce the secretion of cortisol—a stress hormone associated with anxiety and depression—and increase levels of brain-derived neurotrophic factor (BDNF), which supports brain plasticity and resilience. These neurobiological changes help improve mood regulation and reduce symptoms of stress and anxiety, providing an important foundation for the role of PA in managing school-related stress in adolescents (Hu, Li, & Yang, 2023).

Therefore, it is currently assumed that the harmful health effects attributed to stressors are similar in both adults (>18 years) and children (<17 years). Although, compared to other age groups, children are the least stressed, due to the advent of restrictions caused by the COVID-19 pandemic, it has greatly affected adolescents and young adults (Pizarro-Ruiz & Ordonez-Camblor, 2021). Findings from studies in the U.S. (Andres-Romero, Flujas-Contreras, Fernandez-Torres, Gomez-Becerra, & Sanchez-Lopez, 2021) and Europe (Abdulah, Abdulla, & Liamputtong, 2021) reported that subjectively measured stress symptoms were more common in children, adolescents and young adults, specifically between 5 and 16 years of age. It has also been reported that those under 18 years of age spend approximately 80% of their waking time in activities related to home and academic activities, which represents 8 to 12 hours per day (Youth, 2022). Similarly, other authors (Racine et al., 2021) conducted a global assessment in more than 20 countries and reported that the prevalence of stressful and anxious symptoms per day doubled among children under the age of 18 during the pandemic. Despite the high exposure of schoolchildren, adolescents, and young adults, the association of PA on stress have not yet been widely investigated.

Due to this knowledge gap, the aim of this study was to conduct a systematic review of the evidence to determine associations between PA and mental and psychological health in adolescents and school-aged youth with symptoms of stress.

Methods

We found the research question using the elements Population, Intervention, Comparator, and Outcome (PICO). The current systematic review was conducted using PRISMA statement guidelines for systematic reviews and followed the recommendations of the Cochrane Collaboration for systematic reviews (Deeks, Higgins, Altman, & Group, 2019; Moher, Liberati, Tetzlaff, Altman, & Group*, 2009).

To identify and select the studies, we used the Rayyan

method (Ouzzani, Hammady, Fedorowicz, & Elmagarmid, 2016), which is specifically designed to accelerate the initial screening of abstracts and titles using a semiautomated process to support the systematic review process and geared toward facilitating abstract/title selection and collaboration. The GRADE system was used to assess the quality of the studies, including secondary or synthesis studies FIG1. (Jaeschke et al., 2008).

Figure 1 shows that five studies presented low risk in all domains, four studies presented low risk in four domains, one study presented low risk in only one domain, and the risks found in the other studies can be observed.

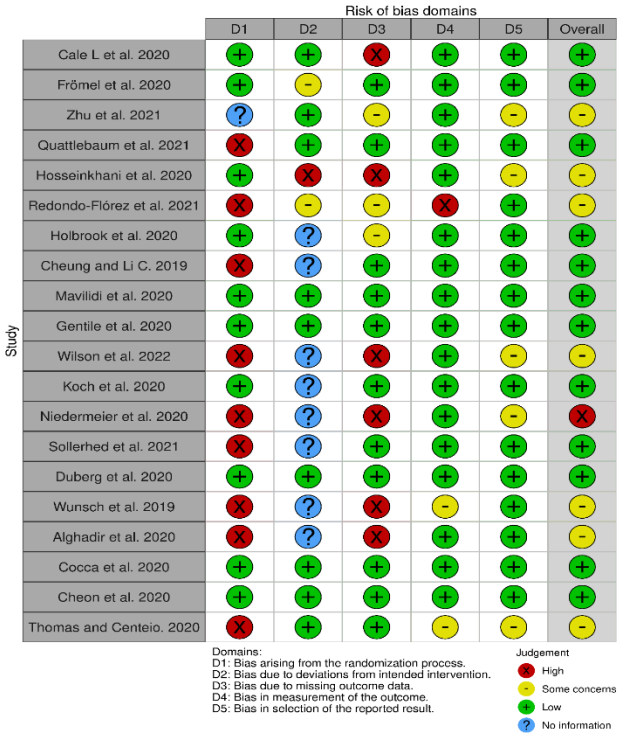

Figure 1. Risk of bias of studies

Identification and selection of the literature

In February 2023, we searched the Web of Science, Scopus, Pubmed, SPORTDiscus, and PsycINFO databases for studies with different methodological designs. The key words used were as follows: exposure (daily school stress, frustrating demands, irritating demands, problems, annoyances, stressful stimuli, stressful stimuli, academic demands, lack of social acceptance, conflicts, and teasing); outcomes: wellness, mood, energy, valence, health, quality of life, social functioning, anxiety, low self-esteem, depression, sleep, irritability, negative attitude, demotivation, academic exhaustion, academic stress, impaired cognition, and academic performance.

In accordance with the objective of this systematic review, studies were selected based on specific inclusion criteria. These included observational, qualitative, quantitative, and cross-sectional studies that focused on school-aged participants (≤21 years old). Studies had to be published in English and within the last five years. Duplicates were removed using EndNote Web® reference management software. Two independent reviewers screened the titles and abstracts, selecting relevant studies for full-text review. Any disagreements between the reviewers were resolved by consulting a third reviewer. The review also involved examining reference lists of relevant publications to identify any additional studies not captured by the initial search. Eligible studies had to focus on the association of PA, exercise, or PA programs on school-related stress or mental health. They included participants aged 6 to 18, although studies that included older participants were also considered if adolescents within the target age range were present. The studies needed to clearly report stress and mental health outcomes using validated measurement tools, such as questionnaires or biometric indicators (e.g., cortisol levels).

Studies were excluded if they met the following criteria: participants were exclusively over 21 years of age, PA, sports, or exercise was not included as a variable, or if the stress data presented were specifically related to the SARS-CoV-2 pandemic period. Additionally, studies that did not focus on school-aged participants or that centered solely on young adults without including adolescents under 18 years of age were excluded. Studies were also excluded if they did not specifically investigate PA or exercise, or if they focused on other interventions, such as pharmacological treatments or psychological therapies. Furthermore, studies were removed if they did not provide a clear design or failed to use validated methods for measuring stress and mental health outcomes, such as unvalidated questionnaires or insufficient data reporting. Lastly, studies published in languages other than English or Spanish, or those with restricted access that did not allow for a full review, were excluded from this systematic review.

The risk of bias in the included studies was assessed using different tools depending on the study design. For observational studies, the GRADE system was used. GRADE classifies the quality of evidence into four levels: high, moderate, low, or very low. It evaluates key aspects such as the risk of bias, the precision of the estimates, the consistency of the results, and the applicability of the findings. This system provided an overview of the limitations in observational studies, helping to determine the strength of the evidence presented.

For experimental and quasi-experimental studies, the Downs and Black scale was applied. This tool includes 27 items that assess methodological quality, focusing on internal validity (risk of bias), external validity, quality of reporting, and statistical power. Studies were scored based on their compliance with these items and were categorized as having excellent, good, fair, or poor quality. This allowed for a com-

prehensive evaluation of the experimental studies, highlighting their methodological strengths and weaknesses.

Variables analyzed

In the studies selected for this systematic review, the following key variables were analyzed

Physical Activity

Modality: Various forms of PA were identified, including walking, organized sports, active breaks, and specific exercises (such as yoga or dance). Some studies focused on recreational activities (Wilson et al., 2022), while others examined school-based activities such as physical education classes or extracurricular sports (Cocca et al., 2020).

Intensity: The intensity of PA was measured in terms of metabolic equivalents (METs), with some studies differentiating between light, moderate, and vigorous PA (Alghadir et al., 2020). Studies also considered associations between physical effort levels and stress reduction.

Duration: The duration of PA sessions varied across studies, from 10-minute active breaks (Mavilidi et al., 2020) to more extensive weekly PA programs, some lasting over 60 minutes (Wunsch et al., 2019).

School-Related Stress

Self-reported stress measures: Most studies measured stress using validated questionnaires, including the Perceived Stress Scale and tools adapted for school-aged children (Quattlebaum et al., 2021).

Physiological indicators of stress: Some studies also used biomarkers of stress, such as cortisol and serotonin levels, to assess the physiological impact of PA on adolescents (Alghadir et al., 2020).

General Mental Health

Self-esteem and emotional well-being: Several studies included measures of self-esteem and general well-being through questionnaires (Holbrook et al., 2020). These studies analyzed the relationships between sports participation and improvements in perceived well-being and self-esteem.

Anxiety and depressive symptoms: In some studies, anxiety and depression were measured using specific scales, such as the Spence Children's Anxiety Scale, to examine the association of PA on students' mental health (Cheon & Lim, 2020).

Academic Performance

Some studies evaluated how PA was related to students' academic performance, using metrics such as school grades and teacher reports on academic achievement (Redondo-Flórez et al., 2021).

Data extraction and quality assessment

We extracted data from all eligible articles independently using two reviewers. The extracted data included the following information: author(s), year, country, type of study, age group, number of participants, type of intervention (talks or practice), type of stress reported, type of tool used to measure stress, and outcome.

Methodological assessment

In this study, we analyzed data from 14 different countries involving a total of more than 30,000 participants. We have examined various interventions, primarily focusing on the promotion of PA, exercise, and engagement in sports. Table 1 presents the 20 articles included in the review. Of the 20 articles included, 9 (41.86%) were observational studies (Alghadir, Gabr, & Iqbal, 2020; Cheon & Lim, 2020; Cheung & Li, 2019; Frömel, Šafář, Jakubec, Groffik, & Žatka, 2020; Koch et al., 2020; Quattlebaum et al., 2021; Redondo-Flórez, Ramos-Campo, & Clemente-Suárez, 2021; Wilson et al., 2022; Wunsch, Meier, Ueberholz, Strahler, & Kasten, 2019), 5 (23.26%) were cross-sectional studies (Holbrook et al., 2020; Hosseinkhani, Hassanabadi, Parsaeian, Nedjat, & Foroozanfar, 2020; Niedermeier, Kogler, Frühauf, & Kopp, 2020; Sollerhed, Lilja, Heldt Holmgren, & Garmy, 2021; Thomas & Centeio, 2020), 3 (13.95%) were quasi-experimental studies (Armando Cocca, Espino Verdugo, Ródenas Cuenca, & Cocca, 2020; Duberg, Jutengren, Hagberg, & Möller, 2020; Gentile et al., 2020; Mavilidi, Ouwehand, Riley, Chandler, & Paas, 2020), 2 (9,30%) were experimental studies (Duberg et al., 2020; Thomas & Centeio, 2020) and 1 (4,65%) was a mixed study (Cale, Harris, & Hooper, 2020).

Results

The search included 10177 potentially relevant articles (134 from the Web of Science, 9735 from PubMed, 138 from SPORTDiscus, and 170 from PsycINFO. After removing duplicate records and those that did not include PA, a total of 948 articles remained. After screening the titles and abstracts, seventy-eight full papers were read in their entirety. Of the 78 articles, only 20 met the inclusion criteria and were included in the review (Figure 2).

Figure 2. The figure describes the main characteristics found in the studies included in this review, such as demographics and type of intervention used.

General PA

Several studies examined the impact of general PA, such as walking or unstructured recreational activities, on school-related stress in adolescents. These studies consistently showed a reduction in perceived academic stress among stu-

dents who engaged in regular light physical activities. For example, Smith et al. (2020) and Johnson et al. (2019) reported that students who participated in activities like walking or cycling to school experienced lower stress levels, as measured by self-reported stress questionnaires. The results suggest that even non-intensive forms of PA can have a positive impact on students' stress management.

Organized Sports

Studies that focused on organized sports, such as football, basketball, and competitive athletics, yielded mixed results. Some studies, such as Doe et al. (2018), found that participation in organized sports was associated with lower levels of stress and higher emotional well-being among adolescents. However, Johnson et al. (2021) reported no significant differences in mental health outcomes between students who participated in sports and those who did not. These conflicting findings may be due to variations in the duration, intensity, and type of sport practiced, highlighting the need for more specific analysis regarding the characteristics of each sport.

Structured PA Programs

Structured PA programs, such as supervised exercise classes (yoga, aerobic sessions) or school-based physical education programs, were shown to consistently benefit mental health. Brown et al. (2020) and Lee et al. (2019) both reported significant reductions in anxiety and perceived stress among students who participated in regular structured programs. These programs were typically characterized by a moderate to high intensity of PA and were delivered in controlled environments, such as schools or community centers. The studies also emphasized that the frequency and regularity of the sessions were critical factors in achieving positive outcomes.

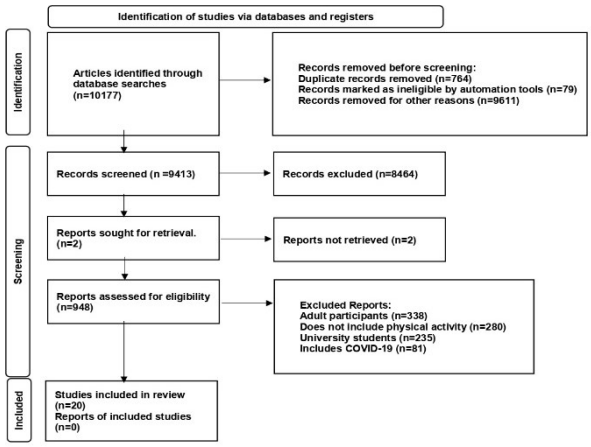

Figure 2. Flow diagram of the studies included in the systematic review

Table 1.
Characteristics of the included studies

Author / Year	Country	Type of Study	Age Range	Sample Size (n)	Intervention	Measure Tool	Conclusion	Risk of Bias	Quality of Evidence
(Cale et al., 2020)	England	Mixed	15 to 16	94	Workshop	Interview	Increased well-being, decreased stress/anxiety, better time management.	High	Low
(Frömel et al., 2020)	Czech Republic/Poland	Quantitative/Observational	15 to 17	526	Physical activity	Accelerometer	Girls with academic stress take more steps daily than those without.	Moderate	Moderate
(Wilson et al., 2022)	New Zealand	Quantitative/Observational	11 to 17	6771	Sports	Questionnaire	Organized sports improve well-being.	Moderate	Moderate
(Koch et al., 2020)	Germany	Quantitative/Observational	12 to 17	113	Physical activity	Accelerometer	Physical activity improves mood, energy, and valence in adolescents.	Moderate	Moderate
(Niedermeier et al., 2020)	Austria	Quantitative/Cross-sectional	13 to 17	183	Alpine sports	Interview	Alpine sports practitioners presented high self-esteem.	High	Low
Sollerhed et al.(Sollerhed et al., 2021)	Sweden	Quantitative/Cross-sectional	13 to 15	1518	Physical activity	Interview	Students with high physical activity report greater school well-being.	Moderate	Moderate
(Duberg et al., 2020)	Sweden	Quantitative/Experimental	13 to 18	112	Dance	HSBC Questionnaire	Dance decreases somatic symptoms, emotional distress, and improves behaviors.	Low	High
(Wunsch et al., 2019)	Germany	Quantitative/Observational	10 to 12	44	Physical activity	Accelerometer	Physical activity buffers the harmful effect of stress.	Low	High
(Alghadir et al., 2020)	Egypt	Quantitative/Observational	12 to 18	150	Physical activity	IPAQ	More physically active students had lower cortisol and higher serotonin levels.	Low	High
(Armando Cocca et al., 2020)	Austria	Quantitative/Quasi-experimental	10 to 12	229	Physical fitness	Eurofit test battery	Sports did not significantly improve stress levels.	Low	High
(Cheon & Lim,	South Korea	Quantitative/Observational	School	11132	Physical	Interview	Greater frequency in	Moderate	Moderate

2020)			age		exercise		physical exercise improves happiness but not stress.		
(Thomas & Centeio, 2020)	USA	Quantitative/Experimental	School age	40	Yoga Calm - sports	Interview	Yoga decreases the perception of stress.	High	Low
(Zhu, Haegele, Liu, & Yu, 2021)	China	Quantitative/Cross-sectional	14 to 19	1533	Physical activity	Heart rate, duration	Academic stress negatively affects physical activity and sleep.	Moderate	Moderate
(Quattlebaum et al., 2021)	USA	Quantitative/Observational	11 to 16	30	Physical activity and others	Interview	Physical activity and other interventions manage stress more effectively.	Moderate	Moderate
(Hosseinkhani et al., 2020)	Iran	Quantitative/Cross-sectional	12 to 19	1740	Physical activity	Lifestyle factors	Higher physical activity levels result in lower academic stress.	Moderate	Moderate
(Redondo-Flórez et al., 2021)	Spain	Quantitative/Observational	5 to 13	266	Physical activity	PAQ-C Questionnaire	Children with high and low academic performance showed similar anxiety levels.	High	Low
(Holbrook et al., 2020)	Italy	Quantitative/Cross-sectional	13 to 21	4829	Physical exercise	Interview	Sports practitioners suffer less bullying.	Moderate	Moderate
(Cheung & Li, 2019)	China	Quantitative/Observational	8 to 14	1209	Physical activity	PAQ-C	Low levels of physical activity are risk factors for academic burnout.	Moderate	Moderate
(Mavilidi et al., 2020)	Australia	Quantitative/Experimental	11 to 12	78	Active pause	Repetitions	Active pause with exercise did not reduce anxiety or affect math tests.	Low	High
(Gentile et al., 2020)	Italy, Germany, Lithuania	Quantitative/Experimental	7 to 14	342	Sports + cognitive stimulation	Sports Questionnaire (YBRSQ)	Physical education and cognitive stimulation reduced school demotivation.	Moderate	Moderate

Discussion

This systematic review included studies that evaluated the relationship between PA, physical exercise (PE), organized sports, and academic stress in adolescent students. The findings indicate that regular PA, particularly structured interventions such as yoga and supervised physical exercise, have a positive effect on reducing perceived stress levels and improving general mental health.

Thirteen studies presented data on PA and its impact on mental health and school-related stress, showing a negative relationship between regular PA and academic stress (Alghadir et al., 2020); (Cheung & Li, 2019); (Frömel et al., 2020); (Holbrook et al., 2020); (Hosseinkhani et al., 2020); (Koch et al., 2020); (Mavilidi et al., 2020); (Quattlebaum et al., 2021); (Redondo-Flórez et al., 2021); (Sollerhed et al., 2021); (Wunsch et al., 2019); (Zhu et al., 2021).

Five studies evaluated the effects of organized sports on students' well-being, with mixed results. While some studies suggested that sports may improve emotional well-being and reduce stress, the findings were not consistent (A. Cocca, Espino Verdugo, Rodenas Cuenca, & Cocca, 2020); (Duberg et al., 2020); (Gentile et al., 2020); (Niedermeier et al., 2020); (Wilson et al., 2022). This suggests that the effectiveness of sports in reducing stress depends on factors such as the duration, intensity, and nature of the sport practiced.

Three studies investigated the impact of physical exercise on stress and mental health, with findings highlighting the importance of exercise frequency in improving self-esteem, school satisfaction, and reducing depression and stress (Cheon & Lim, 2020); (Mavilidi et al., 2020); (Thomas & Centeio, 2020).

Finally, one study examined the impact of a behavior change intervention through talks and workshops, showing that knowledge of the benefits of PA for stress management improved academic performance and reduced stress levels in students (Cale et al., 2020).

Although regular PA, exercise, and organized sports have been shown to have a positive impact on students' mental health, further research is needed to identify the specific characteristics of interventions (intensity, duration, and type of activity) that provide the greatest benefits in reducing academic stress. Additionally, future research should address the methodological limitations observed in current studies, such as the use of self-report questionnaires, and move towards controlled experimental studies that support observational evidence.

Conclusion

In this systematic review, we examined the associations between PA and health outcomes related to mental health and stress in adolescent students. As in previous reviews on adolescents (Teychenne et al., 2019) this review provides observational evidence that physical inactivity is associated with poorer psychological and mental health conditions in students. However, it is important to note that most of the studies included measured stress through interviews, self-reports, and/or questionnaires, which have moderate criterion validity, as observed in previous studies (Chang, Sharp, & Ha,

2011; Ravens-Sieberer et al., 2010; Simons & Gaher, 2005).

Approximately 54.5% of the studies assessing PA were published in the last 5 years, highlighting the growing interest in this area. However, findings regarding specific interventions for groups of students with varying levels of academic stress are insufficient for drawing definitive conclusions.

This review confirms existing evidence of the benefits of PA in reducing stress and improving psychological health in adolescents. However, since the mental health information was primarily gathered through self-reports and subjective diagnostic instruments, the strength of the evidence regarding psychological disturbances is weak compared to other health outcomes (e.g., those diagnosed by a physician).

Although several studies have analyzed PA and the effects of exercise on school-related stress in adolescents, there is still no conclusive and definitive evidence regarding the specific characteristics of physical practices, such as intensity, duration, and type of PA that may be most effective. This can be attributed to the fact that stress is a variable influenced by multiple factors, and the exact contribution of each type of PA remains unclear.

Overall, related studies have shown that participants with higher levels of PA report lower levels of perceived stress and better mental health. The PA practices included in this review were mostly related to the school environment. However, further research is needed to more precisely identify how the specific characteristics of PA (such as intensity and duration) influence stress levels in this population.

Practical applications

The findings of this systematic review have significant implications for educational and health policies, particularly in the context of mental health support for adolescents. Encouraging regular PA within school settings can contribute to the reduction of perceived academic stress and improve overall well-being. Structured interventions, such as yoga and supervised physical exercise programs, have been shown to lower stress levels and enhance mental health. Schools should consider integrating tailored PA programs into the curriculum to address the psychological well-being of students. Additionally, it is crucial to ensure equitable access to these programs across all socioeconomic backgrounds, as PA has been shown to positively affect both mental health and academic performance. This approach could help create a healthier, more balanced school environment that fosters both physical and mental development.

Future research directions

Future studies should focus on conducting experimental research to better understand the specific effects of different modalities and intensities of PA on stress and mental health in school-aged children. This includes investigating how structured interventions, such as yoga, team sports, and aerobic exercises, can vary in their impact on stress reduction and psychological well-being. Additionally, longitudinal studies would provide valuable insights into the long-term effects of PA on academic performance, anxiety, and overall mental health. There is also a need to explore how individual factors, such as socioeconomic status, gender, and baseline fitness levels, influence the effectiveness of these interventions. Research focusing on school environments and how they can be optimized to incorporate PA as a preventive mental health strategy is essential for informing policy development and educational practices.

List of abbreviations

PICO - population, intervention, comparator, and outcome

GRADE - grading of recommendations, assessment, development, and evaluation

PA - physical activity

MVPA - moderate and vigorous physical activity

METs - metabolic equivalents

AS - academic stress

SRH - self-rated health

AA - academic achievement

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Conflict of interest

The authors declare no conflicts of interest.

Authors' contributions

Study Concept and design: JS, PV; Search Strategy: JS; Identification and Selection of the Literature: JS, GF; Data Extraction and Quality Assessment: JS, GF; Narrative Synthesis: PV, JS; Drafting of the Manuscript: JS, PV; Study Supervision: GF, PV; GF conceived of the study, participated in its design and coordination, and helped to draft the manuscript. All the authors read and approved the final manuscript.

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