



The Impact of Cardiorespiratory Fitness on the Academic Performance and Well-Being of Children and Adolescents: An Integrative Review

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ABSTRACT

Background: Cardiorespiratory fitness (CRF) is a fundamental component of physical fitness assessment, particularly within the school setting. Growing evidence suggests that CRF may influence not only physical health but also cognitive performance and psychosocial well-being among children and adolescents.

Objective: To synthesize the available scientific evidence on school-based activities targeting cardiorespiratory fitness and to examine their impact on academic performance and well-being in children and adolescents.

Methods: An integrative literature review was conducted using primary studies retrieved from the Scientific Electronic Library Online (SciELO), Latin American and Caribbean Health Sciences Literature (LILACS), and PubMed databases. The literature search was performed between April and May 2025 and included studies published between 2019 and 2024. The search strategy combined the descriptors *schoolchildren* OR *students* AND *cardiorespiratory fitness* AND *academic performance* OR *well-being*. Study selection followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Results: Seven studies met the eligibility criteria and were included in the qualitative synthesis. Six studies (86%) reported that lower levels of cardiorespiratory fitness were associated with poorer academic performance and lower perceived well-being. Only one study (14%) found no significant association between these variables.

Conclusions: Current evidence consistently supports an association between cardiorespiratory fitness, academic achievement, and perceived well-being among school-aged children and adolescents. However, further high-quality studies are warranted to clarify the cognitive mechanisms underlying this relationship and to better understand how improvements in cardiorespiratory fitness contribute to educational and psychosocial outcomes.

KEYWORDS: Cardiorespiratory fitness, Physical activity, Academic performance, Schoolchildren, Well-being.

INTRODUCTION

Physical inactivity has become an increasingly important public health concern worldwide.¹ Within this context, sedentary behavior—defined as prolonged periods of low-energy expenditure during waking hours—has emerged as a major health issue, particularly among adolescents. High levels of sedentary behavior in this population have been associated with multiple contributing factors, including lifestyle changes, increased screen time, and reduced participation in physical activity.²

Increasing opportunities for physical activity in and beyond schools has emerged as one of the most effective strategies for reducing sedentary behavior and improving students' health outcomes. Schools provide an ideal setting for encouraging regular participation in physical activity, especially considering that higher levels of sedentary behavior have consistently been associated with adverse health outcomes, including impaired cardiometabolic health, poorer perceived well-being, and reduced sleep duration.³

Cardiorespiratory fitness (CRF), commonly assessed by maximal oxygen uptake ($\text{VO}_{2\text{max}}$), reflects the capacity of the cardiovascular and respiratory systems to efficiently deliver oxygen during sustained physical activity. Lower CRF has been associated with an increased risk of cardiovascular disease and cognitive impairment, whereas higher CRF is related to reduced systemic inflammation and more efficient lipid and substrate metabolism.⁴

In recent years, the relationship between CRF and perceived well-being has attracted growing scientific interest, particularly regarding its potential contribution to teaching and learning processes. Beyond its well-established physiological benefits, improved CRF has been associated with reduced stress, anxiety, and depressive symptoms—conditions frequently observed among school-aged populations—as well as enhanced concentration, memory, and cognitive performance.⁵

Improvements in these domains may ultimately contribute to a better quality of life by promoting students' overall development, extending beyond academic achievement to encompass emotional health and resilience. In this regard, school-based physical activity interventions may play a pivotal role in fostering both educational and psychosocial development.⁶

Accordingly, the association between cardiorespiratory fitness, physical activity, academic achievement, and student well-being has become an important area of investigation. Evidence suggests that improved CRF may enhance concentration, learning capacity, intelligence, and cognitive function while also supporting emotional well-being, thereby facilitating better academic performance.⁷

Therefore, the present integrative review aimed to synthesize the available scientific evidence regarding school-based interventions targeting cardiorespiratory fitness and to examine their impact on academic performance and well-being among children and adolescents.

METHODS

Study Design

This study was conducted as an integrative literature review. The research question was developed using the PICO framework, in which P represented the population (children and adolescents), I the intervention (the influence of cardiorespiratory fitness), C the comparison (no comparison with other interventions was established), and O the outcome (improvements in academic performance and well-being).

The guiding research question was:

“What evidence is available in the scientific literature regarding the influence of cardiorespiratory fitness on academic performance and well-being among school-aged children and adolescents?”

Literature Search

The literature search was conducted between April and May 2025 using the following electronic databases: Scientific Electronic Library Online (SciELO); Latin American and Caribbean Health Sciences Literature (LILACS), and PubMed.

Search terms were selected using the Health Sciences Descriptors (DeCS) and additional free-text terms considered relevant to the research topic. The following search strategy was applied: (schoolchildren OR students) AND (“cardiorespiratory fitness”) AND (academic performance OR well-being).

The review process was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 27-item checklist.

Eligibility Criteria

Study selection was performed through a comprehensive screening of titles and abstracts.

Initially, 52 records were identified.

The inclusion criteria were: full-text articles available free of charge; original primary research; publications between 2019 and 2024; studies addressing the research topic directly; no language restrictions.

The exclusion criteria included: studies not directly related to the research question; review articles; books; commentaries; articles without free full-text access; secondary studies.

After title and abstract screening, followed by full-text assessment, seven studies met the eligibility criteria and were included in the qualitative synthesis (Figure 1).

Data Extraction and Analysis

Data extraction and quality assessment were independently performed by two reviewers. Whenever disagreements arose during the extraction process, a third reviewer was available to resolve discrepancies.

The study selection process is illustrated in Figure 1. All retrieved references were imported into EndNote X7 (Thomson Reuters) for organization and management of the bibliographic records.

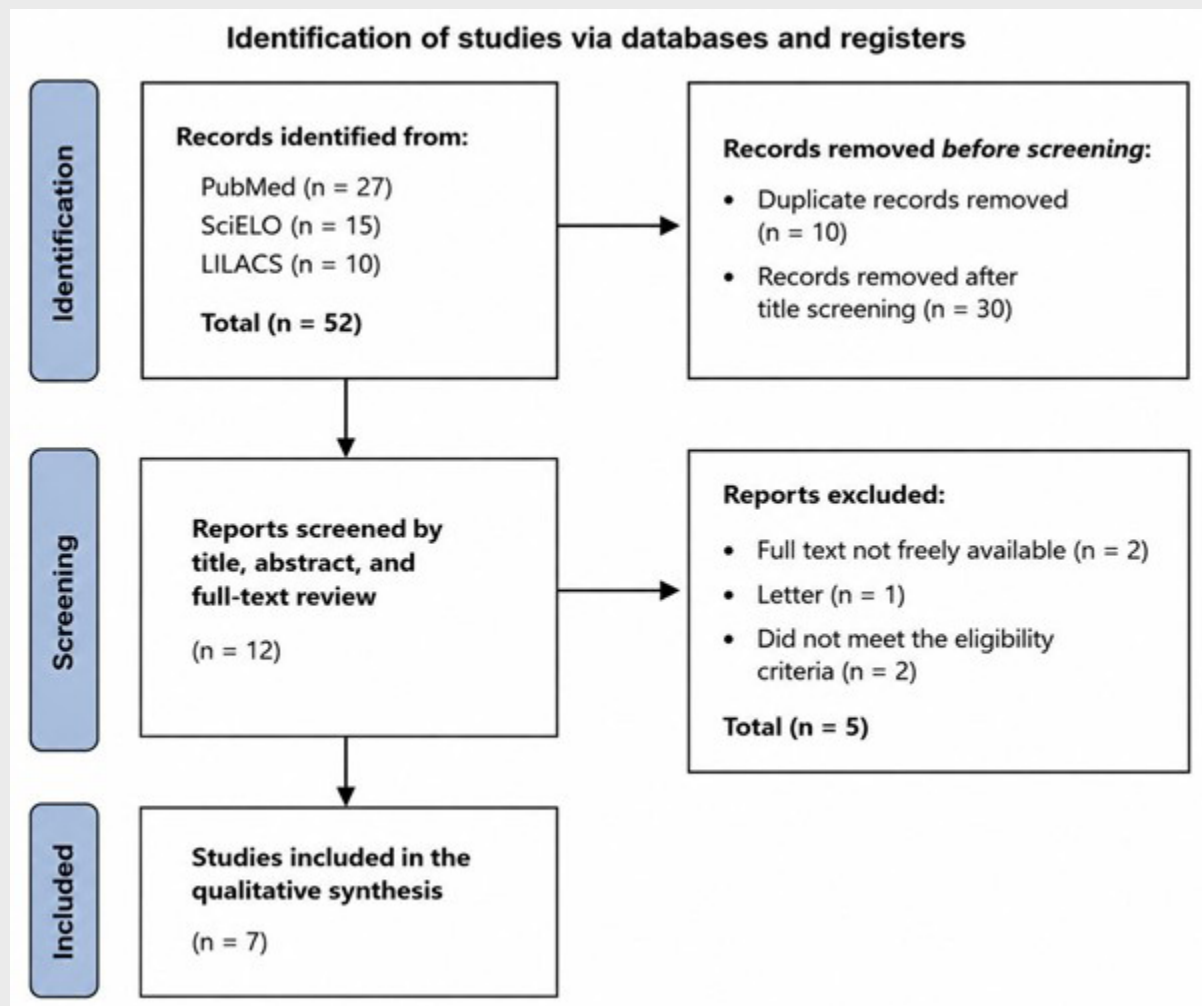


Figure 1. PRISMA flow diagram illustrating the study selection process.

Source: Prepared by the authors.

RESULTS

Following a full-text review of the eligible articles, the principal findings of the studies included in the qualitative synthesis are presented in Table 1. The studies were summarized according to the following characteristics: author/year, sample size, study design, country, educational level, and main outcomes.

Most of the included studies consistently demonstrated positive associations between higher cardiorespiratory fitness and favorable educational outcomes, although the magnitude of these associations varied according to study design and population characteristics. The randomized trials compared intervention and control groups to evaluate the effects of school-based physical activity programs, whereas the cross-sectional studies assessed short-term associations between cardiorespiratory fitness and academic or health outcomes. The longitudinal studies examined these relationships over extended follow-up periods.

Regarding the geographical distribution of the studies, four were conducted in countries recognized for their high-performing

educational systems—Norway, Denmark, Spain, and China.^{9,10,14} In contrast, the remaining studies were carried out in Brazil and Mexico.¹¹⁻¹³ Differences in educational quality should be considered when interpreting the findings, as educational context may influence both academic achievement and student well-being.

Despite these contextual differences, the available evidence consistently supported an association between cardiorespiratory fitness, academic performance, and well-being. In countries with less favorable educational indicators, lower levels of CRF were associated with poorer quality of life and academic achievement. Notably, one study reported that students with poor cardiorespiratory fitness were approximately twice as likely to exhibit poor academic performance.

Studies evaluating interventions aimed at improving cardiorespiratory fitness,^{9,13,14} demonstrated that aerobic exercise programs significantly enhanced perceived quality of life, improved sleep patterns, and reduced risk factors associated with chronic conditions, including cardiovascular disease, hormonal disorders, and obesity.

Gatica-Domínguez et al.¹³ evaluated the physical fitness of children from eight elementary schools in Morelos, Mexico, following the implementation of an intervention designed to prevent childhood obesity. A total of 214 children were randomly allocated to either the intervention community (n = 111) or the control community (n = 103). Physical fitness was assessed using the 6-minute walk test, the 50-meter sprint test, and daily step counts.

Conversely, the cross-sectional studies conducted by Castro and Oliveira¹¹ and Oliveira¹² indicated that lower cardiorespiratory fitness was associated not only with poorer academic outcomes but also with increased screen time. Furthermore, adolescents with lower CRF were approximately twice as likely to demonstrate lower academic achievement than their peers with higher fitness levels, highlighting the importance of CRF for both physical and cognitive functioning.

The findings reported by Castro and Oliveira¹¹ further suggested that poor physical fitness may negatively affect students' ability to

complete academic tasks successfully and substantially increase the likelihood of poor school performance. In contrast, only the study by Tarp et al.¹⁰ failed to detect significant improvements after a 20-week intervention that incorporated structured physical activity during recess, at home, active transportation, and across multiple school subjects in addition to physical education classes. The authors acknowledged several methodological limitations, including the reliance on self-reported physical activity measures.

Similarly, Jiménez-Boraita et al.¹⁴ investigated the relationship between cardiorespiratory fitness, body composition, and adolescent health. Their findings indicated that these variables are important determinants of adolescent health status. The study examined the associations between CRF, body composition, mental and psychosocial health indicators, lifestyle behaviors, and sociodemographic characteristics, ultimately identifying key predictors of adolescent health outcomes.

Table 1: Characteristics of the studies included in the qualitative synthesis according to author/year, study design, country, educational level, and main findings (n = 7).

Author (Year)	Participants (n)	Study Design	Country	Educational Level	Main Findings
Kolle et al. (2020) ⁹	1,981	Cluster randomized controlled trial	Norway	Elementary, secondary, and university education	Improved CRF and perceived well-being after a 9-month intervention.
Tarp et al. (2016) ¹⁰	632	Randomized controlled trial	Denmark	Lower secondary education	A 20-week physical activity intervention did not improve academic performance or executive functioning.
Castro & Oliveira (2016) ¹¹	326	Cross-sectional study	Brazil	High school	Poor cardiorespiratory fitness doubled the likelihood of poor academic performance.
Oliveira et al. (2020) ¹²	2,764	Cross-sectional study	Brazil	Lower secondary and high school	Cardiorespiratory fitness was associated with and predicted screen time.
Gatica-Domínguez et al. (2019) ¹³	214	Longitudinal study	Mexico	Elementary education	Better physical fitness contributed to improved health-related quality of life among schoolchildren.
Jiménez-Boraita et al. (2021) ¹⁴	761	Cross-sectional study	Spain	Lower secondary and high school	Lower cardiorespiratory fitness was associated with poorer academic performance, poorer sleep patterns, and a higher risk of chronic diseases.

DISCUSSION

The findings of this integrative review demonstrate a consistent association between cardiorespiratory fitness (CRF), academic performance, and perceived well-being among children and adolescents. Overall, lower levels of CRF were associated with poorer academic achievement and reduced quality of life, reinforcing the importance of incorporating regular physical activity into the school routine. Importantly, the evidence suggests that the benefits

of physical activity extend beyond physical education classes, supporting the adoption of broader school-based strategies aimed at promoting health and academic success.

The health benefits of regular physical activity have been extensively documented, particularly regarding improvements in physical and psychological well-being. Within the educational context, these benefits appear to be closely associated with enhanced cognitive function, including information processing, executive functioning,

memory, and learning capacity, which collectively contribute to improved academic performance.^{15,16}

Schools represent an ideal environment for promoting health because children and adolescents spend a substantial portion of their daily lives in this setting. Although physical education classes play a fundamental role in encouraging active lifestyles, opportunities for physical activity should extend beyond the classroom and be incorporated into the broader school environment as well as students' daily routines outside school.^{17,18}

Evidence from a recent systematic review by Wilhite et al.¹⁹ indicates that students who engage in higher levels of physical activity and spend less time in sedentary behaviors generally experience longer sleep duration than their less active peers. Sleep, in turn, plays a critical role in memory consolidation, and insufficient sleep, delayed sleep onset, or poor sleep quality may negatively affect academic performance.^{20,5,6}

Aerobic exercise has also been associated with improvements in sensorimotor connectivity and cognitive function. Previous studies have demonstrated that regular aerobic exercise may attenuate global brain atrophy in individuals with Parkinson's disease and serve as a valuable non-pharmacological strategy for reducing symptoms of attention-deficit/hyperactivity disorder (ADHD) in children and adolescents. These findings suggest that the benefits of cardiorespiratory fitness extend beyond academic outcomes, contributing to improved quality of life in educational, family, and social settings.^{21,22}

Likewise, previous investigations have reported that motor activity may facilitate cognitive processes by improving cerebral blood flow, promoting neural development, strengthening synaptic connectivity, and enhancing neuroplasticity.^{23,24} Furthermore, cognitively engaging physical activities that require rapid decision-making and problem-solving may stimulate multiple brain regions simultaneously, fostering the development of new neural connections and cognitive skills.^{16,18,23}

Cardiorespiratory fitness reflects the ability of the cardiovascular and respiratory systems to deliver oxygen efficiently to the working muscles during exercise. It has consistently been recognized as an important marker of overall health and has been associated with academic achievement in previous studies.¹⁵ Consequently, increasing attention has been directed toward understanding the mechanisms through which CRF influences cognitive performance and psychological health.²⁵

Several studies included in this review further suggest that interventions designed to improve cardiorespiratory fitness may enhance concentration, strengthen immune function, and promote overall health. At the physiological level, higher CRF has been associated with improved mitochondrial function, reduced oxidative stress, and enhanced immune defense, potentially contributing to greater resilience against viral infections and improved health-related quality of life.²⁶

These findings have practical implications for educators and school administrators. School-based strategies aimed at improving cardiorespiratory fitness may represent a feasible and low-cost

approach to simultaneously promote students' health, well-being, and academic achievement.

Despite these promising findings, several limitations should be acknowledged. Considerable heterogeneity existed among the included studies regarding the methods used to assess cardiorespiratory fitness, academic performance, and quality of life. In addition, differences in educational systems, regional contexts, and school quality may limit the generalizability of the findings. Therefore, further well-designed longitudinal and intervention studies are needed to clarify the psychophysiological mechanisms linking cardiorespiratory fitness with academic achievement and perceived well-being among school-aged populations.

CONCLUSION

This review provides consistent evidence that higher levels of cardiorespiratory fitness are associated with better academic performance and improved well-being among school-aged children and adolescents. Schools should be encouraged to incorporate regular aerobic physical activity beyond traditional physical education classes. Nevertheless, academic achievement is multifactorial, and future longitudinal and intervention studies are needed to clarify the mechanisms underlying these associations.

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CONFLICTS OF INTEREST

All authors declare that they have no conflicts of interest.

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