Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
Published by: Campus Educa Sportis. Collaborator: University of A Coruña
A Coruña. Spain
E-mail: v.arufe@udc.es Web: www.sportisjournal.com
ISSN-e 2386-8333

Revision. Association between sleep quality and duration and physical fitness among children and adolescents. A systematic review of cross-sectional studies. Vol. 11, n. º 4; p. 1-26, October 2025.
https://doi.org/10.17979/sportis.2025.11.4.11951

Association between sleep quality and duration and physical fitness among children and adolescents. A systematic review of cross-sectional studies

Asociación entre calidad y duración del sueño y condición física en niños y adolescentes: revisión sistemática de estudios transversales.

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Editorial schedule: *Article received 04/04/2025 Accepted: 25/06/2025 Published: 01/10/2025/*
https://doi.org/10.17979/sportis.2025.11.4.11951

To cite this article use the following reference:
Carbonell-Escalas, D.; Vidal-Conti, J.; Galmes-Panades, A.M. (2025). Association between sleep quality and duration and physical fitness among children and adolescents. A systematic review of cross-sectional studies. Sportis Sci J, 11 (4), 1-26 https://doi.org/10.17979/sportis.2025.11.4.11951

Contribución específica de los autores: Todos los autores contribuyeron de forma equitativa al trabajo.

Financiación: No existió financiación para este proyecto.

Consentimiento informado participantes del estudio: Se obtuvo consentimiento informado.

Conflicto de interés: Los autores no señalan ningún conflicto de interés.

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Abstract

Sleep and physical fitness are key components of health, yet their relationship in children and adolescents remains unclear. While previous research has extensively examined the link between physical activity and sleep, fewer studies have focused on the association between physical fitness and sleep quality or duration. This systematic review aims to analyze cross-sectional studies published in the last five years that examine the relationship between physical fitness and sleep duration or quality in individuals aged 6 to 19 years. A systematic search was conducted in Web of Science, PubMed, and Scopus, following PRISMA guidelines. Studies were included if they assessed physical fitness and sleep parameters in healthy children and adolescents. Methodological quality was evaluated using the STROBE checklist. A total of nine studies with 11,321 participants were included. Findings indicate an inconsistent relationship between physical fitness and sleep duration. While adequate sleep duration was associated with better cardiorespiratory fitness in adolescents, results in younger children showed discrepancies. No significant associations were found between sleep duration and muscle strength. Additionally, there is a gap in the literature regarding the impact of sleep quality on physical fitness. Most studies relied on self-reported sleep data, which may affect result validity. The relationship between sleep and physical fitness remains unclear, particularly in younger children and in components beyond cardiorespiratory fitness. Future research should utilize objective sleep measurements while accounting for factors such as gender and sociocultural differences to gain a clearer understanding of this relationship.

Key words

sleep quality; sleep duration; physical fitness; adolescents; children

Resumen

El sueño y la condición física son componentes claves para la salud, pero su relación en niños y adolescentes sigue sin estar clara. Aunque se ha investigado ampliamente la relación entre actividad física y sueño, hay menos estudios sobre la relación entre condición física y calidad o duración del sueño. Esta revisión sistemática analiza estudios transversales de los últimos cinco años sobre la relación entre condición física y calidad o duración del sueño en individuos de 6 a 19 años. Se realizó una búsqueda en Web of Science, PubMed y Scopus que incluyó estudios que evaluaron la condición física y el sueño en niños y adolescentes. La calidad metodológica se valoró con la declaración STROBE. Se incluyeron nueve estudios con 11,321 participantes. Los hallazgos muestran una relación inconsistente entre condición física y duración del sueño. Una duración adecuada se asoció con mejor aptitud cardiorrespiratoria en adolescentes, pero hubo discrepancias en niños más pequeños. No se encontraron asociaciones significativas entre la calidad y duración del sueño y la fuerza muscular. Además, hay un vacío en la literatura sobre el impacto de la calidad del sueño en la condición física. La mayoría de los estudios utilizaron datos autoinformados, lo que podría afectar a la validez de los resultados. La relación entre sueño y condición física sigue sin estar clara, especialmente en niños y más allá de la aptitud cardiorrespiratoria. Futuras investigaciones deben emplear mediciones objetivas del sueño y considerar factores como género y diferencias socioculturales para una comprensión más precisa.

Palabras clave

calidad del sueño; duración del sueño; condición física; adolescentes; niños

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Introduction

Children's and adolescents' health is influenced by physical fitness (Evaristo et al., 2019; Liu et al., 2021), nutrition (Dinu et al., 2018; Geraets & Heinz, 2023), stress management (O'Connor et al., 2021; Turner et al., 2020), and sleep (Dalmases et al., 2019; Liew & Aung, 2021). In recent years, decreased physical activity and sedentary habits have led to a decline in overall health (Bujosa-Quetglas et al., 2023). This highlights the relevance of understanding the role of physical fitness and sleep as key contributors to health.

Physical fitness is defined by the American College of Sports Medicine as the capacity to execute specific motor skills with vigor and awareness, without undue fatigue, and with enough energy to enjoy leisure activities and respond to unforeseen emergencies (Liguori & American College of Sports Medicine, 2021). It provides multiple benefits: enhanced immune, mental, metabolic, and cardiovascular health, as well as muscular strength, endurance, blood pressure control, and bone and joint maintenance (Safitri et al., 2024).

Low physical fitness increases weakness (Spini et al., 2017), which can negatively impact motor and cognitive development in children and adolescents (Ihle et al., 2017).

Physical fitness is a recognized biomarker (Aimar et al., 2024) and is key to functional capacity (Medrano-Ureña et al., 2020). It can be classified into two categories: health-related fitness (body composition, cardiorespiratory fitness, muscular endurance, and strength) and motor skills (agility, coordination, balance, strength, reaction time, and speed) (Dong et al., 2019; Liguori & ACSM, 2021).

Standardized test batteries assess these components in youth. A previous review identified 24 tools, including the ALPHA battery, EuroFit, and the Physical Fitness Test Battery (Ortega et al., 2008; Council of Europe, 1998; Marques et al., 2021). According to Marques et al. (2021), standardizing these tests is essential for comparing results across countries and improving data reliability.

In terms of healthy habits, sleep is a cornerstone behavior, encompassing both sleep quality and duration. Recommended duration is 9–11 hours for children (6–12 years) and 8–10 hours for adolescents (Hirshkowitz et al., 2015). Not meeting these recommendations is linked to increased mortality risk and poor cardiovascular outcomes (Krittanawong et al., 2020; Yin

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et al., 2017). Sleep quality is defined as an individual's subjective satisfaction, considering all aspects of the sleep experience (Nelson et al., 2022). It is closely linked to both mental and physical health (Clement-Carbonell et al., 2021; Scott et al., 2021) and other relevant factors, such as overall quality of life (S. Lee et al., 2021).

Sleep-related problems among children and adolescents have increased in recent decades (Chattu et al., 2018; Grandner, 2017; Şimşek & Tekgül, 2019). Numerous studies emphasize that poor sleep quality and short duration are global issues affecting youth. (Galan-Lopez et al., 2021; Gariepy et al., 2020; Illingworth, 2020; Kansagra, 2020).

To assess sleep, both objective tools (accelerometers, polysomnography, heart rate monitors) and subjective methods (sleep diaries, questionnaires) are used. These questionnaires measure duration (e.g., sleep hours) or quality (e.g., awakenings, daytime sleepiness), and may be completed by the individual or their parents (Mallinson et al., 2019; Matricciani, 2013; Nascimento-Ferreira et al., 2016).

Common instruments include the PSQI and the Children's Sleep Habits Questionnaire for sleep quality, and the Sleep Timing Questionnaire or Sleep Habits Survey for duration (Buysse et al., 1989) Validated questionnaires such as the Sleep Timing Questionnaire (STQ) and the Sleep Habits Survey (SHS) are frequently used to assess sleep duration (Buysse et al., 1989; Mallinson et al., 2019).

Several studies show that sleep quality influences physical fitness, and shorter sleep duration is linked to lower cardiorespiratory and general fitness levels (Hsu et al., 2020; Lee et al., 2020; Sousa-Sá et al., 2024; Xiong et al., 2022).

Numerous systematic reviews examine the relationship between physical activity and sleep duration or quality (Bacil et al., 2024; Huang et al., 2024; Wang et al., 2024; Wilhite et al., 2023). However, there is a gap of knowledge regarding the relationship between physical fitness and sleep quantity or quality. A systematic review from 2019 (Fonseca et al., 2021) did examine this relationship, but an update is warranted.

This review analyzes cross-sectional studies published between 2019 and 2024 on the relationship between physical fitness and sleep in individuals aged 6 to 19.

Materials and Methods

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a) Data Sources and Search Strategies

This systematic review was conducted following the PRISMA methodology (Page et al., 2021). The databases used for the search were Web of Science (WoS), PubMed, and Scopus, targeting articles published between November 1, 2019, and November 1, 2024.

The search period was defined to update Fonseca et al. (2019) and to capture recent studies reflecting changes in sleep and physical fitness patterns in youth. This timeframe includes research published after the COVID-19 pandemic, a period marked by significant shifts in health behaviors. It also reflects methodological advances, such as the use of objective sleep measurements and standardized fitness assessments, which enhance data quality and relevance.

The selection process consisted of three phases: identification, screening, and inclusion, as illustrated in Figure 1. In the identification phase, the article title, abstract, and keywords were analyzed using the following search equation: (((((TS=(sleep duration OR sleep time OR sleep pattern OR sleep patterns OR sleep hygiene)) AND TS=(cardiorespiratory fitness OR cardiometabolic risk OR cardiovascular disease OR CVD OR physical fitness OR handgrip strength OR grip strength OR Fitness OR Healthy behaviors OR Physical activity OR Muscle strength OR Muscular strength OR Cardiometabolic health OR 24h movement guidelines OR Health associations OR aerobic endurance OR cardiovascular fitness OR endurance OR aerobic fitness OR aerobic endurance OR Physical conditioning, human OR endurance training)) AND TS=(adolescents OR young OR adolescence OR youth OR child OR children)) AND PY=(2019-2025))). The search equation was adapted for each database, and Boolean operators AND and OR were used to refine the results.

A list of inclusion and exclusion criteria (Table n.º 1) is provided to clarify the process of selecting articles eligible for the study.

Table n.º 1. Inclusion and exclusion criteria for the studies selected for review.

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Inclusion Criteria	Exclusion Criteria
Published articles in Spanish or English.	Articles published in languages other than Spanish or English
Articles published between November 2019 and November 2024	Articles published before November 2019 or after November 2024
Cross-sectional studies	Non-cross-sectional studies.
Population aged 6 to 19 years	Participants with any diagnosed physical, mental, neurological, or chronic condition; individuals outside the 6–19 years age range
Studies that included the relationship between physical fitness and sleep duration or quality	Studies that did not include the mentioned relationship

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only

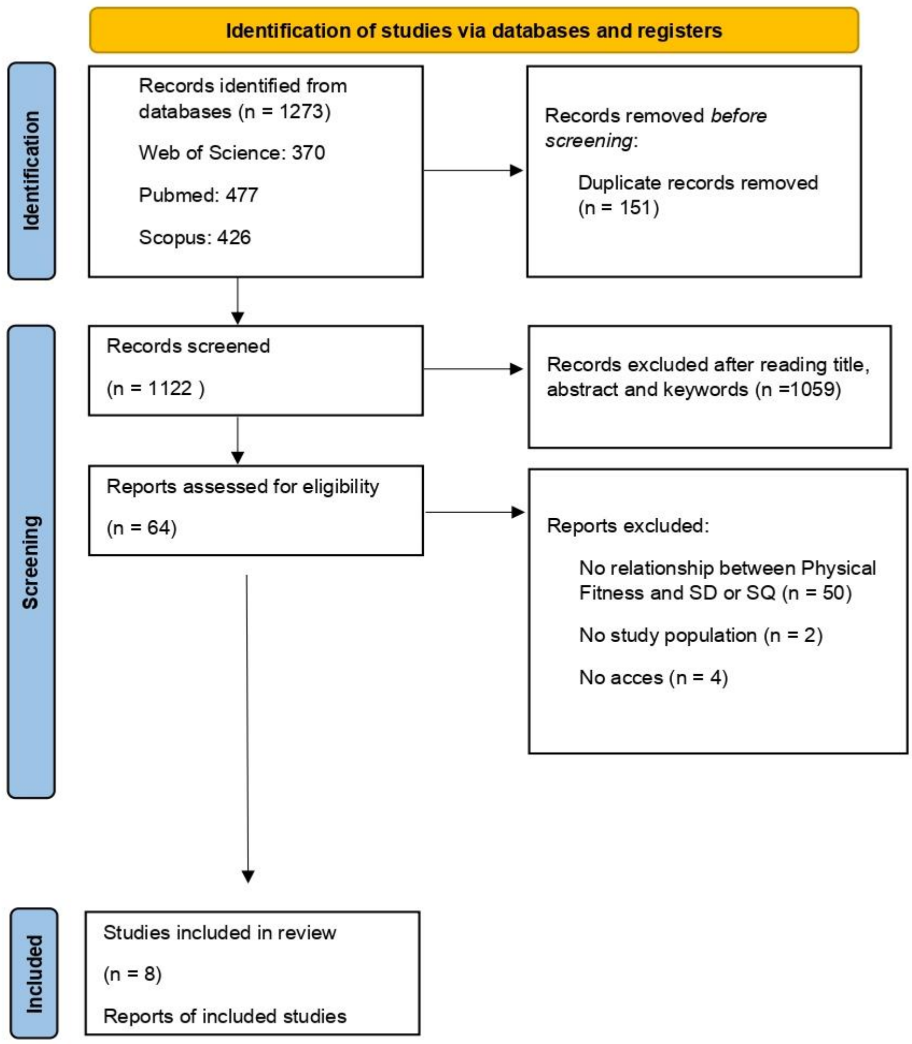

Fig. n.º1 Study selection process

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b) Article Selection Procedure

The initial search in the WoS, Scopus, and PubMed databases resulted in a total of 1,273 articles. The search was limited to peer-reviewed articles, full text, and available in English or Spanish. Duplicates were removed, leaving a total of 1,122 articles. Subsequently, 1,059 articles were excluded after reviewing the title, abstract, and keywords. If it was not possible to determine whether the article could be selected based on these sections, the full article was obtained. Finally, 64 articles were deemed eligible. Of these, 9 articles were selected, which formed the basis of the systematic review.

c) Assessment of Study Quality

The methodological quality of the studies included in this review was assessed using the STROBE checklist (Strengthening the Reporting of Observational Studies in Epidemiology) (von Elm et al., 2008), which consists of 22 items distributed across five dimensions: general reporting, external validity, bias, confounding factors, and statistical power. Each item was scored as "1" if at least one of its sub-items was met, and "0" if it was not, with a maximum score of 22 points, representing full compliance with the criteria. This approach facilitated a structured assessment of the methodological quality of the studies, highlighting strengths and weaknesses, and ensuring the validity and reliability of the conclusions drawn from the review.

No publication bias analysis was performed, as the review included only cross-sectional studies and did not involve effect size calculations or meta-analysis. Study quality was assessed using the STROBE checklist, which, while not measuring bias directly, provides a structured overview of methodological transparency.

Results

Table n.º 2 shows the results obtained regarding the methodological quality of the articles included in the review. The mean score and standard deviation were 19 ± 1.333, with a maximum score of 21, and a range of 17-21. Detailed information about the selected articles can be found in Table n.º 3.

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Table n.º2. Quality assessment based on the STROBE checklist

Authors names	Shang et al., 2020	Timurtaş et al., 2021	Al-Rasheed & Ibrahim, 2020	Confortin et al., 2022	Kochman et al., 2023	Yoshikawa et al., 2025	Tanaka et al., 2020	Higgins et al., 2020	Sehn et al., 2022
1. Title and abstract*	N (a) Y (b)	N (a) Y (b)	Y (a, b)	Y (a, b)	Y (a, b)	N (a) Y (b)	N (a) Y (b)	Y (a, b)	N (a) Y (b)
2. Background	Y	Y	Y	Y	Y	Y	Y	Y	Y
3. Objectives	Y	Y	Y	Y	Y	Y	Y	Y	Y
4. Study design	N	Y	Y	Y	Y	Y	Y	N	Y
5. Setting	Y	Y	Y	Y	Y	N	Y	Y	Y
6. Participants	N	Y	Y	Y	Y	Y	Y	Y	Y
7. Variables	Y	Y	Y	Y	Y	Y	Y	Y	Y
8. Data sources / measurement	Y	Y	Y	Y	Y	Y	Y	Y	Y
9. Bias	N	N	N	Y	N	N	N	Y	N
10. Study size	Y	Y	Y	Y	N	N	N	Y	Y
11. Quantitative variables	Y	Y	Y	Y	Y	Y	Y	Y	Y
12. Statistical methods*	Y (a, b, c, d,e)	Y (a) N (b, c, d, e)	Y (a, d) N (b, c, e)	Y (a, b, c) N (d, e)	Y (a, b, c, d, e)	Y (a, b, c, d) N (e)	Y (a, b, c) N (d, e)	Y (a, b, c, d, e)	Y (a, b, d, e) N (c)
13. Participants*	Y (a) N (b,c)	Y (a) N (b, c)	Y (a, b) N (c)	N (a, b, c)	Y (a, b, c)	Y (a, b, c)	Y (a, b) N (c)	Y (a, c) N (b)	N (a, b, c)
14. Descriptive data*	N (a, b)	Y (a) N (b)	Y (a) N (b)	Y (a) N (b)	Y (a, b)	Y (a, b)	Y (a) N (b)	Y (a) N (b)	Y (a) N (b)
15. Outcome data	Y	Y	Y	Y	Y	Y	Y	Y	Y
16. Main results*	Y (a, b, c)	Y (a,b) N (c)	Y (b) N (a, c)	Y (a) N (b, c)	Y (a, b) N (c)	Y (b) N (a, c)	Y (a, b) N (c)	Y (a, b) N (c)	Y (a, b) N (c)
17. Other analyses	Y	Y	N	N	Y	Y	N	Y	Y
18. Key results	Y	Y	Y	Y	Y	Y	Y	Y	Y
19. Limitations	Y	Y	Y	Y	Y	Y	Y	Y	Y

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20. Interpretation	Y	Y	Y	Y	Y	Y	Y	Y	Y
21. Generalizability	N	Y	N	Y	Y	Y	N	N	Y
22. Funding	N	N	Y	N	Y	Y	N	Y	Y
Sum of “yes” (0-22)	17	20	19	19	20	18	17	21	20
%	77.27	90.90	86.36	86.36	90.90	81.81	77.27	95.45	90.90

Abbreviations: Y: Yes; N: No *Give information separately for exposed and unexposed group

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Table n.º3. Characteristics and Key Findings of Included Studies

Authors	Year	Location	Sample size	Age	Inclusion/exclusion criteria	Variables	Instruments	Absolute effect
Yoshikawa et al.,	2025	Japan	2308	10–12y	- No exclusion criteria were set for recruitment because all children attending public schools in Japan are required to be educated equally	-Sleep duration -CRF -Handgrip strength -Abdominal muscle strenght -Flexibility -Ball throwing -Jumping ability -Speed	Sports battery tests: -20-m shuttle run -Handgrip strength -Sit-ups -Sit-and-reach flexibility -Standing long jump -Ball throwing -Side-to-side jump -50-m sprint -Lifestyle questionnaire	A longer weekday sleep duration was linked to poorer performance in the 20-meter shuttle run. The relationship between sleep duration and physical fitness was inconsistent.
Kochman et al.,	2023	Poland	236: 85 boys (36.2%) and 150 girls (63.8%)	16-17y	Inclusion criteria: -Written informed consent -16–17y -No contraindication to physical Activity. Exclusion criteria: -Chronic diseases, pain, injury, or other conditions within 6 months from the study indicating those as contraindications to perform physical exercises -Discontinuation from performing tests -Incorrectly performed physical trials.	-Sleep duration -Arm muscle strength -Abdominal muscle strenght -Flexibility -Endurance -Speed -Jumping ability	-Questionnaire -Zuchora's Physical Fitness Index.	Those who slept 7–8 hours scored higher on fitness tests than those who slept less than 6 hours or more than 9 hours.
Sehn et al.,	2022	Brazil	1502 (876 girls)	10–17y	Inclusion criteria: -10–17y -Go to a private or public school in the city of Santa Cruz	-Endurance -Sleep duration	-6 Minute Walk Test on a track field -Questions: "What time do you go to sleep during the week and the weekend?" and "What time do you get up during the week and weekend?"	In girls, insufficient sleep duration increased the likelihood of poorer CRF.

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Confortin et al.,	2022	Brazil	1269 (50.3% mens and 49.7% girls)	18-19y	Inclusion criteria: -Born in a maternity hospital located in São Luís - MA in 1997.	-Handgrip strength -Sleep Time	-Digital hydraulic dynamometer Jamar Plus + (by Sammons Preston) -Accelerometer (model GTX3 +, Actigraph®):	No significant association between sleep duration and handgrip strength
Timurtaş et al.,	2021	Turkey	110 (47% male)	9-14y (11.85±0.35)	Inclusion criteria: -No diagnosis of neurological cardiovascular, metabolic, rheumatic, or vestibular diseases, -No injuries or previous surgery	-Endurance -Agility -Muscle strength -Sleep time	-6 Minute Walk Test -T-test -Eurofit battery: Vertical and Broad Jump -Sleep time: not specified how it was obtained	Sleep duration was not significantly associated with the participants' physical fitness level.
Higgins et al.,	2020	New Zealand	276 (52.5% female)	14–18y	Inclusion criteria: -14-18y -Be a New Zealand citizen	-CRF -Sleep duration	-20-m multi-stage shuttle run -Sleep Habits Survey for Adolescents	Social jetlag is negatively associated with CRF in adolescent males.
Tanaka et al.,	2020	Japan	243 (115 boys and 128 girls)	9.4± 1.7y	Inclusion Criteria: -Japanese primary school children -6–12y -Be from six urban schools in Tokyo. -Informed consent from children and parents. -Data collected during school years 2010–2012.	-Sleep duration -Handgrip Strength -Endurance -Flexibility -CRF	-Questionnaire -New Physical Fitness Test of the MEXT	Children who met both MVPA and sleep recommendations scored higher on the sit-up test compared to those who did not meet them, although the effect was similar to that of meeting only the MVPA recommendation.
Shang et al.,	2020	China	5315 (48.7% boys)	6-13y (9.55 ± 1.19)	Does not specify inclusion/exclusion criteria	-Endurance -Agility -Sleep pattern	-50-m shuttles run (CASIO, HS-70W stopwatch) -7-day Physical Activity Recall questionnaire	Bidirectional link between CRF and sleep patterns: poor sleep predicted low CRF, while low baseline CRF inversely linked to poor sleep.
Al-Rasheed & Ibrahim	2020	Saudi Arabia	62	12-15y	Exclusion criteria:	-Sleep quality -Handgrip strength	-PSQI	No significant differences in isometric muscle strength

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	-A history of musculoskeletal, neural, visual, vestibular, mental, or psychological disorders -Diabetes mellitus -Obesity and underweight based on the Centers for Disease Control/World Health Organization (CDC/WHO) BMI classification		-Hydraulic hand dynamometer and pinch gauge (JAMAR Hand Evaluation Kit, Patterson Medical Holdings, Inc., Canada	parameters between poor sleep quality and normal sleep quality groups.

Abbreviations: Y: years; h: hours; CRF: cardiorespiratory fitness; m: meters; MVPA: moderate-to-vigorous physical activity; MEXT: Ministry of Education, Culture, Sports, Science, and Technology; BMI: Body Mass Index; PSQI: Pittsburgh Sleep Quality Index

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Regarding the geographical distribution of studies, two were conducted in Brazil, two in Japan, and one each in Poland, New Zealand, Saudi Arabia, China, and Turkey. A total of 11,321 participants were evaluated across the nine studies. There were significant variations in sample sizes across the studies. Al-Rasheed & Ibrahim (2020) analyzed 62 participants aged 12–15 years, Timurtaş et al. (2021) included 110 children aged 9–14 years, and Tanaka et al. (2020) examined 243 Japanese schoolchildren aged 6–12 years. Higgins et al. (2020) studied 276 New Zealand adolescents aged 14–18 years, Kochman et al. (2023) included 236 Polish adolescents aged 16–17 years, and Sehn et al. (2022) recruited 1,502 Brazilian children and adolescents aged 10–17 years. Confortin et al. (2022) analyzed data from 1,269 Brazilian young adults aged 18–19 years, Yoshikawa et al. (2025) included 2,308 Japanese children aged 10–12 years, and Shang et al. (2020) had the largest sample, with 5,315 Chinese children aged 6–13 years.

The studies assessed variables related to physical fitness and sleep, employing various measurement tools. Physical fitness evaluations involved assessing muscular strength using handgrip dynamometry. (Al-Rasheed & Ibrahim, 2020; Confortin et al., 2022; Tanaka et al., 2020; Timurtaş et al., 2021; Yoshikawa et al., 2025) and pull-up tests (Kochman et al., 2023). Aerobic capacity was measured using the 20-meter shuttle run test. (Higgins et al., 2020; Tanaka et al., 2020; Yoshikawa et al., 2025) and the six-minute walk test (Sehn et al., 2022; Timurtaş et al., 2021). Speed was evaluated through the 50-meter sprint (Shang et al., 2020; Yoshikawa et al., 2025). Standardized test batteries were used to evaluate various fitness aspects, including flexibility, agility, abdominal strength, and jumping ability. Some of the more commonly used tests included the EuroFit test battery, (Council of Europe., 1998) the Japanese Ministry of Education's Physical Fitness Test (Tanaka et al., 2020), or the Zuchora's Physical Fitness Index (Kochman et al., 2023).

Among sleep-related variables, sleep duration was the most extensively studied, and it was typically measured through self-reported questionnaires (Higgins et al., 2020; Kochman et al., 2023; Sehn et al., 2022; Shang et al., 2020; Tanaka et al., 2020; Yoshikawa et al., 2025), while Confortin et al. (2022) used accelerometers for more objective data. Timurtaş et al. (2021) reported sleep duration, but it was not specified whether it was self-reported or objectively

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https://doi.org/10.17979/sportis.2025.11.4.11951

measured. Sleep quality was assessed in one study, using the Pittsburgh Sleep Quality Index (PSQI) (Al-Rasheed & Ibrahim, 2020).

The association between sleep and physical fitness showed variability across studies. Confortin et al. (2022) reported no notable connection between sleep duration and muscular strength. Similarly, Al-Rasheed & Ibrahim (2020) found no significant relationship between sleep quality and muscular strength. Yoshikawa et al. (2025) found that longer sleep duration on weekdays was linked to poorer performance in the 20-meter shuttle run, while the associations with other physical fitness parameters were inconsistent. Timurtaş et al. (2021) did not find significant relationships.

Conversely, Kochman et al. (2023) found that better physical fitness outcomes were associated with sleeping 7–8 hours in adolescents. Sehn et al. (2022) identified that inadequate sleep duration is negatively associated with cardiorespiratory fitness, particularly in girls. Tanaka et al. (2020) showed that meeting sleep recommendations was associated with better performance in abdominal strength tests. Finally, Shang et al. (2020) highlighted a bidirectional relationship between sleep patterns and cardiorespiratory fitness, while Higgins et al. (2020) observed that social jetlag harmed physical fitness in adolescents.

Discussion

This systematic review aims to identify cross-sectional studies conducted in the past five years that examine the relationship between physical fitness and sleep duration or quality. Although children and adolescents are recommended to sleep between 8 and 12 hours per night depending on age (Hirshkowitz et al., 2015; Paruthi et al., 2016), a significant proportion fail to meet these guidelines. Studies indicate that nearly 40% of this population sleeps less than 9 hours per night (Wheaton & Claussen, 2021), with adolescents averaging between 7 and 7.5 hours (Lucas-Thompson et al., 2021; Ojio et al., 2016). This widespread sleep deficit, influenced by factors such as screen time, noise exposure, and sedentary behavior (Coel et al., 2023; Gariepy et al., 2020; Sejbuk et al., 2022), may have implications for physical development, including cardiorespiratory fitness and muscular performance—key outcomes explored in this review.

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The present review shares several key aspects with the study conducted by Fonseca et al. (2021), particularly the evaluation of the relationship between sleep and physical fitness in the population aged 6 to 19 years. Both reviews emphasize that sufficient sleep duration is positively linked to improved cardiorespiratory fitness, particularly in adolescents. While Fonseca highlighted studies such as Countryman et al. (2013) and Mota & Vale (2010), this review reinforces those findings through recent evidence (Shang et al., 2020; Sehn et al., 2022). Together, these studies suggest a consistent pattern: adolescents who meet sleep duration recommendations tend to perform better on cardiorespiratory fitness tests.

In contrast to the more consistent findings in adolescents, studies examining younger children report mixed or non-significant associations between sleep duration and cardiorespiratory fitness. This was observed both in Fonseca's (Thivel et al., 2015; Zaqout et al., 2016) and in recent evidence such as Yoshikawa et al. (2025). These inconsistencies may reflect developmental differences in physiology, variability in bedtime routines, or reduced sensitivity of fitness indicators at earlier ages. Future research should explore how pre-sleep behaviors and sleep hygiene influence physical performance during childhood.

The evidence regarding the connection between muscle strength and sleep duration is inconsistent across studies. Fonseca's review found no consistent association between muscle strength and sleep duration in either children or adolescents. Studies by Zaqout et al. (2016), Countryman et al. (2013), and Lee & Lin (2007) support this observation. This review reflects similar findings, with Confortin et al. (2022) reporting no significant association between handgrip strength and sleep duration in young adults (18-19 years), while Yoshikawa et al. (2025) reported similar results in children aged 10 to 12 years. These findings suggest that muscular strength may be less sensitive to short-term variations in sleep behavior, or that other factors may play a more dominant role. Further research is needed to clarify the potential pathways involved.

Findings related to other physical fitness components—such as speed, agility, flexibility, and muscular endurance—are limited and largely non-significant. Both Fonseca's review and more recent studies (Zaqout et al., 2016; Tímurtas et al., 2021; Tanaka et al., 2020) found no meaningful associations with sleep duration. These components may be less

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ISSN-e 2386-8333

https://doi.org/10.17979/sportis.2025.11.4.11951

influenced by sleep duration or more dependent on neuromuscular coordination and short bursts of performance, which are less likely to be affected by moderate sleep variation.

The connection between sleep quality and different physical fitness components, however, has been less explored in comparison to sleep duration, and shows inconsistent findings. While some studies suggest that better sleep quality is linked to improved cardiorespiratory fitness (Mota & Vale, 2010; García-Hermoso et al., 2017), others report unexpected or null associations. For instance, Lee & Lin (2007) found poorer sleep quality linked to higher fitness levels, while Al-Rasheed & Ibrahim (2020) found no significant association with muscular strength. These inconsistencies may result from the use of subjective sleep quality measures, varying operational definitions, or sample differences. More research using standardized tools is needed to clarify these relationships.

From a methodological perspective, both reviews used similar tools to assess key variables. Both reviews consistently used the 20-meter shuttle run test to assess cardiorespiratory fitness, a widely recognized and validated method used in studies such as those by Mota & Vale (2010) in Fonseca's review, and Yoshikawa et al. (2025) and Tanaka et al. (2020) in this review. In terms of sleep duration, self-reported questionnaires were the predominant method employed across studies in both reviews, except for Confortin et al. (2022) which utilized accelerometry, a more objective and precise approach. This contrast indicates that while self-reported questionnaires are practical and accessible, employing more objective methods in future studies could enhance data accuracy and validity.

Strengths and limitations

To the authors' knowledge, this systematic review is the first to update the literature on the association between sleep duration and quality, and physical fitness in individuals aged 6 to 19 years. This study includes multiple components of physical fitness. The application of the PRISMA model ensures the quality and transparency of the systematic review process, while the methodological quality assessment of the included studies using the STROBE checklist enhances the precision in interpreting the findings.

However, this study also has some limitations. The studies identified did not investigate the physiological mechanisms underlying the relationship between sleep duration or quality and physical fitness, limiting our understanding of the interaction between these variables. Additionally, only one study addressed the relationship between sleep quality and physical fitness, highlighting a gap in existing literature. Another limitation is the widespread use of self-reported questionnaires to assess sleep duration in nearly all studies, which may introduce bias. This underscores the need for future research to employ objective measures of sleep. Finally, most studies did not explore differences in gender, age, and sociocultural context, pointing to another potential avenue for future investigation.

Conclusions

The relationship between physical fitness and sleep in the studied population is inconsistent. Adequate sleep duration is associated with better cardiorespiratory fitness only in adolescents. Schools should combine fitness programs with sleep education to improve both. Interventions targeting these areas may enhance students' overall well-being. No significant relationships were found between other physical fitness variables, such as muscle strength, and sleep duration or quality.

Future studies should explore the mechanisms linking sleep and physical fitness, using more objective methods and considering differences by gender and sociocultural context.

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Published by: Campus Educa Sportis. Collaborator: University of A Coruña
A Coruña. Spain
E-mail: v.arufe@udc.es Web: www.sportisjournal.com
ISSN-e 2386-8333
Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity

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