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Physical Activity, Sitting Duration, and Posture Associated with Low Back Pain: A Systematic Review

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Abstract

Background: Low back pain (LBP) is increasingly prevalent among adolescents and is associated with modifiable lifestyle factors such as physical inactivity, prolonged sitting, and poor posture. Sedentary behavior in school settings may contribute significantly to the development of musculoskeletal complaints.

Objective: This study aimed to systematically evaluate the association between physical activity, sitting duration, and sitting posture with the incidence of LBP in adolescents.

Methods: A systematic review was conducted following PRISMA 2020 guidelines. Literature was retrieved from Scopus, Google Scholar, and Semantic Scholar databases between 2015 and 2025. Observational studies examining the relationship between physical activity, sitting duration, posture, and LBP were included. Six studies met the eligibility criteria after screening and full-text assessment. Methodological quality was assessed using the Joanna Briggs Institute (JBI) checklist.

Results: Six cross-sectional studies were included, with sample sizes ranging from approximately 500 to 7,000 participants. Low physical activity was consistently associated with increased risk of LBP. Prolonged sitting duration and non-ergonomic posture were also significantly associated with higher prevalence of LBP across studies. Methodological quality ranged from moderate to high (JBI scores 8–10). However, heterogeneity in study design and outcome measures limited quantitative synthesis.

Conclusion: Low physical activity, prolonged sitting, and poor posture are key modifiable risk factors for LBP in adolescents. Preventive strategies targeting these factors are recommended, although the overall strength of evidence remains limited due to predominantly cross-sectional designs.

Keywords
Low Back Pain; Motor Activity; Sedentary Behavior; Posture; Adolescent; Risk Factors

Introduction

Low back pain (LBP) is one of the leading causes of disability worldwide and represents a significant public health concern across all age groups, including adolescents.[1] The global burden of LBP continues to increase, with recent estimates indicating that approximately 619 million individuals are affected, and this number is projected to rise in the coming decades.[2,3] Although traditionally associated with adults, LBP is now increasingly reported among adolescents, suggesting an earlier onset of musculoskeletal disorders that may persist into adulthood.[3]

The rising prevalence of LBP in adolescents has been closely linked to changes in lifestyle and behavioral patterns. In particular, the increasing adoption of sedentary behaviors, prolonged sitting during academic activities, and reduced engagement in physical activity have been identified as key contributing factors.[4] School environments, where students spend extended periods in seated positions, often with suboptimal ergonomic conditions, may exacerbate mechanical stress on the lumbar spine.[5] Prolonged static sitting can lead to muscle fatigue, altered spinal alignment, and increased intradiscal pressure, thereby contributing to the development of LBP.[6]

In addition to sitting duration, posture plays a critical role in spinal health. Non-ergonomic sitting positions, such as forward head posture or slouched sitting, can disrupt normal biomechanical loading patterns and increase strain on musculoskeletal structures.[7] At the same time, insufficient levels of physical activity may reduce muscular strength and endurance, further compromising spinal stability and increasing susceptibility to pain.[8] These factors are often interrelated, creating a multifactorial risk profile for LBP among adolescents.

Despite the growing body of literature examining individual risk factors, findings remain inconsistent, particularly regarding the relative contribution and interaction between physical activity, sitting duration, and posture. Previous studies have predominantly focused on single variables or specific populations, limiting the ability to draw comprehensive conclusions. Furthermore, variations in measurement methods, study design, and outcome definitions contribute to heterogeneity in the evidence base.

Systematic reviews offer a rigorous methodological approach to synthesize available evidence and identify patterns across studies. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines provide a standardized framework to enhance transparency, reproducibility, and methodological quality in evidence synthesis.[9] However, there remains a lack of systematic reviews that specifically integrate these three key modifiable factors, physical activity, sitting duration, and posture, in relation to LBP among adolescents. This review was guided by a PICO framework: Population (adolescents), Exposure (physical activity, sitting duration, posture), Comparison (varying exposure levels), and Outcome (low back pain).

Therefore, this study aims to systematically evaluate the association between physical activity, sitting duration, and sitting posture with the incidence of low back pain in adolescents. By synthesizing current evidence, this review seeks to clarify inconsistencies in the literature, identify research gaps, and provide evidence-based insights to inform preventive strategies, particularly in school settings.

Methods

This study employed a systematic literature review design conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The review aimed to synthesize evidence regarding the association between physical activity, sitting duration, and sitting posture with the incidence of low back pain (LBP) in adolescent populations.

The literature search was conducted between January and March 2026 across three electronic databases: Scopus, Google Scholar, and Semantic Scholar. The search strategy was developed using a combination of Medical Subject Headings (MeSH) and free-text terms. Boolean operators ("AND", "OR") were applied to optimize sensitivity and specificity. The core search string used was as follows: ("low back pain" OR "lumbar pain" OR "musculoskeletal pain") AND ("physical activity" OR "exercise" OR "motor activity") AND ("sitting duration" OR "sedentary behavior") AND ("posture" OR "sitting posture") AND ("adolescent" OR "high school students"). The search strategy was adapted for each database to account for differences in indexing and syntax. Only articles published between 2015 and 2025 were included to ensure the relevance and currency of evidence. Additionally, only studies published in English or Indonesian and available in full text were considered. Grey literature was excluded to maintain methodological rigor and ensure inclusion of peer-reviewed sources.

Study selection followed the PRISMA 2020 framework, consisting of identification, screening, eligibility, and inclusion stages. A total of 305 records were initially identified, of which four duplicates were removed. The remaining 301 records were screened based on titles and abstracts, resulting in the exclusion of 271 studies due to irrelevance. Thirty full-text articles were assessed for eligibility, with 16 excluded due to population mismatch, irrelevant variables, or lack of full-text availability. Ultimately, six studies met all inclusion criteria and were included in the final synthesis. The selection process was conducted independently by two reviewers, and disagreements were resolved through discussion to minimize selection bias.

The inclusion and exclusion criteria were defined a priori to ensure consistency and transparency. Studies were included if they met the following criteria: (1) observational design (cross-sectional, cohort, or analytical studies), (2) involved adolescent or high school populations, (3) examined at least one of the variables of interest (physical activity, sitting duration, or posture) in relation to LBP, and (4) reported measurable outcomes related to LBP. Studies were excluded if they were experimental, reviews, editorials, or involved non-adolescent populations. To improve clarity, the eligibility criteria are summarized in Table 1.

Table 1. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Publication year	2015–2025	<2015
Study design	Observational studies	Experimental, reviews
Population	Adolescents / high school students	Non-adolescent populations
Variables	Physical activity, sitting duration, posture, LBP	Irrelevant variables
Outcome	Low back pain measurement	No LBP outcome
Language	English, Indonesian	Other languages
Accessibility	Full-text available	No full-text
Source	Peer-reviewed journals	Non-scientific sources

Data extraction was performed using a standardized extraction form developed by the authors. Extracted variables included author, year of publication, study design, sample size, population characteristics, exposure variables, outcome measures, instruments used, and key findings. The extraction process was conducted independently by two reviewers to ensure accuracy and consistency. Table 2 presents the data extraction framework used in this study.

Table 2. Data Extraction Framework

Variable	Description
Study identification	Author(s), year
Study design	Cross-sectional, cohort
Sample characteristics	Sample size, population
Exposure variables	Physical activity, sitting duration, posture
Outcome	Low back pain
Measurement tools	IPAQ, NMQ, VAS, observational tools
Key findings	Main results

The methodological quality of included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies. Each study was evaluated across 13 criteria, including clarity of inclusion criteria, validity of measurement, confounding factors, and appropriateness of statistical analysis. Studies were categorized as high quality (≥10), moderate quality (7–9), or low quality (≤6).

Risk of bias was assessed across three domains: selection bias, information bias, and confounding. The results of the quality assessment were integrated into the interpretation of findings to ensure that conclusions were based on robust evidence. Data synthesis was conducted using a narrative and thematic approach due to heterogeneity in study design, measurement tools, and outcome reporting. Studies were grouped according to the main variables of interest: physical activity, sitting duration, and posture. Patterns, consistencies, and discrepancies across studies were identified and analyzed qualitatively. A meta-analysis was not performed due to the absence of comparable quantitative data such as effect sizes or confidence intervals.

All stages of the review process were conducted using reference management software (Mendeley) for citation organization and Rayyan for screening to enhance transparency and reproducibility. As this study was based on previously published data, ethical approval was not required. However, the study adhered to principles of research integrity and proper citation practices.

Results

The study selection process followed the PRISMA 2020 framework. A total of 305 records were identified from three databases, with 4 duplicates removed, resulting in 301 records for screening. After title and abstract screening, 271 records were excluded due to irrelevance. Thirty full-text articles were assessed for eligibility, of which 24 were excluded for reasons including non-relevant populations, unrelated variables, and lack of full-text access. Ultimately, six studies met the inclusion criteria and were included in the final analysis. This review was not registered in PROSPERO.

Subsequently, 30 full-text articles were assessed for eligibility. A total of 24 articles were excluded for the following reasons: non-relevant population (n = 6), irrelevant variables (n = 5), and lack of full-text availability (n = 5), along with other methodological mismatches. Finally, six studies met all inclusion criteria and were included in the qualitative synthesis. To improve transparency and reproducibility, the study selection process is illustrated in Figure 1.

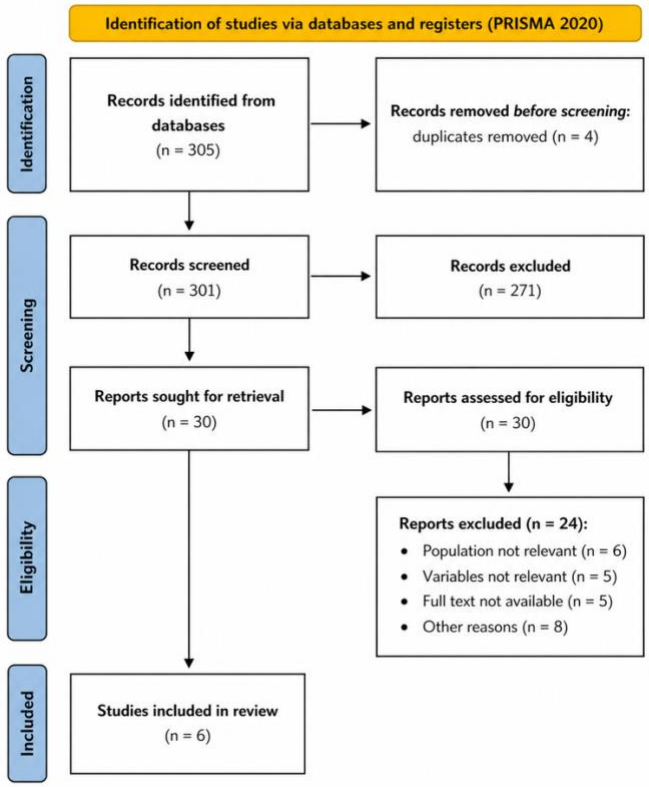

Figure 1. PRISMA Flow Diagram of Study Selection

The included studies were all observational in design, predominantly cross-sectional, with sample sizes ranging from approximately 500 to 7,000 participants. The populations varied from adolescents to general adult populations, although all studies examined at least one of the variables of interest in relation to low back pain (LBP). Measurement tools included validated instruments such as the Nordic Musculoskeletal Questionnaire (NMQ), International Physical Activity Questionnaire (IPAQ), and Visual Analog Scale (VAS). To provide a comprehensive overview of study characteristics, Table 3 summarizes the included studies.

Table 3. Characteristics of Included Studies

No	Author (Year)	Design	Sample	Variables	Instruments	Main Findings
1	Shiri et al. (2018)[10]	Cross-sectional	~7,000 adults	Physical activity, LBP	NMQ, self-report	Low physical activity associated with higher LBP risk
2	Smith et al. (2020)[11]	Cross-sectional	~3,500	Sitting duration, LBP	IPAQ, sitting time	Prolonged sitting associated with musculoskeletal complaints
3	Bento et al. (2020)[3]	Cross-sectional	~1,200	Physical activity, posture, LBP	NMQ, observation	Low activity and poor posture increase LBP
4	O'Sullivan et al. (2019)[7]	Observational	~500	Posture, LBP	VAS, observation	Static posture contributes to LBP
5	Calvo-Muñoz et al. (2018)[4]	Cross-sectional	~2,000 adolescents	Physical activity, LBP	NMQ	Low activity increases LBP risk in adolescents
6	Dianat et al. (2017)[5]	Cross-sectional	~1,300 students	Sitting duration, posture, LBP	Observation, NMQ	Poor posture and long sitting duration increase LBP risk

Note: Most studies were classified as having moderate risk of bias due to reliance on self-reported measures and limited control of confounders.

The methodological quality of the included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies. Overall, the included studies demonstrated moderate to high methodological quality, with scores ranging from 8 to 10 out of 13 criteria. Most studies clearly defined inclusion criteria, used valid and reliable measurement instruments, and applied appropriate statistical analyses. However, several studies showed limitations in controlling confounding variables and relied on self-reported measures, which may introduce information bias. The overall certainty of evidence was considered low to moderate due to the predominance of cross-sectional designs, heterogeneity in measurement methods, and lack of standardized effect size reporting.

The certainty of evidence was evaluated qualitatively based on key GRADE domains, including study design, risk of bias, consistency, and precision. Overall, the certainty of evidence was considered low to moderate. This rating was primarily influenced by the predominance of cross-sectional study designs, which limit causal inference, as well as variability in measurement methods and outcome definitions across studies. In addition, the absence of standardized effect size reporting, such as odds ratios or confidence intervals, reduced the precision and comparability of findings. Despite consistent directional associations between physical inactivity, prolonged sitting, poor posture, and low back pain, these methodological limitations suggest that the overall confidence in the evidence remains limited. A summary of the methodological quality assessment is presented in Table 2.

Table 2. Methodological Quality Assessment (JBI)

Study	Score (0–13)	Quality Level
Shiri et al. (2018)	10	High
Smith et al. (2020)	9	Moderate
Bento et al. (2020)	10	High
O'Sullivan et al. (2019)	9	Moderate
Calvo-Muñoz et al. (2018)	8	Moderate
Dianat et al. (2017)	10	High

Note: High = ≥10; Moderate = 7–9; Low = ≤6

The findings are presented based on the main variables of interest: physical activity, sitting duration, and sitting posture. A meta-analysis was not feasible due to heterogeneity and lack of comparable quantitative data. Four studies examined the relationship between physical activity and LBP. Across these studies, low levels of physical activity were consistently associated with a higher prevalence of LBP. This association was observed in both adolescent and adult populations, with similar trends across different measurement tools.

Three studies reported on sitting duration as a risk factor for LBP. Prolonged sitting was consistently associated with increased musculoskeletal complaints, including LBP. The findings indicated that longer daily sitting time was linked to a higher likelihood of experiencing back pain, regardless of population differences. Three studies evaluated the role of sitting posture. Non-ergonomic and static sitting positions were associated with increased LBP prevalence. Observational assessments showed that poor posture, such as slouched sitting, contributed to mechanical strain on the lumbar spine.

Across the included studies, consistent associations were observed between low physical activity, prolonged sitting, poor posture, and LBP. However, heterogeneity was noted in study populations, measurement instruments, and outcome definitions. None of the studies reported standardized effect sizes (e.g., odds ratios or confidence intervals) in a comparable format, which limited the ability to perform quantitative synthesis or meta-analysis.

Overall, the evidence indicates that physical inactivity, prolonged sitting duration, and non-ergonomic posture are commonly associated with increased prevalence of LBP. Despite consistent directional findings, variability in study design and measurement approaches limits the strength and generalizability of conclusions.

Discussion

This systematic review synthesized evidence on the association between physical activity, sitting duration, and sitting posture with low back pain (LBP). Overall, the findings consistently indicate that low levels of physical activity, prolonged sitting duration, and non-ergonomic posture are associated with an increased prevalence of LBP. However, the strength of evidence remains limited due to the predominance of cross-sectional study designs.

One of the most consistent findings across the included studies is the association between low physical activity and increased risk of LBP. This relationship is biologically plausible, as insufficient physical activity may lead to reduced muscular strength, endurance, and neuromuscular control, particularly in the core stabilizing muscles of the spine.[1,12] Regular physical activity has been shown to enhance spinal stability, improve circulation to intervertebral discs, and reduce inflammatory responses, thereby contributing to the prevention of musculoskeletal pain.[2,13] These findings are consistent with previous systematic reviews demonstrating that higher levels of physical activity are associated with reduced incidence of LBP, although the magnitude of this association varies across populations.[3]

In addition to physical activity, prolonged sitting duration emerged as a significant factor associated with LBP. Extended periods of sitting, particularly in static positions, can increase intradiscal pressure, reduce lumbar lordosis, and contribute to muscle fatigue.[4,11] Over time, these biomechanical stresses may lead to microtrauma and pain in the lumbar region. The findings of this review align with previous studies indicating that sedentary behavior is an independent risk factor for musculoskeletal disorders, even among individuals who meet recommended physical activity levels.[5,14] This suggests that reducing sitting time may be as important as increasing physical activity in preventing LBP.

Sitting posture also plays a critical role in the development of LBP. Non-ergonomic postures, such as slouched or forward-flexed positions, can alter spinal alignment and increase loading on passive structures, including ligaments and intervertebral discs.[6] The studies included in this review consistently reported that poor posture is associated with higher prevalence of LBP. However, it is important to note that posture alone may not fully explain the occurrence of LBP, as it interacts with other factors such as duration of sitting and individual variability in musculoskeletal capacity.[7,15]

Despite the consistency in the direction of findings, heterogeneity across studies must be considered. Differences in population characteristics, measurement tools (e.g., self-reported questionnaires versus observational assessments), and definitions of LBP contribute to variability in reported outcomes.[16] Moreover, the absence of standardized effect size reporting (e.g., odds ratios or confidence intervals) limited the ability to perform quantitative synthesis. This heterogeneity underscores the need for standardized methodologies in future research.[17]

Another important consideration is the level of evidence. Most studies included in this review employed cross-sectional designs, which limit the ability to infer causality. While associations between the variables and LBP are evident, it cannot be definitively concluded that these factors directly cause LBP. Therefore, the overall certainty of evidence can be considered low to moderate, in line with established evidence hierarchies.[8,18] Longitudinal studies and randomized controlled trials are needed to establish causal relationships and evaluate the effectiveness of targeted interventions.

From a clinical and practical perspective, the findings of this review have important implications, particularly in school settings. Interventions aimed at increasing physical activity, reducing prolonged sitting, and promoting ergonomic posture may help reduce the risk of LBP among adolescents.[11] These strategies may include structured physical activity programs, regular movement breaks during classroom activities, and ergonomic modifications to school furniture.[19] However, the implementation of such interventions should be guided by evidence from higher-quality studies.

The findings of this review are generally consistent with recent systematic reviews and meta-analyses examining the relationship between sedentary behavior and low back pain (LBP) in adolescent populations. A recent meta-analysis reported that increased sedentary behavior, particularly screen time, was associated with a higher risk of LBP, with a dose–response relationship indicating a 26% increase in odds for each additional hour of daily exposure.[20] Similarly, earlier systematic reviews have demonstrated a moderate association between sedentary behavior and LBP across age groups, supporting the role of prolonged sitting as a relevant risk factor.[21]

However, some inconsistencies exist in the literature. For instance, recent longitudinal evidence suggests that sedentary behavior may not be a direct causal factor for the onset of spinal pain, despite showing weak associations in cross-sectional analyses.[22] This highlights the complexity of the relationship and suggests that sedentary behavior may act as a contributing or associated factor rather than an independent causal determinant.[23]

In relation to physical activity, previous systematic reviews indicate a non-linear or U-shaped relationship, where both low and excessive levels of activity may increase the risk of LBP, while moderate activity appears protective. These findings align with the current review, which consistently identified low physical activity as a risk factor but lacked sufficient data to evaluate dose–response relationships.[24]

Overall, the present findings are in agreement with the broader literature in terms of direction of association; however, discrepancies in causality, magnitude of effect, and methodological approaches across studies underscore the need for more robust longitudinal and experimental research.

This review has several limitations that should be acknowledged. First, the inclusion of studies with predominantly cross-sectional designs limits causal inference. Second, the restriction to articles published between 2015 and 2025 may have excluded earlier relevant studies, although this approach was intended to ensure up-to-date evidence. Third, the exclusion of grey literature may introduce publication bias. Additionally, variability in measurement methods and lack of standardized reporting may affect the comparability of findings. The included studies did not consistently report effect sizes such as odds ratios or confidence intervals, limiting quantitative synthesis.

Despite these limitations, this review provides a comprehensive synthesis of current evidence and highlights key modifiable factors associated with LBP. Future research should focus on longitudinal and interventional designs, standardized measurement tools, and the integration of biomechanical and behavioral factors to better understand the complex etiology of LBP.

Conclusion

This systematic review demonstrates that low levels of physical activity, prolonged sitting duration, and non-ergonomic sitting posture are consistently associated with an increased prevalence of low back pain (LBP) among adolescents. These findings highlight the importance of modifiable lifestyle and behavioral factors in the development of musculoskeletal complaints in school-aged populations. However, the overall strength of evidence remains limited due to the predominance of cross-sectional study designs, which restrict causal inference. In addition, variability in measurement methods and study populations reduces the generalizability of findings. Therefore, the current evidence should be interpreted with caution.

From a practical perspective, interventions aimed at increasing physical activity, reducing prolonged sitting, and promoting ergonomic posture may serve as effective preventive strategies for LBP in adolescents. These interventions are particularly relevant in educational settings, where students are exposed to prolonged sedentary conditions. Future research should prioritize longitudinal and experimental study designs, standardized outcome measurements, and comprehensive assessment of confounding factors to strengthen the evidence base and support the development of targeted intervention programs.

Author Contribution

Ashley Adeline Vaudy Maspaitella: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing original draft.
Cicilia Febriani Hayuningrum: Supervision, Validation, Methodology, Writing, review, and editing.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Ethics Statement

This study was conducted using previously published data and did not involve human participants directly. Therefore, ethical approval was not required. The study adhered to principles of research integrity and proper citation practices.

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