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ANALYSIS OF RISK FACTORS ASSOCIATED WITH POSTURAL DEVIATIONS AND BACK PAIN IN CHILDREN DURING EARLY ADOLESCENCE

Systematic review

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ABSTRACT

Introduction: The early adolescence period represents a phase of turbulent physical development, characterized by disproportion in the musculoskeletal system, where the muscular system's inability to maintain a normal relationship between certain body segments results in poor posture among adolescents. Back pain is an increasing health problem among children and adolescents. Postural deviations and back pain are common issues among children, caused by the long-term effects of various risk factors associated with modern lifestyles.

Methods: This study is a non-experimental (qualitative) research, specifically a scientific literature review. For the purposes of this paper, a search of relevant databases including Web of Science, Scopus, PubMed, and Med-Line was conducted for articles published between 2011 and 2024.

Results: A significant number of articles were published between 2011 and 2024 in relevant scientific databases. After removing duplicates and irrelevant studies, 13 studies were included in the research. The studies used in this paper were published in Poland, the Czech Republic, Portugal, Tunisia, China, Egypt, Turkey, Pakistan, Brazil, Lebanon, Bosnia and Herzegovina, and Slovenia.

Conclusion: Based on the review of scientific literature, it can be concluded that early identification of risk factors is essential, as it will reduce the frequency of postural deviations and back pain in children during early adolescence. Timely implementation of educational preventive programs on exercises, education about proper posture, sitting techniques, correct school bag carrying, the use of ergonomically adjusted school furniture, and promoting an active lifestyle at home and school, along with regular physical activity, is necessary.

Keywords: postural deviations, back pain, risk factors, children and adolescents

INTRODUCTION

Throughout life, the human body undergoes continuous changes, but the greatest challenges are most evident during periods of dynamic growth due to rapid and progressive development (Quka N et al., 2015).

The early adolescence period represents a phase of turbulent physical development, characterized by disproportion in the musculoskeletal system, where the muscular system's inability to maintain a normal relationship between certain body

segments result in poor posture among adolescents (Terzija S, 2015).

Posture is a fundamental prerequisite for good health, normal growth, and the ontogenetic development of a person, making it crucial to establish posture-related habits from an early age. Proper posture creates favorable conditions for the functioning of the locomotor apparatus. Muscles that maintain body balance remain minimally tense, their tone is uniform, and this ensures their readiness for movement (Colakhodzic E et al., 2017). Back pain is

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an increasing health problem among children and adolescents (MacDonald J et al., 2017). It is associated with issues in the lumbar spine, intervertebral discs, ligaments surrounding the spine, the spinal column and nerves, lower back muscles, internal organs of the pelvis and abdomen, and/or the skin covering the lumbar area (Alibegović A et al., 2020). Contrary to the perception that back pain in children is generally transient and insignificant in terms of individual impact, evidence suggests that its prevalence is high. A significant number of children seek help for back pain, miss school, or skip sports and physical activities (Kamper SJ et al., 2016). According to several international studies, the annual prevalence of back pain in children and adolescents increases with age, ranging from 13.7% to 60.3% (Minghelli B et al., 2014).

Meta-analysis results indicate the presence of poor posture in nearly 30% of children aged 11 to 17, while back pain has been recorded in 30–50% of adolescents (Balague F et al., 1999). Postural deviations and back pain are common issues among children, caused by the long-term effects of various risk factors associated with modern lifestyles. The most common risk factors for postural deviations and back pain include age and gender, body mass index (BMI), the mode of commuting to and from school, sleep duration and quality, lack of physical activity, excessive body weight, school bags, unhealthy lifestyle habits, prolonged sitting in poor posture, and furniture design that does not match the anthropometric characteristics of the child (Quka N et al., 2015; Yao W et al., 2012; Ramprasad M et al., 2010; Kemta Lekpa F et al., 2021). After starting school, children experience reduced spontaneous physical activity, while the time spent in a sitting position increases, both at school and at home. Prolonged sitting negatively impacts the musculoskeletal system (Kratenová J et al., 2007). Early childhood and adolescence are critical periods for developing desirable behavior patterns related to forming basic healthy habits. Therefore, special attention should be directed at developing physical abilities, acquiring new skills and knowledge, and, above all, adopting proper approaches to one's body. Promoting an active lifestyle becomes more significant if implemented from the very beginning of children's engagement in physical activities. This period should also be utilized to develop self-awareness about proper posture. The value of continuous, programmed, controlled, and, above all, timely physical activity is indisputable (Colakhodzic E et al., 2017).

Physiotherapeutic assessment of back pain should include evaluating pain intensity, postural inspection, muscle palpation, mobility assessment, and muscle

strength testing. Treatment of back pain involves rest, home exercises, and physiotherapy (Achar et al., 2020).

METHODS

This study is a non-experimental (qualitative) research, specifically a scientific literature review. The research is limited to articles published in English. For the purposes of this paper, a search of relevant databases including Web of Science, Scopus, PubMed, and MedLine was conducted for articles published between 2011 and 2024. These databases were searched using the keywords "postural deviations," "back pain," "risk factors," and "children and adolescents".

Criteria for Inclusion and Exclusion

Articles were also selected from relevant databases, by searching journal websites and manual searches. Studies were included regardless of time, language, ethnicity, or geographical region, provided they met the following criteria:

1. Presence of postural deviations.
2. Research conducted on children and adolescents.
3. Back pain.
4. Risk factors for the occurrence of postural deviations and back pain.
5. Studies on adults and the elderly, case reports, case series, conference abstracts, or letters without sufficient data were excluded.

Study Selection and Data Extraction

Articles that met the inclusion criteria for the systematic literature review underwent detailed evaluation. The extracted data included: the name of the first author, study design, country of the study, number of participants, age and gender structure of participants, year of the study, publication year, main objectives, research methods and instruments, as well as study results and conclusions.

RESULTS

A significant number of articles were published between 2011 and 2024 in relevant scientific databases. After removing duplicates and irrelevant studies, 13 studies were included in the research (Table 1). The studies used in this paper were published in Poland, the Czech Republic, Portugal, Tunisia, China, Egypt, Turkey, Pakistan, Brazil, Lebanon, Bosnia and Herzegovina, and Slovenia.

Table 1. Summary of study characteristics

Reference	Country	The main aim and purpose	Material and methods	Results	Conclusion
Baranowska A et al.	Poland	To examine the occurrence of postural deviations and back pain in school-aged children and to identify risk factors associated with the development of postural abnormalities.	This study involved measuring the children's height and weight, assessing the children's body posture based on the FITS method (Functional Individual Scoliosis Therapy) by Biatek and M'hango (the authors of this study), and administering a diagnostic survey addressed to parents and guardians of the children ($n = 104$) using a self-designed questionnaire.	Postural deviations were more prevalent among boys, and the age of participants influenced the frequency of deviations in scapular alignment ($p = 0.0037$) and shoulders ($p = 0.0129$), showing a negative correlation with age. The following lifestyle factors were significant: the type of chair used for homework, time spent in front of a computer, and snacking between meals.	Identified risk factors for postural disorders include overweight/obesity, male gender, older children, lack of an adjustable work chair, spending 2 or more hours per day using a computer, and snacking between meals.
Latałski et al.	Poland and the Czech Republic	The study focused on identifying risk factors for the development of postural defects in school-aged children.	The study was conducted using a diagnostic survey. The study group included 380 children aged 14 years (175 girls (46.1%) and 205 boys (53.9%))—randomly selected from schools in eastern Poland and the Czech Republic.	The BMI in the studied population was on average 20.2 (ranging from 14 to 39). Participants living in rural areas and small towns made up 57.63% of the study group, while those from medium and large cities comprised 42.37%. The majority of children in the study had already been examined for postural defects (74.2%), while almost one in ten children had never undergone such an examination.	There is a connection between a child's physical activity and the occurrence of postural deviations. There is also a relationship between the family's economic status and awareness of their own health condition. There is a need to establish an educational system for parents and children about postural defects and the risks associated with these defects.
Azevedo et al.	Portugal	Determine the frequency of back pain in children and adolescents, and identify predisposing risk factors and protective factors.	A cross-sectional study was conducted between October and December 2019 in schools from northern Portugal, evaluating 1463 students aged 9 to 19 years, of both genders. The instruments used were the Spinal Mouse® to assess posture, the Inbody 230® to assess body composition, an online questionnaire to characterize the sample and back pain, and the FITescola® battery test to access physical fitness.	Half of the participants have experienced back pain at least once in their lifetime. Age, female gender, percentage of body fat, prolonged use of smartphones and computers, hyperkyphosis, and lateral spinal tilt to the left side are factors with a higher relative risk of back pain. Regular physical activity or sports, as well as video games, have a protective effect..	The prevalence of back pain in children and adolescents is very high. The study enhances the case for protective factors such as physical activity habits or video games while reinforcing risk factors such as percent body fat, prolonged smartphone or computer use, and posture.
Ben Ayed et al.	Tunis	Identify the prevalence, risk factors, and consequences of neck, shoulder, and lower back pain among school adolescents.	A cross-sectional study conducted among school adolescents aged 12 to 18 years. Participants who met the criteria were randomly selected and asked to complete a four-part questionnaire.	Risk factors associated with back pain include playing video games for ≥ 2 hours daily, watching TV for ≥ 12 hours per week, too low a seat backrest, and too great a distance between the seat and the desk	The prevalence of musculoskeletal pain is significantly high among school adolescents, and their associated risk factors included sociodemographic factors, leisure activities, and classroom furniture. There is an urgent need for a school program based on ergonomics and behavior.
Fazzaa et al.	Tunis	Determine the prevalence of neck and back pain in children and adolescents and investigate the potential association with various risk factors.	A questionnaire was conducted targeting parents of children and adolescents aged between 6 and 18 years, via the Google Forms application.	Back pain in parents was found in 58% of cases. Poor sitting posture was recorded in 55.7%. The average daily screen time was 88.3 ± 75.56 minutes [0-360]. A significant association was found between back pain and exposure to passive smoking, puberty status, type of school bag, and poor posture. A positive parental history of spinal pain was significantly associated with the presence of back pain in children.	Prevalence of back pain was common. Positive parental history of back pain, poor posture during sitting, passive smoking, use of backpacks, older age, and higher BMI were potential associated factors.
Cheung et al.	China	Investigate the effects of torso asymmetry on quality of life during early adolescence related to health and identify daily activities associated with torso asymmetry.	The study included 200 adolescents (52 males and 148 females) aged 10 to 14 years in Hong Kong. Among them, 100 adolescents had torso asymmetry with a trunk rotation angle of $\geq 5^\circ$ and one or more physical signs during a visual inspection. A short 36-item health survey was used to measure eight scales in the physical and mental domains of health-related quality of life.	Compared to adolescents without torso asymmetry, those with torso asymmetry had a lower health-related quality of life in some physical domains such as body pain and general health, as well as in all mental domains: vitality (energy/fatigue), social functioning, role limitations due to emotional problems, and mental health.	The results show that increased computer use is associated with torso asymmetry, which negatively affects the health-related quality of life in adolescents..
EI – Nagar et al.	Egypt	Determine the effect of school bag use, postural habits, and behavior on the occurrence of back pain in schoolchildren..	The research was conducted in 10 rural schools. The instruments used in the study were: a structured self-administered questionnaire, a questionnaire for assessing back pain, an instrument for evaluating back pain and posture, a questionnaire on behavioral habits, a questionnaire on school bag use, and physiological measurements.	The main results showed that 74.1% of the schoolchildren surveyed experienced back pain, which was more common among girls. There was a significant correlation between back pain and the weight of the schoolbag, percentage of body weight, manner, and duration of carrying it. Additionally, there was a significant correlation between back pain and improper sitting posture for writing, computer use, and sitting in the classroom.	The study concluded that back pain among the surveyed schoolchildren was severe, and that the pain affects daily life activities in approximately one-quarter of the students.
Ozdemir et al.	Turkey	Assess musculoskeletal pain and associated risk factors in adolescents and define posture profiles of adolescents	A cross-sectional study was conducted. The questionnaire used for data collection consisted of three parts: (1) descriptive characteristics of the participants, (2) pain assessment in 14 body parts, and (3) the instrument for assessing back pain and posture (BackPEI).	Participants attributed their pain to poor sitting posture in school and carrying school backpacks. A statistically significant difference was found in the physical activities of adolescents and the BackPEI score ($z = 4.40$; $p = 0.001$). Posture factors of the BackPEI results increased as the comfort of the school desk improved.	According to this study, posture was associated with musculoskeletal pain and correlated with physical activities, the comfort of the school desk, and students' academic performance. It is recommended to teach adolescents proper posture and ergonomic positions when using computers, carrying school backpacks, and sitting on school chairs to prevent musculoskeletal pain.
Usman et al.	Pakistan	Investigate the effect of heavy school bags, desks, and postural variations in schools in Karachi and find the association with lower back pain in children.	A descriptive cross-sectional study was conducted with a sample of 500 school children aged 10 to 13 years using a questionnaire.	Around 23% reported lower back pain, 41.2% reported shoulder pain, and 38.6% reported neck pain. 24.3% of girls reported lower back pain compared to 21.6% of boys. Pain was associated with carrying a school bag weighing more than 15% of their total body weight, with 62.8% of children perceiving their school bag as heavy. The majority of pain was noted in the BMI range below 18 kg/m^2 . 14% of students sat slouched at their desks, and 65.9% of children reported postural discomfort. 44.8% of children reported postural discomfort while playing outdoor games.	Lower back pain in schoolchildren is associated with the weight of the school bag expressed as a percentage of their total body weight, older age, female gender, and low BMI. The prevalence of lower back pain was lower than that of shoulder and neck pain. There was no significant association between the desks and lower back pain.

Table 1. Summary of study characteristics

Reference	Country	The main aim and purpose	Material and methods	Results	Conclusion
Usman et al.	Pakistan	Investigate the effect of heavy school bags, desks, and postural variations in schools in Karachi and find the association with lower back pain in children.	A descriptive cross-sectional study was conducted with a sample of 500 school children aged 10 to 13 years using a questionnaire.	Around 23% reported lower back pain, 41.2% reported shoulder pain, and 38.6% reported neck pain. 24.3% of girls reported lower back pain compared to 21.6% of boys. Pain was associated with carrying a school bag weighing more than 15% of their total body weight, with 62.8% of children perceiving their school bag as heavy. The majority of pain was noted in the BMI range below 18 kg/m ² . 14% of students sat slouched at their desks, and 65.9% of children reported postural discomfort. 44.8% of children reported postural discomfort while playing outdoor games.	Lower back pain in schoolchildren is associated with the weight of the school bag expressed as a percentage of their total body weight, older age, female gender, and low BMI. The prevalence of lower back pain was lower than that of shoulder and neck pain. There was no significant association between the desks and lower back pain.
Akdag et al.	Turkey	Examine the correlation between the intensity of back pain and risk factors.	A self-reported questionnaire was used to collect the data. The regression tree method (RTM) was used to determine the risk factors by using the STATISTICA program package. Pain intensity was the outcome variable, and 8 independent variables (body mass index (BMI), sex, regular exercise habit, studying posture, transportation to/from school, duration of studying, bag handling, and type of bed) were used to detect their effect on pain intensity.	The results showed that the intensity of pain is significantly influenced by 4 independent variables: duration of study, type of bed, transportation to/from school, and BMI. The overall mean and standard deviation of pain intensity were 2.58 ± 0.86 (minimum = 1, maximum = 5).	study, show that seriously addressing the concerns of parents and teachers is of vital importance. Our findings indicate that parents and teachers should be informed about factors such as study duration, type of bed, transportation, and obesity, as these are risk factors that predict back pain in schoolchildren.
Scarabottolo et al.	Brazil	Examine the association between back and neck pain and sleep quality in adolescents.	The study involved a total of 1011 randomly selected adolescents. Neck and back pain were assessed using the Nordic questionnaire, while sleep quality was assessed using the Mini-Sleep questionnaire.	19.9% of girls reported lower back pain, while 18.9% reported neck pain. 15.6% of boys reported pain in the lower back or neck. Regarding poor sleep quality, the prevalence was 46.0% for girls and 49.6% for boys. A connection was observed between lower back pain and sleep quality in girls (OR=1.98 [1.25 - 3.12]) and boys (OR=2.58 [1.48 - 4.50]). A connection between neck pain and sleep quality was also observed in girls (OR=2.27 [1.41 - 3.64]) and boys (OR=2.80 [1.59 - 4.91]).	Low back pain and neck pain were associated with poor sleep quality among adolescents even after the insertion of confounding variables.
Mačak Hadžiomerović et al.	BiH	Examine the association between back pain and school bags.	This was a descriptive, cross-sectional study conducted in April 2017. We included 79 students of the fifth and sixth grade from the elementary school in Sarajevo. Information on the weight and type of school bag, method of carrying a school bag, and feelings of pain and tiredness due to school bag were obtained by questionnaire.	In the overall sample, the majority of students (64.6%) report occasional back pain while carrying their bags. About 48.5% of fifth-grade students and 50% of sixth-grade students carry school bags weighing more than 10% of their body weight. A higher average weight of the school bag was significantly more common among students who reported always feeling tired (11.03 ± 2.74%) compared to those who did not feel tired while carrying the school bag (8.41 ± 2%).	In general, the more frequent occurrence of back pain and fatigue in schoolchildren is associated with heavier school bags (>10% of body weight), and the occurrence of back pain due to the school bag is associated with gender (i.e., back pain was more common in girls compared to boys).
Fares et al.	Lebanon	The aim of the study is to investigate the presence of musculoskeletal pain in the neck in children and adolescents, as well as the presence of potential risk factors and complications.	The participants were patients under 18 years old. The positioning of the neck during various activities and other complications were investigated.	Musculoskeletal pain in the neck was diagnosed in 180 patients (N = 180). More women (57%) than men (43%) and more adolescents (60%) than children (40%) were affected. All 180 participants (100%) reported inadequate flexed posture of the back and neck during studying and/or using smartphones and tablets.	Musculoskeletal pain in the neck is an important condition in children and adolescents, with numerous associated risk factors. Increased strain on the cervical spine raises the risk of developing degenerative changes and other developmental, medical, psychological, and social complications.
Loredan et al.	Slovenia	Determine the prevalence of musculoskeletal pain and the relationship between pain and the suitability of school furniture and daily activities among elementary school students.	The adapted Nordic questionnaire was used to assess the prevalence of pain, the BackPEI questionnaire was used to assess school-related factors, and calculations of furniture misalignment were performed to determine the anthropometric suitability of school furniture.	Most students did not maintain proper posture while sitting, did not lift objects properly, and frequently used TV and computers. There was significant misalignment between students and furniture for both seat and desk height. The neck, lower back, shoulders, and upper back were the most affected body parts. The study confirmed that musculoskeletal pain occurs in elementary school students and increases with age, particularly lower back pain. It was found that proper backpack usage is an important factor in alleviating neck pain.	Further efforts should be made to establish a comparable study protocol using objective methods to obtain more valid and reliable data for studying risk factors for musculoskeletal pain in students related to school, through the use of prospective study protocols.

DISCUSSION

A review of scientific literature included 13 studies, revealing a variety of results from different authors regarding the frequency of postural deviations and the risk factors associated with back pain in children during early adolescence. The analysis of age as a risk factor in the presented studies indicates that older children reported more frequent back pain and that postural deviations were more common in older children (Baranowska et al., 2023; Azevedo et al., 2023; Faza et al., 2024; Usman et al., 2014). The

study by Baranowska et al. pointed to a higher prevalence of postural deviations in boys compared to girls, while studies conducted in Portugal, Pakistan, Bosnia and Herzegovina, and Lebanon reported higher rates of back pain in girls (Azevedo et al., 2023; Usman et al., 2014; Mačak et al., 2018; Fares et al., 2017). Research conducted in Poland showed that excess body weight negatively influences the occurrence of postural deviations (Baranowska et al., 2023), while the study by Latalski et al., 2013, highlighted the

average BMI in the study population. Overweight as a risk factor for back pain was identified in studies by Faza'a et al., 2024; Cheung et al., 2021; and Akdag et al., 2011. Conversely, Usman et al., 2014, confirmed that low BMI contributes to back pain. Latalski et al., 2013, and Ozdemir et al., 2021, highlighted the connection between the lack of physical activity and the appearance of postural deviations, while Azevedo et al., 2023, emphasized the importance of physical activity as a protective factor in preventing back pain. With the rapid advancement of technology, the use of information and communication technologies has become a frequent risk factor for the development of postural deviations and back pain, as demonstrated by numerous studies. Prolonged screen time, excessive use of mobile phones, playing video games for ≥ 2 hours a day, watching TV for ≥ 12 hours a week, and improper flexed back and neck posture while using mobile phones have been identified as factors that disturb proper posture and contribute to back pain (Faza'a et al., 2024; Ben Ayed et al., 2019; Fares et al., 2017; Loredan et al., 2024). Misaligned school furniture, prolonged sitting, and poor sitting posture have been shown to significantly impact the occurrence of back pain and poor posture. Loredan et al., 2024, noted a significant mismatch between the anthropometric dimensions of students and school furniture when measuring the height of chairs and desks, while Usman et al. found no significant link between desks and lower back pain. Faza'a et al., 2024, in their study, highlighted the connection between poor sitting posture and back pain, which was also supported by El Nagar et al., 2017, who emphasized that improper sitting posture during writing leads to pain. A study conducted in Turkey revealed a link between back pain and the use of transportation to/from school, as children increasingly use active forms of transportation. This study also pointed out that study duration and type of bed affect the occurrence of back pain, a finding confirmed by research conducted in Lebanon (Akdag et al., 2011; Fares et al., 2017). Scarabottolo et al., 2020, identified a connection between neck and back pain and poorer sleep quality in both boys and girls. Faza'a et al., 2024, linked the type of school bag to poor posture, while El-Nagar et al., 2017, pointed to the relationship between back pain and the weight of the school bag, percentage of body weight, and the manner and duration of carrying it. Usman et al., 2014, confirmed that back pain is associated with a school bag weight greater than 15% of the child's total body weight. According to the study, 62.8% of children reported their school bag as heavy, correlating with the findings of Mačak et al., 2018, which indicated that around 48.5% of 5th-grade students and 50% of 6th-grade students carry school bags heavier than 10% of their body weight.

CONCLUSION

Based on the review of scientific literature, it can be concluded that early identification of risk factors is essential, as it will reduce the frequency of postural deviations and back pain in children during early adolescence. Timely implementation of educational preventive programs on exercises, education about proper posture, sitting techniques, correct school bag carrying, the use of ergonomically adjusted school furniture, and promoting an active lifestyle at home and school, along with regular physical activity, is necessary.

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Conflict of Interest

The authors do not have any conflicts of interest to disclose. All co-authors have reviewed and concurred with the manuscript's content, and no financial interests need to be reported.