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The Impact of Heavy Backpacks on Musculoskeletal Pain in School Going Children: A Scoping Review

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KEYWORDS

Heavy Bags, Heavy Backpacks, Pain, Musculoskeletal Pain, Shoulder Pain, Neck Pain, Back pain, School Children, Children

ABSTRACT:

Introduction: Backpacks are widely used by school children to carry educational materials. In the current education system, heavy school bags have a significant impact on the musculoskeletal health of children and adolescents. Improper weight distribution and prolonged load-bearing can lead to discomfort and long-term health consequences, including neck, shoulder, and back pain**.**

Objectives: This systematic review aims to evaluate the impact of heavy backpack use on musculoskeletal pain in school-going children**.**

Methods: A comprehensive literature search was conducted in accordance with PRISMA-ScR guidelines. Databases including PubMed, Google Scholar, and ScienceDirect were searched for full-text articles (in English) published between 2019 and 2024. Studies were included if they examined the impact of backpack use on the musculoskeletal system in children (ages 10–17). Studies of various designs (cross-sectional, experimental, case studies) were considered. Seven studies meeting the inclusion criteria were reviewed in detail**.**

Results: Findings consistently indicate a strong association between carrying heavy backpacks and the development of musculoskeletal pain in school-going children. The most commonly affected regions are the neck, shoulders, upper back, and lower back. Backpack weights exceedingly roughly 15% of a child's body weight are particularly associated with postural changes and muscular strain. Additional contributing factors include the method of carrying (e.g. using one strap vs. both straps), the duration of backpack use, lack of locker access and even lead to psychological stress. Limited awareness among parents and students about proper backpack ergonomics was also noted as a compounding factor.

Conclusion: The evidence suggests that heavy backpack use contributes significantly to musculoskeletal pain in schoolchildren. Preventive strategies such as providing locker facilities, designing ergonomic backpacks, increasing awareness among parents/teachers, and enforcing school bag weight limits are essential to safeguard children's musculoskeletal health**.**

1. Introduction

Children commonly use backpacks to carry textbooks, notebooks, and other school essentials. Heavy school bags have a substantial impact on the musculoskeletal health of children and adolescents worldwide[1,2]. Carrying a heavy school bag is a daily routine for many students. Although guidelines exist to recommend safe limits for backpack weight, in practice it is often difficult for parents and children to adhere to these limits [3,4]. Improper weight distribution and poor carrying methods can place uneven pressure on certain muscle groups, resulting in back, shoulder, and neck pain [5].

Non-specific musculoskeletal pain is a frequent complaint among school-aged children, and it can persist

Journal of Chemical Health Risks
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over time. A major contributing factor is the strain caused by carrying heavy backpacks, which can affect the cervical spine, shoulders, upper and lower back, and even the arms and hands. Such injuries often arise because children compensate for the extra weight by leaning forward, bending their back, or shifting their posture to one side. Factors like backpack strap length and how the bag is carried (single-strap vs. double-strap) can further influence the risk of musculoskeletal problems [7,8,9].

In many schools, students lack access to lockers, meaning they must carry all of their textbooks, stationery, lunch, and other items for the entire day. This prolonged spinal load has been linked to a higher risk of developing musculoskeletal pain. Globally, the reported prevalence of neck pain in youth varies widely (from about 0.4% up to 86.8% in different studies), and approximately 28.6% of children aged 11–14 years report experiencing neck or shoulder pain [12].

Back pain is also common in school-aged children. Various studies have found prevalence rates ranging from about 25% to 55% among children aged 10 to 17, although the pain is typically of low intensity [6,11]. Carrying an overloaded backpack can shift the body's center of mass forward, which alters the alignment of the head and cervical spine31. Low back pain (often defined as pain occurring below the 12th rib, sometimes radiating to the buttocks) is increasingly reported among adolescents. Importantly, frequent backpack use has been identified as a key factor contributing to low back pain in students [8]. Back pain during adolescence is of particular concern because it has been linked to a higher risk of chronic back problems in adulthood [6].

Studies have shown that over half of adolescents (around 53%) experience musculoskeletal pain at least once in their lives, and roughly 15% report such pain on at least a weekly basis [9]. Girls tend to be more prone to back-related problems than boys, potentially due to their generally smaller stature and different strength-to-weight ratios [12]. According to the Global Burden of Disease data, neck pain and other musculoskeletal disorders rank as the 4th and 10th leading causes of disability among adolescents aged 15–19 years [6.] These musculoskeletal conditions even outrank several more commonly recognized adolescent health issues (such as asthma, substance abuse, and road injuries) in terms of years lived with disability.

Shoulder pain is one of the most frequent musculoskeletal complaints in the general population and can result in significant functional impairment13. In schoolchildren, carrying a heavy backpack places direct pressure on the shoulders and cervical spine. To counterbalance the load, the body must continuously recruit shoulder and neck musculature — chiefly the upper and middle trapezius, levator scapulae, and supraspinatus muscles — to elevate and stabilize the shoulders and shoulder blades. This prolonged muscle activation under load can contribute to fatigue and pain in these regions [33].

Carrying an excessively heavy school bag can also lead to several postural changes. A common issue observed is forward head posture, where the head juts forward while the upper cervical spine extends. This is often accompanied by rounded shoulders (protraction of the scapulae) and an exaggerated thoracic kyphosis (upper back curvature). Such postural shifts disrupt the spine's normal alignment in the sagittal plane and can affect a student's balance, postural stability, and gait. Over time, these changes may lead to noticeable musculoskeletal discomfort and pain [15,17].

There remains a lack of detailed evidence specifically analysing the relationship between heavy backpack use and musculoskeletal pain in children. This gap underlines the need for further research and provides impetus for educators, parents, and policymakers to develop and enforce guidelines to reduce excessive backpack weights. Addressing this issue is crucial to prevent pain and long-term health consequences in the growing paediatric population

2. Objectives

The objective of the study is to evaluate the impact of heavy backpack on musculoskeletal pain in school going children

3. Methods

A comprehensive literature search was conducted using electronic databases in PubMed, Science direct and Google Scholar. The search focused on English full-text articles published in between 2019 and 2024. Relevant keywords used in the search included Heavy Bags,

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Heavy Backpacks, Pain, Musculoskeletal Pain, Shoulder Pain, Neck Pain, Back Pain, School Going Children, and Children.

PROCEDURE:

A total of 491 articles were retrieved through database searches. Out of these, 417 articles were excluded as there were articles other than backpack and musculoskeletal pain. The remaining 74 articles underwent screening, out of which 33 duplicate articles were identified and removed. Consequently, 41 articles were sought for retrieval. However, 17 of these articles could not be retrieved. This left 24 articles, which were assessed for eligibility based on the inclusion criteria such as, studies involving children aged 10 to 17 years old those who were experiencing musculoskeletal pain due to heavy back usage, inclusion of full-texted English articles that were cross sectional studies, randomized controlled trials (RCT's), or case studies which was published between 2019 and 2024. After evaluation, 17 articles were excluded as they did not follow the inclusion criteria. Ultimately, 7 articles were included in the final scoping review. The study selection process has followed the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews). Finally, 7 articles were selected for the study which is represented in Table 1.

Ethics: IRB name; Yenepoya Ethics Committee-1 (YEC-1),

Approval number: YEC-1/2024/309, Approval Date: 11/09/2024,

3. Results

The findings from 7 articles strongly suggest that carrying heavy backpacks contributes significantly to the development of musculoskeletal pain among school-going children. The studies consistently reported a high prevalence of discomfort, particularly in the neck, shoulders, upper back, and lower back, among students bearing excessive schoolbag loads. The association was especially evident when backpack weight exceeded recommended limits or when the weight-to-body ratio was high.

Further, factors such as the method of carrying (e.g., over both shoulders), duration of bag usage, mode of transportation, and lifestyle habits like prolonged computer use were also associated with increased musculoskeletal complaints. Psychological factors such as stress and anxiety were also identified as contributing factor to pain. Parental awareness and supervision regarding bag safety remain limited despite known risks.

4. Discussion

This scoping review explores the impact of heavy backpacks on musculoskeletal pain in school-going children. Overall, the evidence from the included studies indicates a clear link between excessive backpack weight and an increased prevalence of neck, shoulder, and back pain in this population. A consistent observation across studies was that when students carry backpacks exceedingly roughly 10–15% of their body weight, they are more likely to report musculoskeletal discomfort. Many of the studies utilized standard questionnaires and objective measurements (e.g., postural assessments) to arrive at these findings, lending credibility to the results. In essence, the heavier the backpack relative to a child's body, the greater the strain on the musculoskeletal system.

A study by Hanif et al. (2024) in Pakistan found very high rates of pain in children carrying heavy bags. In their survey of private school children, 67.2% of students reported neck pain, 31.3% had shoulder pain, and 62.4% had back pain – highlighting the physical strain associated with daily schoolbag use. Similarly, Sankaran et al. (2021) examined over 1,300 students in Eastern India (using a modified Nordic Musculoskeletal Questionnaire) and reported an overall musculoskeletal pain prevalence of 18.8% in the past week [29]. Notably, Sankaran et al. found a statistically significant association between backpack weight and pain in univariate analysis; however, this association was not significant in multivariate analysis once factors like type of school and urban versus rural residence were considered. This suggests that while backpack weight is an important factor, other contextual factors (such as school environment or lifestyle differences between urban and rural students) may also influence pain outcomes.

Chen et al. (2021) further illuminated the biomechanical impact of heavy backpacks. Their study on male students (albeit slightly older, in a college setting) demonstrated that carrying a backpack weighing more than 15% of body weight led to notable postural changes and muscle

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 2356-2363 | ISSN:2251-6727

strain33. Specifically, Chen and colleagues observed that under heavy load, students exhibited a reduced lumbar lordosis (flattening of the lower back curve), a forward inclination of the head and trunk, and uneven shoulder levels. They also recorded increased activity in the trapezius muscles as the body tried to compensate for the excessive load. These adjustments are essentially the body's way of maintaining balance while carrying a heavy pack, but they come at the cost of increased muscle tension and altered spinal alignment. Our findings correspond with these observations: children in the reviewed studies often showed signs of forward head posture and uneven shoulder elevation when burdened with heavy bags.

Likewise, Aras et al. (2019) reported on a large survey of Turkish schoolchildren and found that 42.1% of students were carrying backpacks above the recommended weight limit30. This study used the standardized Nordic Musculoskeletal Questionnaire and noted significant complaints of pain in the neck, lower back, and shoulders among those students. Importantly, Aras et al. highlighted that children who lacked access to school lockers or who used improper carrying techniques (like one-strapping their backpack) experienced more severe pain [30].

Another angle comes from studies examining posture and gender differences. Ahmed et al. (2024) conducted research in Bangalore, India, using posture analysis software and pain questionnaires[28]. They found that backpacks averaging about 13.5% of the child's body weight significantly reduced the craniovertebral angle (essentially indicating a forward head posture) and the cervical angle, confirming that heavy loads induce measurable postural deviations. Additionally, their results showed a marked sex difference in pain prevalence: 63.9% of girls reported musculoskeletal pain, compared to 50.9% of boys [28]. This gender disparity might be due to girls' generally lower muscle mass and different postural responses or could relate to cultural factors like girls carrying their bags differently or having additional loads. The finding is consistent with the trend noted in our introduction that girls appear to be at higher risk for backpack-related pain [12.]

In a related study, Jameel et al. (2021) focused on the postural changes due to heavy backpacks among school children in Lahore [32]. They reported that the trunk region posture was significantly affected in children carrying heavy bags: about 10.3% of the children in their study were classified as having "poor" posture and 46.2% had "fair" posture (as opposed to good) on an observational posture scale32. These findings reinforce the notion that beyond causing pain, heavy backpacks can alter a child's spinal alignment and overall posture, potentially affecting balance and gait. Over time, such postural changes in growing children could have longer-term implications, making early intervention important.

Another key contribution is from Kędra et al. (2021), who undertook a very large cross-sectional study involving 11,423 Polish students. They found a prevalence of 41.5% for non-spe and adolescents surveyed. Crucially, Kędra's study highlighted that students who perceived their schoolbags to b cific low back pain (NLBP) among the children e heavy had a higher incidence of low back pain [22].

Beyond physical factors, this review also sheds light on the interplay of psychological stress and musculoskeletal pain. Mei et al. (2019) conducted a cross-sectional study in China examining chronic low back pain (CLBP) in adolescents in relation to school-related stress [33]. They found that students with high academic pressure, long hours of sitting (e.g., during study or tutoring sessions), and limited physical activity were more likely to suffer from chronic back pain. When these factors were combined with carrying heavy schoolbags, the risk of pain was even greater. Mei et al. observed that female students and those facing greater academic stress had higher pain prevalence, potentially due to a combination of emotional factors, hormonal influences, and generally lower muscle strength in the back and core muscles among females[33].

Alsiddiky et al. (2019) studied parental awareness in Saudi Arabia regarding children's backpack weights and habits25. Their findings revealed a significant gap between what parents knew and what they practiced. While many parents acknowledged that excessively heavy backpacks could cause back and shoulder pain, a majority were not aware of the recommended weight limit (often cited as no more than 10% of the child's body weight by many pediatric and ergonomic experts). Additionally, most parents did not regularly check or weigh their children's schoolbags, nor did they consistently educate their children on how to wear

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 2356-2363 | ISSN:2251-6727

backpacks properly[25]. The lack of supervision meant many students carried far heavier loads than they should, sometimes out of simply packing all books "just in case" or due to school demands.

Several studies highlight the relationship between backpack carrying duration and pain. Sundas et al. (2019), for example, found a strong association between how long children carry their backpacks and the occurrence of musculoskeletal disorders in a sample of Pakistani school children [26]. In that study, over 60% of students reported feeling fatigue, and nearly 46% reported low back pain, which significantly affected their daily activities and quality of life. On average, students were carrying about 5.1 kg in their bags and many would carry these bags (often on both shoulders) for more than 10 minutes at a stretch (e.g., walking to school or between classes) [26]. Additionally, a large proportion of the students in that study were underweight for their age, which means the relative burden of the backpack was even greater, compounding the strain. The authors of the study called for preventive strategies such as limiting the weight of schoolbags (through school policies if necessary), increasing awareness among students about packing only necessary items, and introducing facilities like school lockers to reduce the time children spend carrying heavy loads [26].

In a more recent study, Zaheer et al. (2022) also examined the effect of backpack carrying time on postural pain in secondary school students. They reported that longer durations of carrying a heavy bag were significantly linked to increased reports of postural pain among students, reinforcing the finding that how long a child bears the load is an important factor in addition to how heavy the load is. This suggests that interventions could include not just reducing backpack weight, but also encouraging students to put their bags down whenever possible (such as between classes or during breaks) to give their muscles a rest [19].

Hassan et al. (2019) provides further insight into the time factor and carrying style. According to their survey, about 44% of students reported experiencing pain after carrying their school bag for more than 20 minutes continuously, and this percentage rose to 56% if the duration exceeded 30 minutes. Moreover, their study found that 74% of students who habitually carried their backpacks on one shoulder (a very common but ergonomically poor practice) experienced higher pain levels[24]. This finding underscores how one-shoulder carrying can drastically increase asymmetric strain on the body, leading to muscle imbalance and pain. Together, the results from Sundas, Zaheer, and Hassan et al. strongly underline the importance of limiting the duration of backpack carriage and promoting balanced carrying techniques (using both straps properly adjusted).

Finally, some studies included in this review offered perspectives on solutions. Sarwar et al. (2024), for example, confirmed a direct correlation between backpack weight and the incidence of back pain in children, thereby reinforcing that this problem is pervasive and not confined to any single region [27]. They frame heavy schoolbags as a public health concern that needs addressing through collective action (schools, parents, and health authorities working together). On a hopeful note, Meenakshi et al. (2023) demonstrated an effective intervention: in their study, an educational program for students about backpack safety and weight management led to a significant reduction in the average weight of the schoolbags after one month18. Before the intervention, a very high percentage of students in both government and private schools were carrying bags heavier than recommended, contributing to musculoskeletal complaints. After conducting awareness sessions and practical demonstrations on how to lighten backpacks (for instance, by leaving unnecessary books at home or school and using proper packing techniques), the students' average bag weight dropped appreciably. This resulted in fewer complaints of pain and discomfort. Meenakshi et al.'s findings illustrate that relatively simple measures — educating students (and by extension, teachers and parents) — can have a tangible impact on reducing risk factors for musculoskeletal pain

In summary, the discussion of these findings suggests that the problem of heavy backpacks causing musculoskeletal pain in children is multidimensional. There is consistent evidence across different countries and contexts that heavy schoolbags are linked to back, neck, and shoulder pain in children. This relationship is influenced by additional factors like carrying duration, technique, and individual student characteristics (such as sex and fitness level), as well as external factors like parental awareness and school infrastructure (lockers, schedules that allow book load management). As such, it

Journal of Chemical Health Risks
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JCHR (2025) 15(6), 2356-2363 | ISSN:2251-6727

calls for comprehensive strategies: weight management of schoolbags, ergonomic education, policy changes (like weight limits or provision of lockers), and potentially broader educational reforms (like digital textbooks or alternate day schedules for books) to ensure children are not overburdened. Importantly, increasing awareness is a recurring theme: when students, parents, and teachers recognize the risks and know how to mitigate them, positive changes can occur.

LIMITATIONS:

This scoping review has a few limitations. First, most available studies on this topic are cross-sectional in nature, which means they can identify associations but not definitive causation. There is a lack of high-quality longitudinal studies and randomized controlled trials examining the impact of reducing backpack weight on pain outcomes in children. This gap makes it challenging to establish cause-effect relationships firmly. Second, the studies were often region-specific. Geographical and cultural factors (such as differences in school infrastructure, average walking distances to school, or typical schoolbag content) may affect how generalizable the results are globally. Many included studies were conducted in specific countries or cities; thus, the global applicability of some findings may be limited. Finally, many studies relied on self-reported measures of pain and backpack weight (or children's perception of weight). Self-reported data can introduce bias or errors in recall. Children might overestimate or underestimate their pain or the heaviness of their bags, and pain reports are subjective.

FUTURE RESEARCH:

Future research should employ longitudinal designs or randomized controlled trials to establish causality between backpack weight and musculoskeletal disorders, as most existing studies are cross-sectional in nature. Comparative studies across diverse regions and school systems may help identify context-specific risk factors and tailor guidelines accordingly.

CONCLUSION:

The evidence gathered in this systematic review highlights a strong link between heavy backpack use and musculoskeletal pain in school-going children. Children carrying backpacks that are too heavy (often more than 10–15% of their body weight) commonly experience pain in the neck, shoulders, and back. Such heavy loads can lead not only to immediate discomfort but also to observable postural changes, including forward head posture, rounded shoulders, and spinal strain. The cumulative findings underscore a clear need for preventive strategies to protect children's musculoskeletal health.

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