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HEALTH RISKS OF HEAVY BACKPACKS IN SCHOOLCHILDREN: A LITERATURE REVIEW

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Abstract
This article reviews the health conditions and risks associated with schoolchildren carrying heavy backpacks. We examine evidence from peer-reviewed studies on how excessive backpack weight and suboptimal backpack design affect children's bodies. Key outcomes identified in the literature include back pain and other musculoskeletal symptoms, changes in posture and gait, and physiological stress responses to load carriage. We also review interventions and ergonomic recommendations to mitigate these risks.

Keywords: Musculoskeletal and Postural Effects, Physiological Stress, risk factors, backpack loads, neck pain, thoracic kyphosis.

Introduction

Carrying heavy backpacks is a daily reality for many schoolchildren, and concerns about the health impacts of this practice have grown in recent decades. Children often carry school bags weighing a significant proportion of their body weight – sometimes as much as 30–40% or more in extreme cases. Such loads exceed commonly recommended limits. Early expert reviews recommended that a child's backpack weigh no more than 10% of their body weight, with later guidelines suggesting a maximal load of 10–15%. However, surveys indicate that these recommendations are frequently exceeded. For example, a recent 2024

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study found that over 80% of students carried backpacks heavier than 10% of their body weight Students in that study averaged about 13.5% of their body weight in backpack load, far above ideal limits. This is troubling because studies have linked heavy and improperly designed backpacks to various musculoskeletal problems and discomfort in children. A rising rate of nonspecific back pain in school-aged populations has heightened community concern that carrying heavy backpacks may be a contributing risk factor to back pain in youth.

This article reviews the health conditions and risks associated with schoolchildren carrying heavy backpacks. We examine evidence from peer-reviewed studies on how excessive backpack weight and suboptimal backpack design affect children's bodies. Key outcomes identified in the literature include back pain and other musculoskeletal symptoms, changes in posture and gait, and physiological stress responses to load carriage. We also review interventions and ergonomic recommendations to mitigate these risks.

Methods

We performed a literature review focusing on studies examining the impact of backpack weight on school-aged children's health. Searches were conducted in scholarly databases (e.g., PubMed and Google Scholar) for peer-reviewed articles published in the past two decades using keywords such as "schoolchildren," "backpack load," "back pain," and "musculoskeletal effects." We included both experimental and observational studies, as well as review articles, that investigated physiological or musculoskeletal outcomes related to backpack use in elementary through high school students. Particular consideration was given to two key sources: a critical narrative review of backpack load impacts by Perrone et al. (2018) and an ergonomic intervention study by Mansoorian et al. (2019). Data from these and other sources were extracted and synthesized qualitatively. Since this is a narrative review of existing literature, no new primary data were collected or analyzed.

In appraising the literature, we noted each study's design and sample characteristics (e.g., ages of children, backpack weight as a percentage of body weight), as well as the main outcomes measured (such as pain prevalence, posture

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changes, or physiological indicators). We critically evaluated methodological quality when reported (for instance, using any provided quality scores or sample size considerations) and prioritized findings from studies with larger samples or higher quality ratings when drawing conclusions. The findings from the selected studies were organized into thematic categories for presentation in the Results section.

Results

Backpack Weight and Prevalence of Overloading

The literature confirms that many schoolchildren carry backpacks that are heavier than recommended. Across various studies and regions, typical backpack loads ranged widely but often exceeded the advised 10–15% of body weight limit. For example, Perrone et al. (2018) reviewed 21 studies and reported that students carried on average over 15% of their body weight in their backpacks. In some instances, loads of up to 20–25% of body weight have been documented even in recent studies. Historical data show even more extreme cases: one survey of Italian schoolchildren found mean weekly backpack loads of 22–27% of body weight, with some children carrying as much as 46% of their body weight. More recently, a 2024 cross-sectional study in India (500 students aged 12–15) found the average backpack weighed 6.53 kg, about 13.5% of the child's body weight. Notably, over 80% of students in that study were carrying more than 10% of their body weight, despite awareness of backpack weight guidelines. These findings indicate that excessive backpack loads are common worldwide, affecting a large proportion of children.

Musculoskeletal and Postural Effects

Heavy backpacks have been linked to a range of musculoskeletal complaints in children, foremost among them back, neck, and shoulder pain. In multiple studies, children who carry heavier bags report higher rates of pain. For instance, a large national survey of schoolchildren (ages 8–13) in Malta found that 32% of students reported back pain; over 70% of those children were carrying bags exceeding the 10% body weight guideline. Similarly, an American study noted that 64% of

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middle-school students (around ages 12–14) experienced back pain, with girls reporting pain more frequently than boys. The pain is often mild or moderate in intensity, but its high prevalence is concerning. Importantly, longitudinal observations suggest that children who experience low back pain may continue to have recurrent pain in later adolescence or adulthood, underscoring early backpack-related pain as a potential public health issue.

Specific pain patterns associated with heavy backpacks have also been documented. Commonly affected areas are the upper back, shoulders, and neck. One clinical study of Indian schoolchildren with heavy packs found that 40% experienced upper back pain, 27% had neck pain, and 20% had shoulder pain. All children in that study showed visible signs of strap pressure, such as redness or swelling on the shoulders. Chronic strain from the straps and weight can even lead to neurovascular compression injuries in rare cases. For example, a subset of children in the same study exhibited symptoms of thoracic outlet syndrome (compression of nerves and blood vessels at the shoulder region) due to heavy backpack use. Another rare but documented condition is "backpack palsy," a brachial plexus nerve injury resulting from sustained pressure of backpack straps on the shoulders. Although serious nerve injuries are uncommon, these cases highlight that overly heavy backpacks can cause more than just transient discomfort.

Postural and Gait Changes

To accommodate a heavy load, children alter their posture and movements in noticeable ways. A consistently observed adaptation is an increase in forward lean of the trunk when wearing a heavy backpack. Students often bend forward at the hips or round their shoulders to counterbalance the backward pull of a heavy bag. This forward head and trunk posture helps maintain balance but may strain the neck, shoulders, and back muscles over time. Studies using posture analysis have found changes in spinal alignment under load: heavy backpacks tend to flatten the normal lumbar lordotic curve (lower back) and reduce the thoracic kyphosis (upper back curvature) as children lean forward. If a backpack is carried on one shoulder (an asymmetrical load), children may lean to one side, leading to lateral

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spinal bending and uneven shoulder heights. Over time, these compensatory postures could contribute to postural deviations or muscle imbalances in the developing child.

Gait dynamics are also affected by backpack weight. Biomechanical studies have noted significant changes in how children walk when carrying heavy packs. With a heavy backpack, children typically take shorter strides and exhibit a longer double-support phase during walking (the period when both feet are on the ground at once). These gait adjustments increase stability under load but may alter the normal walking pattern. Additionally, the pressure distribution on the feet changes: one study observed increased plantar pressures (force on the soles) during standing and walking with heavy backpacks, indicating a shift in how weight is borne by the feet. This can lead to foot discomfort and fatigue. Children carrying heavy loads have also been found to experience more rapid onset of fatigue, which can further alter their movement patterns and potentially affect their ability to participate in physical activities.

Physiological Stress and Other Effects

Beyond musculoskeletal changes, heavy backpacks impose measurable physiological stress on children's bodies. Researchers have recorded elevated heart rate, blood pressure, and respiratory rate in students carrying heavier loads, reflecting the increased effort and energy expenditure required. For instance, one study found that carrying a backpack equivalent to 10% of body weight significantly raised children's heart rates and blood pressure compared to carrying a lighter 5–8% of body weight load. Heavier loads also necessitate greater muscle activity in the trunk and legs to maintain stability, which can contribute to early fatigue. Students often report feeling tired or strained on days when they have to carry many textbooks. Consistent with these reports, excessive backpack weight has been associated with complaints of general fatigue, as well as localized muscle soreness in the shoulders and back. In some cases, children even develop tension headaches or neck pain, likely as a secondary effect of muscle strain from supporting a heavy bag.

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Another area of concern is the impact on respiratory function. An overfilled backpack can restrict normal breathing mechanics by forcing the child into a hunched posture or by directly compressing the chest if the shoulder straps are too tight. Some studies have noted reduced lung capacity or breathing efficiency when individuals carry very heavy loads for extended periods. While specific research on pulmonary effects in children is limited, anecdotal evidence suggests that when a child is carrying an especially heavy pack, they may find it uncomfortable to take deep breaths during walking. Additionally, heavy backpacks can indirectly increase the risk of accidents or injuries. A child encumbered by a large, bulky pack may have impaired balance or agility, potentially leading to trips or falls – particularly on stairs or uneven surfaces. Though not as well documented as other effects, minor injuries such as bruises or even blisters on the feet (from altered gait and pressure) have been reported with prolonged heavy backpack use. Overall, the physiological strain and safety risks associated with overloading children's backpacks reinforce that this issue extends beyond mere discomfort.

Discussion

The evidence reviewed clearly indicates that carrying excessive backpack loads is associated with a variety of adverse effects in school-aged children. Heavy backpacks contribute to musculoskeletal pain (especially back, neck, and shoulder pain) and prompt the development of compensatory postural strategies that could have long-term consequences. The findings are consistent across multiple studies and populations: when children carry more than roughly 10–15% of their body weight, they exhibit changes in posture and gait and often experience discomfort or fatigue. These outcomes are biologically plausible – the growing spine and supporting musculature are subject to abnormal stresses under heavy loads, which over time may predispose children to injury or chronic pain. It is worth noting, however, that back pain in youth is multifactorial. Sedentary lifestyle factors, prolonged sitting, and lack of exercise also contribute to musculoskeletal problems in children. Nonetheless, backpack weight is a

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modifiable risk factor, and thus it represents a key target for intervention in reducing back pain and related issues among students.

Some limitations in the current research should be acknowledged. Many studies rely on cross-sectional designs or self-reported pain outcomes, making it difficult to establish definitive causal relationships between backpack load and long-term health issues. Additionally, as Perrone et al. (2018) pointed out, the methodological quality of backpack studies varies, and further high-quality research (including longitudinal studies) is needed to better elucidate safe load thresholds and mechanisms. Despite these limitations, there is a strong convergence of evidence from biomechanics, physiology, and epidemiological surveys that heavy backpacks have negative impacts on youth health. No single "critical load" has been determined for all children, but the consensus around a 10% of body weight guideline is supported as a prudent maximum. Some children may tolerate slightly higher loads without immediate pain, whereas others experience pain at lower loads – individual variability exists. Therefore, a conservative approach and attentive monitoring of children's comfort are warranted.

The results of this review carry practical implications for schools, parents, and pediatric health professionals. One obvious recommendation is to minimize the weight that students must carry on a daily basis. Schools can help by providing adequate locker space or implementing policies that allow students to leave heavy books at school when possible, as well as by exploring digital textbooks or workbook alternatives to reduce the quantity of materials carried. Parents and students should periodically check backpack contents and remove unnecessary items, aiming to keep the total load within roughly 10–15% of the child's body weight. Encouraging children to wear backpacks correctly is equally important. They should always use **both** shoulder straps (rather than slinging the bag over one shoulder) so that the weight is distributed evenly. The backpack should fit properly – worn high on the back, with straps adjusted so that the bottom of the pack rests near the waist and doesn't sag far down. Wide, padded shoulder straps are preferable, and if the backpack has a waist (hip) belt or chest strap, using these can significantly redistribute load from the shoulders to the pelvis and torso.

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In addition, the design and size of the backpack itself can mitigate risks. Ergonomically designed backpacks with features such as wide padded straps, sternum (chest) belts, and lumbar padding have been developed to improve comfort and load distribution. For example, Mansoorian et al. (2019) created a new backpack incorporating a medical-grade waist belt for additional support; in comparative tests, this design provided a greater sense of comfort and reduced pressure on the users' feet relative to standard backpacks. Selecting an appropriately sized backpack is crucial – the pack's dimensions should be proportional to the child (not wider than the child's torso, and not excessively long). A good practice is to use backpacks with multiple compartments so that items can be arranged efficiently (with heavier books placed closest to the back) to maintain balance. Children and parents should also be educated on how to pack a backpack, distributing weight thoughtfully and not overstuffing the bag.

Finally, awareness and education are key to preventing backpack-related health issues. Regular educational sessions or materials for students, teachers, and parents can help reinforce safe backpack practices. Health professionals such as pediatricians and physical therapists can play a role by checking for signs of backpack strain during routine visits and advising families on proper backpack fit and weight. Some researchers have noted that carrying a backpack does provide a form of physical activity or resistance training for children, but this potential benefit does not outweigh the risks when the load is excessive. It is important to strike a balance: children should be strong and active, but not overburdened by inappropriate loads. The precautionary principle dictates that, given the clear evidence of short-term harm from heavy backpacks, steps should be taken to lighten the load and improve carrying methods even as further research continues.

In summary, heavy backpacks pose a significant – but modifiable – health risk for schoolchildren. Reducing backpack weight and improving how children carry their packs can substantially alleviate pain and prevent undue stress on the developing musculoskeletal system.

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Conclusion and Recommendations

Excessively heavy backpacks can adversely affect children's health, leading to pain, fatigue, and changes in posture and gait that may have lasting consequences. The evidence underscores the importance of keeping backpack loads within reasonable limits and using ergonomically designed packs properly. Based on the literature reviewed, we recommend the following measures to enhance backpack safety for students:

- **Limit backpack weight** to no more than 10–15% of the student's body weight. Periodically weigh the packed backpack to ensure it stays within this safe range (about 10% is ideal, and 15% should be an absolute upper limit).

- **Always use both shoulder straps** and adjust them for a snug fit. The backpack should be worn high on the back, with the bottom of the bag near the child's waist. Avoid one-shoulder carrying, which causes uneven strain on the spine and shoulders.

- **Choose an ergonomic backpack** that is appropriately sized for the child and has padded shoulder straps and, ideally, a chest strap and waist (hip) belt. These features help distribute weight more evenly and reduce pressure on the shoulders.

- **Pack smartly:** Place the heaviest items closest to the child's back and utilize multiple compartments to spread out the load. Remove nonessential items on a daily basis to lighten the backpack.

- **Use school storage options:** Take advantage of lockers or desks to store books and supplies when available. Schools and parents might consider solutions like duplicate textbooks (one set at school, one at home) or digital textbooks to reduce the need to carry heavy books back and forth.

- **Watch for warning signs of strain:** Both parents and teachers should be vigilant for signs of backpack overuse, such as a child consistently leaning forward when walking, **complaints of back, shoulder, or neck pain**, or any

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tingling/numbness in the arms. If a child reports ongoing pain or discomfort, re-evaluate the backpack's weight and fit, and consider consulting a healthcare professional. Early intervention can prevent minor issues from becoming chronic problems.

By implementing these recommendations, stakeholders can help ensure that students carry their necessary school materials in the safest way possible. Lighter loads and proper backpack use will reduce the physical strain on children and promote healthier growth and development.

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