Weight limit recommendation in backpack use for school-aged children

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ABSTRACT

Background: Every day children use backpacks to get their books back and forth from school. Many children carry very heavy backpacks and there are some concerns that this could be contributing to back pain in children. **Objective**: The purpose of this paper is to assess, using the literature, what is the recommended weight limit that should be carried by school-aged children. **Discussion:** Many organizations, such as Back Pack Safety International, are trying to educate children on how to wear their backpacks properly and on the weight limit those children should carry to minimize back pain. However, many factors such as design, weight, how it is worn, and children's physical fitness have been shown to have an influence on the development of pain caused by backpacks. As well, parents and teachers have a determining role in helping children be better organized to have lighter backpacks. The literature does not seem to agree on a set weight limit but it is shown that to prevent back pain it should definitely not exceed 10-15%. **Conclusion:** Backpacks have an influence on back pain in children and the weight limit should not exceed 10-15% of the child's body weight.

Key words: backpack, back pain, school-aged, chiropractic

Introduction

Children around the world use backpacks to carry their school supplies to and from school. Studies show that at least 90% of school children in the developed world are using backpacks every day[1,2]. The weight of backpacks carried by children is creating growing concerns amongst school administrators, parents and healthcare professionals[3]. Negrini and Carabalona (2002) reported that the average daily load of Italian students over a week ranged from 22% body weight (BW) to 27.5% BW with some students wearing backpacks weighing as much as 46% of their BW, exceeding the 30% bodyweight/load ratio proposed for physically fit adults[4,5]. Some researchers hypothesize that heavy backpacks may be contributing to back pain in school-aged children[2,6].

A child's constantly developing spine experiences the highest rate of growth between the ages of 10-12 for girls and 13-15 for boys, with the secondary centers of ossification not fusing completely until the mid-twenties. At this stage, when the spine may be more susceptible to injury, proper backpack use is crucial to preventing postural deformities[7,8]. As well, it is shown that by adding weight to the back with a backpack, the center of gravity is shifted forward toward the rear of the base of support. Postural compensations are needed to maintain balance and functional motion during gait; however, with improper loading of backpacks these postural compensations can result in injuries to the child's spine. Some of these compensations include an increased forward head carriage, an increase in forward lean of the trunk, as well as changes of pelvic positions and gait patterns. Grimmer et al. (2002) found that more than 20% of students in each age group had a mean change of 5° in craniovertebral angle (CVA) with the greatest changes in the smaller age group[9,10]. The degree of posture change in these children is comparable to the change in CVA in adult women suffering from headaches[4].

To try to prevent back pain caused by backpacks, safety tips and information on choosing the right backpack, on how to fill it properly and how to wear it correctly, are available from various websites including the American Academy of Pediatrics[11], The American Academy of Orthopedics[12], Back Pack Safety International[13], American Chiropractic Association[14], and numerous other sites for parents, teachers and school-age kids[4,15]. Different methods of wearing backpacks have been recorded, for example, some studies showed that 73.2% of students carried with one shoulder. This carrying method seems to be decreasing in the United States with the help of backpack education programs that emphasize even weight distribution to avoid torqueing the spine[4].

Back pain in school-age children is becoming a common complaint, with a prevalence ranging from 30%-65%[2, 6, 16]. Unfortunately, some evidence in the literature shows that children suffering from low back pain may still have pain into adulthood; therefore, prevention is becoming important[17-19]. A factor contributing to this high prevalence of back pain in children stems from their increasingly sedentary lifestyle, with more time spent in front of the computer or television. As well, there are some thoughts that the loading of the spine with backpacks every day is contributing to the issue[2, 5]. It is believed that a certain amount of stress or load on the spine may contribute to its strength, however,

excessive and repetitive stress on a child's body may result in overuse injuries. Some injuries reported with backpack use are low back pain, neck pain, shoulder pain, muscle soreness, and rucksack palsy[2]. Other problems associated with backpack use have been reported including respiratory problems, winged scapula, foot blisters, tripping accidents, and getting hit by the backpack[20, 21]. Siambanes et al (2004) surveyed 3,498 Southern California adolescents and found that 41.3% reported pain when carrying backpacks, with 16.9% consulting a doctor for the pain and 16.1% reporting missing school activity due to pain[22]. Korovessis et al. (2004) studied a sample of 3,141 Greek students between 9 and 15 years old that showed an increase in dorsal pain correlated to increased backpack weight[23]. It has also been reported that girls usually experience more pain with backpack use than boys[4, 15, 24, 25]. It is important to note that these complications have not only been associated with the school bag load, but also with the duration that the school bag is carried. Increased duration will cause fatigue and pain; therefore, limiting only backpack weight may not be the solution[5]. The literature is unclear regarding the recommended weight for children – there is some debate whether the cutoff should be no more than 10% of the BW or up to 15% of the BW.

This paper will review the literature to assess what is the recommended limit for backpack weight worn by school-age children.

Methods

The search was performed using PubMed with the following terms "backpacks and children" with limits of "review" and language "English". This resulted in eight papers, which were all kept for analysis. A second search using the terms with no limits "backpacks and children" revealed 60 articles — 14 were kept for references. The articles not kept did not discuss backpack weight limits specifically and were not retained. The articles were hand-searched and 3 more articles were retained. Evidence-based medicine (EBM) has a hierarchy that puts systematic reviews at the top of a pyramid followed by randomized control trials, cohort studies, case-control studies, case series, case reports and editorials and opinions[26, 27]. The results of this search will be explained in order of highest evidence available according to EBM.

Results

Lindstrom-Hazel (2009) produced a systematic review of the literature looking to answer three questions. First, she asked, "Are school-age children at risk for back pain because of carrying backpacks? How much load is too much?" Secondly, "Does backpack in adolescence predict back pain in adulthood? and thirdly "Are there behaviors that lessen/increase the risk of back pain/injury?"[15]. The review was well performed with explained search methods and tables showing the relevant articles. The conclusions were that girls are more likely to experience back pain than boys, that the time carrying a pack may be a strong contributor to pain, and psychosomatic behavior may contribute to back pain. Lindstrom-Hazel (2009) reported that some authors were strongly calling for a weight limit; however, she believed that, up to this point, scientific studies had not yet produced consistent results that allowed her to wholeheartedly endorse safe limits that would protect all children. She believed that the issue of back pain was multifactorial including weight, time carried, and child's height in relation to the backpack. She concluded that back pain in children was a strong predictor of back pain in adulthood. She also reported that, although many organizations have various recommendations for backpacks, many students still choose their pack according to color and size. It can be assumed that many students do not understand the risk of back pain later in life; however, programs are in place to educate parents and teachers on avoiding unnecessary backpack weight. Therefore, according to this review, weight recommendations are not consistently supported to prevent back pain in children.

Brackley et Stevenson (2004) produced another systematic review trying to determine whether the suggested weight limit of 10-15% BW by certain organizations was the appropriate limit for school-age children and supported by the literature[2]. Their approach to the question was interesting because they separated the literature according to three different effects of backpacks use. They looked at the various literatures discussing the physiological consequences, the biomechanical consequences, and backpack design for children. By looking at the effects of backpack use in different ways, this review was the most complete. The search method was well explained and it included tables summarizing the research articles. The conclusion based on the literature, combining the three effects of backpack use, was that 10-15% BW is a justified weight limit. Further research is required to determine the association between backpacks and injury, and the way in which load, backpack design, as well as personal characteristics such as physical fitness, interact and influence adaptations required when carrying a backpack.

Kistner et al. (2012) looked at a small cohort study of 11 school children aged 8-11 years to examine the various effects of backpack loads on posture and postural compensations by evaluating forward head carriage[4]. The results showed immediate and statistically significant change in CVA, indicating increased forward head positions when using backpacks containing 15% and 20% BW. When students carried backpacks with 15% and 20% BW, more than 50% of the subjects reported discomfort after walking, with the

neck as the primary location of reported pain. The conclusion was that backpack loads should not exceed 10% BW due to the increased forward head position. One limitation to note from this study is the small sample size.

Rodriguez-Oviedo et al. (2012) produced a cross-sectional study in Spain that investigated whether backpack weight is associated with back pain and back pathology in school children[25]. Their results showed that 61.4% of participants carried backpacks exceeding 10% BW and 18.1% exceeded 15% BW. The children carrying the heaviest backpacks had a 50% higher risk of back pain and a 42% higher risk of pathology with girls showing a higher risk of back pain than boys. They encouraged the medical community to advise parents and school children about the risks posed by heavy school bags and the fact that this risk can be easily reduced.

Moore et al. (2007) produced a cohort study looking at 531 students in 5 different California schools from 5th to 12th grade and their backpack weights. This study weighed the backpacks and students were then individually interviewed about how often they experienced pain while carrying a backpack, the site of their pain, and if it interfered with activities. The data supported the use of a 10% BW cutoff for safe backpack use for all grade levels and that girls were more at risk for back problems.

Discussion

When analyzing the literature regarding backpacks, it is challenging to recommend a weight limit that would prevent injury in all the children due to the multiple factors involved in the development of pain, i.e. design, weight, how it is worn, and children's physical fitness. Negrini et al. (2002) suggested time worn was also important to consider when analyzing the effects of backpacks[5]. Macias et al. (2008) concluded that perceived pain in the low back was significantly higher while wearing the backpack on one shoulder versus two shoulders[1]. If one looks at the evidence, the systematic reviews (considered higher evidence in evidenced-based medicine) had conflicting conclusions and therefore were unable to suggest a clear weight limit. These reviews agree that more research is needed. Smaller studies performed more recently point to a 10% BW but they are generally focusing on only one factor, such as biomechanical changes. There has been no research performed to date that considers all factors in their evaluation and analysis. It would be worth doing other studies, with more subjects, and analyzing many factors simultaneously to see if the 10% cut-off point should be recommended.

As chiropractors, it is important to incorporate questions regarding backpack use when taking the history of a child. This information can help point the chiropractor towards some of the possible causes of back pain and should open up the discussion with the child and parent on how to carry books and appropriate weight limit. The chiropractors can then incorporate these recommendations when preparing the treatment plan of the child.

Many people, including chiropractors, have a determining role in trying to reduce the weight children carry in their backpacks. Parents should be sensitized to the weight of the backpack as well as the distance the child has to walk to and from school, as well as the design and wearing technique of the backpack. Teachers can influence the children when it comes to what material needs to be brought home daily. They should be sensitized to the changes of posture created by poor backpack use so they understand the importance of proper use. When they are planning their weekly curriculum, they could do so according to the textbooks children will need on a specific day and assess what goes in the children's backpacks[5]. As part of the weekly routine, teachers could have a scale to weigh backpacks and encourage students to lighten their load. Also, to emphasize physical fitness along with a properly fitted backpack, physical education classes could include relay races while carrying the backpack.

In this era of technology, they can make use of e-books and reduce the number of textbooks needed with the use of smart tablets like the iPad. A word of caution is needed here – the use of computers by some schools has actually increased the load students' carry because a specially designed backpack, which is already heavier, is required. Before switching to digital textbooks, we need to ensure that technology does not, in fact, increase backpack weight. Students need to learn how to make good choices when loading their packs, including choosing to carry only things that are absolutely necessary and not everything they think they might need or want to bring home. Furthermore, they should be taught to load bigger books in the back so to decrease stress on the shoulders. Parents should also make sure that the backpack contains no loose or dangling cords, strings and piece of clothing. These can catch while the child is walking, make them fall and create an injury that could be tragic if it got caught in the door of the bus[28]. With support from parents, the school curriculum should include a component of total backpack use including loading, lifting, holding, wearing, organizing, clearing and storing at school, to help prevent back pain in children.

Conclusion

It is evident that backpacks have an influence on back pain in children, but it is not clear if this pain is caused by weight alone or by multiple factors such as design, time worn, and physical fitness of the child. It seems difficult to design a backpack that would be suitable for all children and usable in every situation. It is fair to say that backpack weight

should not exceed 10-15% BW, however the backpack weight appropriate for each child should be determined individually.

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