

# Influences of backpack weight on elementary school students: a literature review

## *Influências do peso da mochila escolar em estudantes do ensino fundamental: uma revisão bibliográfica*

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### ABSTRACT

This article presents a bibliographical review about the excessive weight of schoolchildren's backpacks and its potential harm to their health. Several reviewed studies consider that the proper backpack load is up to 10% of body mass, being acceptable between 10 and 15%, however, with the potential to cause some damage. The backpack load overloads the spine causing postural changes, pain, dysfunction, and metabolic changes observed at the studied time when it is over 15% of the body weight. It is assumed that there is the future harm with the use of backpacks with loads up to 15% of the body mass. We also observed that re-education involving the correct way to use the backpack with a load reduction is of great value as an initiative to prevent harm, being the simplest and most effective action. Therefore, we identify the need for studies with a focus on the development of possible lesions and improved preventive and treatment approaches.

**Key words:** Child; Adolescent; Biomechanical Phenomena; Posture; Spine.

### RESUMO

*Este artigo apresenta uma revisão bibliográfica sobre o peso excessivo das mochilas de escolares e seu potencial prejuízo na saúde desses alunos. Diversos estudos revisados consideram que a carga da mochila adequada é de até 10% da massa corporal, sendo de 10 a 15% aceitável, porém podendo causar algum dano. Se superior a 15% da massa corporal, a carga da mochila sobrecarrega a coluna, provocando alterações posturais, dor, disfunção e alterações metabólicas, observadas no momento estudado. Pressupõe-se que haja prejuízo futuro com o uso de mochilas com carga acima de 15% da massa corpórea. Observou-se também que uma reeducação envolvendo a maneira correta de utilização da mochila com redução da carga é de grande valia como atividade preventiva desses malefícios, sendo o meio de ação mais simples e eficaz. Identifica-se, portanto, uma necessidade de estudos com foco na evolução das possíveis lesões e melhor abordagem preventiva e de tratamento. Palavras-chave: Criança; Adolescente; Fenômenos Biomecânicos; Postura; Coluna Vertebral.*

### INTRODUCTION

Concerns for the health of schoolchildren is not recent, especially regarding probable spinal problems generated by the use of backpacks, the most used way for the transportation of school supplies during childhood and adolescence.<sup>1-3</sup>

Because the schooling years are closely related to growth, with the maximum period of growth for girls at approximately 12 years old and boys at 14 years old<sup>2</sup>, the care related to load and how it is sustained are crucial in this age range to prevent

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damage<sup>1-3</sup> to structures that participate in body support, such as the spine.

If the backpack load exceeds the capacity supported by muscle groups, overload on the spine can determine postural changes, pain, or dysfunction<sup>3</sup>. Since the structures that make up the spinal unit (ligaments and disks) have their development influenced by everyday life habits and do not have regeneration mechanisms<sup>2</sup>, studies that analyze the impact of the use of backpacks are useful tools to verify mid- and long-term effects to which students are exposed, which may reflect in their adulthood.

The Brazilian Society of Pediatric Orthopedics recommends that the weight of backpacks should not exceed 10% of body weight.<sup>4</sup> This limit, however, cannot be sufficient to prevent musculoskeletal disorders, tissue damage, or lumbar pain.<sup>5</sup> However, what is observed is that often times the load value is above this value in students of different countries. Studies in countries in Europe and Asia have observed that most of the students carried more than 10% of body weight and that some backpacks exceeded the value of 20%.<sup>6</sup> In Australia, which also has a maximum value in backpacks load expected to be 10 % of body weight, a study showed that 50% of students were carrying backpacks with values above recommended. In the United States, another research found that the average weight load was 17% of body weight. The Health Society and Development of Hong Kong showed that the average weight of their students' school bags represented 20.2% of body weight. This Society believes that there is a causal relationship between overweight backpacks and vertebral deformities.<sup>5</sup> Other studies observed that changes that predispose to spinal deformities such as increased forward inclination of the trunk and tension in the shoulders and cervical spine. It was also emphasized that in addition to the loaded weight, the time carrying this weight also influences with alterations.<sup>3</sup>

The purpose of this literature review through scientific articles was to report on the possible association between the use of school backpacks with loads higher than those recommended by different studies and alterations in the spine, and thereby, to promote a discussion about the different aspects observed.

It is understood that such a study has a social purpose because the health of schoolchildren is an international concern and, with the knowledge of the subject associated with preventive and corrective measures in childhood and adolescence, pos-

tural problems, and back pain, among others, can be avoided in mid- or long-term in adulthood.

## LITERATURE REVIEW

Scientific articles from the Scielo, LILACS, and Medline databases about the weight of backpacks, focusing on elementary school students, were analyzed. The opinions of appropriate reference societies were also analyzed in the researched area. We selected all the studies that discussed the theme and addressed the particular age group for analysis and comparison. The comparison was conducted according to study type criteria; sample size analyzed, and conclusions drawn.

Physical therapists from the Methodist University of Piracicaba (UNIMEP), Piracicaba (SP), Brazil, graduate students, worked with plant force distribution variables (DFP) and pressure center trajectory (COP) according to the weight carried by students.<sup>2</sup> These variables were indirectly related to the spinal cord because the homogeneous distribution of body mass on the plantar area provides proper alignment to the pelvis. The results demonstrate that the DFP, and consequently gait, do not suffer alterations with different loads and backpack positions. COP was increased with the load of 15% of body weight in the anterior and posterior regions of the trunk. This routinely occurring COP alteration can lead to further problems of columnar deviations and muscle pain, which worsens the quality of life of students.

Despite working with a small sample, Flores et al.<sup>7</sup> corroborate the conclusion reported in the study conducted by physiotherapists from São Paulo. These authors also observed that the gait was not altered with 10% body weight load in backpacks.

Hong et al.<sup>6</sup> claim to have found a strong association between high loads and symptoms in the spine. They also recognize that the most common symptoms associated with overweight backpacks are muscle pain, back and shoulder pain, and numbness in the trunk and limbs. In addition, 45 out of 812 students between 9 and 10 years old examined by the Hong Kong Society for Child Health and Development present spinal deformities when carrying a backpack of approximately 4.74 kg weight, which is slightly heavier than the average load in the sampled group. For this reason, this society states that there is a causal relationship between the carried weight and spine deformities.

The same authors point out that the prolonged habit of carrying an excessive load can result in back pain and musculoskeletal disorder. In addition, the results from backpacks weighing more than 20% of body weight show that it causes the trunk to bend forward. This repetitively occurring bending can trigger vertebral problems such as kyphosis in which there is increased high thoracic curvature that can promote the development of even more serious vertebral diseases that are difficult to treat.

Carvalho and Rodacki<sup>8</sup> made the reconstruction of spine profiles in the sagittal and frontal planes during a walk at low speed carrying school backpacks. Kinematic column changes were detected in all planes of movement, being the most significant when carrying loads of 20% of body weight. The main alteration was the bending of the spine as a compensatory effect to the load. However, no increase in the range of movements was observed.<sup>8</sup> These changes may impose changes in posture and stress on the vertebral bodies, which are serious consequences for the future of children carrying excessively heavy backpacks.

According to the article by Sacco et al.<sup>1</sup>, it is mainly from seven to 14 years of age that bone deformities develop; this being a good period for postural corrections. However, the exposure of children in this age group to increasing overloads is common such as supporting school bags asymmetrically and inappropriately leading to postural adjustments and compensatory actions.

Fernandes et al.<sup>3</sup> confirm this fact. The authors analyzed the effects of educational sessions in the use of school bags in 99 children aged seven to 11 years attending basic education in a private school in São Paulo. The study resulted in good acceptance by the students who changed their habits, replacing backpacks with one strap with those with two straps, reducing the load carried and using the two straps.

## RESULTS

It is the consensus in all evaluated articles that the adequate weight for school bags is up to 10% of body weight without harm to the user. Backpacks with 10-15% of body weight are acceptable and may cause some damage. Backpacks weighing more than 15% are unacceptable because they cause damage to the physical and mental health of children using

them.<sup>1,2,5,6,8,9</sup> These values are also recommended by the Brazilian Society of Pediatric Orthopedics.<sup>4</sup>

In addition to the postural alterations perceived while carrying school backpacks weighing over 15% of body weight, some studies indicate that respiratory disorders can also occur when using school backpacks with these characteristics. These alterations were demonstrated by increased respiratory rate and thoracic volume resulting from the activation of thoracic accessory muscles.<sup>5</sup> Moreover, when placed to walk for 20 minutes with a backpack weighing 20% of body mass, increased oxygen consumption and energy expenditure, and prolongation of normal blood pressure recovery were observed. These results demonstrate the increased effort made by the child when the load exceeds 15% of their body weight.

These children, subjected to great strain in the spine, have more chances of being adults with symptoms of myalgia, back pain, shoulder pain, and paresis in the trunk and limbs. The Secretary of Health of Brazil recognizes the age range of elementary school children as privileged for the formation of values and habits conducive to health.<sup>10</sup> Therefore, the re-education in how to use a backpack, best models, and the allowed load proved to be of great value as a preventive activity and it is the simplest and most effective action, the most comprehensive and effective when conducted correctly.

## CONCLUSION

Through the analysis of the articles found, it is assumed that there is an association between the use of backpacks weighing over 15% of body weight and impaired posture in students because most of the experiments showed posture deviation or metabolic abnormalities in children carrying such a load at the analyzed time. However, it cannot be said that there is a long-term association due to the lack of experimental articles.

Furthermore, the articles indicate that preventive educational activities should be conducted with students. These activities, when properly performed, can prevent the development of health problems and need for treatment of possible diseases resulting from excessive load in backpacks. Thus, it is suggested that further studies be conducted focusing on the Brazilian population, and in the evolution of potential lesions to better define ideal procedures for prevention and optimal therapy.

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