

# Weight and mode of carrying schoolbags at elementary school: effect of the school grades and sex

*Peso e modo de transporte do material escolar no Ensino Fundamental I: efeito dos anos escolares e do sexo*

*Peso y modo de transporte de útiles escolares en una escuela primaria: efecto de los años escolares y del sexo*

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**ABSTRACT** | Schoolbag weight and mode of carrying it can contribute to postural deviations and back pain. Therefore, our objective was to determine and compare, among the school grades and between sexes, the schoolbag weight relative to body weight and the mode of carrying it of Elementary School students, who leave their books on bookcases at the school. A total of 191 students participated in the study. Schoolbag weight and students body weight were determined with a scale, and the mode of carrying the schoolbags was evaluated by means of photographs. We observed that 47.7% of the students carried a weight above the limit established (10% of the student's body weight), and the first grade students carried less weight than the 2nd, 3rd, and 5th grade students; however, no difference was observed between sexes. We observed the prevalence of using double-strap backpack. However, despite the school had a strategy to reduce the schoolbag weight, almost half of the school children carried a weight of more than 10% of body weight. Thus, other measures to raise awareness of those involved are necessary.

**Keywords** | Child; Posture; Prevention; Disease Prevention.

**RESUMO** | O peso do material escolar e o modo de transportá-lo podem contribuir para desvios posturais e dor nas costas. Por isso, o objetivo foi verificar e comparar, entre os anos escolares e os sexos, o peso do material escolar em

relação ao peso corporal e o modo de transporte do material de alunos do Ensino Fundamental I, os quais deixam os seus livros em estantes na escola. Participaram 191 escolares. O peso do material escolar e o peso corporal dos alunos foram verificados com uma balança, e o modo de transporte do material foi avaliado por meio de fotos. Observou-se que 47,7% dos alunos transportavam um peso acima do limite estabelecido (10% do peso corporal do aluno), sendo que o 1º ano transportava um menor peso do que os 2º, 3º e 5º anos, mas não houve diferença entre os sexos. Foi encontrado predomínio do uso da mochila de duas alças. Contudo, apesar de a escola já ter uma estratégia para reduzir o peso do material, quase metade dos escolares transportava um peso superior a 10% do peso corporal. Logo, outras medidas para alertar os envolvidos são necessárias.

**Descritores** | Criança; Postura; Prevenção de Doenças.

**RESUMEN** | El peso y el modo de transporte de útiles escolares pueden contribuir con desviaciones posturales y con dolores de espalda. Por lo tanto, el objetivo fue verificar y comparar, entre los años escolares y entre los sexos, el peso de útiles escolares en relación con el peso corporal y el modo de transporte de los útiles de alumnos de una escuela primaria que dejan sus libros en estantes en la escuela. Participaron 191 alumnos. El peso de los útiles escolares y el peso corporal de

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los alumnos fueron verificados con balanza, y el modo de transporte fue avaluado con fotos. Entre los alumnos, 47,7% transportaban un peso mayor que el límite establecido (10% del peso corporal de los alumnos), y el 1º año transportaba menos peso que los 2º, 3º y 5º años, pero no hubo diferencia entre los sexos. Fue encontrado un predominio de mochilas

con dos correas. Sin embargo, aunque la escuela ya tiene una estrategia para reducir el peso de los útiles, casi la mitad de los alumnos transportaba un peso mayor que 10% del peso corporal. Por lo tanto, son necesarias otras medidas para alertar a las personas.

**Palabras clave** | Niño; Postura; Prevención de Enfermedades.

## INTRODUCTION

Postural changes and back pain are considered public health problems that also affect children and adolescents<sup>1-5</sup> due to changes observed in the musculoskeletal system resulting from growing when exposed to some type of overload in this system<sup>6</sup>. These manifestations are commonly related to bad habits in school, mainly regarding the transportation of schoolbags<sup>7</sup>.

There is great concern about the weight of schoolbags, so much so that, in Brazil, law Project No. 66, of 2012, states that the weight of schoolbag carried by students of basic education cannot be more than 15% of body weight. On the other hand, many studies report that individuals carrying a weight in excess of 10% of body weight or carrying it improperly present a higher risk of developing postural changes and back pain<sup>8-10</sup>.

Thus, investigating the schoolbag weight and mode of carrying it become extremely relevant<sup>11,12</sup>. To this end, Paušić et al.<sup>9</sup> investigated the weight of schoolbags in students from the 1<sup>st</sup> to the 4<sup>th</sup> grade and found that the limit of 10% of body weight was exceeded in every grade, with higher excess in the initial ones. This last result was also found by Kellis and Emmanouilidou<sup>13</sup>, who also observed that the weight of schoolbags in relation to body weight is greater for girls than for boys. The authors still observed that younger children more often wear the double-strap-backpack on the shoulders than older children, and that boys wear the backpack in greater proportion than girls.

However, these studies were performed with children that had to carry all their school materials, and, in reviewing the literature, it can be observed that some authors suggest various measures such as the utilization of lockers<sup>14</sup>. The bill cited also suggests the installation of lockers in schools; however, researches that support

such measure to reduce the schoolbag weight are scarce. Skaggs et al.<sup>15</sup> reported that students who have lockers available for use present lower incidence of back pain compared to children with no lockers available, which, perhaps, could be explained by the use of lockers resulting in lower weight of schoolbags.

Another strategy includes the availability of bookcases to leave books at school<sup>16</sup>. Silva Junior et al.<sup>16</sup> determined the weight and type of backpack (or bag) and how it is carried by students who left the books on shelves at school. They found that almost half of the students carried a weight of more than 10% of body weight, and that the double-strap backpack was the most used. However, only a single school grade was evaluated. Thus, the objective of this study was to determine the weight and mode of carrying schoolbags of students from the 1<sup>st</sup> to the 5<sup>th</sup> grade of Elementary School, who leave their books on bookcases at school, as well as to compare the weight and mode of carrying schoolbags between the sexes and among the school grades.

## METHODOLOGY

The present work was characterized as an institutional case study<sup>17</sup>, by investigating an organization, in this case, a municipal public school in the town of Petrolina, state of Pernambuco, Brazil, which had bookcases available for students to leave their books. The population was composed of 221 students enrolled in Elementary School, who attended classes in the morning in this school and had no impediment to transport the schoolbags. Based on this, the sample was composed of students who had an informed consent signed by guardian and who were present on the day of assessment. Thus, the sample was composed of 191 students (96 boys and 95 girls), aged 5 to 13

years. This study was approved by the ethics committee (0013/270812 CEDEP/UNIVASF) and received the permission of the Municipal Secretariat of Education.

Collection of images of children carrying their schoolbags and measurements of masses of students' schoolbags were held in a reserved place at school, and both assessments were conducted on the same day. To determine the schoolbag mass, two scales were used – an analog scale (Feiteira Ind. Utilid. Dom. Ltda, resolution of 0.025kg and maximum capacity of 5kg) and a digital scale (WISO, model W721, resolution of 0.1kg and maximum capacity of 150kg). The choice of use of analog scale is due to the fact that it has better resolution than the digital; however, it had low capacity. Therefore, the need for use either one or the other depended on the mass of the schoolbags. Due to the fact the scales were simple and of different manufacturers, known masses were measured using both scales. Based on that, the actual values and the measured values were plotted and, then, the function of the two curves was established with the coefficient of determination, which was 0.99 for both.

To determine the students' body mass, the digital scale was used. The participant under evaluation was positioned in orthostasis, in the center of the platform, with the weight distributed on both legs and looking ahead at a fixed point. The masses of the schoolbags and of the students were tabulated in Excel (2010 version), in which we calculated the schoolbag weight in relation to body weight by a simple rule of three.

Since the schoolbag weight was only assessed on a single day of the week, its reproducibility was investigated. For this purpose, schoolbags were weighed again after a week. This procedure was adopted because the school only allowed contact with the students on a single day of the week.

To determine the mode of carrying schoolbags, students were instructed to carry the schoolbags in the same way they carried them daily and, then, they were photographed with a camera (Nikon Coolpix) from the right and back sides. To minimize possible mistakes, analysis of the images was performed by two independent evaluators, who should determine if the student used double-strap backpack, single-strap backpack, wheeled backpack, bag, folder, or others<sup>18</sup>. Although there was no disagreement between them, in case it occurred they should reach a consensus.

For analysis of mode of carrying, frequency analysis was conducted. For analysis of schoolbag weight relative to student body weight, normality and homogeneity of

variance were determined with Kolmogorov-Smirnov and Levene tests, respectively. After having confirmed the normality and homogeneity, a two-factor ANOVA (sex and school grades) with Bonferroni post hoc was conducted to compare the schoolbag weight relative to body weight between sexes and among school grades. A frequency analysis was also conducted to determine the percentage of schoolchildren who carried: (1) weight less than or equal to 10% of body weight; (2) from 10% to 15% of body weight; and (3) more than 15% of body weight. Reproducibility of schoolbag mass was assessed with Cronbach's alpha coefficient and intraclass correlation coefficient (ICC). Significance level adopted was 5%, statistical procedures were performed in SPSS (version 17.0 for Windows), and results are reported as recommended by Field<sup>19</sup>.

## RESULTS

We confirmed the reproducibility of the schoolbag mass evaluation, since the Cronbach's alpha was equal to 0.884<sup>19</sup> and the ICC was equal to 0.7992 (confidence interval of 95% of 0.732 to 0.840;  $p < 0.001$ ), which was characterized as excellent<sup>20</sup>. As observed in Table 1, schoolbag weight relative to body weight presented a significant main effect of school grade,  $F(4, 181)=4.59$ ,  $p=0.001$ , and the 1<sup>st</sup> grade differed from the 2<sup>nd</sup> grade ( $p=0.002$ ), from the 3<sup>rd</sup> grade ( $p=0.01$ ), and from the 5<sup>th</sup> grade ( $p=0.009$ ), while it was similar to the 4<sup>th</sup> grade ( $p=0.227$ ). This result corroborates the percentage found of students that carried a weight of more than 10% of body weight for each school grade (Table 1). In total, 37.2% of the students carried a weight from 10% to 15% of body weight, and 10.5% of the students carried weight of more than 15% of body weight.

We found no significant main effect of sex on schoolbag weight relative to body weight ( $9.62 \pm 3.44\%$  for boys and  $10.59 \pm 3.61\%$  for girls),  $F(1, 181)=2.49$ ,  $p=0.116$ , and 36.5% of boys and 37.9% of girls carried a weight from 10% to 15% of body weight and 6.3% of boys and 14.7% of girls carried a weight of more than 15% of body weight. We also found no significant interaction effect between sex and school grade on schoolbag weight relative to body weight,  $F(4, 181)=0.204$ ,  $p=0.936$ .

Table 2 illustrates the predominance of the use of double-strap backpack regardless of school grade and sex. In total, it was verified that 85.3% of all participants evaluated used double-strap backpack.

Table 1. Mean  $\pm$  standard deviation of body mass ( $M_{\text{body}}$ ), of schoolbag mass ( $M_{\text{bag}}$ ), and of schoolbag weight relative to body weight ( $W_{\text{rel}}$ ), and percentage of students who carried a weight of less than or equal to 10% of body weight ( $W_{\text{rel}} \leq 10\%$ ), from 10% to 15% of body weight ( $10\% < W_{\text{rel}} \leq 15\%$ ), and of more than 15% of body weight ( $W_{\text{rel}} > 15\%$ )

School grade	1 <sup>st</sup> (n=23)	2 <sup>nd</sup> (n=27)	3 <sup>rd</sup> (n=37)	4 <sup>th</sup> (n=49)	5 <sup>th</sup> (n=55)
$M_{\text{body}}$ (kg)	22.2 $\pm$ 4.4	26.6 $\pm$ 5.1	26.6 $\pm$ 3.9	30.8 $\pm$ 6.7	35.2 $\pm$ 10.7
$M_{\text{bag}}$ (kg)	1.7 $\pm$ 0.5	2.9 $\pm$ 1.0	2.8 $\pm$ 0.7	2.8 $\pm$ 0.8	3.6 $\pm$ 0.9
$W_{\text{rel}}$ (%)	7.6 $\pm$ 2.3	11.3 $\pm$ 4.3	10.6 $\pm$ 3.0	9.6 $\pm$ 3.2	10.7 $\pm$ 3.8
$W_{\text{rel}} \leq 10\%$ (%)	82.6	33.3	45.9	57.1	49.1
$10\% < W_{\text{rel}} \leq 15\%$ (%)	17.4	51.9	45.9	32.7	36.4
$W_{\text{rel}} > 15\%$ (%)	0.0	14.8	8.1	10.2	14.5

Table 2. Mode of carrying schoolbags (n=191)

Grade	Sex	Double-strap backpack	Single-strap backpack	Wheeled backpack	Other modes
1 <sup>st</sup> grade	Male (n=12)	83.3%	0.0%	16.7%	0.0%
	Female (n=11)	63.6%	0.0%	36.4%	0.0%
2 <sup>nd</sup> grade	Male (n=16)	100%	0.0%	0.0%	0.0%
	Female (n=11)	81.8%	0.0%	9.1%	9.1%
3 <sup>rd</sup> grade	Male (n=19)	73.7%	10.5%	5.3%	10.5%
	Female (n=18)	83.3%	5.6%	11.1%	0.0%
4 <sup>th</sup> grade	Male (n=27)	88.9%	7.4%	3.7%	0.0%
	Female (n=22)	95.5%	4.5%	0.0%	0.0%
5 <sup>th</sup> grade	Male (n=22)	90.9%	0.0%	4.5%	4.5%
	Female (n=33)	81.8%	0.0%	6.1%	12.1%

## DISCUSSION

The schoolbag weight and mode of carrying it can influence the health and well-being of students<sup>11</sup>, since it can contribute to the development of postural deviations and back pain, which are considered public health problems<sup>1-5</sup>. Therefore, evaluating these variables is important to identify inadequate habits and, then, raise awareness of children, guardians, and school as for the care that must be taken.

After analysis of the results, it was observed that the schoolbag weight relative to body weight and the percentage of students who carried a weight of more than 10% of body weight were lower in the 1<sup>st</sup> grade than in the 2<sup>nd</sup>, 3<sup>rd</sup>, and 5<sup>th</sup> grades (Table 1). This result is in disagreement with some authors who observed that the schoolbag weight relative to body weight is greater in the initial grades<sup>9,13,15</sup>. Probably, the guardians of first-grade students help organize or manage the children's schoolbags, while the older children, possibly, manage their own schoolbags. Although this is an assumption, Forjuoh et al.<sup>14</sup> found that many parents are unaware of the weight carried by their children, and some never checked the contents of the backpack, and that students carry other objects in addition to school supplies. When the schoolbags were heavy, in this study, in general, we observed that the students were carrying unnecessary items to class. This

observation is consistent with the findings of Gomes et al.<sup>21</sup>, who observed that 42.85% of the students evaluated carried other objects in addition to school supplies. That is, in addition to the strategy of providing bookcases so students can leave the books, an educational measure is necessary to change the habits observed.

It was found that almost half (47.7%) of the students evaluated carried a weight of more than 10% of body weight, which corroborates the findings of de Silva Junior et al.<sup>16</sup>. Although this result is similar to those of other researches<sup>9,22,23</sup>, a lower percentage would be expected, since students left their books at school. Thus, this strategy is insufficient to reduce the schoolbag weight, which is consistent with Silva Junior et al.<sup>16</sup>. That is, prevention strategies such as postural education programs, which have demonstrated to have positive effects on the schoolbag weight and mode of carrying<sup>24-26</sup>, are necessary.

Moreover, regarding the schoolbag weight relative to body weight, no differences were found between sexes, which is consistent with other studies<sup>27,28</sup>. However, it is inconsistent with the study of Kellis and Emmanouilidou<sup>13</sup>, in which it was observed that the girls carried a heavier weight compared to the boys. We also observed the predominant use of double-strap backpack (Table 2). This result was expected based on several studies<sup>11,13,26,29</sup>, although no evaluation was conducted on how the

backpack was carried, which constitutes a limitation. It is noteworthy that the double-strap backpack is the most appropriate mode to carry school supplies due to the fact that, when used properly, it provides greater comfort and body symmetry in transportation of load, reducing the chances of postural alterations<sup>21,25</sup>.

Although discussing the definition of maximum tolerable weight was not an objective, that is, if this limit should be 10 or 15% of body weight, the results (Table 1) indicate that, except for the 1<sup>st</sup> grade, there are students that carry a weight of more than 15% of body weight. Although the school investigated had no lockers, but instead bookcases, the results indicate that, after enactment of the aforementioned bill, not only the provision of lockers in schools will be important, but also a wide educational campaign about schoolbag weight, as stated in the project. However, in an attempt to further lessen the chances of postural alterations and back pain, these campaigns should address postural health in a comprehensive manner.

After the evaluations, there were talks on healthy posture habits and a physical education class involving flexibility, muscular endurance, and balance. Additionally, reports were handed to the students' guardians, to teachers, and to the school staff, stating the name of students who carried schoolbags over the limit of 10% of body weight. In this study, no evaluations were conducted after these interventions, which is a limitation. Another limitation involves the comparison between the school investigated and a school with similar characteristics, but with students with no availability of a strategy to reduce schoolbag weight. Based on that, further investigations that surpass these limitations are suggested. Furthermore, studies could be conducted to assess postural alterations, pain, and the relations of these problems relative to schoolbag weight and mode of carrying it.

On the other hand, this study investigated a school in northeastern Brazil, unlike most studies mentioned, which were conducted in other regions<sup>11,21,25,26,28</sup>, predominantly South and Southeast. It is also noteworthy the fact that the analysis was conducted in an institution that adopts a strategy to reduce the weight of schoolbags, unlike most studies on this theme.

## CONCLUSION

In this research, we evaluated public school students who left their books at school. We determined that

the schoolbag weight of almost half of the students evaluated exceeded the limit of 10% of body weight, and that the 1<sup>st</sup> grade carried less weight compared to the 2<sup>nd</sup>, 3<sup>rd</sup>, and 5<sup>th</sup> grades. Between the sexes, the schoolbag weight relative to body weight was not different. Additionally, we observed predominant use of double-strap backpack. Therefore, the results indicate that, in addition to the strategy of leaving books at school, the development of preventive educational measures is necessary, in addition to further studies.

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