CORRELATION BETWEEN RELATIVE SCHOOLBAG WEIGHT AND GENDER AND AGE DIFFERENCES OF THE SCHOOLCHILDREN IN THE PRIMARY SCHOOL

POVEZANOST RELATIVNE MASE ŠKOLSKE TORBE I SPOLNO-DOBNIH RAZLIKA DJECE OSNOVNE ŠKOLE

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ABSTRACT

This study investigated relative schoolbag weight and the correlation between relative schoolbag weight and gender and age differences of the schoolchildren in nine grades of primary schools in Brno, Czech Republic. Measurements of children's anthropometry and schoolbag weight were taken in five different schools. In total 584 school children, 44,35 % girls (N = 259) and 55,65 % boys (N = 325), mean age 9,67 (± 2,4) years and body weight 37,5 kg (± 13,4) took part in this study. Mean schoolbag weight was 4,93 kg (± 1,32) and it represented 14,0 % (± 0,5) of children's body weight. By using a factorial ANOVA in statistical analysis and by setting the statistical significance at p ≤ 0,05, the statistically significant difference between the relative schoolbag weight by ages of participants was noticed (p = 0,000). Schoolchildren in first four grades have statistically significant higher relative schoolbag weight than their older colleagues. On the other hand, there's no statistically significant difference between the relative schoolbag weight and the gender (p = 0,240), but there is a statistically significant difference between the relative schoolbag weight and the interaction between gender and age (p = 0,006). This study showed that for schoolchildren in their early stage of growth, schoolbag load is bigger, and it represents a big risk factor during the very sensitive stage of their growth and development.

Key words: schoolchildren, relative schoolbag weight, schoolbag load, child's health

SAŽETAK

Ova studija istraživala je relativnu masu školske torbe i njenu povezanost sa spolno-dobnim razlikama djece školskog uzrasta od prvog do devetog razreda u osnovnim školama grada Brna u Češkoj. Mjerenja morfoloških karakteristika djece i mase školske torbe provedena su u pet različitih škola. U ovoj studiji sudjelovalo je ukupno 584 školske djece, 44,35% djevojčica (N = 259) i 55,65% dječaka (N = 325), prosječne dobi 9,67 (± 2,4) godine i tjelesne mase 37,5 kg (± 13, 4). Srednja masa školske torbe iznosila je 4,93 kg (± 1,32) i predstavljala je 14,0% (± 0,5) srednje tjelesne mase djece. U statističkoj analizi korištenjem faktografske ANOVA, uz statističku značajnost od p ≤ 0.05, uočena je statistički značajna razlika između relativne mase školske torbe prema dobi ispitanika (p = 0,000). Školarci u prva četiri razreda imaju statistički značajnu veću relativnu masu školske torbe u odnosu na njihove starije kolege. S druge strane, ne postoji statistički značajna razlika između relativne mase školske torbe i spola (p = 0,240), ali postoji statistički značajna razlika između relativne mase školske torbe i interakcije između spola i dobi (p = 0,006). Ovo istraživanje je pokazalo da školarci u njihovoj ranoj fazi imaju veće opterećenje školskom torbom što predstavlja veliki faktor rizika tijekom vrlo osjetljive faze njihovog rasta i razvoja.

Ključne riječi: školarci, relativna masa školske torbe, opterećenje školske torbe, zdravlje djeteta

INTRODUCTION

School childhood is the third stage of child's development, which begins at primary school and at that time anthropological developmental features are similar in both genders. Younger schoolchildren are in a growth and development stage when skeleton grows slowly, it is susceptible to various deviations, although the bone structure contains more and more bone than cartilage tissue. The muscles, and thus the gain of all types of strength, develops slowly in both genders. In the first half of the younger school period (6-8 years) there is a noticeable increase in strength in larger muscles, and at the end of this period (8-10 years) there is an increase in the strength of the smaller muscle groups. Dislocations and sprains, distortion of the spine, foot arch lowering can easily occur until muscles and ligaments don't reach their full functional maturity (18, 22).

The studies have shown that there is significant connection between the musculoskeletal pain and the schoolbag weight (19, 20) especially because schoolbag weight represents an everyday load for schoolchildren. Schoolbag is used for carrying textbooks and school supplies and its transport is one of the daily activities of children (1). It can lower biomechanical and energetics demands, but however, there is a great concern over possible consequences that can be caused by excessive schoolbag weight, its position on the back and inappropriate design (15, 16). Thus, today, there is concern about the negative impact of carrying a schoolbag on a children's physical growth and development during primary school period. That concern is especially expressed about children between 12 and 14 years, because their spine is in critical point of development, and about children who are still growing, and yet they carry bags of similar weight as those of their older colleagues (8). Schoolbag weight is not the only risk factor, but also its size, way and time of carrying it and surface children walk on (5, 13, 14). In urban environments, children mostly walk on hard asphalt and concrete surfaces, which is why foot and body of the child are without the proper stimulation of the muscles that allow the proper development of foot arches and the overall posture (13, 14). On the other hand, uneven load distribution leads to asymmetry in muscular activity and poses a risk of shoulder, neck and back pain. During their school period, children spend most of the time sitting in the benches, which increases their static strain, and because of that they spend less time doing physical activity, which is not beneficial to their muscular strengthening and better mastering of daily schoolbag load.

The problem of excessive schoolbag weight gets more and more attention between sports medicine specialists, school leaders, teachers and parents. Relative schoolbag weight varies within different schools and grades and is most often expressed as a percentage of the body mass of the child. The first suggestion for optimal weight of a schoolbag that makes up 10% of the body weight of a child was given by Voll and Klimt in 1977, and further research showed a greater range of recommended values. Today, the scientific community recommends the optimal values for the schoolbag weight within 10-15% of the child's body weight (2, 4, 6, 9, 27). When in those limits, delayed blood pressure recovery (11, 12) and changes in kinetic, kinematic and electromiographic parameters occur (3, 6). Values higher than recommended interval and some types of schoolbags may contribute to postural changes such as torso bending, lighter lumbar lordosis and cifosis (17, 21, 26), static balance disorder manifested as body swinging (24) and compensatory mechanisms used to reduce instability or mechanical stress on the musculoskeletal system (11, 23, 26).

The aim of this paper was to investigate relative schoolbag weight of schoolchildren in primary schools in Brno in the Czech Republic and to determine whether there is a correlation between relative schoolbag weight and gender and age differences of the school children in the primary school.

METHODS

The research was conducted at the Faculty of Sports Studies at Masaryk University in Brno (Czech Republic). Data was collected by field measurements in five different primary schools in Brno and the sample consisted of 584 school children from first to ninth grade, 44,35 % girls (N = 259) and 55,65 % boys (N = 325), mean age 9,67 (± 2,4) years and body weight 37,5 kg (± 13,4) (Table 1).

Participants and their parents were introduced with measurement protocol, potential contribution of the research, and possible discomforts during the execution the research. They signed *Statement of Consent for*

Table 1.   Descriptive analysis of variables for male and female schoolchildren
Tablica 1. Deskriptivna analiza varijabli za dječake i djevojčice osnovne škole

	Boys		Girls		Total	
	MIN - MAX	MEAN ± SD	MIN - MAX	MEAN ± SD	MIN - MAX	MEAN ± SD
Age (years)	6,0 – 15,0	9,9 ± 2,4	6,0 – 15,0	9,4 ± 2,4	6,0 – 15,0	9,7 ± 0,5
Body weight (kg)	18,9 – 97,4	39,0 ± 14,3	17,1 – 81,1	35,7 ± 11,8	17,1 – 97,4	37,5 ± 13,4
Schoolbag weight (kg)	1,8 – 9,5	5,1 ± 1,3	0,3 – 8,5	4,8 ± 1,3	0,3 – 9,5	4,93 ± 1,3
Relative schoolbag weight	0,04 – 0,29	0,14 ± 0,04	0,01 – 0,26	0,15 ± 0,05	0,01 – 0,29	0,14 ± 0,05

Voluntary Participation in Research. The Committee for Scientific Research and Ethics of the Faculty of Sports Studies approved the implementation of the research. The participants were asked to bring schoolbag with school supplies for that school day, so that data on schoolbag weight and burden it represents for children would be accurate. All children were carrying schoolbag over both shoulders. All measurements were carried out at about the same time of the day, in the morning hours. Student's weight and the schoolbag weight are measured without their shoes on. Mean schoolbag weight was 4,93 kg (± 1,32) and it represented 14,0 % (± 0,5) of children's body weight.

Collected results of anthropometric measurements and measurements of the schoolbag weight are recorded and processed in the 13.0 (Statsoft, Tulsa, USA) software package licensed at the Faculty of Kinesiology of the University of Zagreb. For the purposes of this study, descriptive parameters were calculated and for determining is there a correlation between relative schoolbag weight and gender and age differences of the schoolchildren, factorial ANOVA was used. The level of significance was set to value $p \leq 0,05$.

RESULTS

By using a factorial ANOVA for statistical analysis, it is concluded that there is statistically significant difference between the relative schoolbag weight and ages of participants ($p = 0,000$) (Figure 1). By using the Scheffe post – hoc test, it was showed that schoolchildren in ages 6 – 9 have statistically significant higher relative schoolbag weight than their older colleagues and the mean value of relative schoolbag weight in those ages exceeds recommended value of 0,15. On the other hand, by using the same analysis, it is determined that there's no statistically significant difference between the relative schoolbag weight and the gender ($p = 0,240$) (Figure 2), but there is a statistically significant difference between the relative schoolbag weight and an interaction between gender and age ($p = 0,006$) (Figure 3).
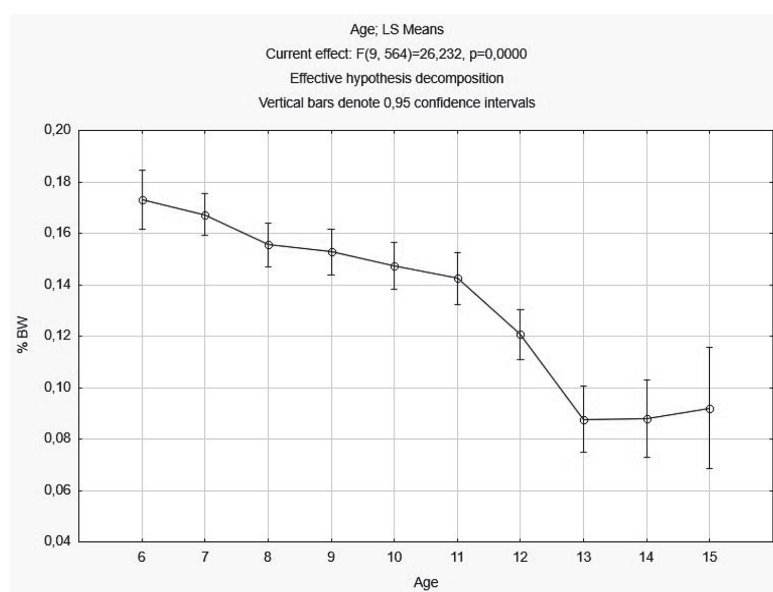

Figure 1. Mean values of relative schoolbag weight (%BW) within ages.
Slika 1. Srednje vrijednosti relativne mase školske torbe (% TM) unutar dobnih skupina.
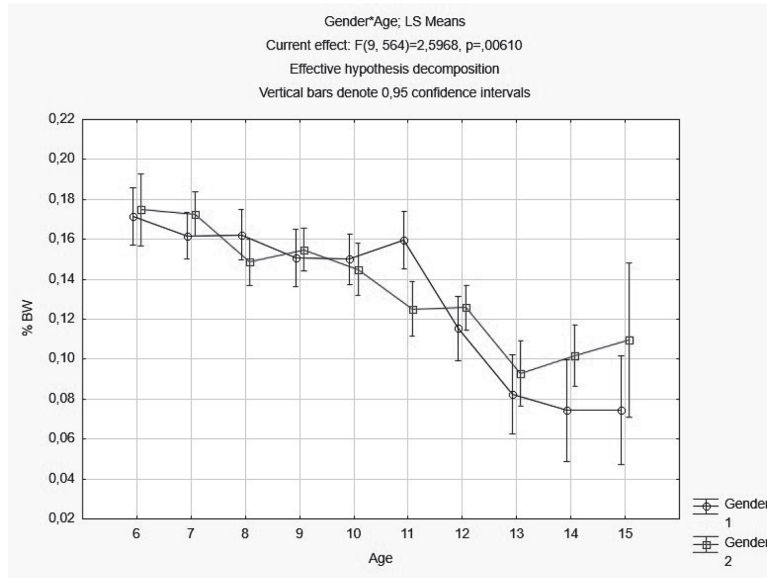
Figure 2. Mean values of relative schoolbag weight (%BW) within genders.
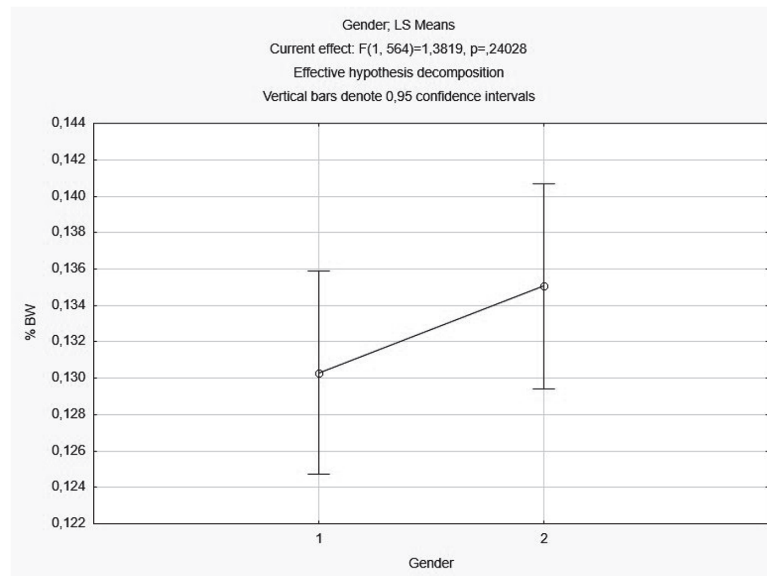Slika 2.   Srednje vrijednosti relativne mase školske torbe (% TM) prema spolovima.

Figure 3. Mean values of relative schoolbag weight (%BW) within interaction between age and gender.
Slika 3.   Srednje vrijednosti relativne mase školske torbe (% TM) u interakciji između dobi i spola.

DISCUSSION

Schoolbags represent the most widespread method of carrying school supplies for a great number of children and adolescents. However, healthcare professionals and parents point out that carrying schoolbag represents potential risk factor for lower back pain in children and adolescents. Regardless of the lack of reference values for schoolbag weight, overload is considered as an important factor that can cause a back pain among schoolchildren. Most scientists and healthcare professionals agree that the schoolbag weight should be within 10 - 15% of the child's body weight and should be equally distributed across both shoulders (7).

Relative schoolbag weight is considered as a measure of load of the locomotor system of children, often because of the difference in body proportions in children of the same age. The relative weight is calculated as schoolbag weight divided by the child's body weight (x100%). This research showed that the gender is not related to the relative schoolbag weight, which doesn't necessary mean that there is no statistically significant difference between the relative schoolbag weight for male and female students. On the other hand, this study confirmed that the relative schoolbag weight is related to the age of the student, i.e. there is a statistically significant difference between the relative schoolbag weight and students of different ages. The result obtained corresponds to the previous research that showed that relative schoolbag weight depends on the class, day of the week, type of school and it differs from country to country (10).

This study showed that the relative schoolbag weight was statistically significantly different between first to fourth graders and fifth to ninth graders. The relative schoolbag weight within schoolchildren from the first to the fourth grade does not differ significantly within this range of grades but is statistically significantly higher than the relative schoolbag weight of the schoolchildren from the fifth to the ninth grade. This research showed that schoolbag represents the biggest load for the schoolchildren in the most sensitive stage of their growth and development, posing a high risk to their health. Previous studies confirmed that excessive relative schoolbag weight induces changes in posture (5), and carrying it may cause increased breathing frequencies, frequency of steps and shortening the length of the gait cycle (23, 25).

CONCLUSION

This research showed that the relative schoolbag weight does not vary significantly between male and female schoolchildren, but it does between students of different ages. The relative schoolbag weight is significantly higher within schoolchildren of ages 6 – 9 than within schoolchildren ages 10-15. Based on that, we can conclude that for schoolchildren from first to fourth grade of primary schools in Brno, schoolbags are too heavy, and they are increasing the load for their locomotor system. Consequently, carrying schoolbags for them represents an increased risk for health and changes in posture as well as the development of compensatory mechanisms due to mechanical stress on the musculoskeletal system.

Research results are of great importance in raising awareness about the schoolbag weight problem. Parents should also control child's schoolbag weight to prevent possible consequences that these factors may have on the child's health. Also, the amount of teaching material should be adapted to the child's age to avoid possible negative effects. It is necessary to carry out educational programs to teach children how to properly fill and carry a school bag to avoid injuries. Children should be taught to carry a schoolbag over both shoulders, pack the heaviest book higher and closer to the body, and not on the lower part of a back, on the lumbar spine. Also, lower class students are advised to carry a smaller schoolbag to avoid carrying too many items in them and suffer excessive load.

The conducted research provided answers about the load that schoolbag represents for the locomotor system and the health of children in primary school, but also opened new questions and guidelines for the future research.

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