



School bags and associated back pain

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ABSTRACT

Introduction: The most common health problem associated with the negative effect of heavy schoolbags is back pain, and non-specific back pain is frequently observed in childhood. The prevalence of back pain in schoolchildren varies from 12% to 92%, depending on the age and affected region of the back. To prevent the occurrence of back pain in schoolchildren, the weight of schoolbag should not exceed 10% of the child's body mass.

Methods: This was a descriptive, cross-sectional study conducted in April 2017. We included 79 students of the fifth and sixth grade from the elementary school in Sarajevo. Information on the weight and type of schoolbag, method of carrying a schoolbag, and feelings of pain and tiredness due to schoolbag were obtained by questionnaire.

Results: In the total sample, the majority of the students (64.6%) reported occasional back pain while carrying the bag, 20.3% of students reported no back pain, and 11.4% of students experienced frequent back pain. The mean schoolbag weight in the fifth grade was 4.01 ± 0.57 kg, and it was significantly higher (4.61 ± 0.86 kg) in the sixth grade. About 48.5% of the students in the fifth and 50% in the sixth grade carried schoolbags weighing more than 10% of the body mass. A higher mean weight of schoolbag was significantly more frequent in students who reported always feeling tired ($11.03 \pm 2.74\%$) compared to those who did not feel tired while carrying the schoolbag ($8.41 \pm 2\%$).

Conclusions: Overall, more frequent occurrence of back pain and tiredness in schoolchildren was associated with heavier schoolbags (>10% of the body mass), and the occurrence of back pain due to schoolbag was related to gender (i.e., back pain was more common in girls compared to boys).

Key words: Schoolbag weight; back pain; tiredness

INTRODUCTION

Non-specific back pain is a common symptom in childhood, and it may occur more frequently in

some cases. Considering the potential effect of recurrent non-specific back pain, which is experienced by children and adolescents during their everyday activities at home and school, health professionals, teachers as well as parents and guardians should pay close attention to this issue (1,2).

Pain associated with musculoskeletal disorders is a condition caused by the load of the musculoskeletal system over a longer period. This load does not only affect the tendons and muscles but also the cervical

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nerves and joints, upper and lower back, thorax, shoulders, arms, and hands. According to epidemiological studies on non-specific back pain in children and adolescents, the prevalence rate increases with the age of respondents, ranging between 12% and 92%.

Some studies showed a higher prevalence of back pain in girls compared to boys, while other studies reported that boys are at greater risk to develop back pain or they found no statistically significant gender difference in the prevalence of back pain (3-6). According to the National Health and Nutrition Examination Survey Series II, non-specific back pain occurs before the age of 20 in approximately 11% of the general population (7).

Although certain types of behavior and sociodemographic factors are assumed to affect the onset of musculoskeletal changes and back pain, the most important causative factors remain unclear (2). Factors that are commonly associated with non-specific back pain in schoolchildren are: Age and gender, schoolbags (heavy schoolbags, method of schoolbag carrying, and improperly packed schoolbags), poor lifestyle habits (watching TV for long hours, excessive computer use, and playing video games), poor posture while sitting for long periods, furniture that does not fit the body proportions of a child, lack of physical activity, obesity, etc. (2,5,6,8).

Schoolbags are the most common means of carrying books and school supplies among schoolchildren (9). The problem of heavy schoolbags is a global problem, and a number of studies addressed this problem in different countries. The most common health problem related to heavy schoolbags is back pain. Other consequences of heavy schoolbags include bad posture, fatigue, exhaustion, and consequently concentration problems and poor school performance (10,11). Moreover, heavy schoolbags can affect the bone growth, cause stress injuries, and shift the center of gravity of a body in the same direction as the load (12).

According to the World Health Organization recommendations, the weight of schoolbags should not exceed 10% of child body mass (13). Schoolbags with a load exceeding 10% of the body mass increase energy consumption, increase the neck and trunk forward lean, and result in decreased pulmonary volume and increased cardiorespiratory parameters (14).

If a schoolbag is worn incorrectly, it may cause strain or injury to the back and abdominal muscles. To prevent this, the shoulder straps of schoolbag should be adjusted, as well as the hip belt if it is present, thus ensuring that the load to the lower back is reduced (15). When a schoolbag is well designed and positioned properly to the back and abdominal muscles, which are among the strongest muscles in the body, they can support the weight of schoolbag. In this way, the load is evenly distributed over the body, reducing the risk of back pain and musculoskeletal disorders (11). The proper method of carrying a schoolbag and the recommended weight are based on the body mass index (BMI) and age of the child (16).

Assessing non-specific back pain at school age may provide a closer insight into the possible development of related disorders in adulthood. To avoid the adverse effects of back pain, early prevention is required (17,18). Early childhood and adolescence is the period when a child develops basic healthy habits and related behavioral characteristics. Therefore, a child should be able to develop its physical abilities from an early age, to acquire new skills and knowledge, and most importantly, to learn how to take care of the body (19).

Our aim was to investigate the prevalence of back pain in fifth- and sixth-grade students of the elementary school as well as to analyze whether schoolbag weight and method of carrying schoolbag lead to tiredness and back pain in children. We have also analyzed the BMI in relation to the occurrence of back pain in the fifth- and sixth-grade students.

METHODS

Study groups

The sample consisted of the fifth- and sixth-grade students of the Elementary School Izet Šabić in Sarajevo. A total of 79 students were included, of which 39 students were enrolled in the fifth grade and 40 students in the sixth grade.

This descriptive, cross-sectional study was conducted in April 2017. We included those students who were present in the school at the time of investigation and for which parental consent was obtained. The students who were not present in the school at the time of investigation as well as students diagnosed with musculoskeletal conditions were excluded from the study.

The study was approved by the Ministry of Education, Science and Youth of Sarajevo Canton and the management of the elementary school.

Research instruments

Measurement of schoolbag weight

We measured schoolbag weight for five consecutive days during a work week (Monday to Friday), using the transtheoretical model scale, model M 130. The ratio of mean schoolbag weight to body weight was determined for each student and used to calculate the percentage weight of schoolbag in relation to the body weight.

Measurement of the BMI

We measured the BMI in the fifth- and sixth-grade students of the Elementary School Izet Šabić in Sarajevo. The BMI is an anthropometric measure of body composition (fat) in relation to age and gender and is calculated by dividing body mass in kilograms by the square of the height in meters ($BMI = kg/m^2$). The BMI is used as an indicator of malnutrition, obesity, and risk of developing obesity in children and adolescents (20).

The questionnaire for assessing schoolbag type, method of carrying schoolbag, items included in the bag, and subjective perception of the schoolbag load, described in the study of Kellis and Emmanouilidou (21), was adapted and used in this study, with permission of the authors: The questionnaire included questions related to the age and gender of students, weight, and type of schoolbag, method of carrying schoolbag, sport activities, distance from school to home, as well as means of commuting to school (21).

Statistical analysis

The database including all survey data was created using Microsoft Excel 2013. After data integrity was confirmed, statistical analysis was performed using IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp., Armonk, NY). Data were presented using different measures of descriptive statistics, including arithmetic mean, standard deviation, median, interquartile range [the 25th and 75th percentile], absolute frequency (N), and relative frequency (%).

Normal distribution of continuous variables was assessed graphically (histogram and quantile plot) and by the Kolmogorov–Smirnov test. Categorical variables were analyzed using Pearson's Chi-squared test or Fisher's exact test. Data with normal distribution were compared using analysis of variance (ANOVA) and Dunnett's test, while data without normal distribution were analyzed using ANOVA with a Bonferroni correction. The results are presented in the forms of tables (with 3 decimal places) or graphs. The level of significance was set at $p < 0.05$.

RESULTS

The study included 79 students enrolled in the Elementary School Izet Šabić in Sarajevo, who met the inclusion criteria. Out of the total number, 39 students attended the fifth grade and 40 attended the sixth grade. There were 45.6% boys and 54.4% girls in the total sample. In the fifth grade, there were 46.2% males and 53.8% females, and similar distribution was observed in the sixth grade (45% males and 55% females). No significant difference was observed in the gender distribution between the grades ($\chi^2 = 0.010$; $p = 0.549$; Table 1).

The mean age in the total sample was 11.04 ± 0.85 years. In the fifth grade, the mean age

TABLE 1. Gender distribution in fifth- and sixth-grade elementary school students

	Grade <i>n</i> (%)		Total <i>n</i> (%)
	Fifth	Sixth	
Gender			
Males	18 (46.2)	18 (45.0)	36 (45.6)
Females	21 (53.8)	22 (55.0)	43 (54.4)
Total	39 (100.0)	40 (100.0)	79 (100.0)

$\chi^2=0.010$; $p=0.549$

TABLE 2. Age distribution in fifth- and sixth-grade elementary school students

Grade	N	X	SD	SEM	Minimum	Maximum
Fifth grade	39	10.31	0.46	0.07	10	11
Sixth grade	40	11.75	0.43	0.06	11	12
Total	79	11.04	0.85	0.09	10	12

$F=200.095$; $p=0.001$; SD: Standard deviation; SEM: Standard error of the mean

was 10.31 ± 0.46 years, while in the sixth grade, it was 11.75 ± 0.43 years (Table 2). We observed no statistically significant difference in the BMI between the students of the fifth and sixth grade ($\chi^2 = 0.574$; $p = 0.449$). The BMI $<18 \text{ kg/m}^2$ (indicating malnutrition) had 54.1% of the students in the fifth grade and 42.1% of the students in the sixth grade. The BMI $19\text{--}25 \text{ kg/m}^2$ (normal weight) had 43.2% of fifth-grade students and 57.9% of sixth-grade students. In the overweight category (BMI $26\text{--}30 \text{ kg/m}^2$), there was only one student from the fifth grade and no student from the sixth grade (Figure 1).

The mean schoolbag weight in the fifth grade was $4.01 \pm 0.57 \text{ kg}$, while it was $4.61 \pm 0.86 \text{ kg}$ in the sixth grade, with a significant difference between the two groups ($F = 12.931$; $p = 0.001$). A significant difference in schoolbag weight between the two groups was also observed in relation to the working days of the week, except for Friday ($F = 2.224$; $p = 0.140$).

On Monday, the mean schoolbag weight in the fifth grade was $4.39 \pm 0.94 \text{ kg}$, and it was $4.93 \pm 0.70 \text{ kg}$ in the sixth grade ($F = 8.237$; $p = 0.005$). On Tuesday, the mean schoolbag weight was $4.21 \pm 0.81 \text{ kg}$ in the fifth grade vs. $4.95 \pm 1.12 \text{ kg}$ in the sixth grade ($F = 11.168$; $p = 0.001$); on Wednesday, $75 \pm 0.93 \text{ kg}$ in the fifth grade versus $4.41 \pm 1.39 \text{ kg}$ in the sixth grade ($F = 6.005$; $p = 0.017$); and on Thursday, $3.97 \pm 0.93 \text{ kg}$ in the fifth grade versus $4.64 \pm 1.25 \text{ kg}$ in the sixth grade ($F = 7.196$; $p = 0.009$) (Table 3).

We also observed a significant difference in the method of carrying schoolbag between the fifth- and sixth-grade students ($\chi^2 = 6.344$; $p = 0.002$). Among the students in the fifth grade, 94.9% carried the bag on the shoulders, 2.6% on one shoulder and 2.6% across the body. In the sixth grade group, 62.5% students carried the bag on the shoulders, 30% on one shoulder, and 7.5% on the side of the body. No student in the sixth grade carried the bag across the body (Figure 2).

Overall, most students (50.6%) reported sometimes feeling tiredness while carrying the schoolbag. This feeling was reported by 64.1% of fifth-grade students and 37.5% of sixth-grade students, with no significant difference between the two groups ($\chi^2 = 3.001$; $p = 0.083$). Frequent, schoolbag-related tiredness was reported by 25.6% of students in the fifth and 32.5% of students in the sixth grade. Among the fifth-grade students, 5.1% reported that they never felt tired while carrying the schoolbag, and the same percentage of students was always tired. In the sixth-grade group, 10% of students never felt tired and 20% always felt tired while carrying the schoolbag (Table 4).

In the total sample, the majority of the participants (64.6%) reported occasional back pain while carrying the bag in the last 4 weeks, and no significant difference was observed between the two groups ($\chi^2 = 0.671$; $p = 0.413$). In the fifth grade, 23.1% of students and in the sixth grade 17.5% of students reported no schoolbag-related back pain. Frequent schoolbag-related

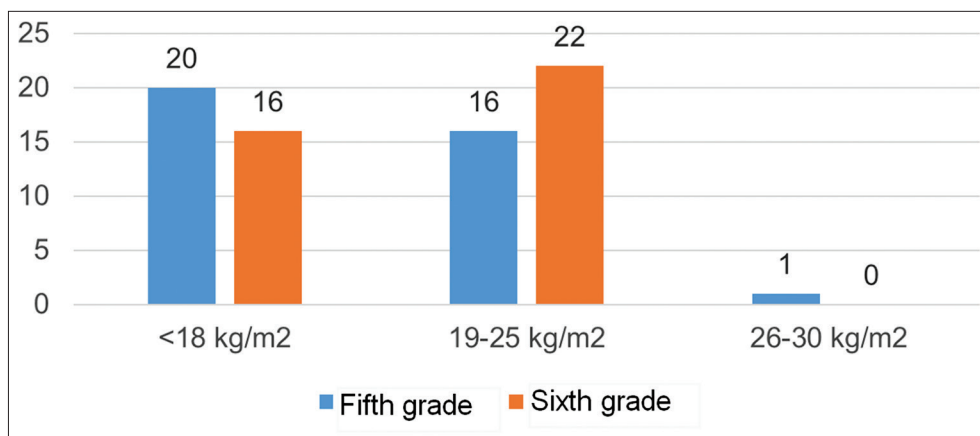


FIGURE 1. Groups of fifth- and sixth-grade elementary school students according to the body mass index.

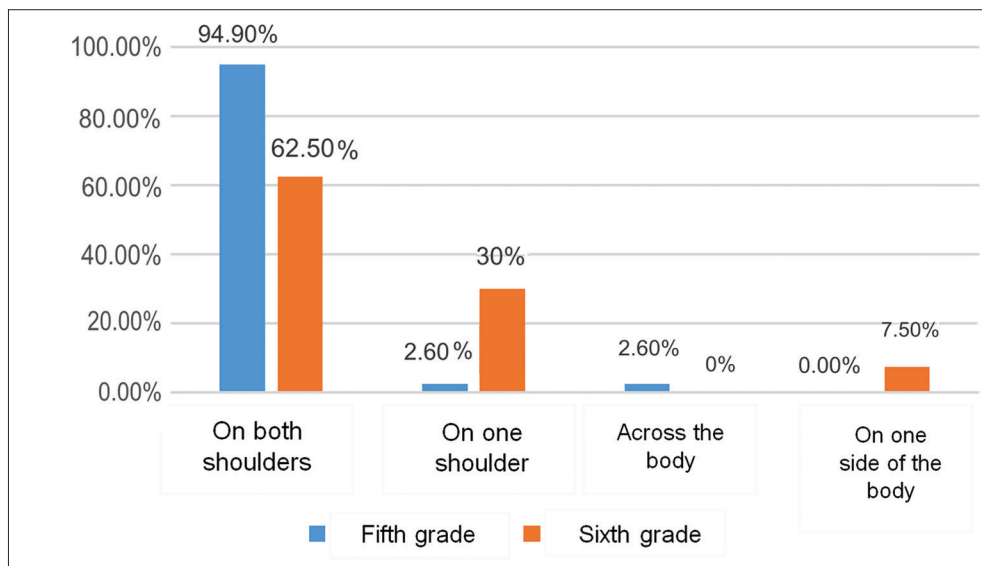


FIGURE 2. Methods of carrying schoolbag among fifth- and sixth-grade students of elementary school.

TABLE 3. Mean schoolbag weight (kg) in relation to workdays of the week

Day of week	N	X (kg)	SD	SEM	Minimum	Maximum
Monday						
Fifth	39	4.39	0.94	0.15	2.50	6.25
Sixth	40	4.93	0.70	0.11	3.50	6.50
F=8.237; p=0.005						
Tuesday						
Fifth	39	4.21	0.81	w0.13	2.50	6.75
Sixth	40	4.95	1,12	0.17	3.00	7.00
F=11.168; p=0.001						
Wednesday						
Fifth	39	3.75	0.93	0.14	1.75	6.50
Sixth	40	4.41	1,39	0.22	2.25	7.50
F=6.005; p=0.017						
Thursday						
Fifth	39	3.97	0.93	0.14	2.25	6.25
Sixth	40	4.64	1,25	0.19	2.50	7.00
F=7.196; p=0.009						
Friday						
Fifth	39	3.73	0.98	0.15	2.00	5.75
Sixth	40	4.09	1,13	0.18	2.00	6.00
F=2.224; p=0.140						
Total						
Fifth	39	4.01	0.57	0.09	2.79	5.70
Sixth	40	4.61	0.86	0.13	2.90	6.04
F=12.931; p=0.001						

SD: Standard deviation; SEM: Standard error of the mean

back pain was experienced by 10.3% of fifth grade and 12.5% of sixth-grade students (Table 5).

The mean schoolbag weight/body mass ratio was $9.94 \pm 2.70\%$ (4.8–16.3%) in the overall sample, with no significant difference in the ratio between the two groups ($9.67 \pm 2.72\%$ in the fifth and $10.21 \pm 2.68\%$ in the sixth grade; $F = 0.765$; $p = 0.384$).

While there was no significant difference in the body mass of students between the fifth- and sixth-grade groups ($p = 0.304$), there was a significant difference in schoolbag weight ($p = 0.001$), i.e., the weight of schoolbag was higher in sixth grade (Table 6).

The students from the fifth and sixth grade were compared in relation to schoolbag weight according

TABLE 4. Feeling of tiredness related to schoolbag

	Grade n (%)		Total n (%)
	Fifth	Sixth	
Feeling of schoolbag-related tiredness			
Never	2 (5.1)	4 (10.0)	6 (7.6)
Sometimes	25 (64.1)	15 (37.5)	40 (50.6)
Often	10 (25.6)	13 (32.5)	23 (29.1)
Always	2 (5.1)	8 (20.0)	10 (12.7)
Total	39 (100.0)	40 (100.0)	79 (100.0)

$\chi^2=3.001$; $p=0.083$

TABLE 5. Occurrence of schoolbag -related back pain in the last 4 weeks

	Grade n (%)		Total n (%)
	Fifth	Sixth	
Occurrence of back pain due to schoolbag			
Never	9 (23.1)	7 (17.5)	16 (20.3)
Sometimes	25 (64.1)	26 (65.0)	51 (64.6)
Often	4 (10.3)	5 (12.5)	9 (11.4)
Always	1 (2.6)	2 (5.0)	3 (3.8)
Total	39 (100.0)	40 (100.0)	79 (100.0)

$\chi^2=0.671$; $p=0.413$

TABLE 6. Schoolbag weight (absolute and relative) in relation to the body mass of students

Parameters	N	X	SD	SEM	Minimum	Maximum
Schoolbag weight (kg)						
Fifth grade	39	4.01	0.57	0.09	2.79	5.70
Sixth grade	40	4.61	0.86	0.13	2.90	6.04
Total	79	4.32	0.73	0.11	2.90	6.04
$F=12.931$; $p=0.001$						
Child body mass (kg)						
Fifth grade	39	44.36	11.62	1.86	29	80
Sixth grade	40	46.73	8.49	1.34	31	66
Total	79	45.56	10.16	1.14	29	80
$F=1.071$; $p=0.304$						
Schoolbag weight (%)						
Fifth grade	39	9.67	2.72	0.43	4.80	16.30
Sixth grade	40	10.21	2.68	0.42	5.80	15.80
Total	79	9.94	2.70	0.30	4.80	16.30

$F=0.765$; $p=0.384$. SD: Standard deviation; SEM: Standard error of the mean

to the body mass, i.e., $\leq 10\%$ or $>10\%$ of the body mass of the student. There was no significant difference between the fifth- and sixth-grade students ($p = 0.546$) with regard to the schoolbag weight (%), and in both groups, about half of the students (48.5% in the fifth grade and 50% in the sixth grade) carried heavier schoolbags ($>10\%$ of body mass) (Figure 3).

A higher mean weight of schoolbag (%) was significantly more frequent in students who reported always feeling tired ($11.03 \pm 2.74\%$) compared to those who did not feel tired while carrying the schoolbag ($8.41 \pm 2\%$) ($p = 0.034$), thus confirming the association between the weight of schoolbag and the occurrence of tiredness in children of school age (Table 7).

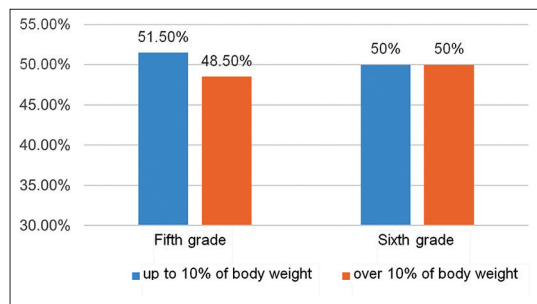


FIGURE 3. The percentage of students in each grade in relation to the weight of schoolbag (%), i.e., $\leq 10\%$ or $>10\%$ of the body mass.

Similarly, back pain was more common in students with a higher mean weight of schoolbag (%) compared to those with lower schoolbag weight ($p = 0.042$). The mean schoolbag weight was $10.90 \pm 3.81\%$ in students who reported persistent back pain while carrying the bag (Table 8).

There was also a significant difference in the occurrence of back pain in relation to gender, where back pain was more frequent in female compared to male students ($p = 0.005$). In our study group, the BMI was not associated with the occurrence of back pain while carrying schoolbag ($p = 0.457$) (Table 9). The type of schoolbag and method of carrying schoolbag were also not associated with the occurrence of back pain in our group ($p > 0.05$) (Table 10).

DISCUSSION

Our study group comprised 45.6% boys (46.2% males in the fifth grade and 45% in the sixth) and 54.4% girls (53.8% females in the fifth grade and 55% in the sixth). The average age in the total sample was 11.04 ± 0.85 years.

The BMI $<18 \text{ kg/m}^2$ had 54.1% of the students in the fifth grade and 42.1% in the sixth grade. The BMI $19\text{--}25 \text{ kg/m}^2$ had 43.2% of the fifth-grade students and 57.9% of the sixth-grade students. Only one student from the fifth grade had BMI $26\text{--}30 \text{ kg/m}^2$, and no student from the sixth grade was in that

TABLE 7. Schoolbag weight (%) in relation to feeling of tiredness

Schoolbag-related feeling of tiredness	N	X (%)	SD	SEM	Minimum	Maximum
Never	6	8.41	2.00	0.82	4.80	10.50
Sometimes	40	10.06	2.78	0.44	5.80	16.30
Often	23	9.67	2.62	0.54	6.40	15.80
Always	10	11.03	2.74	0.86	7.90	15.70
Total	79	9.94	2.70	0.30	4.80	16.30

F=8.142; $p=0.034$. SD: Standard deviation; SEM: Standard error of the mean

TABLE 8. Schoolbag weight (%) in relation to back pain

Schoolbag-related back pain	N	X (%)	SD	SEM	Minimum	Maximum
Never	16	9.66	2.66	0.66	4.80	14.30
Sometimes	51	9.95	2.75	0.38	5.80	16.30
Often	9	10.07	2.53	0.84	7.70	15.80
Always	3	10.90	3.81	2.20	6.50	13.20
Total	79	9.94	2.70	0.30	4.80	16.30

F=7.041; $p=0.042$. SD: Standard deviation; SEM: Standard error of the mean

TABLE 9. Gender and BMI in relation to back pain

Parameters	Occurrence of schoolbag-related back pain in the last 4 weeks				<i>p</i>
	Never	Sometimes	Often	Always	
Gender (%)					
Male	11 (68.8)	24 (47.1)	0 (0.0)	1 (33.3)	0.005
Female	5 (31.3)	27 (52.9)	9 (100.0)	2 (66.7)	
BMI (kg/m ²)	19.79±4.32	18.43±3.07	19.77±3.40	18.84±3.41	0.457

BMI: Body mass index

TABLE 10. Type of schoolbag and method of schoolbag carrying in relation to back pain

Parameters	Occurrence of schoolbag-related back pain in the last 4 weeks (%)				<i>p</i>
	Never	Sometimes	Often	Always	
Type of schoolbag					
Backpack	16 (21.3)	48 (64.9)	7 (9.5)	3 (4.1)	0.166
Single-trap bag	0 (0.0)	3 (60.0)	2 (40.0)	0 (0.0)	
Method of carrying schoolbag					
On both shoulders	12 (19.4)	39 (62.9)	8 (12.9)	3 (4.8)	0.384
On one shoulder	3 (23.1)	9 (69.2)	1 (7.7)	0 (0.0)	
Across the body	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	
On one side of the body	0 (0.0)	3 (100.0)	0 (0.0)	0 (0.0)	

category. There was no statistically significant difference in the BMI between the students of the fifth and sixth grade.

Zaidi et al. (22) investigated association of musculo-skeletal pain with heavy bag packs in schoolchildren. In their group consisting of 56% girls and 44% boys of average age of 12 years, 48% of students had BMI lower than normal (BMI <18 kg/m²) indicating malnutrition in those children, 52% had normal BMI, between 19 kg/m² and 25 kg/m², and no student was overweight (BMI 26–30 kg/m²) (22). These results are in agreement with ours.

In our group, the mean schoolbag weight in the fifth grade was 4.01 ± 0.57 kg, and it was significantly higher (4.61 ± 0.86 kg) in the sixth grade ($F = 12.931$; $p = 0.001$). A significant difference in schoolbag weight between the fifth- and sixth-grade students was also observed in relation to the working days of the week, except for Friday ($F = 2.224$; $p = 0.140$).

Paušić et al. investigated the effects of schoolbag weight on back pain in students from the first to fourth grade of elementary school. They showed that a higher weight of schoolbag was significantly associated with higher grades, i.e., in the first grade, the

mean schoolbag weight was 4.92 kg, in the second 5 kg, in the third 4.54 kg, and in the fourth, it was 5.28 kg (23). Considering that Paušić et al. (23) used a similar methodology as in our study, we can conclude that the results of the two studies are in agreement.

Moreover, in the study of Kellis and Emmanouilidou (21), which provided the questionnaire used in our study, the mean schoolbag weight was 5.30 ± 1.25 kg, in 703 boys and girls from Greece, aged 6 to 14 years. They also showed that the weight of schoolbag was significantly higher in groups with older students compared to groups with younger students (21).

Most of our students carried the bag on both shoulders, i.e., 94.9% students in the fifth grade and 62.5% in the sixth grade. In the study of Paušić et al. (23), 93.1% of the students wore the bag on both shoulders. Similar results were reported by two other studies that investigated back pain in schoolchildren (24,25). On the other hand, El-Nagar and Mady reported that the majority of students who felt back pain in their study carried the schoolbag on one shoulder or in one hand (6), which is not in agreement with our results.

Most of the students from both of our groups (50.6%) reported that they sometimes felt tiredness while carrying the schoolbag (64.1% of fifth-grade students and 37.5% of sixth-grade students), with no significant difference between the two groups. Frequent tiredness was reported by 29.1% of students in the total sample (25.6% in the fifth and 32.5% in the sixth grade). Similar results were reported by Kellis and Emmanouilidou (21), i.e., most of their participants (28.2%) felt tiredness often or sometimes, while carrying the schoolbag.

The majority of the students in our group (64.6%) reported occasional back pain while carrying the bag in the last 4 weeks (64.1% in the fifth grade and 65.0% in the sixth grade). In the total sample, 20.3% of students reported no back pain (23.1% of fifth-grade students and 17.5% of sixth-grade students). Frequent back pain was experienced by 11.4% of students (10.3% of fifth grade and 12.5% of sixth-grade students). In a cross-sectional study on 586 Iranian schoolchildren aged 12–14 years, Dianat et al. (26) showed that the students of higher grades reported feeling of pain while carrying the schoolbag significantly more frequently than the lower grades students (26). Their results correlated with ours to some extent.

In our study, the mean schoolbag weight/body mass ratio was $9.94 \pm 2.70\%$ (4.8–16.3%) in the overall sample, with no significant difference in the ratio between the fifth- and sixth-grade groups. Furthermore, there was no significant difference in the body mass of students between the fifth- and sixth-grade groups, but schoolbag weight was significantly higher in the sixth-grade group. This may be explained by the fact that schoolbag weight depends on class schedule, where students of higher grades usually have more school subjects and consequently more books and other school items to carry. In general, the weight of schoolbag should not exceed 10% of the child body mass (13).

We observed no significant difference between the fifth- and sixth-grade students in relation to the schoolbag weight ($\leq 10\%$ or $>10\%$ of child body mass), and in both groups, about half of the students (48.5% in the fifth and 50% in the sixth grade) carried schoolbags weighing more than 10% of the body mass. Two other studies on the

association between schoolbag weight and back pain in children showed that majority of students carried heavier schoolbags ($>10\%$ of the body mass) (27,28). Overall, these results indicate that schoolchildren are often required to carry schoolbags that are heavier than recommended.

A higher mean weight of schoolbag (%) was significantly more frequent in students who reported feeling tired constantly compared to those who did not feel tired while carrying the schoolbag, confirming the relationship between the weight of schoolbag and the occurrence of tiredness in schoolchildren. This is probably because the body tries to compensate for the load on the spine caused by a heavy schoolbag, leading to higher levels of tiredness.

Consistently, back pain was more common in our students with a higher mean weight of schoolbag (%) compared to those with lower bag weight. The mean schoolbag weight was $10.90 \pm 3.81\%$ in the students who reported persistent back pain. In agreement with our findings are the results of Adeyemi et al. (28) who also demonstrated the significant effect of heavy schoolbag on the degree of feeling back pain in 615 schoolchildren aged between 7 and 12 years.

In our group, the occurrence of back pain was related to the gender, and back pain was more frequent in female compared to male students. Comparably to our results, Aprile et al. (29) demonstrated, in a group of 5318 healthy students aged 6–19 years, that schoolbag-related pain was significantly more frequent and more severe in girls compared to boys (29).

CONCLUSION

Almost two-thirds (64.6%) of fifth- and sixth-grade schoolchildren experience occasional back pain due to the weight of the schoolbag, while 11.4% experience frequent back pain. Half of the schoolchildren carry the schoolbags weighing more than 10% of the student's own weight and heavy schoolbags are more frequently associated with tiredness and back pain. Back pain associated with weight of the schoolbag occurs more frequently in female students. No association was observed between the method of carrying the schoolbag and back pain.

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