



Weight of School Bags and its Relationship with Musculoskeletal Disorders in Elementary School Students of Kerman, Iran in 2014

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Abstract

Background: Heavy school bags increase students' musculoskeletal disorders. According to instructions, weight of school bags should not exceed 10% of students' body weight. This study aimed at investigating the ratio of school bags weight to students' body weight and evaluating the prevalence of musculoskeletal disorders.

Methods: In this cross-sectional study, 723 students were selected from six elementary schools in Kerman. Such information as the prevalence of musculoskeletal disorders and demographic characteristics were collected using a researcher-made questionnaire.

Results: The highest prevalence of musculoskeletal disorders was related to shoulders, neck, and waist. Indeed, weight of 50.1% of students' bags was over 10% of their body weight. The results showed a significant relationship between the prevalence of musculoskeletal disorders and school bags' weight to students' weight ratio ($P = 0.03$). Additionally, such disorders were significantly more frequent among students of higher grades.

Conclusions: This study revealed a significant relationship between school bags' weight and musculoskeletal disorders.

Keywords: Body Weight, Elementary School, Musculoskeletal Diseases

1. Background

Musculoskeletal disorders refer to any disorder in muscles, tendons, tendon sheath, peripheral nerves, joints, bones, ligaments, and blood vessels caused either by repetitive stress in the long run or a sudden acute strike, such as sliding or falling (1).

Increasing risk of chronic musculoskeletal disorders in students due to heavy school bags and inappropriate carriage may cause problems in spine development (2, 3). In previous studies, females with an average age of 10.5 years old and males with average age of 12.5 years old were reported to experience their first backaches (4). Lifting and carrying heavy bags causes forward deviation of the spine. Students' inappropriate posture results in pain and appearance of symptoms of discomfort in the neck, shoulders, and back (5, 6). Studies have shown that 55% of students carry school bags weighing more than their body weight (10% to 15% of their total body weight) (7). Since their body is growing and developing, they are more sus-

ceptible to musculoskeletal disorders and spinal pains (8). Although different studies have reported a range of 5% to 20% as the safe range (9), 10% is usually considered to be the cut-off (10-13). According to a study by Beheshtipoor, weight of school bags of 35% of primary school students in Shiraz exceeded 10% of their body weight (13).

Weak musculoskeletal system in students, who are growing will be exacerbated as the result of carrying heavy bags and writing practice in an inappropriate posture (14, 15). Other factors involved in appearance of such disorders include gender, individual differences in muscular and skeletal framework and adipose tissue, unstandardized way of carrying school bags, and unsuitability of school desks for students' bodies (16-20). Hosseini et al. (2014) found that neck, wrist, upper part of the body, and arm were the most painful spots in students with musculoskeletal disorders (18). In the same line, Shamsodini et al. reported that in secondary schools, the highest rates of musculoskeletal disorders were related to shoul-

ders (37.9%), neck (28.5%), and waist (17.4%). In addition, a significance difference was found between the students with and without musculoskeletal disorders regarding the mean weight of school bags (10).

Based on an inquiry from Kerman department of education, about 65,000 female and male students are studying in primary schools of Kerman, Iran. However, no studies have assessed musculoskeletal disorders and the ratio of school bags weight to students' body weight. Hence, the present study aimed at evaluating the above-mentioned subject.

2. Methods

In this descriptive cross-sectional study, multi-stage cluster sampling method was applied to collect information. In doing so, an inquiry by Kerman department of education was used to determine the number of all-female and male primary schools in educational regions "one" and "two". After that, three all-female and male schools were randomly selected. Then, considering the study sample size, some students from first to sixth grades were recruited in the research. According to Beheshtipoor's study in Shiraz and by considering the prevalence of students' school bags weight that exceeded the permissible level (35%), a 350-subject sample size was determined for the study. Finally, by considering a design effect of two, the sample size was increased to 700 students and 723 students participated in the study. Selection was completely randomized and based on students' lists.

The inclusion criteria of the study were being a primary school student, lacking the symptoms of musculoskeletal disorders, and having experienced no accidents affecting the musculoskeletal system.

A tape measure with millimeter accuracy was used to measure the students' heights. A digital scale was used to weigh the students and their bags. Moreover, Nordic body map was used to collect information on the prevalence and rate of perceived pain as a result of musculoskeletal disorders. A visual analogue scale in form of a researcher-made questionnaire was also applied to assess the experienced pain in body organs due to musculoskeletal disorders (Figure 1). Demographic characteristics, unstandardized way of carrying the school bag, way of carrying it, repeated perceived pain in the body, students' evaluation of the weight of their bags, watching TV, and playing computer games were asked and recorded.

To check the validity and reliability of the study questionnaire, five experts were asked to express their opinions about clarity, relevance, and simplicity of the questions using a four-point scale. Accordingly, content validity index (CVI) of the questionnaire was 0.97. Besides, the reliability

of the questionnaire was assessed by the test-retest method and the difference between the results of the two series of questionnaires completed by the researchers was not significant ($P < 0.05$).

Data collection was performed during the second half of the academic year of 2013 to 2014. The day of measuring school bags' weight was randomly selected to prevent the impact of heavy school bags on a particular day. The data were analyzed using the SPSS statistical software, version 20. Level of significance was 0.05.

3. Results

The study population included 362 males (49.5%) and 370 females (50.5%). The mean age of the participants was 9.53 (SD = 1.77) years, ranging from 7 to 13 years.

The students' mean weight and mean height, schools bags' weight, bags' weight to students' weight ratio, and significance level of mean difference in males and females using the t-test are presented in Table 1.

Table 1. Means (SD) of the Students' Weight, School Bags' Weight, and Bags' Weight to Students' Weight Ratio in Males and Females (Girls = 370, Boys = 362)

	Mean \pm Std. Deviation	T	P Value ^a
Weight, kg		0.679	0.497
Girls	33.3 \pm 12.1		
Boys	33.9 \pm 11.8		
Mean weight of school bags, kg		-0.754	0.451
Girls	3.3 \pm 1.3		
Boys	3.2 \pm 1.2		
Mean height, cm		0.263	0.792
Girls	137.5 \pm 12.8		
Boys	137.8 \pm 12.4		
Bags' weight to students' weight ratio		-1.586	0.113
Girls	10.8 \pm 4.8		
Boys	10.3 \pm 4.2		

^aT-test.

The weight of school bags of 367 students (50.1%) exceeded 10% of their body weight. Among these students, 48% ($n = 176$) were males and 52% ($n = 191$) were females, and the results of chi-square test showed that this difference was not statistically significant (OR = 1.22, CI = 0.84 - 1.5, $P = 0.19$).

The students' mean height and mean weight, bags' weight, and bags' weight to students' weight ratio based on gender and grade are presented in Table 2.

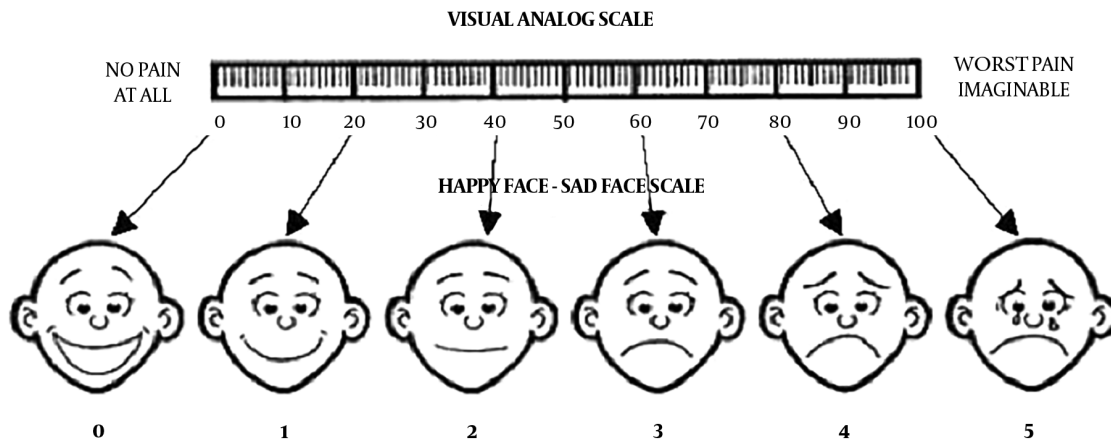


Figure 1. visual analogue scale applied to assess the experienced pain in student' organs due to musculoskeletal disorders

Table 2. Mean (SD) of the Students' Height and Weight, Bags' Weight, and Bags' Weight to Students' Weight Ratio Based on Gender and Grade

	Frequency,%	Students' Height		Students' Weight		School Bags' Weight		Bags' Weight to Students' Weight Ratio	
		Mean ± SD	Min-Max	Mean ± SD	Min-Max	Mean ± SD	Min-Max	Mean ± SD	Min-Max
First-graders	628.5	122.4 ± 5.3	112.3-134	24.5 ± 5.7	17.5-40.5	2.7 ± 0.7	1.4-4.3	Girls 11.6 ± 3.1	6.5-2.4
Second-graders	587.9	129.5 ± 4.9	120-139	26 ± 5	18.4-46.4	2.8 ± 0.83	1.6-6.4	11 ± 3	3.8-18.8
Third-graders	598.1	136.7 ± 9	120-165	30 ± 7.8	18.4-52.6	3.4 ± 1.2	1-7.5	11.6 ± 5	2.7-26.6
Fourth-graders	618.3	122.4 ± 8.5	122-157	31.7 ± 8.1	20.3-54.8	3.9 ± 1.4	1.8-7.8	12.4 ± 5.6	3.9-32.1
Fifth-graders	608.2	144.1 ± 10.7	111-160	39.4 ± 10.6	23-63	3.3 ± 1.3	0.7-6.8	9 ± 4	1.1-20.1
Sixth-graders	709.6	151.9 ± 9.5	125-168	45.6 ± 14.6	21.3-106.5	3.6 ± 1.6	0.5-8.2	8.7 ± 5.3	1.3-27.9
First-graders	628.5	123.8 ± 7.2	96.4-141	24.7 ± 5.3	15.3-40.2	2.6 ± 0.74	1-4.5	Boys 11.3 ± 3.8	3.15-18.3
Second-graders	598.1	128.7 ± 6.2	115-145	26.6 ± 5.2	15-42.6	3.1 ± 1.1	1.1-7	12 ± 4.1	4.1-28
Third-graders	577.8	136.6 ± 7.3	120.7-155	32.5 ± 9.3	20.4-55	3.2 ± 1.1	1.2-6.5	10.5 ± 4	4.8-28.9
Fourth-graders	598.1	137.8 ± 7	119-158	32.2 ± 7.2	22.5-60	3.1 ± 1.2	1.1-7.2	10.1 ± 3.8	2-19.4
Fifth-graders	618.3	146.5 ± 9.4	121-169	40.1 ± 10.9	26.5-85.8	3.6 ± 1.3	1.3-8.2	9.7 ± 4.6	2.9-23.7
Sixth-graders	709.6	152.4 ± 7.6	130-168	46.7 ± 13.1	28.5-79.5	3.5 ± 1.2	1-7	8 ± 3.4	1.6-18.9
Females	37050.5	137.5 ± 12.7	111-168	33.3 ± 12	17.5-106	3.3 ± 1.3	0.5-8.2	Total 10.8 ± 4.7	1.1-32.1
Males	36249.5	137.8 ± 12.4	96.4-168	33.9 ± 11.8	15-85.8	3.2 ± 1.2	1-8.2	10.3 ± 4.1	1.6-28.9
Total	732100	137.7 ± 12.6	96.4-168	33.7 ± 12	15-106.6	3.3 ± 1.3	0.5-8.2	10.5 ± 4.5	1.13-32.1

The gender and grade had a significant relationship with musculoskeletal disorders with P-value for the chi-square test of 0.003 and 0.001, respectively. The prevalence of left-handedness was 9.3% (n = 68). The results showed no significant relationships between musculoskeletal disorders and dominance of hands (P=0.127). Age, height, student's weight and school bag's weight were significantly associated with musculoskeletal disorders based on the t-test (Table 3).

The students whose bag weight to body weight ratio exceeded 10% were more susceptible to musculoskeletal disorders compared to those whose bag weight to body weight ratio was below 10% (P = 0.04). Also, the risk of

musculoskeletal disorders was 1.43 times higher in children whose bag weight exceeded 10% of their body weight compared to those whose bag weight was less than 10% of their body weight (OR = 1.43, CI:1.1-1.99). Additionally, the rate of musculoskeletal disorders was 1.44 folds higher in females than in males (OR=1.55, CI=1.16-2.07), and the difference was statistically significant (P = 0.018) (Table 3).

The students spent 1.8 hours (SD=1.1) doing their homework, one hour (SD = 1) watching TV, and 1.7 hours (SD = 1.2) working with the computer. Duration of doing homework and duration of watching TV were significantly related to musculoskeletal disorders (Table 3).

The highest rates of musculoskeletal disorders were re-

Table 3. The Relationship Between Univariate Variable and Musculoskeletal Disorders in Participant Students

Variable/Sub Group	With Musculoskeletal Disorders (n = 194)	Without Musculoskeletal Disorders (n = 538)	P Value
Gender^a			0.018
Boy	109 (14.9)	253 (34.6)	
Girl	85 (11.6)	285 (38.9)	
Grade^a			< 0.001
First	51 (7.0)	73 (10.0)	
Second	47 (6.4)	70 (9.6)	
Third	32 (4.4)	84 (11.5)	
Fourth	26 (3.4)	94 (17.5)	
Fifth	30 (3.6)	91 (12.4)	
Sixth	8 (1.1)	126 (17.2)	
Dominance hand^a			0.31
Right	180 (24.8)	484 (66.1)	
Left	14 (1.9)	54 (7.4)	
Standardized way of carry of school bag^a			0.39
Yes	160 (21.9)	450 (61.5)	
No	34 (4.6)	88 (12)	
Age^b	8.7 (1.5)	9.8 (1.7)	< 0.001
Height^b	133.3 (11.4)	139.3 (12.6)	< 0.001
Student's weight^b	30.7 (10.7)	34.7 (12.2)	< 0.001
School bag's weight^b	3.2 (1.2)	3.3 (1.3)	0.34
body weight to Bag weight ratio^a	11.1 (4.1)	10.4 (4.5)	0.04
Duration of doing homework^b h	1.6 (1.05)	1.9 (1.05)	0.004
Duration of working with computer^b h	0.89 (0.9)	1.04 (1.08)	0.08
Duration of watching TV^b h	1.45 (1.08)	1.8 (1.3)	0.001

^aChi-square test.^bIndependent Samples T-test.

lated to shoulders (63.1%, n = 462), neck (24.7%, n = 181), and back (18%, n = 132). Out of 73.5% of the cases (n = 537), who had experienced at least one musculoskeletal disorder, 4.8% (n = 35) experienced pain on a yearly basis, 12.4% (n = 91) experienced pain on a monthly basis, 44.8% (n = 328) experienced pain on a weekly basis, 4.4% (n = 32) experienced pain on a daily basis, and 1.7% (n = 52) experienced

pain continually. Only 194 students (26.8%) did not experience any musculoskeletal disorders.

As the students' grades increased, the rate of musculoskeletal disorders also increased; (Diagram 1) these differences were statistically significant (chi-square test $P < 0.001$).

In this study, 83.3% of the students (n = 610) had backpacks with shoulder straps, 8.3% (n = 61) had wheeled backpacks, 3.7% (n = 27) had one-strap backpacks, and 4.7% (n = 34) had briefcases. According to the results, 12 (6.1%), 112 (15.3%), 265 (36.2%), 290 (39.9%), and 53 (7.2%) students believed that their bags were very light, light, average, heavy, and very heavy, respectively. There was a significant relationship between being afflicted with musculoskeletal disorders and students' perception of their school bags' weight ($P < 0.001$). The results of the t-test indicated that the students' perception of heaviness of their bags was significantly related to the ratio of their bags' weight to their weight ($P < 0.001$). The intensity of experienced pain in the students' pain sites was assessed using a face pain analogue scale. Severe pain (level 5) was mostly experienced in the shoulders (6.5%), neck (5.5%), and back (10.6%).

Logistic regression with backward condition was applied to evaluate factors affecting musculoskeletal disorders. The variables with a P value of less than 0.2 that were entered in the model were age, gender, student's weight, school bag's weight, grade, body weight to bag weight ratio, time spent working with the computer, time spent doing homework, and time spent watching TV. The odds ratio of musculoskeletal disorders in females was 1.5 times higher than males (P value = 0.006 OR = 1.53). Study on fourth-graders and sixth-graders, duration of watching TV, and bag weight to body weight ratio exceeded 10% and had an antagonistic effect on MSDs (Table 4).

4. Discussion

According to Ontario chiropractic association of Canada, weight of school bags of primary school students should not exceed 10% of their body weight (21). The results showed that over 50% of the students carried bags weighing more than 10% of their body weight. Odds of musculoskeletal disorders was significantly higher in fourth-graders and sixth-graders compared to first grade students (OR = 2.14 and 3.42, respectively). Iyer et al. (2011) reported that 55% of students carried bags weighing more than 10% of their body weight (6). Similar studies showed that 30% to 50% of elementary school students carried bags weighing more than 10% of their body weight (22-25). Whittfield et al. reported that the average weight of bags was 13.2% of students' body weight in third graders and 10.3% of their body weight in sixth graders. Among

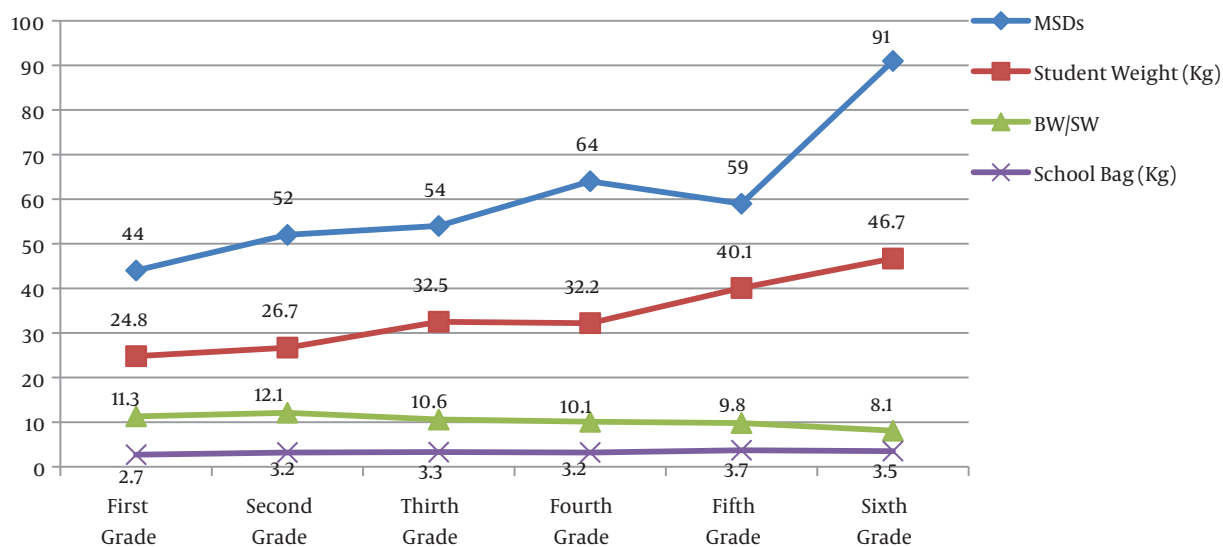


Figure 2. Means students' weight, school bags' weight, and bags' weight to students' weight ratio (732 students)

Table 4. Predictor Factors That Influenced Musculoskeletal Disorders in Logistic Regression Model

Variable ^a /Sub Group	OR	95% CI	P Value
Gender			
Male			
Female	1.53	1.13 - 2.08	0.006
Grade			
First	-	-	-
Second	1.50	0.87 - 2.57	0.14
Third	1.54	0.86 - 2.78	0.15
Fourth	2.14	1.17 - 3.90	0.01
Fifth	1.57	0.80 - 3.90	0.19
Sixth	3.42	1.59 - 7.37	0.002
Duration of watching TV	1.20	1.06 - 1.36	0.004
body weight to Bag weight ratio	1.08	1.01 - 1.16	0.04

^aReference in categorical variable was first variable.

these students, 77.1% had experienced musculoskeletal disorders, such as pain in their necks, shoulders, and backs (26). This might be attributed to bags' net weights, students' inability to distinguish which textbooks or materials to carry based on daily schedules, and parents' inattention to their children's bags' contents.

In this study, the highest rates of musculoskeletal disorders were related to shoulders, neck, and back. These results are consistent with the study of Shamsoddini et al. (10), in which the highest frequency of musculoskeletal disorders was related to shoulders (37.9%), neck (28.5%), and back (17.5%).

In a study by Beheshtipoor, the prevalence of pain was 45% in shoulders and neck and approximately 6% in the back (11). In the same line, VanGent conducted a study on 745 students and indicated that the prevalence rates of neck and/or shoulder complaints and also back complaints were reported in about 45% of young adolescents. Severe complaints of neck and/or shoulder pain were reported by 6%, and severe back complaints by 7% of the school children (24). Negrini et al. in Milan, Italy showed that 46.1% of students had back pain and 56.7% complained about fatigue caused by the weight of school bags (22-24). Another result was a significant correlation between gender and musculoskeletal disorders and higher prevalence of musculoskeletal disorders in females than males. Also Zamanian et al. (2014) in their studies reported that female students due to weaker physical structure and muscle tissue susceptibility experienced more musculoskeletal disorders than males (25). Similarly, Zakeri et al. (2016) reported age and gender as a significant factor in musculoskeletal disorders in elementary school students (26).

In the current study, the students' perception of heaviness of their school bags was correct and in line with the ratio of bags' weight to their weight. In a study by Farhood, 31% of students assessed their bags weight to be normal, 28.5% reported light weight, and 40.1% thought they were heavy. Moreover, 80.4% of the students, who carried bags of more than 5 kg and 19.6% of those, who carried bags of less than 5 kg suffered from pain in their upper backs (27).

Overall, carrying heavy school bags and the way they were carried were effective factors in the incidence of musculoskeletal disorders. Besides, there was a significant relationship between bags' weight to students' weight ratio and musculoskeletal disorders.

4.1. Conclusions

In addition to gender and how to spend leisure time, bag weight to body weight ratio exceeded 10% and an unstandardized way of carrying school bags had an antagonist effect on student's muscular skeletal system.

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