

School Bag Weight and the Occurrence of Shoulder, Hand/Wrist and Low Back Symptoms among Iranian Elementary Schoolchildren

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ABSTRACT

Background: Schoolchildren usually use school bags to carry their school materials. Carrying heavy school bags can cause several problems such as musculoskeletal problems among schoolchildren. The aim of this study was to investigate the association between the weight of school bags and the occurrence of low back, shoulder and hand/wrist symptoms among primary school children.

Method: This cross-sectional, descriptive-analytical study was conducted among a sample of 307 elementary school children in Tabriz, Iran. Data were collected using a questionnaire and from measurement of the school bag weight, body weight and height of each participant. Data were analysed using SPSS software.

Results: The average load carried by schoolchildren was 2.9 kg, representing approximately 10% of the children's body weight. Girls and lower grade children carried a greater percentage of their body weights. Approximately 86% of the children reported some kind of musculoskeletal symptoms. The occurrence of shoulder, wrists/hands, and low back pain among schoolchildren was 70%, 18.5% and 8.7%, respectively. The results of binary logistic regression indicated that the school bag weight (expressed as a percentage of body weight) was only significantly associated with hand/wrist symptoms ($P<0.05$). Girls were more likely to complaint from low back pain than boys were. Age was significantly negatively associated with hand/wrist symptoms. Body mass index was also significantly associated with shoulder symptoms.

Conclusion: The results indicate a high prevalence of musculoskeletal symptoms among elementary schoolchildren. Preventive measures and appropriate guidelines with regard to safe load carriage in schoolchildren are therefore needed to protect this age group.

Keywords: School bag; Load carriage; Musculoskeletal symptoms; Weight limit; Children

Introduction

In recent years, there has been an increasing attention to the amount of loads carried by schoolchildren to and from school [1-10]. The mean school bag weight

reported in previous studies in other countries has a range between 4.7 kg and 9.3 kg [1, 3, 11-17]. Effectively, the relative load carried by school children expressed as

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percentage of body weight (% BW) in these studies represents a range between 10% and 22% BW.

The relative load carried by schoolchildren (expressed as % BW) has been considered in ergonomic studies as one of the contributory factors for developing musculoskeletal problems among this age group. A school bag weight limit of 10% to 15% of body weight has been suggested as a maximum load for school students [18]. However, a recent study conducted on school bag carriage among 13-14 year old children, found significant changes in body posture, rating of perceived exertion (PRE) and muscular strain when school bag load reached 10% of their body weight, and therefore the authors suggested that a school bag weight limit of 15% of body weight might be excessive [5]. Furthermore, it has been noted that carrying loads exceeding 10% of body weight should be avoided as these loads induce significant changes in electromyography, kinematics and subjective assessments [19].

There is evidence that the prevalence of musculoskeletal problems in schoolchildren and adolescents is increasing [7, 13, 20-25]. Previous research has shown that carrying heavy school bags can affect the musculoskeletal system of children and are likely to cause different problems such as changes in head/neck and spinal posture and increase the neck and trunk muscle activity levels [26-30]. Carrying heavy school bags may be an additional factor contributing to musculoskeletal complaints in schoolchildren. In a study of 140 high school students (mean age 13.6 years) in New Zealand in 2005, it was found that the musculoskeletal symptoms due to school bag carriage were experienced by 77.1% of the students and the symptoms were most prevalent in the neck, shoulder, upper back and low back, respectively [3]. Additionally, in a study of 1269 secondary school students (12.9-16.8 years) in Australia, gender and age specific

associations were found between low back pain, the school bag weight and the time spent carrying a school bag each day [1]. Similar findings regarding the association between carrying heavily loaded school bags and reported musculoskeletal pain or discomfort have been reported in other studies [14, 31, 32].

Currently, there is a need to examine the epidemiology of musculoskeletal symptoms among schoolchildren and identify risk factors associated with such symptoms. It has been emphasised that ergonomic studies should focus on the risk factors associated with musculoskeletal problems among schoolchildren [33]. Therefore, further research on this issue can help to understand better the demands of school bag carriage and its impact on the musculoskeletal systems of schoolchildren, and to introduce appropriate preventive measures and develop guidelines with regard to safe load carriage in schoolchildren.

The purpose of this study was to investigate the use of school bags and the occurrence of musculoskeletal symptoms among primary school children in Iran.

Materials and Methods

A sample of 307 primary school children including 154 girls and 153 boys, aged between 7 and 12 years, who were in grades one through five (based on Iran's primary education system) participated in the study. Children were randomly selected from elementary schools located in the city of Tabriz in Northwest Iran. All children were given a written consent form to be approved by their parents. Both parental and child written consent was obtained before participation in the study. Permission for carrying out the research was granted from the Tabriz Department of Education and the school authorities involved. The Ethics Committee of Tabriz University of Medical Sciences approved the study.

This cross-sectional, descriptive-analytical study was conducted during a five-

month period between January and May 2010. A letter was sent to the Tabriz Department of Education asking for permission to approach schools in the study area. Then, investigators arranged with individual schools and visited each participating school for data collection. Children were selected from 20 elementary schools (including both public and private schools) that were randomly selected from all elementary schools located in the study area. Schools which refused to participate (n=1) were replaced by other schools in the study area. To obtain a representative sample of elementary school children in the area, the schools were selected randomly from all five educational districts in the study region, comprising four elementary schools (two boy's schools and two girl's schools) from each educational district. Within each school selected, 15 children were selected randomly including three children from each grade (i.e. first, second, third, fourth and fifth grades). Data collection was carried out on an unscheduled day so that children could not alter their school bag weight.

A portable stadiometer was used to measure the standing height of each student (in centimetres to one decimal place). A digital electronic scale was also used to measure the body weight and the weight of the school bag (including any additional items carried separately from the school bag). The scale was accurate to 0.01 kg and was calibrated over a range of known weights prior to data collection.

To collect data on musculoskeletal symptoms and the use of school bags among children, a questionnaire was used. Most of the studies regarding the use of school bags among children reflect the reporting by questionnaires [1, 2, 7, 14, 31, 34, 35]. The questionnaire first recorded demographic details such as the age, gender and grade level of the children as well as the type of school bag carried by the children. Musculoskeletal symptoms in different body regions was assessed using

the modified Nordic Musculoskeletal Disorders Questionnaire [36], which includes a body map with clearly identified body areas and labelling to allow respondents to report areas of musculoskeletal symptoms. The Nordic questionnaire has been used in similar previous studies on school bags and children and, thus is well tried and tested [3, 7, 37, 38]. The children were asked to indicate if they had experienced any ache, pain, discomfort or numbness that may be because of carrying their school bags using the body map. Musculoskeletal symptoms experienced in the week preceding data collection were recorded following the procedures found in the literature [3, 37]. The questionnaire was translated into both English and Persian languages and evaluated through a pilot study and minor revisions related to clarity and wording were made based on pilot testing feedback from a sample of 30 school students and teachers in elementary education (grades one through five). All questionnaires were completed by a trained investigator in this study. The questionnaire took less than 10 minutes to complete.

Statistical analysis of the data was performed with SPSS software version 17.0. Two-way Analysis of variance (ANOVA) followed by Tukey's *post hoc* tests was used for evaluation of weights in this respect. The relationship between prevalence rates with gender and grade level were assessed by binary logistic regression analyses. The factors included in the final logistic regression model were individual factors including age, gender, body mass index (BMI in weight/height²) (less than 19, 19-24, more than 24), as well as school bag weight expressed as a percentage of body weight (% BW) (less than 10% BW and equal or more than 10% BW). The odds ratios (OR) and their 95% confidence interval (CI) were calculated from multiple logistic regression models. P-Values <0.05 were considered as significant for all analyses.

Results

Table 1 shows the demographic characteristics of the sample of school children participated in the study. The weight of school bags and school bag weight expressed as % BW is presented in Table 2. Figure 1 shows the types of school bag used by children in the study. The mean school bag weight for all of the children was 2.9 ± 0.89 kg. The results showed significant differences in the amounts of loads carried by the children in terms of their grade levels ($P < 0.001$). The results of Tukey's *post hoc* test showed that the mean bag weight carried by the first grade students (2.5 kg, SD = 0.66) was significantly lower than those carried by the third (3.2 kg, SD = 0.93), fourth (3.0 kg, SD 0.83) and fifth grade (3.1 kg, SD = 1.08) students. In addition, the third and fifth grade students carried significantly heavier school bags than the second grade students did (2.7 kg, SD = 0.62). Statistically significant differences ($P < 0.05$) were also found between boys (2.8 kg, SD = 0.83) and girls (3.1 kg, SD = 0.93) in terms of the mean school bag weight.

The mean school bag weight expressed as % BW for all of the children was also statistically significant between different grade levels ($P < 0.001$). The mean school bag weight for all of the children was 10.1% (SD = 3.55) of their body weight. According to the results of Tukey's *post hoc* test, school bag weight expressed as % BW was significantly heavier for the first (10.8% BW), second (10.2% BW) and third grade (11.7% BW) students than fifth grade students (8.2% BW). The difference

between the third and fourth (9.2% BW) grade students was also statistically significant (Table 2). The mean school bag weight expressed as % BW was significantly higher for girls (10.5% BW) than for boys (9.5% BW) ($P < 0.05$).

Approximately 86% of the children reported some kind of musculoskeletal symptom that was attributable to school bag carriage at some time during the week preceding data collection. The results of the study demonstrated that the occurrence of shoulder, wrists/hands, and low back pain among all of the children was 70%, 18.5% and 8.7%, respectively (Fig. 2(a), 2(b) and 2(c)). The results of binary logistic regression models showed that the school bag weight expressed as % BW as well as individual factors including age, gender and body mass index were significantly associated with the occurrence of musculoskeletal symptoms of different body regions. The school bag weight expressed as % BW was found to be significantly associated with hand/wrist symptoms (OR = 1.61, 95% CI = 1.03–2.54, $P < 0.05$) in the multiple regression models. No significant association was found between the school bag weight expressed as % BW and shoulder or low back symptoms. Additionally, age was a demographic factor that was significantly negatively associated with hand/wrist symptoms (OR = 0.40, 95% CI = 0.24–0.68, $P < 0.001$). Low back pain was reported by girls (13.6%) more than by boys (3.8%) (OR = 4.48, 95% CI = 1.46–13.76, $P < 0.01$) (as shown in Fig. 2(c)). Body mass index was another individual factor that was significantly associated with shoulder symptoms (OR = 0.41, 95% CI = 0.24–0.70, $P < 0.001$).

Table 1: Demographic characteristics of the sample of schoolchildren participated in the study

Grade level		N	Age (years)	Weight (kg)	Height (cm)	Body mass index (kg/m ²)
			Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Grade one	Boys	31	7.3 (0.47)	24.2 (3.20)	123.8 (6.23)	15.7 (1.62)
	Girls	29	7.3 (0.48)	23.6 (4.85)	123.0 (6.96)	15.4 (1.87)
Grade two	Boys	29	8.2 (0.43)	27.2 (7.46)	128.6 (5.70)	16.3 (3.42)
	Girls	30	8.3 (0.48)	28.0 (6.66)	128.3 (5.74)	16.8 (3.06)
Grade three	Boys	33	9.2 (0.48)	30.1 (8.23)	135.1 (6.11)	16.4 (3.43)
	Girls	29	9.3 (0.54)	29.0 (6.35)	133.5 (7.41)	16.1 (2.84)
Grade four	Boys	31	10.5 (0.56)	35.3 (9.41)	139.6 (6.49)	17.9 (3.70)
	Girls	33	10.3 (0.58)	33.1 (9.73)	137.8 (7.77)	17.2 (3.49)
Grade five	Boys	29	11.3 (0.48)	41.6 (11.76)	147.4 (6.34)	19.0 (4.48)
	Girls	33	11.4 (0.56)	39.3 (10.55)	147.2 (7.42)	17.9 (3.56)
All		307	9.3 (1.53)	31.2 (9.97)	134.6 (10.55)	16.9 (3.38)

Table 2: The weight of school bags and school bag weight expressed as percentage of body weight (% BW)

Grade level		N	School bag weight (kg)	School bag weight as % BW
			Mean (SD)	Mean (SD)
Grade one	Boys	31	2.3 (0.50)	9.6 (2.09)
	Girls	29	2.7 (0.76)	12.0 (3.47)
Grade two	Boys	29	2.5 (0.54)	9.7 (2.45)
	Girls	30	2.8 (0.67)	10.7 (3.18)
Grade three	Boys	33	3.2 (0.95)	11.5 (4.5)
	Girls	29	3.3 (0.92)	12.0 (4.17)
Grade four	Boys	31	2.9 (0.85)	8.8 (3.58)
	Girls	33	3.0 (0.81)	9.6 (3.00)
Grade five	Boys	29	3.0 (0.87)	7.8 (2.82)
	Girls	33	3.3 (1.22) ^a	8.5 (3.13) ^b
All	Boys	153	2.8 (0.83)	9.5 (3.42)
	Girls	154	3.1 (0.92) ^c	10.5 (3.62) ^d

^aSignificant difference between different grade levels (p < 0.001)

^bSignificant difference between different grade levels (p < 0.001)

^cSignificant difference between boys and girls (p < 0.05)

^dSignificant difference between boys and girls (p < 0.05)

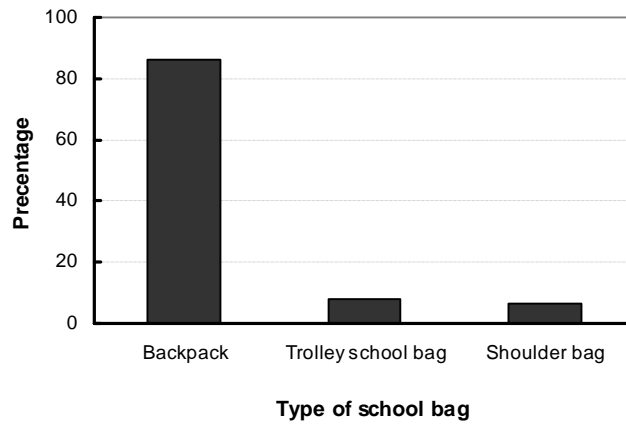


Fig. 1: Types of school bag used by children

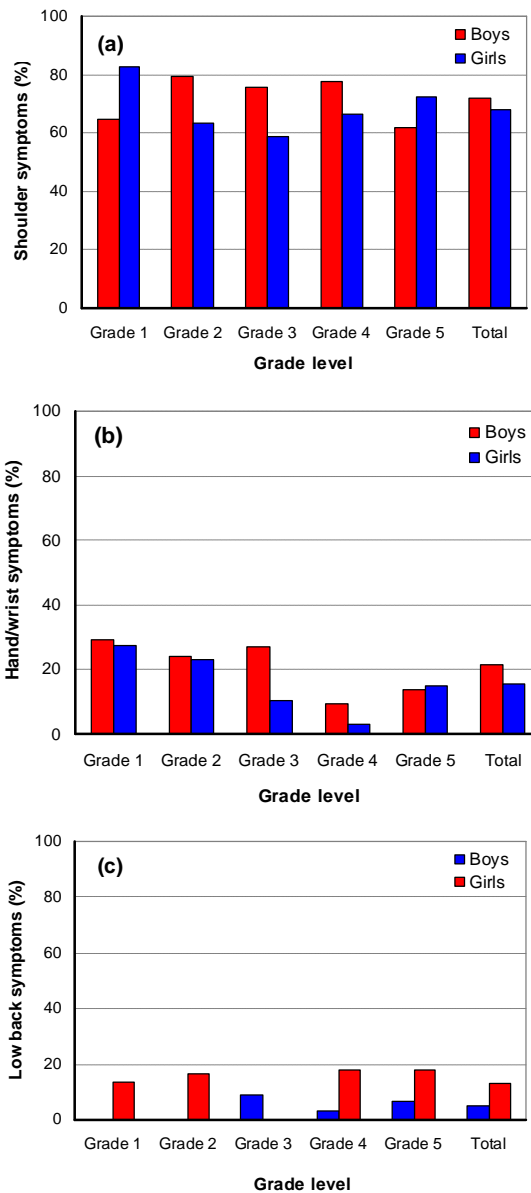


Fig. 2: Frequency of reported musculoskeletal symptoms in the last 7 days in (a) shoulders, (b) hands/wrists and (c) low back

Discussion

The present study investigated the prevalence of musculoskeletal symptoms among elementary school children in relation to the use of school bags. The results indicated that approximately 86% of the children reported some type of musculoskeletal symptoms in at least one body region, with shoulder complaints being the most reported symptom (70%), which is similar to findings reported by Whittfield et al. (2005) among secondary school students in New Zealand [3]. However, the finding that girls in this study carried heavier school bags (in terms of both raw school bag weight and school bag weight expressed as % BW) than boys is not in agreement with the findings from the study conducted by Whittfield et al. (2005), who found no significant difference between boys and girls in this respect [3]. In addition, consistent with previous investigations [10, 16, 17], upper grade children (i.e. third and fifth grades in this study) carried heavier school bags than lower grade children did. This finding may be explained by the higher number of courses taken by the upper grades, which requires them to transport more educational materials to or from schools. In contrast, school bags weights expressed as % BW were heavier for lower grade children (i.e. they carried a greater percentage of their body weights), which is also in agreement with the findings of the study conducted by Pau and Pau in Italy [17].

As shown by the results, the mean school bag weight carried by the children in the current study (which is 2.9 kg) was much lower than weights reported in most previous studies conducted in other countries [1, 3, 11-17]. This result suggests that schoolchildren in this study are required to transport fewer educational or recreational materials to or from schools, which may be attributable to the differences in school curriculum or the type of books required in each of the different countries. In addition,

the mean school bag weight expressed as % BW in this study was approximately 10%, which is either similar to [1, 3, 13] or much lower than those reported in some previous studies [12, 14].

The results indicated that the mean school bag weight expressed as % BW that was included in the logistic regression models was only associated with hand/wrist symptoms, and did not contribute to any increased or decreased risk for shoulder or low back complaints. The lack of association between the weight of school bags and low back pain in this study is consistent with previous reports [3, 7, 15, 38, 39]. Similarly, the results from the current study supports the findings reported by previous studies [7, 15] which found no association between the weight of the school bags and the occurrence of neck pain among school children. Regarding the individual risk factors, it was shown that age was significantly associated with musculoskeletal problems of the hands/wrists. This indicated that younger children (e.g. 7-8 years old) were more likely to complaint from such symptoms than older students were. In addition, it was shown that gender was a significant factor for low back pain, so that girls were more likely to report such symptoms than boys were. This is similar to the findings by van Gent et al. who reported that back pain occurred more frequently in 12 to 14-year-old girls than in boys of the same age [15], or findings reported by Korovessis et al. among high school students (mean age 16 years) [40]. The results also indicated that those children with a lower body mass index (e.g. BMI less than 19) were more likely to suffer from shoulder symptoms than those children with a higher body mass index were. These findings suggest that individual factors including age, gender and body composition need to be considered as potential confounders in fu-

ture analysis of musculoskeletal complaints among school children. The findings of the present study indicated that the mean school bag weight (as expressed by % BW) carried by children is well within the recommended weight limit of 10% BW recommended in the literature [5, 19]. However, the prevalence of musculoskeletal symptoms reported by the children in the current study is relatively high. It seems that the percentage of body weight may not alone represent the demands on the musculoskeletal systems of school children and recommendations regarding a weight limit for school bag carriage should take into account other conditions involved. Another possible explanation is that the current proposed weight limit for school bag carriage may not be appropriate for elementary school children. This is simply because these recommendations regarding weight limit are mostly based on studies that have studied older age group of school students than those studied in the current study. However, further studies are recommended to investigate this possibility. There were several limitations to the present study. As in any epidemiological study, data on musculoskeletal symptoms in this study were based on self-report questionnaires, which may be subject to recall and other biases. However, as noted by Auvinen et al., so far no objective method to measure pain has been evolved [41]. Another limitation is the cross-sectional nature of the study, which prevented an evaluation of the relationship between cause and effect. Therefore, the results should be regarded as a general indication of the problem. Finally, there are no rural children participating in this study and it is only generalisable to city children.

Conclusion

The findings of the present study provide additional information about the use of school bags and musculoskeletal symp-

toms among elementary school children. The results indicated that the prevalence of musculoskeletal complaints among schoolchildren was considerably high. This suggests the need for preventive measures and appropriate guidelines with regard to safe load carriage in schoolchildren to protect this age group. It was shown that girls were more likely to complaint from musculoskeletal symptoms in the low back than boys. The mean school bag weight expressed as % BW was found to be associated with the presence of musculoskeletal symptoms of the hands/wrists. In addition, individual factors including age, gender and body mass index was shown to be associated with the presence of musculoskeletal symptoms in different body regions.

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