

## A Study of Features of Backpack Carrying Methods by Schoolchildren: A Population-Based Study

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### Abstract

**Background:** Nowadays, backpack is the best and most commonly used tool for carrying books and stationery by students. There are huge evidences which confirmed that carrying method of school backpack influences on the students' health status. The aim of this study was to determine of features of backpack carrying methods by schoolchildren.

**Materials and Methods:** A cross-sectional study was conducted on 650 primary schoolchildren in Gonabad city (Iran) in 2017. Using both a made researcher's questionnaire and observation, we collected the required data. The gathered data were analyzed using SPSS software (version 22.0).

**Results:** The results showed that 85.87% of student carried their backpacks in the incorrect way. Although 83.13% of the students used both straps of his/her backpacks, there was a backpack between the two scapulae in only 55% of the students. Besides, just 31.3% of their backpacks were attached to back of the respondents. In terms of appropriateness of the size between students and backpacks, only 40.1% of the students used a suitably sized backpack with their own body structure. The results of multiple logistic regression analysis showed that there were significant association between backpack carrying methods of the students and their age, gender, school grade type of school (governmental, non-governmental) ( $P < 0.001$ ).

**Conclusion:** Findings of the study showed that most of the students do not carry their backpack by proper method. Therefore, educational and executive interventions are necessary in order to prevent future musculoskeletal disorders in students.

**Key Words:** Backpack, Behavior, Carrying method, School Bag, Student.

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## 1- INTRODUCTION

Carrying a schoolbag is a workday activity among most children and one of the most popular schoolbags amongst students is backpack (1). Backpack as compared to other school bags, cause minimal musculoskeletal changes in students, while incorrect carrying of backpack is one of the most important factors causing back pain and skeletal disorders among students (1, 2). Wrong carrying a backpack or carrying an inappropriate backpack with body size could increase the risk of musculoskeletal and spinal cord injuries (3). There is evidence that if a person has low back pain at an early age, he/she will experience more back pain during adulthood (3).

It seems inappropriate use and overuse of muscles, leading to fatigue, reduced performance and neuromuscular dysfunction, and muscle activity pattern changes (4). Results have been shown that there is a strong relationship between use of backpack and musculoskeletal problems (5); besides, it is indicated that students do not have enough knowledge about the proper method of carrying backpack (6). Also, it is thought that a lot of books and other student's supplies will increase the loading and improper carrying of backpacks by students (7). According to high prevalence of musculoskeletal problems due to improper backpacking (8), it is recommended that for the comfort of the person and the further distribution of backpack weight on shoulders, a backpack should have a wide shoulder strap with a pad. It also should have a back pad for more protection of the body through weight distribution among all parts of the body (9). The American Orthopedic Surgeons Academy expressed features of a good backpack to be having two wide shoulder straps, back pads, lumbar strap, low weight, and wheels (10). The results showed that the method of carrying school bag, its weight and duration of school bag

delivery by students in a day would effect on developing their musculoskeletal problems (9, 11, 12). To make a person feel more comfortable and better stability backpack, it is advisable to carry a backpack with two shoulder straps on the back. It also must be fixed at a height of 5.08 cm above the waist to make the person feel more comfortable and stable (10). The current guidelines propose that carrying a backpack with both shoulders is the best way for students, and based on research, it has been shown that, in terms of energy consumption and impact on body condition, the use of backpack is more appropriate than handbags and shoulder bags (13). Using only one of the backpack straps, even if it weighs less than 10% body weight, has a negative impact on the spine and causes more pain (14). Carrying a backpack with a strap, the student is forced to bend to one side to compensate for excess weight on the shoulder, which may cause damage to the shoulders and spine (1).

Findings from some studies indicate that between 40% and 88% of students complained of pain in the shoulders, neck and back while carrying the school bag. Besides, between 30% and 80% of them associate their musculoskeletal problems with carrying school bags (15). Results of a study in secondary students showed that the greatest musculoskeletal discomfort was in shoulders, neck, and back, which was significantly correlated with carrying heavy backpacks (12). In a study conducted in Iran, 51.5% of students were carrying their backpack with a one- strap and 80.6% said their pain was related to the carrying of a school bag (16). Since attention to the health of primary school students can affect their health in adolescence as well as on future health of the community, this study was conducted to determine of features of backpack carrying methods by the students and the

associations with the students' personal and family characteristics.

## 2- MATERIALS AND METHODS

This cross-sectional, descriptive-analytical study was conducted on students of primary schools in Gonabad city, Iran in 2017. Using the previous study (17) to estimate the sample size, [ $d=0.04$ ;  $\beta=80$ ;  $P=0.28$ ;  $\alpha=5\%$ ]. According to the below formula, the sample size was estimated to be 504 students, due to access to more samples, total of 650 students were enrolled into the study.

$$n = \frac{(z_{1-\frac{\alpha}{2}})^2 p(1-p)}{(d)^2}$$

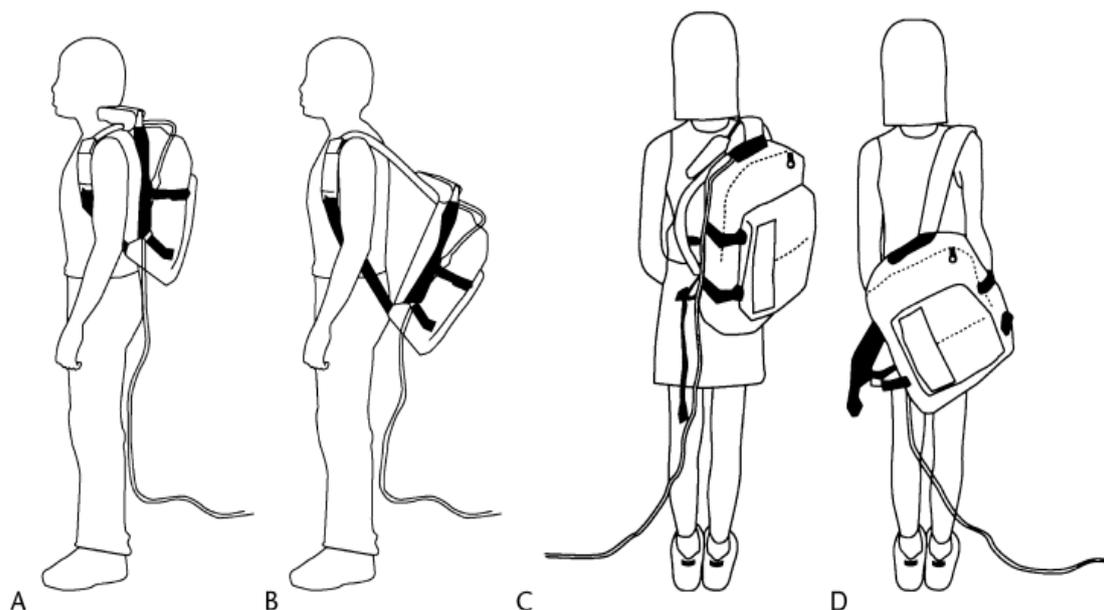
Criteria for entering the study include the absence of orthopedic or muscle and joint diseases, no history of fracture or dislocation in the past year, and ability to carry backpack by one shoulder and both shoulders. Exclusion criteria were any orthopedic and muscular disease and spinal or foot deformities. The study was approved by the ethical review committee of Gonabad University of Medical Sciences. All children were given a written consent form to be approved and signed by their parents before participating in the study. They were given the opportunity to refuse participation. We selected the sample units through a multi-stage sampling method. Initially, a list of the district primary schools was extracted (58 schools); then we create four school type strata in terms of governmental and non-governmental, as well as gender of the students. Finally, we randomly selected 6 schools (two governmental girl's school, two governmental boy's school, one non-governmental girl's school, one non-governmental boy's school), and all the students were entered into the study. In this study, each school was considered as a cluster. The research process was initiated after obtaining the necessary approvals from the relevant officials and

coordinating with the given authorities (e.g., Ministry of Education). At first, the study objectives were explained to the subjects, and written informed consent was obtained prior to the study. Before the students' arrival to the school, seven educated observers presented to the school. After the students entered the school, the way of carrying the schoolbag by the researchers was evaluated by observation method. A questionnaire designed to collect data that the introductory version of the questionnaire was concluded for use after pretest in a pilot study of 40 students in schools, and then minor modifications were made on original questionnaire. The questionnaire including: the demographic factors such as (gender, parent's education, parents job, school type, grade of the student, type of schoolbag, etc.), which were completed by the researchers. To standardize the questionnaire, face and content validity (qualitative and quantitative assessment) were done using experts panel of occupational health and reliability coefficient of the questionnaire was confirmed with Cronbach's alpha value greater than 0.7.

Data collection was completed in two steps: the first step was to information about; gender, age, parent's education, parents job, school type, grade of the student, type of schoolbag, etc. The second step included the type of schoolbag (1 straps backpack, 2 straps backpack or roller trolley), and way of carrying the bag (1 shoulder, 2 shoulders or rolling trolley). The types of backpack carrying methods are visible in **Figure.1** (18). Data analysis was also conducted using SPSS (version 22, SPSS Inc., Chicago, IL, USA), and descriptive methods such as mean, standard deviation, frequency, and percentage as well as t-test, ANOVA, Chi-square test, and univariate and multiple logistic regression models. In terms of the regression analysis, the variables were

initially entered into univariate regression and then those with a significant level lower than 0.2 were fed into multiple regression, such a research method had

been recommended by some experts (19) and also used in some literature (20). The level of statistical significance was considered as  $p < 0.05$ .



**Fig.1:** Schematic of backpack donning conditions. Schematic of the backpack in the high-back, (A) and low-back, (B) conditions with the shoulder strap over the right and left shoulder. Schematic of the backpack in the high-back, (C) and low-back, (D) conditions with the shoulder strap over the right shoulder only.

### 3- RESULTS

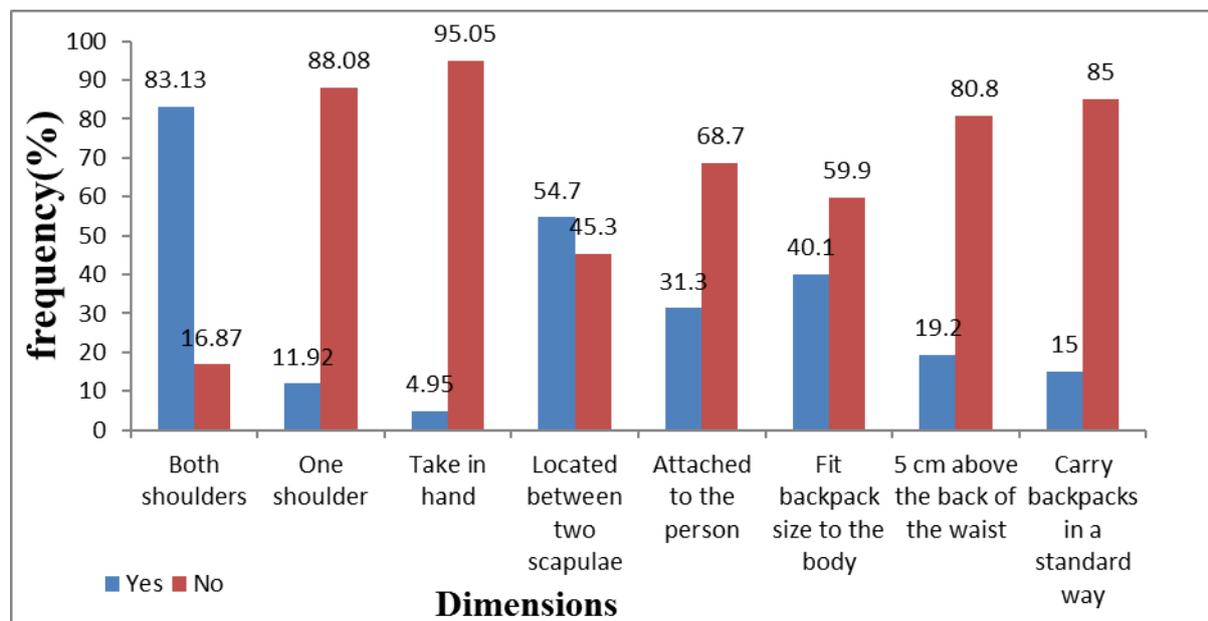
In this study, 348 (55.86%) of the participants were female and 275 (44.14%) were male. The mean age of the students was  $9.82 \pm 1.81$  years. The results showed that 85.87% of student carried their backpacks in the incorrect way, and there were significant associations between carrying backpack of the students and their gender, type of school, and school grade (**Table.1**). Frequency of carrying backpack by students is shown in **Figure.2**. Based on the results of the observation, 537 the students (83.13%) used both straps of backpack, 77 (11.92%) used one strap of backpack, and only 32 (4.95%) carrying

backpacks by hand. In 354 (54.7%) of the students had a backpack between two scapulae, and only 203 (31.3%) of the backpack were attached to the person. In terms of appropriateness between schoolchildren and backpack size, only in 251(40.1%) the students this appropriateness was seen and just in 121 (19.2%) the students their backpack was 5 cm above the lumbar line. In total, only 88 the students (15%) carried the backpack in the right way. **Table.2** shows the results of multiple logistic regression analysis. Based on the results, there were significant associations between carrying backpack and gender, age, and school grade.

**Table-1:** Frequency distribution of carrying school backpacks based on demographic variables

Variables	Dimensions	Carrying school backpacks		P-value
		Correct, N (%)	Incorrect, N (%)	
Gender	Female	60(17.2)	288(82.8)	0.012
	Male	28(10.2)	247(89.8)	
Father's education level	Illiterate	1(9.1)	10(90.9)	0.897
	Diploma and Under diploma	58(14)	357(86)	
	Academic	24(13.7)	151(86.3)	
Mother's education level	Illiterate	2(16.7)	10(83.3)	0.387
	Diploma and Under diploma	65(14.7)	377(85.3)	
	Academic	16(10.4)	138(89.6)	
Father's Job	Employee	22(14.7)	128(85.3)	0.894
	Un Employee	65(14.3)	390(85.7)	
Mother's job	housewife	71(14)	436(86)	0.854
	Working outside the home	16(14.7)	93(85.3)	
Type of School	Government	74(10.4)	393(89.6)	0.034
	private	14(15.8)	142(84.2)	
School grade of student	Grade1	11(11.8)	82(88.2)	<0.001
	Grade2	7(6.5)	100(93.5)	
	Grade3	9(8)	104(92)	
	Grade4	20(18.2)	90(81.8)	
	Grade5	27(27)	73(73)	
	Grade6	14(14)	86(86)	

N: number.

**Fig.2:** Distribution of how to use backpack by students.

**Table-2:** Results of multiple regression analysis in terms of carrying school backpacks (correct, incorrect) and associated demographic factors among participants

Variables	Univariate Regression			Multiple Regression		
	OR	95 % CI	P-value	OR	95 % CI	P-value
Gender	1.838	1.138-2.969	0.013	1.705	1.015-2.865	0.044
Age	0.914	0.806-1.035	0.157	2.098	1.404-2.135	0.001
Birth rank	0.820	0.531-1.266	0.370	-	-	-
Number of family members	0.843	0.466-1.525	0.571	-	-	-
Father's education level	0.979	0.608-1.578	0.932	-	-	-
Mother's education level	1.433	0.852-2.408	0.175	1.483	0.857-2.566	0.159
Father's Job	1.033	0.611-1.740	0.908	-	-	-
Mother's job	0.947	0.526-1.702	0.854	-	-	-
School grade of student	0.814	0.709-0.936	0.004	0.428	0.280-0.653	0.001
Type of school	1.910	1.045-3.489	0.035	1.630	0.778-3.418	0.196

OR: odds ratio; CI: confidence interval.

#### 4- DISCUSSION

The purpose of this study was to determine of features of backpack carrying methods by elementary students. The health and well-being of students is a priority subject. The prevention of back pain and other musculoskeletal disorder is important for students' current and future well-being (8). In this study, the results of multiple logistic regression showed that there were significant relationships between the students' methods of carrying backpack and their gender, age, and School grade. In this study, 89.9% of students used a backpack to carry their equipment; in other studies, the backpack was the most used method of carrying school appliances (9, 11, 15, 21). We also found that 82.9% of the students used both straps for carrying the backpacks; while in other studies, the carrying method of backpack with two straps in students were reported from 48.9% to 75.6% (9, 11, 12, 15, 22, 23). Although near 83% of the students used both straps for carrying the backpacks, 45.3% of them did not fit their backpack between their scapulae, and among 31.5% of the subjects, the backpack was suspended and not fitted to their body.

The results showed that despite the fact that students used tow- straps, they did not observe other standards for carrying the backpack, which is significantly related to backache and musculoskeletal disorders (24, 25). According to the results, only using two-strap is not sufficient to prevent musculoskeletal problems, and it is necessary for the students to learn other proper conditions of carrying a backpack. A former study revealed that 99.8% of students carried their backpack in an improper manner, indicating that they were not aware of the proper conditions of carrying a backpack (26). In another study, backpack did not fit between scapulae in 35% of the students (27), and the backpack was suspended in 53.3% of students (26). The inappropriateness of backpack strap can cause pressure on the body and cause kyphosis and lordosis in the students (24). It seems that the students did not learn the correct methods of carrying the backpack and do not know that the potential damage caused by carrying the backpack is incorrect. Studies have shown that students are able to learn the healthy behaviors of carrying the backpacks, which may prevent lower back pain in the future (28).

According to the results of a study, 75.6% of students reported that they preferred to use both straps of the backpack, 11.7% used only one strap of the backpack, and 12.4% used hand strap to carry their backpack (11). The results of the study by Fernandez et al. showed that after educational intervention, the students' use of two-strap backpacks increased from 46.5% to 60.6%, and the student's use of two-strap backpacks for carrying it from 41.4% to 55.6%, which was a significant increase (6). In 59.9% of the students, the backpack was not proportionate to the size of the students, and the backpack was large for the students' body size, which points to the fact that parents and students are inadvertent to buying backpacks appropriate for the student's size. Carrying a large backpack by students can bring about backache and shoulder pain (29).

On the other hand, the results of study Zakeri et al. showed that non-standard backpack weight can lead to musculoskeletal problems include dropped shoulders, kyphosis and lordosis in primary school students (1). In this study, only 19.2% of the students had backpacks higher than the lumbar spine. The results showed that wearing a backpack lower than the back causes high pressure to the body (18). In this study, none of the students used the lumbar strap for carrying their backpack. In the studies by Abdelati et al. (26) and Skaggs et al. (21), only 0.3% and 2.7% of the students used the lumbar strap for carrying their backpacks, respectively. There was a significant relationship between the carrying backpack and gender, that girl students used backpacks more appropriately than boy students. The results of this study were in agreement with Dianat et al.'s study (11), and incongruent with some studies (30, 31). The reason for this discrepancy can be the different methods of data collection. More appropriate use of backpack by girls can be explained by the

increased attention given by the parents and the sensitivity of girls to the damage caused by improper backpack and possible malformations. The results of this study presented that the prevalence of lower back pain among male students was higher than in girls (26). In addition, the results of this study showed that the prevalence of backache among students using one backpack strap was higher than those using two straps (32). Moreover, the results of a study showed a significant association between gender and pain sensation, meaning that girls were more likely to feel pain than boys (15). There was a significant relationship between the use of backpack and school grade, meaning that fifth-grade students used the backpack more appropriately. The results of this study were in agreement with Dianat et al study (11), and incongruent with some studies (30, 31), which can be because fifth grade students receive the necessary training on the proper way of wearing a backpack or the suitability of the size of backpack for these students' body size compared to students of lower grades.

There were much strength and some limitations in this study. Sampling method and using trained observers to recognize features of carrying backpack by the students would be our strengths. The probability of inappropriate cooperation by the County Education Management was a potential limitation for running this study. Minimizing this limitation, coordination meetings were conducted to support and collaborate on the study. Another constraint was the inadequate co-operation of students and their parents in the study. To address this problem, the goals were explained to them before the study, and written informed consent was obtained from them and their parents. This study conducted among elementary students. To avoid harming students and to carry the school bags and backpack by students, we suggested that future studies consider other

target groups such as parents, teachers, school administrators and managers of county education management. It seems these groups could have important roles to increase awareness, attitude and, ultimately, behavioral change in students.

## 5- CONCLUSION

Our findings revealed that carrying backpack by most of the students did not perform properly. Besides, there was no appropriate fitness between student size and his/her backpack size. So, holding educational programs for students, their parents, and their school authorities on methods of safe carrying backpack and appropriateness between students and backpack size is recommended.

**6- CONFLICT OF INTEREST:** None.

## 7- ACKNOWLEDGEMENT

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