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The effect of back pack load carriage on respiratory parameters in primary school student

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Abstract

Students commonly use backpacks to carry their textbooks, books, pencils, etc on a daily basis. The purpose of this study was to determine the effects of different backpack weights on pulmonary capacities of schoolchildren. This study was conducted among 30 boy and girls primary school students. Each partticipants for 20 min with different backpack weights (0,5,10 and 15% of body weight) in different days on a treadmill at a speed of 1/1 meters per second would carry. Their lung capacity is vital capacity, forced expiratory volume of air in one second and the ratio of these two measurements were recorded using a spirometer. According the results, significant relationship between the weight of the backpack there was with forced vital capacity (FVC)، forced expiratory volume in 1 second (FEV_1) and FEV_1/ FVC ratio. The FVC levels were higher in boys than girls and differences between the two groups showed significant. FEV_1 levels were higher in girls than boys and differences between the two groups showed significant relationship. In general, backpack weight with each elementary school students was led to reduced lung capacity, carrying backpacks heavier obviously more serious consequences will follow. Therefore appropriate strategies should be carried out on a backpack to remove the Iranian elementary school students.

Keywords: Backpacks, Elementary School, Respiratory Parameters, Student

Introduction

Students commonly use backpacks to carry their textbooks, books, pencils, etc on a daily basis [1]. Nowadays, use of backpack for carrying school supplies Is a routine duty of school children and associated With many symptoms of musculoskeletal disorders in children using a backpack, therefore it is a considerable problem that should be regarded by education authorities and health experts. Researches show that more than 50 percent of students are carrying heavy backpacks and 55% of this load is higher that than the permissible limit (10 to 15% of body weight [2]. Design, material, duration of carrying per day, frequency of carrying, Method of carrying and weight of backpack carrying

the hypothesize that may contribute to the high reports of musculoskeletal problems in students [3].

According to scientific researches, More than 60 percent of students who was carrying backpacks for school, Exposed to the structure-stature problems and early fatigue [4]. Research in this area shows that a significant relationship between backpack weight and postural responses (postural body when carrying a backpack) there. For example, when individuals using the backpacks With weight more than 15-10% of the body weight, the forward head posture occurs. Forward head posture is one of the leading causes of neck and shoulder tension, pain and headaches [5]. Also carrying heavy backpacks leads to musculoskeletal pain in over 70% of students [6,7]. In addition to the biomechanical and postural effects, Influencing on the respiratory capacity Are due to carrying heavy backpacks, The 20-30% of lung capacity using heavy backpacks school students is reduced [8].

Wearing a weighted backpack could have the dual negative effect of mass loading and restricting the chest-wall. Both loading and restricting of the chest-wall could cause an increase in inspiratory muscle work and lead to respiratory muscular then lead to reduction of lung capacity and lung volume. Carrying the Backpack more than 10% of body weight increases respiratory rate and reduced the respiratory amplitude [9].

According to the literature searches, research in this field was not found in Iran. Also foreign studies were the rare, For example, in a study Bygrave and his colleagues examined the effect of backpack load on the pulmonary capacities, according to their findings, carrying backpacks more than 15 percent of body weight significantly reduce lung capacity [10].

In Iran, literature search has revealed no previous study on this field among school children and due the differences in dimensions of Iranian school children such as, physical, psychological, nutritional status, number of books in grade school students, design of bag or backpack with school children from other countries, Results of other studies in different countries cannot be generalized to students in Iran. For this purpose, the local epidemiological studies on this subject will be more evident. According to importance of this issue needed in this field by conducting appropriate studies on students, Led to more attention to the country's health and education. The aim of this study was to determine the effect of backpack load on the pulmonary capacities of elementary school students.

Method

In this quasi-experimental study recruited 30 students (15 boyes and 15 girls) from the fifth grade students in Sanandaj, the west of Iran, in 2013. Paicipants were selected based on previous studies. In this section based on study objectives we used the past study information such as: Power = 0.84 and the mean and standard deviation (SD) of first and second group 0.84 ± 3.42, 0.79 ± 2.58, respectively [10-12]. For all students participating in the study, parents' inform consent obtained before doing the tests. Students without a history of pulmonary disease, cardiovascular and other diseases included in this study and before the tests on each of the students, medical examinations performed to ensure cardiovascular health of them. Students with specific diseases and cardiovascular and professional athletes were excluded from the study.

A multistage stratified sampling was performed to paicipant selection.

Firstly based on sex: male and female the number of paicipants were specifed which each category was composed of 15 participants. Then we selected 10 schools randomly from 65 primary schools in the city of Sanandaj, finally we recruited paicipants randomly from these 10 schools. students were lack of inclusion criteria were remover from this study and then re-sampling was used to select individuals. selection

resons of fifth grade students were due to their critical physical growth period, higher prevalence of carrying school backpack and better understanding of spirometry issue. For explanation of study purpose and spirometry test was held and education session for participated students. To collection of the data we used a researcher-made questionnaire, and to validation of data, questionnaire was given to five experts that associated to subject of our research before the beginning of the study. The final questionnaire to collection of data was composed from two parts as follows: Part 1: demographic information including gender, age, school name, weight, height and type *of bag used in school. Part 2:* respiratory capacity without the weight of a backpack, backpack 5, 10 and15 percent of their body weight was measured and recorded (in this research a backpack was prepared measuring the number of anthropometric dimensions of each student such as weight, height and BMI). Before the spirometry performed the devices were placed inside the backpack and weight backpack to the body weight student ratio was varied. Spirometry was performed as follows: the first each student without carrying backpack For 20 minutes on the treadmill at a speed of 1.1 meters per second were walking and then using a spirometer VITALOGRAPH 2120 model, respiratory capacity included FVC, FEV_1 and FEV_1/FVC was measured and recorded. To increase of precision, measuring of pulmonary capacity related to the each of the backpacks loads measured in separate days, then lung capacities measured after carrying backpacks with different weights in different days were compared.

Definition of the respiratory volume: Volumes that are studied in this research are:

Forced vital capacity (FVC): is the volume of air that can forcibly be blown out after full inspiration, measured in liters. FVC is the most basic maneuver in spirometry tests.

FEV_1: is the volume of air that can forcibly be blown out in one second, after full inspiration FEV_1/FVC: (FEV_1%) is the ratio of FEV_1 to FVC. In healthy adults this should be approximately 75–80%.

SPSS-19 was used for data analysis. Descriptive statistics were used to assess the frequency variables and to analyze and evaluate relationships between variables were used the paired t.test, Independent paicipant t-test and repeated measurement. for Statistically significant $p<0.05$ was considered significant.

Results

The mean and Standard Deviation (SD) of age, height, weight and BMI of the students participating in this study were 11.42 ± 0.6 years, 1.58 ± 7.51 meter, 48.84 ± 11.35 kg and 19.17 ± 3.7, respectively.

Mean values of respiratory capacities (FVC, FEV_1 and FEV_1/FVC) were compared in both boy and girl students. According to the results detailed in Table 1, FVC in states without carrying bag (p=0.001), backpack weighing 0.05 body weight (p=0.004), backpack weighing 0.10 body weight (p=0.001) and backpack weighing 0.15 body weighting (p=0.001) in boys higher than girls, but measures of FEV_1 in different states including without carrying backpack (p=0.006), backpack weighing 0.05 body weight (p=0.003), backpack weighing 0.10 body weight (p=0.01) and backpack weighing 0.15 body weight (p=0.01) in girls was significantly higher than boys. As shown in Table 1, the weight of backpacks carried by students led to decrease in all indexes of pulmonary capacities.

Table 2 summarized the results of assessing effect of carrying backpack on spirometric parameters. As you see in Table 2, by increasing the weight of student backpacks, a significant reduction in FVC occurred, the difference in mean FVC in states without carrying a backpack and carrying a backpack with weights of 5, 10 and 15% body weight was significant. There was a significant relationship between increase in the backpack weight and mean of FEV_1 and FEV_1/FVC.

Table 1 *Relationship between sex and spirometric parameter under no carrying backpack (0%) and carrying weighting backpack 5%,10%,15% of participations Body Weight*

	Sex	Mean	SD	p-value
FVC(0%)	Boys	3.36	0.96	0/001
	Girls	3.26	0.33	
FEV_1(0%)	Boys	2.58	0.71	0.006
	Girls	2.88	0.28	
FEV_1/FVC(0%)	Boys	0.76	0.07	0.12
	Girls	0.88	0.05	
FVC(5%)	Boys	3.18	0.88	0.004
	Girls	3.18	0.45	
FEV_1(5%)	Boys	2.70	0.69	0.003
	Girls	2.74	0.41	
FEV_1/FVC(5%)	Boys	0.85	0.06	0.21
	Girls	0.85	0.02	
FVC(10%)	Boys	3.06	0.92	0.002
	Girls	3.23	0.22	
FEV_1(10%)	Boys	2.65	0.78	0.01
	Girls	2.78	0.37	
FEV_1/FVC(10%)	Boys	0.86	0.05	0.78
	Girls	0.85	0.07	
FVC(15%)	Boys	3.20	0.85	0.002
	Girls	3.11	0.35	
FEV_1(15%)	Boys	2.74	0.82	0.01
	Girls	2.70	0.37	
FEV_1/FVC(15%)	Boys	0.83	0.07	0.28
	Girls	0.86	0.06	

Table 2 *Effect on carrying backpack on spirometric parameter in different measurement*

	Different weights of Body Weight	Frequency	Mean	Standard deviation	p- value
FVC	FVC(0%)	30	3.31	0.70	0.001
	FVC(5%)	30	3.18	0.69	
	FVC(10%)	30	3.15	0.68	
	FVC(15%)	30	3.11	0.61	
FEV_1	FEV_1 (0%)	30	2.72	0.55	0.001
	FEV_1 (5%)	30	2.72	0.56	
	FEV_1 (10%)	30	2.71	0.60	
	FEV_1 (15%)	30	2.72	0.62	
FEV_1/FVC	FEV_1/FVC (0%)	30	0.82	0.08	0.04
	FEV_1/FVC (5%)	30	0.85	0.05	
	FEV_1/FVC (10%)	30	0.85	0.06	
	FEV_1/FVC (15%)	30	0.84	0.07	

Table 3 compares the mean FVC in status without carrying a backpack and carrying a backpack in various weighing in different scenarios is showing. According to results in the Table 3 carrying backpacks of all sizes decreased FVC in comparison with no carrying backpack.

Table 3 *FVC in no carrying backpack(0%) and carrying weighting backpack 5%,10%,15% of participations Body Weight (BW)*

Different states of carrying backpack	Mean FVC	p-value
No carrying backpack (weighting 0% of BW)	3.31	-
Carrying backpack (weighting 5% of BW)	3.18	0.001
Carrying backpack (weighting 10% of BW)	3.15	0.003
Carrying backpack (weighting 15% of BW)	3.11	0.002

Table 4 shows the comparison of the mean FEV_1 in different status include: without carrying a backpack and carrying a backpack in various weighing. According to results of Table 4, there was no significant relationship between reduction of students FEV_1 and carrying any backpack weight.

Table 4 *FEV_1 in no carrying backpack (0%) and carrying weighting backpack 5%,10%,15% of participations Body Weight (BW)*

Different states of carrying backpack	Mean FEV_1	p-value
No carrying backpack (weighting 0% of BW)	2.72	-
Carrying backpack (weighting 5% of BW)	2.71	0.99
Carrying backpack (weighting 10% of BW)	2.72	0.86
Carrying backpack (weighting 15% of BW)	2.71	0.99

Table 5 shows the comparison of the mean FEV_1/FVC in different states: without carrying a backpack and carrying a backpack in various weighing. As you observe in Table 5, carrying backpack significantly increased FEV_1/FVC of students in states of 0.05 and 0.10 body weight compare to without carrying backpack. But there was no significant relation between the mean FEV_1/FVC and carrying backpacks with 15% of body weight.

Table 5 *FEV_1/FVC in no carrying backpack (0%) and carrying weighting backpack 5%,10%,15% of participations Body Weight (BW)*

Different states of carrying backpack	Mean FEV_1/ FVC	p-value
No carrying backpack (weighting 0% of BW)	0.82	-
Carrying backpack (weighting 5% of BW)	0.85	0.03
Carrying backpack (weighting 10% of BW)	0.86	0.02
Carrying backpack (weighting 15% of BW)	0.84	0.12

Discussion

The results of the present study showed that backpack load makes a negative impact on the students' pulmonary capacity and this impact was different on boy than girl students. In the most previous studies, the backpack load has been found to be the most important risk factor for musculoskeletal and biomechanical problems. The results of the present study are in agreement with the results of previous studies.

In this study, the values of FVC, FEV_1, and FEV_1/FVC were compared in two groups of boy and girl students. The results showed different FVC values in two gender groups. Carrying backpack of 15% body weight resulted in higher values of FVC in boy students than in girl students. Carrying backpack of 10% body weight brought about higher FVC values in girl students than in boy students. However, carrying backpack of 5% body weight resulted in the same FVC values in two gender groups. Jing Xian Li 2003 [16] and Joukar [17] also reported higher mean FVC in boys. This may due to the higher physical activity of boys inside and outside home that may increase the lung capacity.

According to the obtained results, the FEV_1 values in the states of no carrying backpack, and carrying backpack of 5, 10, and 15 percent body weight were significantly different between boy and girl students. In the states of no carrying backpack, and carrying backpack

of 5% and 10% body weight, the FEV_1 values in girls were higher than in boys. However, in carrying backpack of 15% body weight, the value of FEV_1 in boys was higher than in girls. Chow [18] and Lai [19] investigated the effect of carrying backpack of 5 and 10% body weight on lung capacities. They have stated that the higher volume of lung in girls than in boys may be due to the higher rate of physical growth in girls in this age range. The increased Respiratory Muscle Strength and endurance in boys than in girls may result in the reduced capacity in boys. Exhaustion and shortness of breath in girls than in boys has been proven in the previous studies. The difference in the mean FEV_1/FVC in the states of carrying backpack of various loads was not significant between boys and girls The contrary results were obtained in the studies of Tomczak [11] and Guenett [20]. The opposite results may be due to the several reasons. Since sufficient information has not been obtained in this field, the comparison of our findings with the results of limited number of similar studies may not be reasonable.

The results showed that FVC values in the students significantly decreased with increasing backpack load. The mean FVC value differed significantly in the state of no carrying backpack compared to the states of carrying backpacks of 5, 10, and 15% body weight. In the studies of Legg [9], Bygrave2004 [10], Jing Xiang Li [16], Chow [18] Lai [19], and Paolo et al. [21] it has been confirmed that carrying backpacks more than 15% body weight should not be allowed. However, in the present study we found that carrying backpack even below 15% body weight can reduce the FVC values and according to our findings, carrying backpacks of any weight should not be allowed for primary school students. One of the possible reasons in the biomechanical point of view is the change in the body posture of students carrying the backpack. When the trunk has a forward posture , by carrying backpack it gives a leaning backwards and the resulted chest expansion may show the opposite effect on the respiratory volume.

The results of this study showed that there was no significant relationship between increasing backpack load and the mean values of FEV_1 in the students. In other words, carrying backpacks could not decrease significantly the lung capacity in terms of FEV_1 indicator. The contrary results have been reported by Legg [9], Bygrave [10], Lai [19], and Paolo [21]. A contradiction also exists on the weight of backpack reducing lung capacity so that in the aforementioned studies, carrying backpack more than 15% body weight adversely affect the respiratory capacity. However, in the present study we found that carrying backpacks of any weight generally should not be allowed because of the associated adverse effects. This contradiction may be originated from the characterization of subjects being studied. Most previous studies have been carried out on persons of at least 18 years old whom reached musculoskeletal maturity. Hence, it is likely that the effect of carrying loads on these subjects is different from the elementary students. Another possible reason may be the short-term carrying backpack in the present study. Performing the tests in longer duration and dynamic states may result in the observation of long-term effects of carrying backpack on breathing. While the maximum recommended backpack load to carry is 10 to 15 percent body weight [19], we examined carrying backpack of 0, 5, 10, and 15% body weight. In studies that have investigated the effect of backpack load on the respiratory volumes, different backpack loads have been used. For example, Muza [8] used loads of 0, 10, and 30 kg, Legg [9] used constant load of 6 kg, Chow [18] used backpack loads of 0, 5, 7, 10.5, 12.5, Lai [19] used backpack loads of 10, 20, and 30% body weight, , and 15% body weight, and Paolo et al. [21] used backpack weight of 15, 25, and 35 kg. Therefore, the difference in the weight of backpack may be another reason for the different results obtained.

The results showed that there was a significant relationship between increasing backpack load and the mean value of FEV_1/FVC. So, carrying backpack by schoolchildren caused

a significant increase in FEV_1/FVC. The same results was reported by Chow [18] and Lai [19], although they examined the effect of carrying backpacks weighed more than 20% student body weight.

Although the obtained results indicated a significant relationship between increasing backpack load and FEV_1/FVC , increasing backpack weight showed no adverse effect on the FEV_1/FVC indicator. This has also been confirmed by Muza [8] and Chow [18].

The results of such studies can be employed to apply the ergonomics principles for improving physical school environment and facilities, planning educational programs for the students, and designing ergonomic backpacks.

There were not specific limitations in performing the present study except for the problems in the Spirometry training to the students and getting the students to the lab, which were overcome by cooperation and coordination with the governmental educational agency in Sanandaj city.

Conclusion

The current study found that most of respiratory capacity including; FVC and FEV_1/FVC were significantly reduced with carrying a heavy backpack and this capacity between boys and girls is differences.. This means that female students more than male students are prone to injury. Therefore this study recommends that the carrying backpack in any weight negative affected on respiratory capacity Iranian primary school students. It is clear that carrying heavy backpack has more serious consequences will follow. According to importance of this study, necessary education in collaboration with health professionals series of planning to prevent damage to adopt school children. In this context is suggested that, as in other developed countries that have banned the carrying backpacks for primary students, this will provide the basics of our country.

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Contribution

Study design: FA, MJ

Data collection and analysis: FA, MJ, KR

Manuscript preparation: FA, MJ, KR , KE, FB, FB

Conflict of Interest

"The authors declare that they have no competing interests."

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