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Relationship between Backpack Weight and Prevalence of Lordosis, Kyphosis, Scoliosis and Dropped Shoulders in Elementary Students

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Abstract

Background
Carrying heavy backpacks by school students at growth age can cause irreversible physical harms. This study aimed to investigate the relationship between backpack weight and the incidence of lordosis, kyphosis, scoliosis, and dropped shoulders in elementary school students.

Materials and Methods
This descriptive-analytical study was conducted in 2015 in Abadan, Iran, and 383 elementary school students were selected and enrolled using the cluster sampling method. Data was collected through the grid method and a demographic questionnaire. The weights of students' backpacks were recorded, and it was determined whether they were standard or not. Statistical analysis was conducted using SPSS version 22, descriptive statistics, and the Chi-square test.

Results
Findings showed that 36.9% of public school students' backpacks and 55.1% of private school students' backpacks were non-standard with respect to weight. A significant relationship was also found between non-standard backpack weight and prevalence of dropped shoulders, kyphosis and lordosis ($P<0.05$) among students.

Conclusion
Findings showed that non-standard backpack weight increases the prevalence of dropped shoulders, kyphosis and lordosis in elementary school students that can endanger the physical health of the future society; therefore, parents, teachers and health workers must give needed training to students about carrying the bags and backpacks.

Key Words: Backpack, Lordosis, Kyphosis, Scoliosis, Student.

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1- INTRODUCTION

Schools are important social institutions that involve about 20% of the active members of societies (1). Students spend a considerable amount of time in schools; thus, providing a safe and healthy environment can reduce their vulnerability and physical complications in them (2). Several studies have been conducted in schools about the prevalence and related factors with disorders such as asthma (3), allergic rhinitis (4), atopic dermatitis (5), vitamin D deficiency (6), sleep disorders in children(7). This shows the importance of screening in students who are at the age of growth. An important physical problem in students that has been mainly overlooked is those caused by the heavy school bags or backpacks, which significantly affect the occurrence of movement disorders at a young age (8).

An excessively heavy backpack causes the child to arch his/her back excessively or bent his/her head and trunk forward to withstand the weight of school bag. The pressure on neck and back muscles can cause excessive fatigue and damage to the skeletal system and eventually spinal deformities (9). If the student carries the backpack on one shoulder, he/she bends to the opposite side to compensate for the extra weight, which may damage the shoulders and spine (9). In recent years, carrying and handling school supplies and bags have been regarded by several studies as risk factors for musculoskeletal disorders (10-14). Bags and school supplies are carried in different ways. In addition to textbooks, students carry other supplies as well. Supplies' weights and the method of carrying them should be considered important, because unsuitable supplies and carrying heavy things for multiple times can cause physical problems and skeletal figure changes (15). Among the different ways to carry school supplies (such as a shoulder bags, handbags, wheeled bags, etc.), backpacks are more popular. The most popular school bag among students is backpack, followed by shoulder bag and handbag. Compared with other types of bags, backpacks cause the least negative physiologic changes and the least inconsistency in muscle activity between the left and right sides of trunk muscles (16). Most researchers recommend the maximum allowed load for children to be 10% of their body weight (17-19). In a study by Mohammadi et al. (2012) on elementary school students in Tehran, only 28.3% of backpacks had a weight of less than 10% body weight (20).

A significant relationship was also found between low back pain and backpack weight and carrying time in students of all age groups. Increased backpack weight increased the pressure on the spine in the sagittal plane. Bending of the body forward to maintain balance in carrying heavy weights has a negative impact on the natural curvatures in the lumbar area. Heavy backpacks cause dropped shoulders and increases the curvature in chest area or upper back, leading to a hump. Consequently, students will feel pain in their shoulder, back and neck (13). Long-term effects of carrying of such bags are not yet known; however, the pressure due to carrying heavy bags may cause musculoskeletal abnormalities in students (21, 22) and lead to permanent postural deviation (23) and lack of postural balance control. The negative effects of carrying heavy backpacks include development of kyphosis, scoliosis (24, 25) and forward head (26) postures. In addition to the type of bag, its weight and carrying duration, as well as the location of the bag on the back of the user can influence the occurrence of such problems (18, 24, 25).

Shamsedini (2012) reported that the average backpack weight in students with musculoskeletal disorders was significantly greater than students without musculoskeletal disorders ($P<0.05$). This study showed that backpack weight is

closely related to musculoskeletal problems in the shoulder, neck and back of students (27). A study by Duckrel (2015) showed that most backpack weight-related musculoskeletal disorders are in shoulders and lower back area (28). Ramprasad (2010) examined the effect of backpack weight on the size and angle of spinal curvatures in 410 Indian adolescents, and concluded that non-standard backpack weight significantly increases the sizes and angles of spinal curvatures ($P<0.05$) and ultimately causes skeletal disorders (29).

Chao concluded that carrying heavy and non-standard backpacks creates significant changes in spinal curvature and my cause permanent changes. It also causes stretches in the neck, bending the chest and trunk forward, and increases the spinal curvature (30). Identification of the causes of these disorders can reduce both the prevalence and the complications of these disorders and consequently improve the health of today's students and tomorrow's adults. Since carrying school bags starts at the elementary school and prevention of adverse effects on the musculoskeletal system and its continuation maintains a healthy body structure in adulthood, research on school backpacks should start from elementary school students. The present study evaluated the association between backpack weight with the prevalence of dropped shoulders, scoliosis, kyphosis and lordosis, while some other studies examined the relationship between backpack weight and spine curvatures, and others studied only the relationship between backpack weight and musculoskeletal pain or a limited number of disorders. This prompted the researchers to study the relationship between backpack weight and prevalence of dropped shoulders, scoliosis, kyphosis and lordosis in elementary school students in Abadan.

2- MATERIALS AND METHODS

2-1. Study design and population

This descriptive-analytical study examined the relationship between backpack weight and prevalence of dropped shoulders, scoliosis, kyphosis and lordosis. It was conducted on 383 elementary school students in Abadan, South West of Iran, in 2015. The study population included all elementary school students in Abadan city. According to the study by Bhrouzi et al. on the prevalence of scoliosis in 9-16-year-old students studying in Arak's schools (26), sample size was calculated as 300 using the following formula. The sample size was increased to 383 to increase the accuracy of the study [d=0.03; confidence interval (CI): 0.95%; P=0.01; α=5%].

$$n = \frac{Z_{1-\alpha/2} \cdot P(1-P)}{d^2}$$

Cluster sampling was used to select the samples. First, Abadan city was divided into 3 districts (floors) using the regional municipal areas. In each district, three elementary school for boys (3 clusters) and three elementary school for girls (3 clusters) were randomly selected (a total of 18 schools). At each school, 20 students were then randomly selected from different grades. Inclusion criteria included: the absence of neurological or rheumatic disease or muscle and joint disease, and no history of fracture or dislocation in the past year.

2-2. Measuring tools

Data collection tool included: 1) a grid used to measure and detect dropped shoulders, kyphosis, scoliosis and lordosis, and 2) a demographic questionnaire that asked the gender and weight of the students, the type of backpack (wheeled or regular), the weight of backpack, school type (public-private), and grade. Weights of students were measured using a digital scale (GLAMOR BS-807, China) (accuracy of 0.1 kilograms), and weights of backpacks were measured using a

kitchen scale (Oasis, Tefal, France) with two digits of precision.

2-3. Methods

Spine examination to assess disorders including dropped shoulders, scoliosis, kyphosis and lordosis was conducted by a masters in physiotherapy (research assistant), while the students wore shorts with bare upper body. In order to achieve a general and generalizable sample, students backpack weights were measured in three even days of a week because students carried different books and supplies on different days by students. The average backpack weight in the three days was calculated and considered as the weight carried by the students. It was determined whether or not the backpack weight was standard. The majority of researchers recommend a maximum backpack weight of 10% of body weight (20-22). If the backpack weighted 10% or less of the student body weight, the backpack was considered standard, and if the backpack weighted more than 10% of the student body weight, it was considered non-standard.

2-4. Data analyses

The Chi-square test was then used to evaluate the relationship between non-standard backpack weight and prevalence of disorders such as dropped shoulders, scoliosis, kyphosis and lordosis. Data collection was conducted using interviews and questionnaires, observation and examination. Questionnaires were completed by the researcher in the presence of parents. SPSS- 22 was used for statistical analysis and data entry, and descriptive statistics and the Chi-square test were used to assess the association between variables ($P<0.05$).

2-5. Ethical considerations

This study was approved by the ethics committee of Ahvaz University of Medical Sciences (ID Number: 93172). The aim of this research and confidentiality of personal information were first explained to the authorities, parents and students. Before the study, verbal consents were obtained from students, and written consents were obtained from parents.

3-RESULTS

In total, 318 (83%) students studied in public schools and 65(17%) were in private school, and 195(51%) were girls, and 188 (49%) were boys. The mean age in boys was 34.09±11.72, and the mean age in girls was 34.61±13.87. The mean backpack weight was 3.54±.091. The mean backpack weights in the public and private schools were 3.43±0.91 and 3.60±0.90, respectively.

Out of 383 students, only 15 (4%) had wheeled backpacks, and the rest had regular backpacks. In total, 17.1% of the regular backpacks and 40% of the wheeled backpacks had non-standard weights. With respect to gender, 14.4% of girls' backpacks and 21.8% of boys' backpacks had non-standard weight. In other words, non-standard backpack weight was more frequent in boys than in girls. With respect to school type, 36.9% of public school students' backpacks and 55.1% of private school students' backpacks had non-standard weight.

Table.1 indicates the prevalence of musculoskeletal disorders by standard or non-standard backpack weight. The relationship between standard or non-standard backpack weight and the prevalence of dropped shoulders, kyphosis, scoliosis and lordosis is also shown in (**Table.1**).

The Chi-square test was used to investigate the relationship between standard backpack weight and the prevalence of skeletal disorders. Significant relationships were found between non-standard backpack weight and the prevalence of dropped shoulders ($P=0.04$), kyphosis

(P=0.008), and lordosis (P=0.02) among students. In other words, the prevalence of dropped shoulders, kyphosis, and lordosis was significantly higher in in students who used backpacks with non-standard weight; however, no significant relationship was observed between non-standard backpack weight and the prevalence of scoliosis (P=0.48) among the students.

Table.1: Prevalence of musculoskeletal disorders by standard or non-standard backpack weight in all students and the relationship between non-standard backpack weight and prevalence of skeletal disorders

Disorder	Backpack weight		P-value
	Standard (%)	Non-standard (%)	
Dropped shoulders	76.1	84.9	0.04
Scoliosis	80	84.3	0.48
Kyphosis	6.2	16.4	0.008
Lordosis	18.3	29.1	0.02

4- DISCUSSION

Findings showed a significant relationship between non-standard backpack weight and the prevalence of dropped shoulders (P=0.01), kyphosis (P=0.009), and lordosis (P=0.02) among students. In other words, the prevalence of dropped shoulders, kyphosis, and lordosis was significantly higher in the students who used backpacks with non-standard weights. Findings are in agreement with various studies; Ramprasad (2010) concluded that non-standard backpack weight significantly (P=0.002) increases the size and angle of spinal curvatures and ultimately causes musculoskeletal disorders (29). Chao concluded that carrying heavy and non-standard backpacks creates significant changes in curvature of the spine and may cause permanent changes. It also causes stretching of the neck and bending of the chest and trunk forward and increases the back curvature (30). Carrying heavy backpacks causes kyphosis (24). Heavy backpacks cause dropped shoulders and increase the curvature in the chest or upper back area, leading to a hump (13). There is also a significant relationship between low back pain and backpack weight and carrying time in students at all age groups (13). Shamseddini et al. (2012) reported a close relationship between musculoskeletal disorders in the shoulder, neck and back of students (27). Duckrel (2015) observed that most backpack weight-related musculoskeletal disorders occur in shoulders and lower back area (28).

Out of 383 students, only 15 (4%) had wheeled backpacks, and the rest had regular backpacks. In total, 17.1% of the regular backpacks and 40% of the wheeled backpacks had non-standard weights. Barkhordari examined the weight and other characteristics of backpacks in 783 elementary school students in Yazd-Iran and reported that most students had standard backpacks. More students used regular backpacks, and only 4% of them used wheeled backpacks (32), which is consistent with the results of this study. Mohammedi reported that 28.3% of backpacks weighted under 10% of students' weights (20), which is inconsistent with our results. This may be due to the fact that a majority of samples in Mohammadi's study were girls, whereas approximately equal numbers of girls and

boys were enrolled in the present study. Weight and contents of the backpack boys' and girls' backpack are also different. On the other hands, this study was conducted in public and private schools, while Mohammadi's study was conducted only in public schools. Regarding school type, 36.9% of backpacks of public school students, and 55.1% of backpacks of private school students had non-standard weight, which is consistent with other studies (32-34). Parents' income and social status in private schools, as well as extra-curricular classes, increases the number of carried supplies and weight of the backpacks (20). The mean weight of students' backpacks was 3.45 kg in present study, while it was 4.6 kg in Barkhordari study (32) and 2.48 kg in Shamsoddini study (27). The difference in findings may be due to method of measuring the weight of backpacks and different school grades and other conditions of the study.

5. CONCLUSION

The prevalence of dropped shoulders, kyphosis and lordosis was significantly higher in students who used backpacks with non-standard weight. Therefore, non-standard backpack weight was found to be significantly related to the prevalence of some musculoskeletal disorders. This issue can be a warning in student, which, if not prevented, can cause more complications and problems in later stages. Thus, careful attention must be paid to this issue to prevent such problems in students. Reducing the number of school supplies carried by students can reduce the weight of backpacks; however, the effect of education management to avoid this damage is not negligible. Allocating enough spaces to public schools and sufficient funds to build book closets and shelves to avoid carrying extra weight to schools, as well as training the teachers about planning for controlling the books and supplies students carry every day to the school, should be considered in this regard. The students in one-shift schools do not even need closets and can use the space under their benches and tables. School health workers, parents and teacher must train students about the correct way of sitting, standing, and carrying a school bag and detect student's bad habits and teach correct behaviors in a timely manner.

6- CONFLICT OF INTEREST: None.

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