Assessment of Backpacks Parameters and Postural Structure Disturbances Association among Iranian Children

Shahrbanoo Moslemi[1], Saber Mohammadi[2], Mahin Hosseininejad[1], Sima Mohtasham[1], *Elaheh Kabir-Mokamelkhah[3]

[1]Occupational Medicine Department , Iran University of Medical Sciences, Tehran, Iran.
[2]Professor, Occupational Medicine Department, Iran University of Medical Sciences, Tehran, Iran.
[3]Assistant Professor, Occupational Medicine Research Center (OMRC), Iran University of Medical Sciences, Tehran, Iran.

Abstract

Background: Postural structure abnormalities have been highly prevalent among children in primary school children. The present study aimed to assess the relationship between the backpacks weight and method of carrying with postural structure disturbances in primary school children.

Materials and Methods: This cross-sectional study was performed on 472 primary school children in Karaj-Iran. Study investigators, assessed stature structure disturbances of head, neck, and spinal cord based on the New York scoring protocol. Ergonomic data of backpacks such as type of bag, weight of students' bags, the method of carrying bag, feeling pain when carrying the backpack, the mean time for carrying the backpack from school to home, was evaluated

Results: In this study 97.2% of students carried backpacks as the school bags and only 1.9% carried their bags correctly. The mean time for carrying backpacks was associated with the increased risk for posture disorder including forward head (p<0.001), crookneck (p = 0.006), scoliosis (p = 0.006), lordosis (p = 0.006), and kyphosis (p<0.001). Also, the risk for all disturbances was significantly higher in those students who carried their bags themselves than others used services. Kyphosis was significantly more prevalent in students having backpacks weighted higher than 10% of their body weight (odds ration [OR] = 2.50, 95%confidence interval [CI]: 1.61-4.10, p < 0.001).

Conclusion: According to the results the postural structure disturbances was partially high among primary school children and were closely associated with some ergonomic parameters such as weight and type of backpack.

Key Words: Iran, Musculoskeletal abnormality, Spinal Curvatures, Student.

Corresponding Author:

Elaheh Kabir-Mokamelkhah, Occupational Medicine Research Center (OMRC), Iran University of Medical Sciences, Tehran, Iran.

Email: Salman.khazaei61@gmail.com

1- INTRODUCTION

The physical condition (arrangement of body organs relative to each other) is an important indication of individual's health status. Correct walking, correct sitting, and standing not only makes a person's movements to being beautiful, but also can be associated with greater efficiency and less fatigue because of minimal muscular power consumption body in the ideal situation (1). Any change in position or misalignment in one part of the body can make a difference in other parts of the body forcing the body makes to adapt or compensate the change. In some cases, these changes can cause severe disruption on musculoskeletal status especially on postural structure (2, 3). In general, the abnormal performance of musculoskeletal system along with degenerative disorders is well known as the main cause of the disruption of postural structure (1, 4).

Based on the results of screening studies among students, postural structure abnormalities have been highly prevalent among students. Several reasons can be raised for the high prevalence of these abnormalities such as improper postures in the class, taking improper postures while doing homework, and carrying heavy bags (5, 6). For instance, in a study on 62 students aged 8 to 11 years in the United States, carrying excess backpacks could worse postural changes, and these changes were directly related to condition and time for carrying the backpacks (7).

In another study in Iran and with the goal of assessing postural structure among middle school students and the effects of reform training on such abnormalities, the most and the least prevalent abnormalities were related to droopy shoulder syndrome and lordosis respectively (8). In other words, the studies mostly focused on the relationship between the manifestations of musculoskeletal disorders such as pain, numbness and fatigue with unfit weight of students' backpacks and Improper carrying

backpack, but the relation between the method of carrying and backpacks weight with postural structure of students has been less considered. As instance, in study on 1,315 students aged 8 to 12 years, it was revealed a prevalence of 48% for musculoskeletal pains regardless of its zone. In that study, the severity of shoulder pain duration was associated with the weight of school bags as well as with the time for carrying bag, but not with the method of carrying bag (9).

The present study aimed to assess the relationship between the condition of carrying and backpacks weight with postural structure disturbances in primary school children in Iran.

2- MATERIALS AND METHODS

This cross-sectional study was performed between November 2015 and April 2016 on boy and girl primary school children with age between 10-12 years who selected using stratified sampling method in Karaj city, Iran. The schools located in district no.1 of the city were divided into North and South areas according to the socio-economic level of the population and then two boy's schools and two girl's school (totally eight schools including 616 students) were randomly selected in each area. Those students with the history of congenital skeletal deformity, or trauma-related deformity and students, who did not clearly know how to carry their bags in previous academic years, were excluded from the study.

A specific checklist was used to collect information on demographic characteristics and ergonomic data on backpacks. Data collection was carried out during exercise hours with the presence of a researcher in the school environment and one-to-one visits to the exam room. The information collected were type of school, gender, age, type of bag (shoulder bag, backpack, handbag, or wheeled bags), the method of carrying bag (by the student or

school service), feeling pain when carrying the backpack, the mean time for carrying the backpack from school to home, history of chronic disorders or diseases related to spinal cord ,the duration of doing homework at home(Less than 2 hours and more or equal to 2 hours), and its position (on the floor or desk), the duration of computer gaming or watching television at home and physical function out of the school environment.

Height and weight were similarly measured using a single standard tool. To determine the weight of students' bags, the bag weighed with complete equipment inside measured three days a week and the mean of these measures was recorded as the final weight of the bags. In our study, the ratio of the weight of bag to students' body weight (with the cutoff value of 0.1) was considered as the ergonomic variable. To evaluate the stature structure of head, neck, and spinal cord (forward head posture, crookneck, crooked shoulder, scoliosis, Lordosis, kyphosis), the student positioned with minimum wear behind the checkered plate and the severity of postural structure disturbances was determined based on the New York scoring protocol. This plate included a frame dimensions 200×100 cm^2 that were netted to the units with dimensions of 5×5 cm^2 using thread.

A plumb line was passed through vertical thread. Using this tool and the New York scoring, diagnosing simple skeletal abnormalities can be achieved (10). In the present study, cervical spine deviation to the front and back of the line vertical on checkered plate was considered as forward head posture and cervical spine deviation to the left- and right-sided of the line vertical on checkered plate was considered as crookneck. Also, a crooked shoulder was considered if the presence of the deviation of horizontal line connecting the two shoulders up or down relative to the horizontal posture, while the curvature of

the spine to the right or left of the vertical line was considered as scoliosis. Lordosis was also considered as the curvature of the spine inward in lateral position relative to the vertical line on checkered plate. kyphosis was also considered as the curvature of the spine Outside in lateral position relative to the vertical line on checkered plate .To assess the ergonomic status of backpacks, the students were asked to carry with consistent and conventional method. The checklist for assessing ergonomic pattern of backpacks consisted 16 items measured on a 2-point Likert Scales. The scales of this checklist ranged from 0 to 16 that higher score indicated better ergonomic status of backpacks. Four items including correctly picking up the pack, carrying the bag using the two cords, putting the bag three inches above the waist line and also the ratio of the weight of bag to students' body weight were the most important items of the checklist.

For statistical analysis, results were presented as mean ± standard deviation (SD) for quantitative variables and were summarized by frequency (percentage) for categorical variables. Continuous variables were compared using t test or Mann-Whitney test whenever the data did not appear to have normal distribution or when the assumption of equal variances was violated across the study groups. Categorical variables were, on the other hand, compared using chi-square test. P values of ≤ 0.05 were considered statistically significant. For the statistical analysis, the statistical software SPSS version 23.0 for windows (*IBM*, Armonk, New York) was used.

3- RESULTS

3-1. General characteristics

In this study, 472 students (270 boys and 202 girls) were assessed. The mean height and weight of students was 151.18 ± 7.80cm and 44.36 ± 11.38kg and body

mass index (BMI) was $19.20 \pm 3.90 kg/m^2$ with ranged 12.20 to 40.7 kg/m^2. Most students (94.5%) had no history of disorders in spinal cord. In 279(59/1%) students, the time of watching television or computer gaming were less than two hours a day and in 193 of them (40.9%) were more than two hours a day. Postural condition within home working was behind the desk in 36.0% and sitting on the ground in 64.0%. Nearly half of the students (41.9%) except the school program were not involved in another sporting event. Of others, swimming was reported in 10.8%, ball sports in 32.2%, and martial arts in 15.0%.

3-2. Condition of students' backpacks

Of total students, 97.2% carried backpacks as the school bags and thus 2.8% carried other types of bags including shoulder bag, handbag or wheeled bags. In this study, only nine (1.9%) carried their backpack correctly and 463 (98.1%) raised their bags from the ground improperly. In this study, 91.1% carried dual-band backpacks and 8.9% carried single-band bags. The ratio of the weight of bag to students' body weight in 160 students (33.9%) was below 10%, and in 312 (66.1%) of students was higher than 10%. The mean time for carrying backpacks was 12.16 ± 13.88min. The position of backpack in 18 (3.8%) was 3 cm above the waist and 454 (96.2%) was lower than that. Of all students, 346 (73.3%) did not complain of pain when lifting a backpack, and 18 (3.8%) of the students had low pain, 104 (22%) moderate pain, 4 (8%) severe pain during their carrying bag.

3-3. Disturbances in postural structure

In total, 36.4% suffered crookneck, 37.1% suffered droopy shoulder syndrome, 56.6% had lordosis, 65.0% had scoliosis, 20.0% had kyphosis and 18.2% had forward head posture. All postural structure disturbances were more prevalent in girls than in boys and there was statistically significant

difference in lordosis (p = 0.04), and kyphosis (p < 0.001) by gender. Also, forward head posture disorder, crookneck, droopy shoulder syndrome, scoliosis, and kyphosis were more prevalent in taller students but that was statistically higher in forward head posture disorder (p = 0.025). In this study, all disturbances expect scoliosis and forward head were more common in students with a higher weighted average .Also, a significant relationship was found between body weight and rate of kyphosis (p = 0.03). In this study, the time for home working at home in students with forward head (p = 0.76), crooked neck (p = 0.60), scoliosis (p = 0.49), and lordosis (p = 0.49) was more than healthy students, but this time had significant associated with higher prevalence of kyphosis (p = 0.003).

Also, compared to students that did their homework behind the desk those who did it by sitting on the ground ,suffered more from lordosis (odds ratio [OR] = 1.71, 95%confidence interval [CI]: 1.16-2.53, p = 0.006), kyphosis (OR = 2.26, 95%CI: 1.13-3.92, p = 0.003), and forward head posture disorder (OR = 1.62, 95%CI: 1.08-2.43, p = 0.010). Watching television and computer gaming longer than two hours was associated with increased risk for kyphosis (OR = 2.30, 95%CI: 1.37-3.90, p = 0.001) and crookneck (OR = 1.50, 95%CI: 1.30-1.80, p = 0.03).

3-4. Association between the characteristics of backpacks and postural structure Disturbances

The mean weight of backpacks was higher in those with forward head posture disorder (p=0.33), crookneck (p=0.94), scoliosis (p=0.38), lordosis (p=0.38), but this factor had significant associated with higher prevalence of kyphosis (p = 0.01). Also, the mean time for carrying backpacks was associated with the increased risk for forward head (p<0.001), crookneck (p = 0.006), scoliosis (p = 0.006), lordosis (p = 0.006), and kyphosis

(p<0.001). Also, the risk for some disturbances including forward head posture disorder (OR = 2.70, 95%CI: 1.81-4.22, p = 0.001), crookneck (OR = 1.47, 95%CI: 1.17-2.59, p = 0.006), scoliosis (OR = 2.31, 95%CI: 1.26-4.25, p = 0.006), lordosis (OR = 3.31, 95%CI: 2.23-4.93, p = 0.001), and kyphosis (OR = 5.60, 95%CI: 2.80-11.60, p < 0.001) was significantly higher in those students who carried their bags themselves than others used services for this aim. Also, kyphosis was significantly more prevalent in students having backpacks weighted higher than 10% of their body weight (OR = 2.50, 95%CI: 1.61-4.10, p < 0.001). Moreover, the risk for forward head posture disorder (OR = 0.87, 95%CI: 0.21-3.54, p = 0.85), crookneck (OR = 2.07, 95%CI: 0.55-7.83, p = 0.27), scoliosis (OR = 2.65, 95%CI: 0.53-13.1, p = 0.21), lordosis (OR = 0.42, 95%CI: 0.11-1.59, p = 0.19), and kyphosis (OR = 0.55, 95%CI: 0.06-4.50, p = 0.57) was similar in the groups put their bag three inches above the waist line and other ones. Demographic characteristics in students with lordosis and scoliosis showed in **Tables 1, 2**.

Table-1: The comparing of demographic and backpack characteristics among students with and without scoliosis.

Variables	Students with scoliosis (n=307)	Students without scoliosis (n=165)	P-value
Height(cm) (Mean± SD)	151.46 ± 7.85	151.93 ± 7.81	0.69
Weight(Kg) (Mean± SD)	44.86 ± 11.71	44.30 ± 11.36	0.73
body mass index(kg/m^2) (Mean± SD)	16.6 ± 3.91	19.14 ± 3.94	0.37
weight of bag(Kg) (Mean± SD)	4.76 ± 0.62	4.68 ± 0.63	0.38
Time for carrying(min) (Mean± SD)	15.5 ± 0.5	13.5± 4.70	0.006
Time for doing Home working(H) (Mean± SD)	2.6 ± 1.22	2.14 ± 7.85	0.49

SD: standard deviation.

Table-2: The comparing of demographic and backpack characteristics among students with and without lordosis.

Variables	Students with lordosis (n=267)	Students without lordosis (n=205)	P-value
Height(cm) (Mean± SD)	151.65 ± 8.06	152.31 ± 7.31	0.38
Weight(Kg) (Mean± SD)	44.30 ± 11.36	43.81 ± 11.02	0.73
Body mass index(kg/m^2) (Mean± SD)	19.14 ±3.94	19.0 ± 3.79	0.37
weight of bag(Kg) (Mean± SD)	4.73 ± 0.64	4.68 ± 0.63	0.38
Time for carrying(min.) (Mean± SD)	15.7 ± 4.45	13.5 ± 4.70	0.006
Time for doing Home working (H.) (Mean± SD)	2.37 ± 1.14	2.14 ± 1.16	0.49

SD: standard deviation.

4- DISCUSSION

Some structural abnormalities such as forward head posture disorder, asymmetric neck; shoulder asymmetry, scoliosis and kyphosis were more prevalent in students who had higher height that was consistent with other studies (11). In our study, kyphosis and scoliosis was more seen in taller students. Lordosis and kyphosis was also associated with higher body weight. These findings can be due to the effects of weight on increasing risk for these abnormalities that is consistent with other studies. Our study also showed more back pain in those with lordosis that was also previously pointed (11). We also indicated more prevalence of lordosis and kyphosis in girls than in boys probably due to less volume of muscle mass, less exercising and having improper positions at doing homework such as prolonged sitting in girls. Except for scoliosis, other postural disorders were more prevalent in those who carried bags themselves. It seems that scoliosis might be influenced more from genetic factors.

In addition, our study findings showed that higher rate of postural disturbances in those who did their homework by sitting on the ground. These findings were against to a study among Indian students with higher rate of disturbances in students doing their homework behind the desk (12). Postural structure disturbances were associated with longer time for watching TV and gaming because of bad postural position. We found no association between postural structure disturbances and using double-band backpacks because most students used such backpacks and thus a sample size of students used single-band backpacks were low leading lowering the power of study. The ratio of the weight of bag to students' body weight higher than 10% was associated with the risk for postural structure disturbances in that was similar to previous studies (13, 14). Postural structure disturbances was more frequent in those without pain because appearing pain has a protective role and thus tend the students to change their position for reliving the pain. We also found an association between the rate of postural structure disturbances (especially shoulder pain, shoulder asymmetry, kyphosis), and weight of backpacks indicating a central role of weight on occurring these abnormalities.

It was similarly shown by Dianat et al. (13), postural structure disturbances particularly forward head posture disorder and lordosis were also more prevalent in those students with more homework that could be related to bad position when doing homework especially prolonged bending the neck. The present study is one of the few studies done with partially large sample including primary school children. In addition, the physicians based the diagnosis of disorders on both interviewing and clinical examination.

4-1. Limitations of the study

The study had some potential limitations. First, our study had cross-sectional structure without ability to achieve causality relationships. Second, because of some limitations, we could not assess all ergonomic risk profiles such as dimension tables and benches.

5- CONCLUSION

Our study could well show that postural structure Disturbances is partially high among primary school children and are closely associated with some ergonomic parameters such as weight and type of backpacks. We suggest that next advanced studies such as longitudinal or clinical trials, can perform for controlling of these ergonomic factors might help us to achieve reduction in prevalence of postural structure disturbance among students.

6- CONFLICT OF INTEREST: None.

7- ACKNOWLEDGMENTS

8- REFERENCES

1. Kendall FP, McCreary EK, Kendall HO. Muscles, Testing and Function: Testing and Function: Lippincott Williams and Wilkins; 1983.

2. Posner I, WHITE III AA, Edwards WT, Hayes WC. A biomechanical analysis of the clinical stability of the lumbar and lumbosacral spine.Spine. 1982;7(4):374-89.

3. Shumway-Cook A, Gruber W, Baldwin M, Liao S.The effect of multidimensional exercises on balance, mobility, and fall risk in community-dwelling older adults.Physical therapy. 1997;77(1):46.

4. Panjabi MM. The stabilizing system of the spine. Part II. Neutral zone and instability hypothesis.Clinical Spine Surgery. 1992;5(4):390-7.

5. Radzevi ien L, Kazlauskas A. Posture Disorders And Their Causes In Rural Schools Pupils. Social Welfare: Interdisciplinary Approach. 2016;1(6):118-25.

6. Zakeri Y, Baraz Sh, Gheibizadeh M, Bijan Nejad D, Latifi SM. Prevalence of Musculoskeletal Disorders in Primary School Students in Abadan-Iran in 2014; Int J Pediatr 2016; 4(1): 1215.

7. Kistner F, Fiebert I, Roach K, Moore J. Postural compensations and subjective complaints due to backpack loads and wear time in schoolchildren. Pediatric Physical Therapy. 2013; 25(1):15-24.

8. Shamsedini A, Hellisaz M, Dalvand H, Khatibi A, Sobhani V. The investigation of prevalence of musculoskeletal symptoms and discomfort caused by them in students of Tehran. Ann Mil Health Sci Res. 2011; 8(4):271-6.

9. Azabagic S, Spahic R, Pranjic N, Mulic M. Epidemiology of Musculoskeletal Disorders in Primary School Children in Bosnia and Herzegovina. Materia socio-medica. 2016; 28(3):164.

10. McRoberts LB, Cloud RM, Black CM. Evaluation of the New York Posture Rating Chart for assessing changes in postural alignment in a garment study.Clothing and Textiles Research Journal. 2013; 31(2):81-96.

11. Zamanian z, Ghanbari a, Arghavani f, Hasanzadeh j. Determining the Relationship between Carrying School bags and Busculo skeletal Pains in 12-15 year old students.Armaghane danesh. 2014;19(9):808-16.

12. Dutta S, Dhara P. Evaluation of Different Sitting Postures of Rural Primary School Boys in the Classroom. J Ergonomics. 2012;2(105):2.

13. Dianat I, Javadivala Z, Asghari-Jafarabadi M, Asl Hashemi A, Haslegrave CM. The use of schoolbags and musculoskeletal symptoms among primary school children: are the recommended weight limits adequate? Ergonomics. 2013;56(1):79-89

14. Zakeri. Y , Baraz. Sh, Gheibizadeh, M, Saidkhani, M; Relationship between Backpack Weight and Prevalence of Lordosis, Kyphosis, Scoliosis and Dropped Shoulders in Elementary Students. Int J Pediatr, 2016;4(6):1860.