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Effect of Ergonomic Modification Training about Schoolbag on Reduction of Musculoskeletal Complaints in Primary School Students

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Abstract

Introduction: Students spend about 6 hours a day. Ergonomic properties of school bag including bag weight, bag type, carrying method and bag size in relation to the student>s anthropometric dimensions are among the important causes of musculoskeletal pain and discomfort in students. In this study we assessed the effect of training on reduction of the symptoms and ergonomic correction of the school bag.

Methods: 109 students in the 6th grade entered the study. Musculoskeletal complaints, ergonomic properties of school bag, and its carrying method were assessed before and after a training intervention. P-values less than 0.05 considered significant. Data analysis was performed with SPSS software using Student T-test, Paired T test and chi square test for variables with normal distribution and Mann-Whitney U test and Kruskal Wallis test for variables without normal distribution. Kolmogorov-Smirnov test was used to test the normality of the variables.

Results: Bag weight was decreased significantly from 3.41 ± 0.48 kg before training to 2.60 ± 0.86 kg after training ($P < 0.01$). School bag carrying time was decreased significantly after training ($P < 0.01$). Frequency of using ergonomic bag was not significantly changed after intervention ($P = 0.96$).

Conclusions: Our training program about ergonomic modification of school bag was effective specially on the lowering the bag weight, but not on bag ergonomics; this reduction in the bag weight resulted in the reduction of the neck, shoulder, and back pain.

INTRODUCTION

Students spend about 6 hours a day at least 5 days a week and 3 seasons a year in the school. So they may suffer from some musculoskeletal disorders due to carrying non-ergonomic and inappropriate school bag and using inappropriate chair and desk. Ergonomic properties of school bag including bag weight, bag type, carrying method and bag size in relation to the student's anthropometric dimensions are among the important causes of musculoskeletal pain and discomfort in students [1, 2]. The size of the bag should be appropriate for anthropometric dimensions of the students and its weight should be lower than 10% of the student's weight [3, 4]. It should be balanced with two appropriate handles (for a back bag) and carried on both shoulders. The gravity center of the bag should rest on dorsal spine and the student should stay upright when carrying the bag [5, 6].

Different studied reported a high prevalence of musculoskeletal pains due to carrying school bag in the students [1, 4]. The prevalence of pain was about 40 to 70 percent in different studies [5, 7-9]. In most of the studies bag weight was more than 10% of the student's weight [10, 11].

Pain can decrease student's concentration and performance, so it may affect the educational efficacy. In the other hand, the medical costs of diagnosis and treatment are of concern. Musculoskeletal disorders in the childhood and adolescence may lead to more severe musculoskeletal disorders in adulthood and it may affect the individual's career. Musculoskeletal disorders, especially low back pain are among the most frequent reasons for lost working days, low worker's performance, and high medical costs. Considering the probable origin of these disorders in childhood, they could be prevented by training

and correction of the causes [7, 10].
Broadly speaking, ergonomic interventions, such as training, can positively affect the individuals' postures and decrease some musculoskeletal complaints. Most previous studies on school bag were cross-sectional, without assessment of the effect of training on ergonomic correction of school bag [6, 8-11]. Some studies could not find a relationship between ergonomics of school bag and frequency of musculoskeletal pain [8].
So in this study, we aimed to assess the relationship between musculoskeletal pain and non-ergonomic school bag and determine the effect of training on the reduction of the symptoms and ergonomic correction of a school bag.

METHODS

Study Design

This was an interventional study conducted in a school in Yazd, Iran from December 2013 until May 2014.

Subjects

Totally 109 students (55 females and 54 males) were randomly selected from the students studying in grade 6 of the school. Students with chronic pains and pains with known etiology such as trauma, rheumatologic diseases and menstruation, and students with known musculoskeletal disorders were excluded from the study.

Measurement Tools

We determined the student's weight and the weight of bag (kg) using a digital scale (Leica, China, accuracy: 0.1 kg). Student's age was recorded in years according to their identity card. The characteristics of bags including the type of the bags (backpack, shoulder bag and handbag), bag transportation modes (carrying with both shoulders, carrying with a shoulder, and carrying by hand), and ergonomic features of the bags were recorded in another questionnaire. The existence of pain and its location (neck and shoulders, back and spine, upper limbs, and lower limbs) were recorded using Nordic Body Map questionnaire, and pain severity was assessed by Visual Analogue Scale questionnaire [12]. A questionnaire including demographic data was filled for each participant. Nordic body map questionnaire and visual analog scale were used for assessment of the musculoskeletal complaints and pain.
Questionnaires were filled in two phases, before and after training. In the first Phase (before training) it was done within two weeks (5 days per week) on two occasions with a one-month interval. Totally, for each student in the first phase, the questionnaires were filled 10 times in order to minimize the effect of confounding factors such as transient infections, psychological causes, and others. The second phase of completing the questionnaires was performed 4 months after the intervention.

Intervention

A training intervention was designed for students, their parents, and teachers. Training was performed as lectures using powerpoint slides. The content of the training program included the following issues: ergonomic features of a school bag; how to select an ergonomic bag; what is the standard weight for a school bag; what is the best method for carrying a school bag; how long a student should carry a school bag. For the parents of students who did not participate in the educational programs a film as well as some pamphlets were used. Color posters were also installed in the classrooms boards to help the students learn more about the school bags ergonomics.

Statistical Analysis

Data were analyzed by SPSS (ver. 16) using Student's T-test, Paired T-test and chi-square test for variables with normal distribution and Mann-Whitney U test and Kruskal-Wallis test for variables without normal distribution. Kolmogorov-Smirnov test was used to test the normality of the variables. P-values less than 0.05 considered significant.

Ethical Issues

The protocol of the study was approved by the ethics committee of Shahid Sadoughi University of Medical Sciences. Oral informed consent and written informed consent was obtained from the students and their parents, respectively.

RESULTS

Totally 109 students entered the study among whom 89 (about 82%) filled out the questionnaires. All students participated in the training programs. Among parents 38 (46%) participated in training classes, 66 (74%) studied educational papers prepared for them, 49 (55%) were observed instructional videos prepared for them.
The rating of the 89 parents who answered the questions, were as 20% excellent, 62% good, 12% average, and 6% poor. The motivation of the parents to change the status of school bags, were as 38% higher, 43% moderate, 16% less, and 3% lack of motivation for change in the school bags.
The mean age of the students was 11.63 ± 0.52 and 11.58 ± 0.49 in boys and girls, respectively, and there was not a significant difference between two genders (P = 0.67). Mean weight of boys and girls were 40,42 ± 9.16 and 40.02 ± 9.78 Kg, respectively, and the difference was not statistically significant between two groups (P = 0.83). The mean weight of school bag was 3.63 ± 0.80 kg before training, which was reduced to 2.83 ± 0.93 kg after training (P < 0.01).
Bag weight to student weight ratio was 9.47 ± 2.91 which was reduced to 7.32 ± 2.71 after training (P < 0.01). The changes after intervention in boys and girls were similar (Fig 1 and Fig 2), After training, 27 students (25%) had attempted to change the school bag. The frequency of ergonomic bags in this group was increased from 11% before the intervention to 22% after the training, but this change was not statistically significant (P = 0.12).

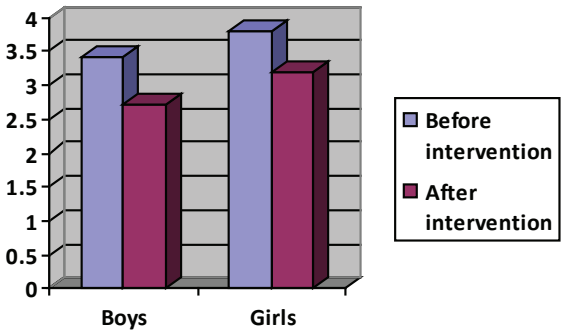

Figure 1: Comparison of the Effects of Ergonomic Education on Bag Weight in Two Genders before and after Training

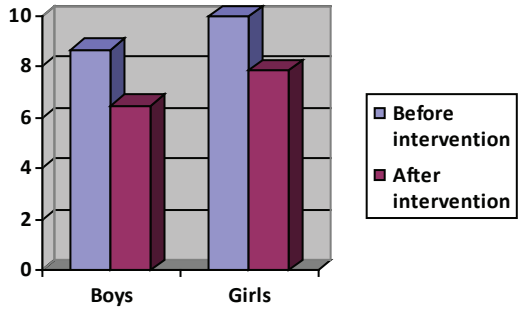

Figure 2: Comparison of School Bag Weight to Student Weight Ratio in Two Genders before and after Training

In Table 1 we compare the different aspects of the parameters pertaining to school bag before and after training intervention.

Table 1: Comparing the Distribution of School Bags Quality Parameters before and after Training, Regarding Gender

Variables	Before Training		After Training		P value
	Number	Percent	Number	Percent	
Bag Ergonomics					
Boy					0.18
Ergonomic	140	26	121	22	
Not Ergonmic	400	74	419	78	
Girl					0.16
Ergonomic	120	22	140	26	
Not Ergonmic	430	78	410	74	
All					0.96
Ergonomic	260	24	261	24	
Not Ergonmic	830	76	829	76	
Bag Type (Backpack/Shoulder Bag/Handy Bag)					
Boy					< 0.01
Backpack	440	81	390	72	
Shoulder Bag	90	17	90	17	
Handy Bag	10	2	60	11	
Girl					< 0.01
Backpack	440	80	450	82	
Shoulder Bag	110	20	90	16	
Handy Bag	0	0	10	2	
All					< 0.01
Backpack	880	81	840	77	
Shoulder Bag	200	18	180	17	
Handy Bag	10	1	70	6	
Loading Type (Bi-shoulder/Uni-Shoulder/Hand)					
Boy					< 0.01
Bi-shoulder	383	71	324	60	
Uni-Shoulder	131	24	115	21	
Hand	26	5	101	19	
Girl					0.15
Bi-shoulder	348	63	334	61	
Uni-Shoulder	202	35	216	35	
Hand	12	2	23	4	
All					< 0.01

Bi-shoulder	731	67	658	60
Uni-Shoulder	321	29	308	28
Hand	38	4	124	12

In Table 2 we compare the frequency of pain in different body parts before and after the intervention.

Table 2: Comparing the Frequency of Musculoskeletal Complaints, before and after Training, Regarding Gender

Variables	Pain Existence	Before Training		After Training		P value
		Number	Percent	Number	Percent	
Overall Pain						
Boy						< 0.01
	Negative	394	73	442	82	
	Positive	146	27	98	18	
Girl						< 0.01
	Negative	388	70	472	86	
	Positive	162	30	78	14	
All						< 0.01
	Negative	782	72	914	84	
	Positive	308	28	176	16	
Neck and Shoulder Pain						
Boy						< 0.01
	Negative	447	83	480	89	
	Positive	93	17	60	11	
Girl						< 0.01
	Negative	430	78	507	92	
	Positive	120	22	43	8	
All						< 0.01
	Negative	887	80	987	91	
	Positive	213	20	103	9	
Back Pain						
Boy						0.01
	Negative	498	92	517	96	
	Positive	42	8	23	4	
Girl						0.66
	Negative	524	95	527	96	
	Positive	26	5	23	4	
All						0.03
	Negative	1022	94	1044	96	
	Positive	68	6	46	4	
Upper Extremity Pain						
Boy						0.36
	Negative	536	99	533	99	
	Positive	4	1	7	1	
Girl						0.70
	Negative	547	99	546	99	
	Positive	3	1	4	1	
All						0.34
	Negative	1083	99	1079	99	
	Positive	7	1	11	1	
Lower Extremity Pain						
Boy						0.27

	Negative	522	97	528	98	
	Positive	18	3	12	2	
Girl						0.13
	Negative	532	97	540	98	
	Positive	18	3	10	2	
All						0.06
	Negative	1054	97	1068	98	
	Positive	36	3	22	2	

DISCUSSION

Comparison of quantitative data on school bags before and after the training represents a very significant reduction in the weight of the bag and the average percentage of body weight in both boys and girls. School backpack type using was declined in boys after training but in female students, it was slightly increased. These changes were quite significant. The reason for the increase in the use of the non-ergonomic bag was worn and torn off the stacks of bags set in 4-5 months gap between two phases of assessment, and lack of preparation for their new bags, or use of old handbags that were available at home. Carrying the bag by hand was increased in all categories after intervention and carrying on both shoulders was reduced. The change in boys was significant, but in girls was not significant. The reason for this difference is probably more use of a handbag after training. Another reason for this was that bag weight after training was reduced, so the students were able to easily use handbag instead of a backpack. Use of backpacks in our study was about 80 percent, but carrying on both shoulders was about 65 percent. This was almost the same in a study conducted by S. Dockrell and colleagues [5].

The frequency of using ergonomic school bags after training was increased in a small group who had tried to change their bag and buy another one. It should be mentioned that one reason for this reality that students didn't change their bag is probably inadequate influence of training provided, but there are other important factors as well: this study was performed in the middle of the educational year and the parents usually buy school bag at the beginning of the educational year, other explanations include lack of financial ability of the parents to buy ergonomic bags which are more expensive than other bags, or lack of availability of ergonomic bags in the market. Also, almost all of our bags did not have the front strap to close the bag around the chest or waist, and they have not any wheels, but they were appropriate in the number of the side pockets. For this reason, we have removed these three categories of ergonomic school bag criteria, and the greater emphasis was about the appropriateness of the size of the bag and the bag center of gravity on the student's spine.

The overall frequency of pain, neck pain and shoulder pain significantly decreased in all groups after training. Back pain in male students was significantly reduced following the training, but in female students, it was reduced but not statistically significant. Changes in the upper and lower limb pain in all groups were not significant. The frequency of pain in our study was significantly reduced after the intervention, which was inconsistent with the results of the other studies [5, 7, 9, 11].

The frequency of low back pain in this study was 6% and 4%, before and after training respectively, which was different in comparison to other studies which had found a frequency of about 10-20 percent [5, 7, 9, 11]. This difference can be explained by the difference in the design of our study that chronic pain (more than 3 months) [12] and another known causes of pain (such as trauma) were not included in the final results of the study. We assessed the frequency of pain in a longer period of time. Another reason for this would be the lower mean ratio of the student's bag weight to student's weight, which in our study was about 9%, but in other studies, it was often more than 10% [1, 5, 7, 9].

This study had some limitations: our intervention was performed in the middle of the educational year, but parents routinely buy a school bag at the beginning of the year; we couldn't provide ergonomic bags for the students due to monetary problems.

This study was a residency thesis in occupational medicine in Shahid Sadoughi University of Medical Sciences.

This study showed that training is effective to some extent in the bag weight reduction, and pain incidence reduction, particularly in the neck and shoulders, and somehow back pain, but it had little effect in the upper and lower extremity pain. Training had little effect on the ergonomics of the bags. In light of the above, it can be concluded that bag weight reduction results in a lower incidence of pain, especially in the neck and shoulder, and is somewhat effective in back pain, but not effective in limb pain.

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CONFLICTS OF INTEREST

All of the authors declare that they have not any conflict of interests.

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