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RESEARCH ARTICLE

THE EFFECTS OF SCHOOLBAG USE ON MUSCULOSKELETAL PAIN AMONG SECONDARY SCHOOL CHILDREN

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ABSTRACT

Introduction: The aim of this study was to investigate the effect of schoolbag weight on musculoskeletal pains.
Method: The age, gender, height, body weight, presence of systemic diseases and scoliosis, Weight of schoolbag, the duration of SB carrying, method of travel to/from school, hours per week using a computer and method of studying were reported in this retrospective study. The standardized Nordic Musculoskeletal Questionnaire was used to evaluate the musculoskeletal pains.
Results: A total of 751 girls and 1046 boys were enrolled in the study. There were 756 children (42.1%) carrying schoolbags which were more than 10% of their body weight. The mean weight of schoolbag and percentage of weight of schoolbag to body weight were significantly higher in schoolchildren with musculoskeletal pains than without ($p<0.05$). Most of the musculoskeletal pains were in neck, lower back, upper back and shoulders respectively.
Conclusion: We found that musculoskeletal pains were more observed in those with heavy schoolbags in this study. We suggest carrying out prospective longitudinal studies about this subject and detection of prevention to be taken about this subject.
Key Words: Musculoskeletal pain; schoolbag; schoolchildren

ÖZET

Giriş: Bu çalışmada okul çantası ağırlığının kas iskelet sistemi ağrılarına etkisi amaçlanmıştır.
Metod: Retrospektif olarak yapılan bu çalışmada yaş, cinsiyet, boy, kilo, sistemik hastalıklar ve skolyoz, okul çanta ağırlığı, okul çantası taşıma süresi, okula ulaşma yöntemi ve ders çalışma yöntemi sorgulandı. Kas iskelet sistemi ağrılarını değerlendirmek için Nordik Kas İskelet Sistemi Anketi uygulandı.
Bulgular: Çalışmaya 751 kız ve 1046 erkek öğrenci olmak üzere toplam 1796 öğrenci dahil edildi. 756 öğrenci (%42.1) vücut ağırlıklarının %10'undan daha fazla ağırlıkta okul çantası kullanmaktaydı. Okul çantası ağırlığı ve okul çantasının vücut ağırlığına oranı kas iskelet sistemi ağrısı olan çocuklarda anlamlı olarak yüksek bulundu ($p<0.05$). En sık kas iskelet sistemi ağrıları sırasıyla boyun, bel, sırt ve omuz bölgelerinde tespit edildi.
Sonuç: Bu çalışmada ağır okul çantası taşıyan öğrencilerde kas iskelet sistemi ağrılarının daha çok olduğunu gözlemlendi. Bu konu ile ilgili uzun süreli takipli prospektif çalışmaların yapılarak uygulanacak önlemlerin tespit edilmesi gerektiğini düşünüyoruz.
Anahtar Kelime: Kas iskelet sistemi ağrısı; okul çantası; öğrenci

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INTRODUCTION

Many factors can provoke musculoskeletal pains in schoolchildren such as increased participation in sports or exercise, poor posture while sitting, long periods of inactivity and carriage of heavy schoolbags (SBs) [1]. Definitely heavy schoolbag (SB) or carrying it wrongly can lead to musculoskeletal pains in all children [2-3]. Schoolbags of children induce excess weight into the spine and musculoskeletal pains are significantly correlated with weight of schoolbag (WSB) . It is a worrying situation especially for the children in secondary schools, as the spine is at critical stage of development in children between 12-14 years of age [2-7].

Carrying a heavy SB causes forward head posture and bad posture, which can lead to pain and discomfort in the neck, shoulders and back [2-3]. There was a significant relationship between the SB

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weights excess the recommended safe weight limits of 10% to 15% of body weight of schoolchildren [8]. Researchs in this area show that although the average weights differ greatly between studies, most reports point to that the weights carried by schoolchildren are greater than the recommended limits [1,9]. Although these weight limits have been recommended in few states or countries, conflict findings to exist in the literature about the effects of WSB on back pain in schoolchildren [8].

Carrying a heavy SB yields the scoolchildren unable to maintain proper standing and walking posture(10). Nonetheless, the WSB carried by children varies from day to day, and causes various results [2,11]. Combined effects of heavy SB, duration carrying the SB, handling of SB, method of carrying, position of the load on the body are risk factors for musculoskeletal pains associated with SB carriage [8-9,12]. There is only one thesis study available investigating the effects of heavy SB on musculoskeletal system in our country, within our knowledge [13].

The aim of our study was to evaluate the effect of SB on musculoskeletal system in secondary schoolchildren in Kırıkkale province center.

METHOD

Study Design and Participants

One thousand seven hundred ninety-seven (1797) of schoolchildren were included in this retrospective study between November and December 2014. Inclusion criteria were: 1. Schoolchildren aged between 12-14 years 2. Ability to carry SB. Exclusion criteria were 1. Having orthopedic, muscular, neurologic and rheumatoid diseases. 2. Having deformity in spine and joints of upper and lower extremities. Ethical approval was obtained from ethics committee in University. Informed consent participates in study signed by all of parents.

The age, gender, height, body weight, presence of systemic diseases and scoliosis, WSB, the duration of SB carrying, method of travel to/from school, hours per week using a computer and method of studying (studying at desk or studying on bed etc) were reported. The weighing scales were placed on a flat surface in a corner of the classroom and set to zero. After shoe removal the height and weight of each child, as well as the weight of SB, were recorded during the interview using a measuring tape and electronic weighing scales, respectively. We did not inform the children before performing the WSB determination, to avoid changes in the pattern of WSB. WSB as a percentage of body weight was computed by dividing the weight of the bag by the children's weight.

The standardized Nordic Musculoskeletal Questionnaire was used to evaluate the symptoms of back, neck, shoulders and extremities and about potential risk factors (1,14). This questionnaire shows a body diagram consisting of nine body parts, including neck, shoulder, upper back, lower back, elbow, arm, hand, thigh, knee, and leg to assist the schoolchildren in identifying the correct body parts when answering the questions. The questions regarding musculoskeletal pains lasting for one month were asked.

Data Analysis

Statistical analysis was used with SPSS (Statistical Package for Social Sciences version 20.0, Chicago). Mean and standart deviations were calculated for the parameters. Responses were analyzed using frquency distributions and descriptive statistics. Normality of the distribution continous variables by the Kolmogorov-Smirnov test, while the homogeneity of variance was checked using Levene'test. Comparisons between groups were performed used Student's t test for two and one way ANAVO for more than two groups. Chi-square cross tabulations were used to distinguish differences in response by parameters. P values less than 0.05 considered statistically significant.

RESULTS

The study consisted of 751 girls and 1046 boys. The mean age were 11.6±1.1 and 11.8±1.0 years in girls and boys respectively. There was a significant difference between the girls and the boys for the parameters including the mean age, height, BMI, WSB and hours per week using computer (Table 1 and 2).There was a significant difference in the methods of studying between the girls and boys (studying at desk or studying on bed etc) (Table 2).None of the children had school locker.

The most common method of SB used by the schoolchildren was on both shoulders (93.3% for overall, 92.8% for girls, 93.6% for boys). The presence of scoliosis was more common in girls than in boys ($p<0.05$).

There were 756/1797 children (42.1%) carrying SB which were more than 10% of their body weight and of these 332/573 (57.9%) children were from fifth, 225/535 (42.1%) children were from sixth and 199/689 (28.9%) children were from seventh classes.

When the fifth, sixth, and seventh classes were compared in terms of WSB and WSB to body weight and hours per week using computer, there was a significant difference between fifth and sixth classes for WSB ($p<0.05$). There was a significant difference between three classes in terms of the

WSB to body weight (p<0.05). There was a significant difference between fifth and sixth classes; fifth and seventh for hours per week using computer (p<0.05) (Table 3).

Table 1. Demographic characteristics of schoolchildren

	Girls (n=751)	Boys (n=1046)	p
Age year)	11.6±1.1	11.8±1.0	**0.000**
Height (cm)	150.6±8.2	149.3±9.1	**0.001**
Weight (kg)	44.7±11.2	45.0±12.1	0.557
BMI	19.5±3.7	19.7±4.0	**0.013**
Grade 5	35.6	29.3	
Grade 6	32.0	28.2	
Grade 7	32.5	42.5	**0.000**

BMI; body mass index, p<0.05

Table 2. The comparison of the parameters affecting the musculoskeleta pains between the girls and boys

	Girls (n=751)%	Boys (n=1046)%	p
WSB (kg)	4.2±1.3	4.0±1.3	**0.014**
WSB as %BW	9.8±3.6	9.5±4.0	0.128
SB carrying time (min)	13.5±11.7	13.9±11.2	0.499
Hours per week using a computer	2.7±3.8	3.8±5.4	**0.000**
Method of travel to/from school; walk	81.1	82.2	0.542
bus/car	18.9	17.8	
Method of SB carriage; on both shoulder	92.8	93.6	0.721
on one shoulder	6.5	5.6	
by hand	0.7	0.8	
Method of study; studying at desk	84.8	79.3	**0.003**
	15.2	20.7	
Studying on bed etc			
Scoliosis; yes	2.3	0.6	0.003
no	97.7	99.4	

WSB; weight of schoolbag, BW; body weight, SB; schoolbag, p<0.05

Table 3. The comparison of the parameters of fifth to seventh classes

	Fifth class (n=573)	Sixth class (n=535)	Seventh class (n=689)
Age year)	10.7±0.6	11.6±0.6	12.6±0.5
Height (cm)	143.6±6.4	149.5±7.2	155.6±12.1
Weight (kg)	39.2±9.1	44.0±10.5	50.3±12.1
BMI	19.5±3.7	19.7±4.0	20.6±3.9
WSB (kg)	4.2±1.3*	4.1±1.2*	4.0±1.3
WSB as %BW	11.1±4.0ϕ	9.5±3.6ϕ	8.5±3.4ϕ
Hours per week using a computer	2.7±3.8π	3.3±5.4	3.64±4.7

WSB; weight of schoolbag, BW; body weight, SB; schoolbag *significant difference between fifth and sixth classes with one –way ANOVA, significant difference between three classes with one –way ANOVA π significant difference between fifth and sixth classes; fifth and seventh with one –way ANOVA, p<0.05

Table 4. Distribution of musculoskeletal pains in schoolchildren

Regions involved	Girls (n=751)%	Boys (n=1046)%	p
Neck; yes	11.2	12	
no	88.8	88	**0.575**
Shoulders; yes	8.3	10.2	
no	91.7	89.8	**0.003**
Elbow; yes	3.3	3.8	
no	96.7	96.2	0.157
Wrist and hand; yes	5.9	7.2	
no	94.1	92.8	0.270
Upperback; yes	9.2	13.1	
no	90.8	86.9	**0.01**
Lowerback; yes	10.5	10.7	
no	89.5	89.3	0.898
Hip; yes			
no	1.2	1.3	
	98.8	98.7	0.960
Knees; yes	9.1	7.7	
no	90.9	92.3	0.960
Ankle and foot; yes	6.5	6.1	
no	93.5	93.9	0.727
Total musculoskeletal pains; yes	34.4	37.5	
no	65.6	62.5	0.174

Table 5. The comparison of the demographic characteristics of schoolchildren with and without total musculoskeleta pains

	Schoolchildren without total musculoskeleta pains (n=1147)	Schoolchildren with total musculoskeleta pains (n=650)	p
Age year)	11.7±1.1	11.7±1.0	0.971
Height (cm)	149.9±8.7	149.8±8.8	0.839
Weight (kg)	44.9±11.6	44.8±11.8	0.901
Gender;girls (%)	43	39.7	
boys	57	60.3	0.171
BMI	19.8±3.9	19.8±3.8	0.917
Grade level (%)			
Grade 5	32.3	31.1	
Grade 6	29.4	30.5	0.829
Grade 7	38.3	38.5	

The distribution of musculoskeletal pains in schoolchildren was shown in table 4. Most of the musculoskeletal pains were in neck, lower back, upper back and shoulders respectively. Boys reported the highest prevalence of upper back pain with 13.1% than girls did (p<0.05).

The mean WSB and percentage of WSB to body weight were significantly higher in schoolchildren with musculoskeletal pains than without (p<0.05). No differences were observed between schoolchildren with and without musculoskeletal pains, particularly in terms of age, grade of

schoolchildren, gender, body weight, BMI, presence of scoliosis, SB carrying time, method of SB carriage, travel to/from school, studying and hours per week using a computer (p>0.05) (Table 5 and 6).

Table 6. The comparison of the parameters of schoolchildren with and without total musculoskeletal pains

	Schoolchildren without total musculoskeleta pains (n=1147)	Schoolchildren with total musculoskeleta pains (n=650)	p
WSB (kg)	4.0±1.3	4.2±1.3	**0.013**
WSB as %BW	9.5±3.7	10.1±4.0	**0.036**
SB carrying time (min)	13.7±12.7	13.7±10.0	0.929
Hours per week using a computer	3.1±4.5	3.6±5.1	0.071
Method of travel to/from school;(%)			
walk	81.1	82.9	
bus/car	18.9	17.1	0.331
Method of SB carriage; on			
both shoulder	93.5	92.9	
on one shoulder	5.8	6.5	
by hand	0.8	0.6	0.770
Method of study; studying at			
desk	82.5	80.2	
studying on bed etc	17.5	19.8	0.222
Scoliosis; yes	1.4	1.1	
no	98.6	98.9	0.720

WSB; weight of schoolbag, BW; body weight, SB; schoolbag, p<0.05

DISCUSSION

The purpose of our study was to evaluate musculoskeletal pains and describe their relationship with SB use in schoolchildren.There are most available data on the occurrence and characteristics of musculoskeletal pain in schoolchildren in particularly developed countries [15]. Even a SB had been designed similar to a life jacket to minimize the impact of heavy SB and distribute the carried weight on the chest and on the back [16].

Schoolbags were regularly used by the all of schoolchildren who participated in our study; these results are consistent with levels of use observed by other authors [17]. Similar to our findings some authors [17-19] have suggested that heavy SB is associated with higher prevalence of musculoskeletal pain, and therefore, causing temporary or permanent postural maladaptation, muscle contracture, and inflammation however others have found no association [20-23].

We found that girls were taller than the boys, while the BMI was higher in boys than in girls. Of note, differences in stature between genders increase from 10 years of age; this process is related to the onset of adolescence, which has been explained by hormonal influences that affect females before males [24-25]. Some investigators have shown a positive correlation between BMI and back pain, while others have found no association between BMI and back complaints [4,26-28].

T he method of carriage (2 shoulders/not 2 shoulders/hands) was found to be associated with back pain in previous studies but we found no differences between schoolchildren with and without musculoskeletal pain similar to other studies [9,17,26,29]. It could be explained by the fact that only 6% of children carry SBs on one shoulder, while more than 90% use it bilaterally; the remaining 0.7% of the them use bag with hands. However, it seems that carrying a SB on both shoulders is the best method of carrying a SB, as it has been shown that carrying a SB on one shoulder is likely to be associated with increased risk of back pain, increased lateral spinal bending and shoulder elevation [21,26].

Carrying a heavy SB for long periods of time could result in repetitive stress injuries to the growing body. This follows the changing of the child's centre of gravity in the direction of the weight when carrying a heavy SB [8]. The method of school transport was by walking in 80% of schoolchildren and the mean SB carrying time was 13.5 and 13.9 minutes for girls and boys respectively in our study similar to the study of Dockrell et al [30]. There was no significant difference between groups with and without musculoskeleta pains for school transport method in our study similar to a study though Mwaka et al found significant positive correlation with pain of lower back [8,29].

We found the percentage of scoliosis was 2.3% and 0.6% in in girls and boys respectively and no significant differences were observed between the scoliotic and healthy children for WSB similar to the study of Gelalis [31].

It was reported that the carriage of heavy SB is a main factor, and therefore represents an overlooked physical stress for secondary schoolchildren [1]. In our study, the WSB with an average of 4.2 kg for fifth, 4.1 kg for sixth, and 4.0 kg for seventh class of schoolchildren and the percentage of WSB to BW were 11.1, 9.5, 8.5 for fifth, sixth and seventh schoolchildren respectively. The schoolchildren of fifth class might have lack of experience in recognation of their need of books. The percentage of musculoskeletal pains did not differ in three classes that doesn't similar to other studies [1-2].

The WSB and the the percentage of WSB to BW were significantly higher in those with musculoskeletal pain in our study match with Macedo's study although they were found at between the recommended levels (recommended level; 10%-15% of body weight) [17]. More importantly, there is evidence that musculoskeletal pain in

children can be predictive of musculoskeletal pain in adult and that nonspecific musculoskeletal pain can persist from chilhood to adolescence [32]. As noted earlier, it is not yet clear from the recommended weight limit for carrying SBs (e.g. 10%-15% of body weight) whether or not the limit should be set the same for both boys and girls. There was significant difference in the mean WSB carried between girls and boys, but there was no difference between genders for the other SB carriage variables in our study. This can be attributed to girls' being more paying attention to school supplies than boys. Besides that our study indicated there was no significant difference between girls and boys in terms of musculoskeletal pains.

Musculoskeletal pains, especially of the neck, lower back, upper back and shoulders are common among schoolchildren. The mean percentage of total musculoskeletal pains (34.4% in girls and 37.5% in boys) in schoolchildren was lower than previous studies [1-2]. The results of the our study indicates that the prevalence of total musculoskeletal pain was not different in terms of gender but boys experienced upper back pain more frequently than girls incompatible with many studies [33]. Higher prevalence rate in boys may be attributed to long duration of using computer.

To further reduce on the effects of WSB, schools should provide schoolchildren with lockers for storage of their scholastic materials. Schools should also have fully functional libraries where scholchildren can sit, read and borrow text boks instead of carrying them daily in their SBs. None of the children had school locker in our study. Ergonomic health promotion program could be administered by a trainers covering strategies to minimize musculoskeletal pains [34].

Currently, many professional organizations are communicating virtually the same message: choose the right size SB; pack well and empty out unnecessary items; wear straps on both shoulders; and carry less than 10%- 15% of body weight [17].

Strength and Limitation of Research

The strength of this work was the largest attendance of the participants but this study was cross-sectional retrospective in design, which prevented an evaluation of the relationship between cause and effect, and therefore prospective longitudinal studies are recommended. Also, more complex models taking into account other variables (e.g. physical and psychological factors) are recommended for the future [30]. There is a lack of longitudinal studies that investigate the cumulative effects of carrying a SB over several years. Children in fifth, sixth and seventh classes were included in this study therefore it may not represent all schoolchildren. Such a study, if well designed, could yield definitive results on the true relationship between carrying a SB and significant musculoskeletal disorders and pain that extend into adolescence. A large national longitudinal study would be prime, but it would require substantial resources to follow, monitor, and assess children over time.

Conclusion

We found that musculoskeletal pains were more observed in those with heavy SBs. The most common method of SB carriage was over two shoulders and girls had heavier SB than boys. It was found that most of the girls were studying at the desk. The majority children have musculoskeletal pain especially in the neck, lower back, upper back and shoulders. Boys spend more time using a computer and they reported the highest prevalence of upper back and shoulder pain. We suggest that many factors including the WSB, the duration of of SB carrying, method of transportation to school, type of SB etc. in schoolchildren could lead to musculoskeletal pain. Especially longitudinal and educational studies are needed to prevent these effects.

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