

Effect of school bags on body mechanics among Saudi children

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ABSTRACT

It is well known that school bag has effects on the posture of early school students. Therefore, lack of data about the impact of school bags on body mechanics of children from Saudi Arabia. This study aimed to assess the effect of heavy school bag on the student's body mechanics at elementary school in Riyadh. We conducted this observational cross-sectional study by observing the posture, palpation meter (PALM), interview, and examining school bag content, of primary school students across the Riyadh. Total of 200 students was included in our study. Less than half of the students reported pain (41.5%). Students who reported pain (n=83) most of them had inappropriate school bag weight (85.5%), whereas (14.5%) school bag weight was appropriate and (67%) students had tilted in the shoulders. Our finding suggested that heavy school bags contributed to the presence of pain and shoulder tilt, whereas long duration of carrying school bag did not affect shoulder tilt. Thus, in future, education for parents must be conducted to make sure to prevent students from carrying bags exceeding the acceptable standard limit.

KEY WORDS: SCHOOL BAG, ELEMENTARY SCHOOL, POSTURE, PAIN

INTRODUCTION

It is well known that schoolbag has effects on the posture of early school students. Studies have revealed that the prevalence of musculoskeletal issues in school children due to heavy school bags is increasing; therefore, it

has become a concern, (Chow *et al.* 2010, Shamsoddini, *et al.* 2010). Earlier studies have shown that carrying heavy school bags has harmful effects on the children's musculoskeletal systems such as increasing in postural sway, and trunk muscle activity levels, Dianat *et al.* 2013). Students cannot carry heavy loads due to their

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
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size and weight. Thus, carrying heavy school bags leads to schoolbag-related injuries for children, Watson *et al.*, (2003). According to doctors and physical therapists, the schoolbag weight should not exceed 10-15% of the students' body weight to avoid musculoskeletal problems. Several workers (Murphy *et al.* 2007, Dockrell *et al.* 2013, Al-Saleem *et al.* 2016 and Dowshen, 2017) have found the prevalence of back pain among school students by evaluating the school bags weight about their weight. Out of 2567 school students, 1860 (72.46%) were carrying schoolbags more than the acceptable standard. The results have shown that female student's school bags are more substantial than male student school bags, and 42% of the school students reported back pain.

Body mechanics education depends on the researcher that assesses the effects of mechanical loading or stress on controlling and supporting the spine. The mechanism of loading could be compression, torque, bending, shear, and tension or a summation of these forces to perform functional tasks from the dynamic nature, Lieber *et al.* (2000). Excessive forces working on the spine can cause a dynamic deformation of the spine structure the human body can reduce pain stimulation by lowering mechanical stress thus contribute to pain management Lieber *et al.* 2000. The majority of the studies focused on the schoolbag weight as the most important factor affecting the musculoskeletal system, while there are also other factors such as duration and method of carrying schoolbags affecting the musculoskeletal system, (Dianat *et al.* 2013, Dockrell *et al.* (2015) and Patil *et al.* 2016).

Carrying the school bag over one shoulder makes the student lean to one side due to the extra weight which harms the student by causing back pain, shoulder and neck strain. If the school bag is placed in a wrong way over the shoulders, it could lead to back, shoulder and neck pain because the student tries to resist the weight's force that pulls backward by bending forward which causes compression to the spine. Also, carrying school bag incorrectly causes bad posture Pascoe *et al.* (1997). Dianat *et al.* (2014) reported that musculoskeletal symptoms prevalent for 307 primary school students were caused by school bags. Results have shown that the shoulders were most affected body region among the sample with (70%), then wrists/hands (18.5%), upper back (13.6%) and low back (8.7%), while no symptoms were noted for the lower limbs, (Dianat *et al.* 2013) .

The basic assumption based on the biomedical model is that the maturing spine cannot handle the mechanical load of the backpack sufficiently Reneman *et al.* (2006). A previous study has shown that head, cervical spine and shoulder alterations in posture throughout gait terminations in student due to load carriage. Carrying more than the standard limit for schoolbag weight has effects on the posture of the head, cervical spine, and shoulder

throughout gait terminations. The posture of the head became more forward, while it affected the shoulder to be more rounded and tilted Reneman *et al.* 2014, Mwaka *et al.* (2014). Center of gravity has a significant effect on schoolbag weight and in consideration of proper carrying techniques. Different carrying bag techniques is one of the significant factor on posture and gait of students aged between 11 ± 13 years old, there is no difference in the lateral spinal deviation between two-strap backpack and students without the bag, Nevertheless, two-strap school bag reduced carrying stress on the student back, neck and shoulders, (Pascoe *et al.* 1997, Skoffer *et al.* 2007, Mwaka *et al.* 2014). Moreover confirmed the musculoskeletal pain as result of the heavy backpack.

The literature has demonstrated the detrimental effects of carrying heavy school bags on school students. Studies have revealed that the prevalence of musculoskeletal issues in school students due to heavy school bags is increasing. There was a lack of data about the effect of school bags on body mechanics of children at Saudi Arabia. So, we this study aimed to assess the effect of heavy school bag on the student at elementary school body mechanics in Riyadh. In this study, we took in consideration factors that contribute in heavy bags and the duration of carrying the bag.

MATERIALS AND METHODS

This study was carried out in primary schools in Riyadh, Saudi Arabia between Augusts to November 2017. It was an observational cross-sectional study. The sample size (n=200) divided equally for each gender as 100 males and 100 females. The sample included primary school students between 9-11 years old (third grade to fifth grade). We excluded students with congenital deformity, history of accident, students younger than 9 years, and older than 11 years, obese students. Multistage cluster sampling was used, thus we divided Riyadh into regions or clusters.

The schools were selected from eastern region, and students were chosen randomly. The participants in each school were waiting in a classroom and numbers were distributed to them randomly so we called them by the number then they came to do the assessment. One assessor measured the student weight and their bag weight, and examined student bags whether it was one/two strap, loose/tight, width of strap, and its contents. Second assessors were interviewed by self-designed questionnaire, and the other assessors were measured with Palpation Meter (PALM).

The questionnaire was developed to cover the areas we wanted to collect in this study. There were 22 questions about demographic details, pain, duration of carrying the school of bag, and whether they are educated about

the topic. The measurement tool that has been used in this study is valid and reliable tool called palpation meter (PALM) Petrone *et al.* (2003), Kellis *et al.* (2010). This tool allows to determine skeletal asymmetry and then locate the point of asymmetry by making measurements at various landmarks in the body. Also, we used scale to weigh the students and their bags. Before visiting schools, we contacted the school principal to permit the conduct of the study. Informed consent form was sent to the parents of the student for signed consent. All details of the study delivered to the parents before the start of the study.

DATA ANALYSIS

The calculated data entered into Microsoft Excel. Categorical variables represented in frequencies and percentage. Mean and Standard Deviation used for continuous variables. The data analysis used Chi-square test to compare proportion the difference for various variables. A statistical package was SPSS version 22 used for statistical analysis of the data. The P-value <0.05 was considered the level of significance. Appropriate diagrams have also been used.

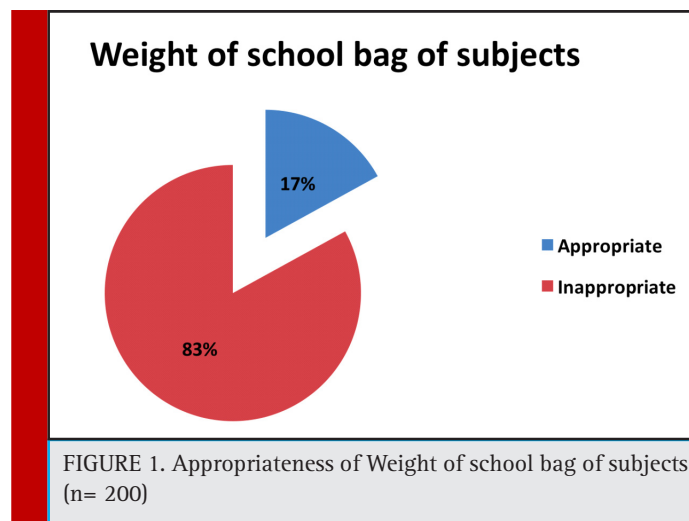


RESULTS AND DISCUSSION

A total of 200 students from 4 different schools participated in the study. The average age was 9.58 years and the SD was 0.711. There were (100) 50% male and (100) 50% female. There were 110 (55%) third grade (9 years), 64 (32%) fourth grade (10 years), and 26 (16%) fifth grade (11 years). The study found that 83% of the students had inappropriate schoolbag weight and 17% appropriate as seen in (Fig 1).

It was found that female had more inappropriate school bag weight (54.2%), while this was 45% for students. The percentage of students with inappropriate school bag weight of each age group was highest for students with 10 years (90.6%), then 9 years (80%) and lowest in 11 years (76.9%) see Table 1. Students who were educated about the effects of school bag on body mechanics were less (32.5%) than who were not educated (57.5%). All the students had backpack and carried their backpacks over two shoulders and most of the bags had wide strap (91.5%) and loose strap (67.5%), whereas (8.5%) of their bags had thin strap and (32.5%) tight strap. The mean weight of school bags was 4.82 ± 1.536 kg (Table 2). It was found that students who carried books according to their daily schedule were (84%) while (16%) did not. The majority of male students (66%) and female students (78%) had extra bag content. Less than half of the students reported pain (41.5%), and the rest (58.5%) of them did not. The students who reported pain (n=83) most of them had inappropriate school bag weight (85.5%), whereas (14.5%) school bag weight had appropriate school bag (Table 1).

The most area of pain reported was shoulder (70%), then (18%) in back. and the least reported was in their neck (12%). Among the students who reported pain, the majority felt pain while carrying the bag (79.5%), after carrying the bag (14.5%), and 6 % had felt it all the time



				Chi square	P-value
		Appropriate	Not appropriate		
When do you feel the pain? (n=83)	While carrying the bag	7(58.3%)	59(83.1%)	9.224	0.010
	After carrying the bag	2(16.7%)	10(14.1%)		
	All the time	3(25.0%)	2(2.8%)		
What is the level of your pain? (n=83)	Mild	2(16.7%)	36(50.7%)	12.813	0.002
	Moderate	5(41.7%)	30(42.3%)		
	Severe	5(41.7%)	5(7%)		
Gender (n=200)	Female	5(20%)	46(42.2%)	4.252	0.039
	Male	20(80%)	63(57.8%)		
Educated about this topic before (n=200)	Yes	13(38.2%)	52(31.3%)	0.614	0.433
	No	21(61.8%)	114(68.7%)		
Tilt (n=200)	Yes	25(18.7%)	109(81.3%)	0.790	0.374
	No	9(13.6%)	57(86.4%)		
Tilt side (n=134)	Right	17(68.0%)	69(63.3%)	0.195	0.659
	Left	8(32.0%)	40(36.7%)		
Where do you feel pain exactly? (n=83)	Neck	1(8.3%)	9(12.7%)	2.236	0.327
	Shoulder	7(58.3%)	51(71.8%)		
	Back	4(33.3%)	11(15.5%)		
Do you feel any pain? (n=200)	Yes	12(14.5%)	71(85.5%)	0.650	0.420
	No	22(18.8%)	95(81.2%)		
Age in years (n=200)	9	22(64.7%)	88(53.0%)	4.019	0.134
	10	6(17.6%)	58(34.9%)		
	11	6(17.6%)	20(12.0%)		

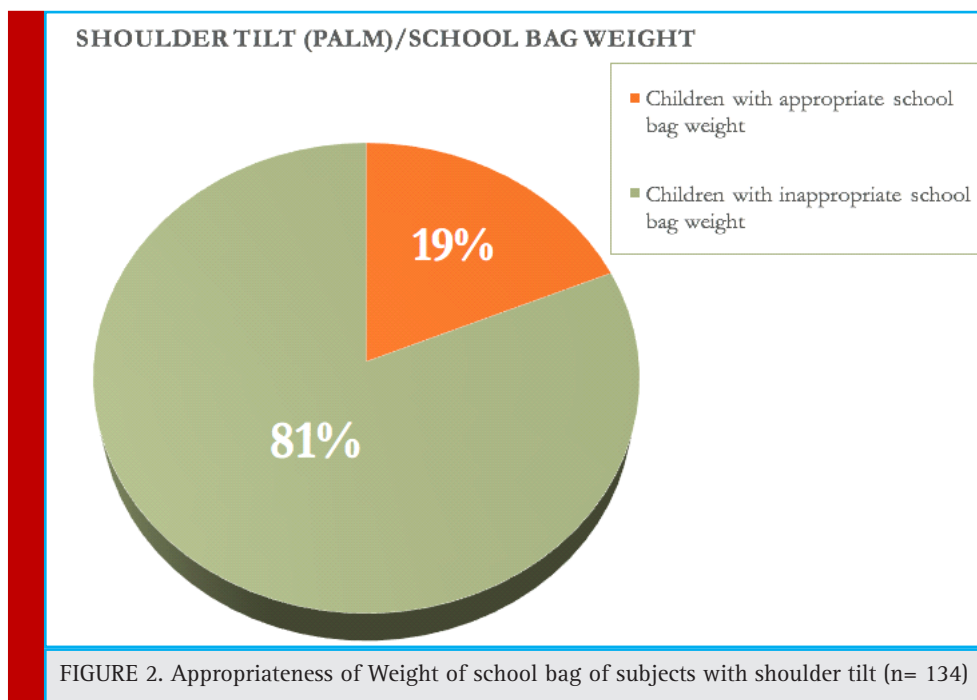
	N	Minimum	Maximum	Mean	Std. Deviation
Schoolbag Weight	200	2	14	4.82	1.536

(6%). Also, among those students who reported pain most of them had mild level of pain (46%), then moderate pain (42%) and very few had severe pain (12%). According to the age group, pain was highest among student who age 11 years (n=26) 13(50%) and lowest in 9 years (n=110) 41(37.2%). There was no significant difference between the prevalence of pain between male (49.4%) and female (50.6%). We found that carrying the bag in morning line increase the incidence of pain

as (50%) who have answered yes to carrying it in the morning have pain whereas (3.87 %) who have not carry the bag in the morning line have pain see Table 3.

Students who had pain and tilt were 52 (26%), 19 (45.2%) of them were female, and 33 (80.5%) were male see Table 4. 134 (67%) students had tilt in the shoulders and 67 (33%) of them did not have any tilt. From the students who had tilt in their shoulders 19% had schoolbag weight appropriate while 81% had inappro-

		Do you feel any pain?		Total
		Yes	No	
Do you carry your bag while standing in the school morning line?	Yes	22(26.6%)	22(18.8%)	44(22%)
	No	61(73.4%)	95(81.2%)	156(78%)
Total		83(100.0%)	117(100.0%)	200(100.0%)



appropriate bag weight (Figure 2). There was variety in the degrees of shoulders tilt from 1 to 4 degrees. Out of the students with shoulder tilt (n=134) the majority were male (61.9%), whereas (38.1%) of them were female. We investigated the link between the school bag weight and the presence of tilt in shoulders in each gender. It was found that out of the male with shoulder tilt (n=83) most of them carried school bag with inappropriate weight (75.9%), also in female (n=51) the majority of them carried school bag with inappropriate school bag weight (90.1%) see Table 1.

In this study, we investigated the school bag weight concerning the student body weight. 83% of the students had school bag weight exceeding the standard limit range (10%) the highest limit according to the Ireland Republic, European and Health Promotion Board of Singapore guidelines and only 17% had an appropriate bag weight, Al-Saleem *et al.* (2016). Alsaleem study found that 72.46% of their sample size had inappropriate school bag weight. Approximately the percentage was similar between our study and theirs, Al-Saleem *et al.* (2016). We found that female bags weight

Table 4. Gender comparison

		Gender (n=200)		Chi square	P-value
Female 100 (50%)		Male 100 (50%)			
Is the schoolbag weight appropriate (10% of the student's body weight) (n=200)	Appropriate	5(20%)	20(80%)	0.650	0.420
	Not appropriate	46(42.2%)	63(57.8%)		
Pain and tilt (n=83)	Yes	19(45.2%)	33(80.5%)	11.017	0.001
	No	23(54.8%)	8(19.5%)		
Tilt (n=200)	Yes	49(74.2%)	17(25.8%)	23.157	0.001
	No	51(38.1%)	83(61.9%)		
Bag Content (n=200)	Necessary things	22(22.0%)	34(34%)	3.571	0.059
	Extra things	78(78%)	66(66%)		

Table 5. Carrying school bag during morning line * tilt

		Tilt		Total
		No	Yes	
Do you carry your bag while standing in the school morning line?	Yes	19(43.2%)	25 (56.8%)	44 (100.0%)
	No	47(30.1%)	109 (69.8%)	156 (100.0%)
Total		66(33%)	134 (67%)	200 (100.0%)

is slightly higher than male. Likewise, Alsaleem *et al.* results have shown that female student's school bags are heavier than male student's school bags. Also, a study found that female carried heavier schoolbags than male, Kellis *et al.* (2010).

The mean weight of school bags was 4.82 ± 1.536 Kg, ranging from 2 kg to 14 kg, statistically significant at 0.05. All the students had a backpack and carried their back packs over two shoulders. Likewise, in Dockrell, Simms, and Blake study the mean schoolbag weight (4.8 ± 1.43 kg) and the majority (85%) carried their school bag over two shoulders. According to the age group, the percentage of students with inappropriate school bag weight was highest for students with ten years (90.6%). Inconsistent with another study, the relative bag weight was significantly heavier in the younger age group (ages 6–8 years), Kellis *et al.* (2010). Pain was highest among student with 11 years' students ($n=26$) 13 (50%) and lowest in 9 years ($n=110$) 41 (37.2%).

According to the measurement findings (PALM) we found that out of the students with shoulder tilt ($n=134$) 51(38%) of them were female while 83 (61.9%) of the male. We concluded that males have more shoulder tilt than female. Thus, the shoulder tilt correlated with the schoolbag weight ($n=134$), as a male with shoulder tilt and carried inappropriate school bag weight 63(57.8%) were more than female with shoulder tilt and carried inappropriate school bag 46(42.2%). The percentage of students who had shoulders tilt with inappropriate bag weight (81%) was higher than those with appropriate school bag weight (19%).this goes in line with the observations and recommendations of Dockrell *et al.*(2015) and Patilet *al.*(2016).

The majority of male (66%) and female (78%) had extra bag items such as coloring books, and toys. In the Dockrell *et al.* study, it was also found that the students' bags had additional details such as sports items and musical instrument. These extra stuff increased the load carriage on students. Inappropriate school bag increased the incidence of pain and tilt in the shoulders. Carrying school bag during morning line increased the incidence of pain as most of the students who took their bags during morning line reported pain (50%). However, it did not show any evidence of increasing the shoulder tilt see Table 5.

The most area of pain reported was a shoulder (70%) this is matched the findings in Reneman *et al.*(2006),

then (18%) in back. And the least reported was in their neck (12%). Similarly, in the study of Dockrell *et al.* (2015), the shoulders and the back were the most frequently reported areas of schoolbag-related discomfort. Students who reported pain ($n=83$) the majority felt pain while carrying the bag (79.5%), then after carrying the bag (14.5%), and the least had felt it all the time (6%). Students who reported pain ($n=83$) Most of them had a mild level of pain (46%), then moderate pain (42%) and very few had severe pain (12%) this matched the result of Spiteri *et al.* 2017. education for (32.5%) were made about the effect of heavy school bags on their body mechanics, but it was reflected negatively as we saw that (80%)of them had inappropriate school bag weight this indicated the poor response of the student to the education, may due to habitual attitude witch need long observation and correction by the family and the school teachers.

The students who had both pain and tilt were 52 students whom 19 (45.2%) female and 33 (80.5%) male students with a P-value 0.001. Thus, not every student with tilt was reported pain and vice versa. The presence of shoulders tilt was higher than the incidence of pain this goes in line with the findings of Ghousia *et al.* (2018).

Limitations of this study was it is only conducted in one region and Strengths of this study were that it considered other factors besides the bag's weight; the books should be unified from Ministry of Education for both public and private schools.

CONCLUSION

This study provided evidence that school bag weight has an effects on body biomechanics which causes shoulders tilt, and it also increased the incidence of pain. So, in future, education for parents must be conducted to make sure to prevent students from carrying bags exceeding the acceptable standard limit. The percentage of students with inappropriate school bag weight is high, so further research should investigate in depth the reasons for carrying heavy bags among primary school students.

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