



**A study to assess the correlation of parameters of schoolbag weight carriage to the intensity of musculoskeletal health problems in primary school students of Kolhapur.**

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**Type of Publication:** Original Research Paper

**Conflicts of Interest:** Nil

**Abstract**

This study investigated various parameters of schoolbag weight carriage and correlated the intensity of musculoskeletal health problems to it, in primary school students of Kolhapur. Primary school students (age 6-10 years) in five randomly selected schools of Kolhapur completed an author-assisted questionnaire. Measurements of body weight and schoolbag weight were taken and completion of a daily Body Discomfort Chart survey was conducted. Of the 886 primary school students under study, 93.2% (n=826) students carried schoolbags which were more than 10% of their body weight. 64% (n=567) students complained of musculoskeletal discomfort related to carrying their schoolbag. Statistically significant relationship was found between the schoolbag weight carried and the discomfort complained by the student. No discomfort was complained by students who had a lumbar support for their schoolbags whereas, students with high slung schoolbags complained of discomfort followed by those who carried low slung schoolbags. Strong association was found between the discomfort complained

by the students and the mode of travel they used to commute to school. Discomfort was reported most in the students (88.9%) using cycle as their mode of transport. 42.2% students of the reported discomfort in the shoulder and 23.9% in the neck region. The intensity of discomfort/pain in the shoulder and neck region was found to have statistical significant co-relation with the schoolbag weight with Spearman Rank correlation factor of 0.2666 and 0.288 for shoulder pain and neck pain respectively. It was found that as the school bag weight increases there is statistically significant rise in neck pain and shoulder pain intensity. The study gives solutions to tackle the problem and highlights the importance of early intervention in terms of creating awareness about the problem among the students, parents and schools.

**Keywords:** Musculoskeletal health problem, Intensity, Body weight, Schoolbag.

**1. Introduction**

In recent years, there has been an increasing attention to the amount of loads carried by students to and from school. The recommended safe load limit of schoolbag

weight carriage for students is 10% body weight [1, 2]. Schoolbags represent a considerable daily 'occupational load' for school children [3]. The relative load carried by schoolchildren (expressed as % body weight) has been considered in ergonomic studies as one of the contributory factors for developing musculoskeletal problems among this age group [4]. Majority of reports in this area indicate that the loads carried by students are greater than the recommended limits [5,6] and that the burden on the children is not just in terms of competing in academics and extra-curricular activities, but also on their developing backbones. Studies have reported relationship between heavy school bags and educational failure, lack of motivation, lack of learning, and absenteeism [7]. The peak rate of growth occurs during childhood, puberty and the growth of the appendicular skeletal system ceases around 16 years of age for females and 18 years for males. However secondary ossification of vertebrae is not complete until the mid twenties. In these years skeletal tissue transforms from cartilage to bone through the process of ossification occurring in several stages and they are most vulnerable at this time [8, 9]. Therefore, the spine may be susceptible to injury for a greater length of time and establishing standard schoolbag weight should be emphasized during the formative years. Children have relatively larger heads and also have higher centre of mass at about T12, compared to L5-S1 in adults resulting in difficulty in maintaining static balance. Indian studies reported that 10%-30% of healthy children experience back pain, especially low back pain, by their teenage years [10, 11]. Creating awareness in primary school students of age group 6-10 years was therefore the motive of this study. A detailed study of parameters of school bag weight carriage, which include the type of schoolbag, weight of schoolbag in terms of percentage body weight, way of carrying the schoolbag, mode of travel of the students, location of musculoskeletal discomfort/pain, and its

intensity; is warranted to advocate practically feasible solutions to tackle the catastrophic effects of schoolbag weight and use in primary school students.

**2. Aim:** To study the parameters of schoolbag weight carriage and musculoskeletal health problems associated with them in primary school students of Kolhapur.

### **3. Objectives**

- 3.1. To determine weights of schoolbags as percentage to bodyweight carried.
- 3.2. To assess way of carrying schoolbag.
- 3.3. To record the mode of travel and home-school distance.
- 3.4. To record reported discomfort due to schoolbag carriage on Body discomfort chart and its intensity on Wong Baker Facial Grimace pain measurement scale.
- 3.5. To assess the correlation between the above mentioned parameters to the musculoskeletal health problems.
- 3.6. To give practicable solutions to tackle the problem and create awareness about the same in students, parents and schools.

### **4. Review of Literature**

The dangers associated with improper childhood school bag weight and musculoskeletal pain in school children is now becoming a burning issue. More than 2.5 million elementary school children carry school bags on their shoulder 5 days in a week for the entire school year, this is a large issue that needs to be addressed this problem has been reported internationally [12]. Effectively, the relative load carried by school children expressed as percentage of body weight in these studies represents a range between 10% -22% body weight. Students sometimes carry as much as 30% to 40% of their bodyweight at least once a week [13]. There is evidence that the prevalence of musculoskeletal problems in schoolchildren and adolescents is increasing [14, 15]. Combined effects of

heavy backpack, duration carrying the backpack, manipulating and handling of backpack, method of carrying, position of the load on the body of students are determinant factors for musculoskeletal complaints associated with schoolbag carriage [16]. Previous research has shown that carrying heavy school bags can affect the musculoskeletal system of children and are likely to cause different problems such as changes in head/neck and spinal posture and increase the neck and trunk muscle activity levels [17]. Heavy schoolbag cause children's back pain, excessively stretch back, increase the children's lumbar dint and their posture deform, and causes lopsided and swept lumbar [18]. A lack of study was found with regards to the way of carrying the schoolbag and the mode of travel of the students, which are two potent contributors to the musculoskeletal health problems in primary schools students. A dire need to study the parameters of schoolbag weight carriage and their association with the musculoskeletal health problems in primary school students of Kolhapur thus formed the backbone of this study.

## **5. Materials and Methods**

This is a cross-sectional, school based study and was conducted in five randomly selected conventional schools in the city of Kolhapur from July to September, 2015. Primary school students from the conventional schools (whose parents gave consent for including their child in the study and; those students satisfying the inclusion criteria) stated above were included in the study. Out of the 950 consent forms distributed, 886 students' parents consented for involving their children to the study, thus accounting for a sample size of 886 primary school students.

### **5.1. Inclusion criteria**

5.1.1. All primary school students (Day scholars) (Class 1-4) (Age group 6-10 years) whose parents have

given consent for involving their child for the research.

5.1.2. Those with the ability to walk and wear school bag independently.

### **5.2. Exclusion criteria**

5.2.1. Those with any orthopedic problems including foot or ankle deformities and leg length discrepancy or any child on chair.

5.2.2. Those with any with congenital and structural abnormalities neuromuscular disorders.

5.2.3. Those suffering from any acute illness or recovered from chronic illness in past 2 months or those with history of any surgery in past 2 months.

5.2.4. Those unable to carry a schoolbag to school.

Data Collection was undertaken after taking Ethical Clearance from the University Ethical Committee. The study was carried out on a week day in the randomly selected schools. Prior permission was taken from the School Authorities. After explaining the format of study to the students, consent forms were distributed among the students and they were asked to get it signed the next day, thus, informed consent was taken from parents of respective students. Consent forms were collected from the students the next day. A surprise visit to the school was then planned for data collection and data collection was carried out at the time of commencement of the school (to measure all the books and any food items; and minimize disturbance to classes). A digital weighing scale (with error of margin 100 grams) was used for the objective testing. The scale was calibrated prior to the study. Weight of student (in kilograms) and schoolbags was recorded by using a calibrated digital scale. An author assisted questionnaire enquired the general information of the school (school address), student (Name, Age, Gender, Residential Address, and Mode of travel to school.). School bag type (High slung/Low slung; 2 straps /1 strap), way of carrying the schoolbag (on single

shoulder, both shoulders) was assessed. Questionnaire seeking information on students' subjective daily view of their bag weight (normal/light/heavy weight) and their perceived level of discomfort secondary to schoolbag carriage (Musculoskeletal pain- eg. back pain, shoulder pain /no pain) was completed. Body discomfort Chart was used to record the site of discomfort; and Wong Baker Facial Grimace Scale pain assessment scale to grade the intensity of discomfort experienced due to carrying their schoolbag. Students were asked to mark the location of pain on the Body Discomfort Chart and also to rate the intensity of their discomfort between 'no discomfort' and 'worst possible discomfort' on a Wong Baker Facial Grimace Scale. The questionnaire was designed in English (for English medium schools included in the study), and was also translated into Marathi for the Marathi medium schools included in the study. It took less than 10 minutes to complete the details.

Questionnaire data was entered into a computer using Microsoft Excel. Total school bag weight as a percentage of body weight was computed by dividing the weight of the bag by the child's weight was determined. Responses were analyzed using frequency distributions and descriptive statistics using SPSS software. Chi-square test, T test, Spearman's test were applied. Results were considered to be significant when the p- value was less than 0.05.

## 6. Results

Of the 5 randomly selected schools, School Authorities of the respective schools permitted to carry out the study in their school. Of the 950 consent forms issued to the primary school students of 5 randomly selected schools taken under study, 93.2% (N=886) were returned. Of those who consented, 100% (N=886) completed all measurements and were included in the study. This included 58.4% (n=517) boys and 41.6% (n=369) girls. Of the 886 primary school students, 90% (n=798) used

backpack style schoolbags whereas 10% (n=88) used horizontal type of schoolbags. Of these, 99.9% (n=885) had two straps, and only one of them was a single strapped schoolbag. 7.2 % (n=64) students carried the schoolbags on one shoulder (i.e., used only one strap) whereas, most of them 92.8% (n=822) students carried their schoolbags on both the shoulders (i.e., used both the straps). 7.7 % (n=68) students had high slung schoolbags i.e. the bag rested on the scapular region. 5.3% (n=47) students carried the schoolbags which rested on the lumbar region and had lumbar support for their bags. 87% (n=771) students had low slung schoolbags i.e. their schoolbags slung below the level of their buttocks. 93.2% (n=826) students carried schoolbags which were more than 10% of their body weight. 64% (n=567) students confirmed that they perceived their schoolbags to be heavy, 28% (n=67) said that it was normal and 28% (n= 252) said that their schoolbag was light weighed. 64% (n= 567) students complained of musculoskeletal discomfort related to carrying their schoolbag. 64.49% (n=238) girls and 57.61% (n=329) boys reported of discomfort due to carrying a schoolbag. *Students with high slung schoolbags complain of discomfort followed by those who carry low slung schoolbags. The students following appropriate method of carrying the schoolbag do not complain of any discomfort* (Refer Table 1.). *Strong association was found between the discomfort complained by the students and the mode of travel they used.* Discomfort was reported most (88.9%) in the children using cycle as their mode of transport followed by those coming to school by bus, two-wheeler, car rickshaw and walking. Statistically significant relation was found between the distance travelled by the student and the discomfort complained. (Refer Table 2. and Table 3.). *42.2% students of the reported discomfort in the shoulder and 23.9% in the neck region.* (Table 4. gives the findings of the Body discomfort Chart) On applying *Spearman Rank*

Correlation Test, the intensity of discomfort/pain in the shoulder and neck region was found to have statistical significant co-relation with the schoolbag weight with correlation factor of 0.2666 for shoulder pain whereas correlation factor of 0.288 for neck pain. Thus, as school

bag weight increases there is statistically significant rise in neck pain and shoulder pain intensity.

Table 1. Association of strap length with discomfort.				
Strap length	Total	Discomfort		
		Present		
		Frequency	Percentage	
High slung	68	49	72.1	
Low slung	771	518	67.2	
Normal	47	0	0	
Total	886	567	64	
Test	Value	df	'p' value	Statistically significance
Chi-square	88.863	2	0.000	Yes

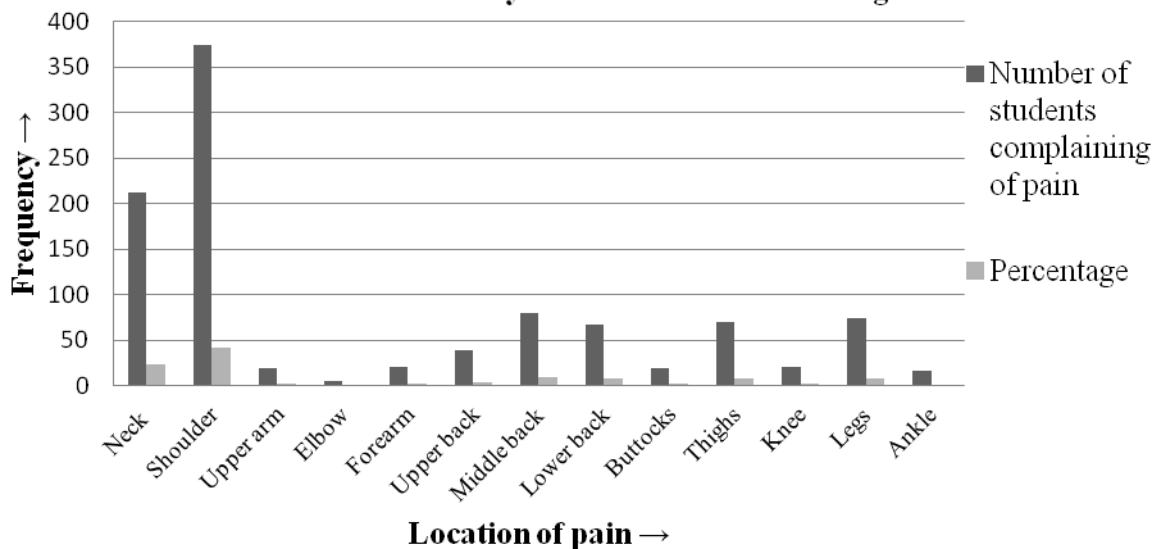
Table 2. Association of mode of travel of the student with the discomfort complained.					
Mode of travel	Discomfort				Total
	Present		Absent		
	(n)	(%)	(n)	(%)	
Bus	50	69.4	22	30.6	72
Car	42	68.9	19	31.1	61
Rickshaw	399	62.9	235	37.1	634
Two-wheeler	22	68.8	10	31.3	32
Cycle	8	88.9	1	11.1	9

Walking	46	59	32	41	78
Chi-square	Value	df	'p' value	Statistically significance	
	5.450	5	0.363	Yes	

Table 3. T-test (Association between distance travelled by the student to the discomfort complained)

Discomfort	Frequency (N)	Mean (Distance travelled) (km)	Standard deviation	Standard error
Present	567	4.27	3.332	0.14
Absent	319	3.76	3.136	0.17
Test	Value	df	'p' value	Statistically significance
T-Test	2.233	884	.026	Yes

Chart 1. Body Discomfort Chart Findings



**7. Discussion**

Of the 950 consent forms issued, 93.2% (N=886) were returned and were eligible for inclusion in the study. The most popular style of schoolbag was found to be a backpack-style bag with two straps (90%) similar to that found by others [19]. It is encouraging that the majority of the students in the study opted to use the backpack for

school since it has been shown to be the most appropriate design for use [20]. 92.8% of students carry their schoolbag on the back over two shoulders. But, this finding is not in agreement with others [20]. From the author-assisted questionnaire it was found that 64% of students reported discomfort due to carrying their schoolbag. This high proportion of reported discomfort is

similar to the 74.4% finding of Sheir-Neiss et al [21]. Prevalence of musculoskeletal symptoms in girls (64.5%) and boys (63.6%) was almost similar, not a finding parallel to that found by Grimmer and Williams [1] and Puckree et al [22]. Strong association was found between the discomfort complained by the students and the mode of travel they used. Discomfort was reported most (88.9%) in the children using cycle as their mode of transport followed by those coming to school by bus, two-wheeler, car, rickshaw and walking. On inquiry to find the cause, it was found that the students who came by cycle, used to carry their bags on their shoulders even while riding the cycle, thereby increasing the duration of carrying the load and ultimately leading to musculoskeletal discomfort. Most of the students who came by bus/ with their parents on two-wheelers/ in car/bus said that they carry their bags on their shoulders even while travelling to school. This in turn increases the duration of carriage of the load on their backs and thereby increases the prevalence of musculoskeletal symptoms. Statistically significant relation found between the home-school distance travelled by the student and the discomfort complained justifies itself as one of the causes of musculoskeletal symptoms, since as the time of travel increases, the duration for which the students carry the load also increases in turn increasing the prevalence and intensity of musculoskeletal discomfort/pain. Out of the 886 students in this study, 42.2% students of the reported discomfort in the shoulder and 23.9% in the neck whereas higher levels of discomfort of 43.6% neck, shoulder pain [18]; 86.9% shoulder, neck and back pain [23] was reported by different authors. The intensity of discomfort/pain in the shoulder and neck region was found to have statistical significant co-relation with the schoolbag weight with correlation factor of 0.2666 for shoulder pain whereas correlation factor of 0.288 for neck pain. Therefore, as school bag weight increases there is statistically significant rise in neck pain

and shoulder pain intensity. Thus, it is important for the students to adhere to the guideline of carrying schoolbags weighing not more than 10% of their body weight and to adopt the correct posture of carrying the schoolbag.

## **8. Conclusions:**

- 8.1. High prevalence of musculoskeletal symptoms in primary school students in Kolhapur.
- 8.2. Majority of the students carry schoolbags more than the recommended safe load limits.
- 8.3. Most of the students use two-shouldered schoolbags. Low slung schoolbags and high slung school bags are associated with increased musculoskeletal health problems.
- 8.4. Mode of travel adopted by students has positive correlation with the musculoskeletal health problems.
- 8.5. Musculoskeletal symptoms mostly reported in the shoulder and neck region.
- 8.6. As school bag weight increases there is statistically significant rise in neck pain and shoulder pain intensity.

## **9. Recommendations**

- 9.1. Correct manner and posture in carrying school bags and the adverse effects that over-weight schoolbags will bring about, should be explained to the students by carrying out interactive sessions in the school.
- 9.2. Parents should be urged to select school bags and items which are made of light-weight materials and those with two straps and a lumbar support.
- 9.3. Students should bring books according to the school timetable.
- 9.4. Students shouldn't carry their schoolbags on their shoulders while travelling to school. For example:
  - a. Students coming to school by cycle should put their schoolbags on the cycle rear carrier instead of hanging them on their shoulders while they ride.

b. Students who walk to the school should keep a check on their schoolbag weights; and master the correct manner and posture of carrying school bags.

9.5. Students should be encouraged to do regular exercise. For example: Neck up and down/shoulder rotations/hip rotations/ankle rotations exercise should be done preferably during the school assembly.

9.6. Use of tier system of education: In this, semester wise/ 3 monthly single booklet containing all the subjects may be designed and used which will help reduce the schoolbag weight.

## 10. Acknowledgments

- The first author expresses deep gratitude to the Indian Council of Medical Research for approving the research proposal and report for the prestigious ICMR STS scheme.
- Also thanks to the Dean and Faculty of authors' Medical College, Kolhapur for their valuable guidance and encouragement.
- Special mention of friends and family for their constant motivation and support.

## 11. References

1. Grimmer K, Williams M: Gender-age environmental associates of adolescent low back pain. *Appl Ergon* 2000, 31:343-360.
2. Leboeuf-Yde C, Kyvik KO, Bruun NH: Low back pain and lifestyle: part I: smoking: information from a population-based sample of 29,424 twins. *Spine (Phila Pa 1976)* 1998, 23:2207-2213.
3. Negrini S Carabolona R and Sibilla P. Backpack as a daily load for schoolchildren. *The Lancet*. 354 (1999) 1974.
4. Iman Dianat<sup>1</sup>, Zeynab Javadi<sup>2</sup>, Hamid Allahverdipour<sup>3</sup> School BagWeight and the Occurrence of Shoulder, Hand/Wrist and Low Back Symptoms among Iranian Elementary Schoolchildren

(Received: 25May 2011/ Accepted: 23 July 2011)  
*Health Promotion Perspectives*, Vol. 1, No. 1, 2011;  
P: 76-85

5. Negrini S, Carabalona R: Backpacks on! Schoolchildren's perceptions of load, associations with back pain and factors determining the load. *Spine (Phila Pa 1976)* 2002, 27:187-195.
6. Iyer MSR: An ergonomic study of chronic musculoskeletal pain in schoolchildren. *The Indian Journal of Paediatrics* 2001, 68(10):937-941.
7. Ko, J and M.Kim, 2013. Reliability and responsiveness of the gross motor function measure-88 in children with cerebral palsy. *Phys. Ther.*, 93; 393-400.
8. Lanes T, Gauron E, Spratt K, Wernimont T, Found E, Weinstein J. Long term follow up of patients with low back pain treated in a multidisciplinary rehabilitation program. *Spine* 1995; 20: 801-806.
9. Shumway CA. Control of normal mobility. In: Shumway CA, Woollacott MH, Eds. *Motor Control: Theory and Practical Applications*.
10. Mayank M, Upendar S, Nishat Q. Effect of backpack loading on cervical and shoulder posture in Indian school children. *Indian J Physiotherapy Occupational Therapy* 2006;1: 3-12.
11. Grimmer K, Dansie B, Milanese S, Pirunsan U, Trott P. Adolescent standing postural response to backpack loads: a randomized controlled experimental study. *BMC Musculoskelet Disord*. 2002; 3: 10.
12. Forjuoh SN, Schuchmann JA, Lane BL. Correlates of heavy backpack use by elementary school children. *Public Health* 2004; 118:532-535.
13. Mackenzie, W. G., Sampath, J. S., Kruse, R. W., Sheir-Neiss, G. J., *Backpacks in Children*, *Clinical Orthopaedics and Related Research*, vol. 409, pp. 78-84, 2003.



14. Murphy S, Buckle P, Stubbs D. A crosssectional study of self-reported back and neck pain among English schoolchildren and associated physical and psychological risk factors. *Appl Ergon* 2007; 38:797–804.
15. Jones GT, Watson KD, Silman AJ, Symmons, DPM, Macfarlane GJ. Predictors of low back pain in British schoolchildren: A population-based prospective cohort study. *Pediatrics* 2003; 111:822–828
16. Puckree T Silal S and Lin J. School bag carriage and pain in school children. *Disability and Rehabilitation*.26 (2004) 54-59.
17. Hough PA, Nel M, Smit JE, Malan E, van der Watt M, Deacon AF, Grobler L, Bester AM. The Influence of carrying school bag on the developing spine. *Children's Health Care* 2006; 35:339–348.
18. Whittfield J, Legg SJ, Hedderley DI. Schoolbag weight and musculoskeletal symptoms in New Zealand secondary schools. *Appl Ergon* 2005; 36:193–198.
19. Pascoe DD, Pascoe DE, Wang YT, Shim DM, Kim CK. Influence of carrying book bags on gait cycle and posture of youths. *Ergonomics* 1997; 40:631– 641.
20. Chansirinukor W Wilson D Grimmer K and Dansie B. Effects of backpacks on students: measurement of cervical and shoulder posture. *Australian Journal of Physiotherapy*. 47 (2001) 110-116.
21. Sheir-Neiss G Kruse R Rahman T Jacobson L and Pelli J. The association of backpack use and back pain in adolescents. *Spine*. 28 (2003) 922-930.
22. Puckree T Silal S and Lin J. School bag carriage and pain in school children. *Disability and Rehabilitation*. 26 (2004) 54-59.
23. Casey G and Dockrell S. (1996) A pilot study of the weight of schoolbags carried by 10-year old children. *Physiotherapy Ireland*. 17 (1996) 17-21.