



Original Research Article

## **Influence of Schoolbag Use on Musculoskeletal Discomforts among University Students**

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### **ABSTRACT**

**Objective:** The aim of this study was to investigate the prevalence of musculoskeletal discomforts (MSDs) in various regions of the body due to schoolbag use and to examine its association with certain perceived correlates.

**Methods:** This cross-sectional, analytic study was conducted among 500 participants of SRM University in Chennai, India. Data on schoolbag use were collected using a self-administered questionnaire and MSDs using the Nordic musculoskeletal questionnaire. Statistical analyses were conducted using SPSS software version 21.0.

**Results:** A high percentage of respondents (82.2%) reported MSDs. Prevalence of discomforts in neck, shoulder, elbow, wrist/hand, upper back, lower back, hips/thigh, knee and ankle was 48.6%, 61.2%, 11.8%, 14.2%, 38.2%, 29%, 19%, 17.2%, and 16.6% respectively. The average schoolbag weight carried and relative schoolbag weight were 3.7kg and 6.5% respectively. Gender was associated with shoulder, elbow and hip/thigh discomforts ( $P < 0.05$ ) with females being more likely to suffer discomforts than males. Body mass index (BMI) was associated with occurrence of knee and ankle/feet discomforts. Relative schoolbag weight was associated with shoulder and low back discomforts ( $P < 0.05$ ) while frequency of schoolbag carriage was associated with ankle/feet discomforts ( $P < 0.05$ ). There was no association between manner of schoolbag carriage, duration of schoolbag carriage and MSDs ( $P < 0.05$ ). Majority of the respondents perceived their schoolbag weight as being normal (72.1%) and also aware (75.2%) of the potential consequences of incorrect carriage of schoolbag.

**Conclusion:** Prevalence of MSDs was high among the respondents with gender, BMI, relative schoolbag weight and frequency of schoolbag carriage being significant predictors of MSDs.

**Keywords:** Schoolbag, Schoolbag carriage, Musculoskeletal discomforts.

### **INTRODUCTION**

Musculoskeletal conditions continue to be a substantial setback for public health with studies on this aspect being a subject of

interest by many researchers. A wide range of aetiological/predisposing factors are implicated in these disorders and include the different awkward postures associated with

different occupations, schoolbag use or carriage and so forth. Carrying schoolbag is a means of applying external forces to the body and has been commonly associated with postural and gait deviations. [1] Heavy schoolbag load and improper schoolbag use can be threatening to the health of students as studies have shown these factors are associated with muscle imbalance, [2] repetitive strains to the body, intense pressure on joints and ligaments, [3,4] increase in energy consumption and decrease in lung volumes. [5]

In recent years, there has been increase in the incidence of musculoskeletal complaints due backpack use among college students. [6] Previous research has shown that approximately 85% of university students self-reported a discomfort and pain associated with backpack usage in New England. [7] The associated long-term discomforts or pain may lead to potential chronic pain or injury resulting in student's absenteeism from lessons and low productivity thereby affecting students' wellbeing and future careers. [8,9]

The recommended guidelines for schoolbags load vary among organisations. The American Occupational Therapy Association [10] has recommended backpack load limit not more than 10% of student's body weight while American Academy of Pediatrics [11] recommended safety limit ranging 10 to 20% of the student's body weight. However, Martha [12] suggested that these recommendations are feasible with practical goal and it is better to be limited at 10% or less. It is equally important that students develop an awareness of these issues in order to monitor their own practices. [13]

Musculoskeletal discomforts MSDs are considered to be multi factorial in origin. [14] Though, several studies have linked the occurrence of these disorders to loads exceeding the recommended limits however,

other factors related to schoolbag use may contribute significantly in the development of these disorders. Factors such as backpack design, duration and frequency of carriage, inadequate distribution of weight in the backpack, method of transport to school, manner in which the weight is carried as well as improper carriage may all affect the demands on the musculoskeletal system leading to occurrence of musculoskeletal symptoms. [2,15-17] Gender differences has also been shown to have influence in the occurrence of MSDs as studies reveals females are more likely at risk than males [12,13] owing to the fact that factors like manner of schoolbag carriage, physical activity, rate of growth and muscle strength varies across gender. [12,14,17]

A number of studies have investigated the influence of schoolbag use on MSDs in children, adolescent and the elderly but limited data is available on university students. [7] Therefore, it is important to investigate the epidemiology of MSDs among university students and examine its associated factors.

The purpose of this study was to (a) investigate the prevalence of MSDs due to schoolbag use among university students in India, (b) investigate the relationship between genders, body mass index (BMI), relative schoolbag weight, frequency of carriage, method of carriage, duration of carriage and MSDs.

## **MATERIALS AND METHODS**

### ***Participants***

Five hundred students of SRM University comprising 204 males and 296 females within the age range 17-40 years were recruited from nine departments of the three main faculties of the university namely Faculty of Medicine and Health Science, Faculty of Science and Humanities, and Faculty of Engineering and Technology using multi stage random sampling

technique. Potential respondents were registered students of SRM University and were approached in their lecture theaters. Ethics approval was obtained from the Research Ethics Committee of SRM University. Informed consent was obtained from participants after explaining the procedure and benefits of the study. Both male and female between the ages of 17 – 40 years using schoolbags (for a minimum of six months) were included. Students with recent injuries or previous surgeries over the neck, shoulder, back, abdomen, hips, knee or ankle as well as those with any obvious deformity in spine and joints of upper and lower extremities were excluded.

The schoolbag weight, body weight and height of the students were then measured. A standard bathroom scale (Equinox-BR9015 with precise 0.2lb / 0.1kg accuracy) was used to measure weight of school bags and student's weight. Using this data, BMI was computed in  $\text{kg/m}^2$  and relative schoolbag weight was estimated as a percentage of student body weight.

#### ***Questionnaire Administration***

Two questionnaires were administered on the respondents in this study. The first questionnaire was created by the researcher and consists of two sections (A and B). The first section (Section A) focused on demographic details of the students such as age, gender, height, weight and schoolbag weight. The second section of the questionnaire (Section B) focused on close-ended questions about types of schoolbag carried (one strap backpack, two strap backpack), manner of carriage (on one shoulder, on two shoulder, hand-carry method), frequency of bag carriage (twice, several times), duration of carriage (<10minutes, 10-20minutes, 20-30minutes, 30-40minutes, 40-50minutes, 50-60minutes, >60minutes), opinion towards weight of schoolbag (light weight, normal weight, heavy weight) and knowledge towards

incorrect schoolbag usage (yes, no). To ensure content validity, three experts in questionnaire design judged and agreed on the items and the questionnaire was finally created to reflect the intended variable for analysis.

Data on MSDs was collected using the pre-validated Nordic musculoskeletal questionnaire developed by Kourinka et al. [18] The questionnaire is the most popular survey tool for detecting musculoskeletal disorder and was used previously in related studies. [14,19] The questionnaire includes a body map with clearly identified body areas and labelling to allow respondents to reports areas of MSDs. The respondents were encouraged to answer the questions appropriately if they had experienced any discomfort such as pain, ache, numbness, muscle soreness in the last one month in different part of the body including neck, shoulder, elbow wrist/hand, upper body, lower body, hips/thigh, knees and feet that may be due to schoolbag use using the body map. A one month recall period was used because periods longer than one month may give unreliable information. [20] The questionnaire was explained keeping in mind other factors that can lead to MSDs.

The purpose of the questionnaire and how they should be answered was explained, and whenever necessary further information was provided. We also pretested the questionnaire using a sample of convenience (five students from the Faculty of medical and health sciences were sampled) to improve comprehensibility and clarity of the questions and instructions. In addition, potential problems with item interpretation were identified and resolved. The questionnaire were distributed and collected during one-week.

#### ***Statistical Analysis***

All data were entered into SPSS Software version 21.0 and analysed through descriptive and analytical methods. Binary

logistic regression was used to determine factors associated with occurrence of MSDs. A separate regression model was performed for each body region since discomforts were assessed in nine body regions. Relative risks of significant factors of MSDs were also determined using odds ratio. Variables included in the regression models were gender, BMI (<19, 19-24, >24), relative schoolbag weight (<5%, 5-10% and >10%), manner of carriage, frequency of carriage and duration of carriage. An alpha level of 0.05 or less was taken to indicate statistical significance.

## RESULTS

The questionnaire had a response rate of 100%. Of the 500 respondents, 296 (59.2%) were females and 204 (40.8%) were males. Participant's height, weight and body mass index (BMI) ranged from 1.95 to 1.40m, 126 to 34kg and 51.8 to 14.9kgm<sup>-2</sup> respectively. The mean schoolbag weight and the relative schoolbag weight were 3.69±1.47kg and 6.49±2.80% respectively (Table 1).

**Table 1: Participant's demographics, schoolbag weight and relative schoolbag weight**

Variables	(N=500)	(N %)	Range	Mean ± SD
Gender	Females	296 (59.2)		
	Males	204 (40.8)		
Age (yrs)			17-40	19.74 ± 3.51
Weight (kg)			126-34	58.77 ± 13.1
Height (m)			1.95-1.40	1.625 ± 0.10
Body Mass Index (kg/m <sup>2</sup> )			51.8-14.9	22.18 ± 4.21
Schoolbag weight (kg)			11-0.9	3.693 ± 1.47
Relative schoolbag weight (%)			19-1.6	6.496 ± 2.81

**Table 2: Schoolbag use characteristics across gender**

Variables	Male n (%)	Female n (%)	Total n (%)
Relative schoolbag weight (%)			
<5	79 (38.7)	81 (27.4)	160 (32)
5-10	113 (55.4)	176 (59.5)	289 (57.8)
>10	12 (5.9)	39 (13)	51 (10.2)
Types of schoolbag:			
One strap backpack	5(25)	14(4.7)	19 (3.8)
Two strap backpack	190 (93.1)	256 (88.5)	446 (89.2)
Sling bag/Tote	9 (4.4)	26(8.8)	35 (7)
Manner of carriage:			
One shoulder	46 (22.5)	67 (22.6)	113 (22.6)
Two shoulder	154 (75.5)	227 (76.7)	381 (76.2)
Hand-carry	4 (2)	2 (0.7)	6 (1.2)
Frequency of carriage:			
Twice	105 (51.5)	133(38.2)	218 (43.6)
More than twice/ Several times	99 (48.5)	183 (61.8)	282 (56.4)
Duration of carriage:			
Less than 10 minutes	19 (9.3)	18 (61)	37 (7.4)
10-20 minutes	52 (25.5)	98 (33.1)	150 (30)
20-30 minutes	61 (29.9)	84 (28.4)	145 (29)
30-40 minutes	24 (11.8)	38 (12.8)	62 (12.4)
40-50 minutes	16 (7.8)	19 (6.4)	35 (7)
50-60 minutes	15 (7.4)	14 (4.7)	29 (5.8)
More than 60 minutes	17 (8.3)	25 (8.4)	42 (8.4)

### Schoolbag use

Table 2 shows more than half (57.8) of the respondents carried their bag weighing 5-10% of their body weight. Majority of the respondents (89.2%) carried the two-strap backpacks, 3.8% used the one-

strap backpacks while 7% used the sling/tote bags. Statistics indicated 76.2% carried their bags on both shoulders, 22% carried their bags on one shoulder while only 1.2 % carried bag using the hand-carry method. Females (61.8%) carried their schoolbag

more frequently (several times) during the day than males (48.5%).

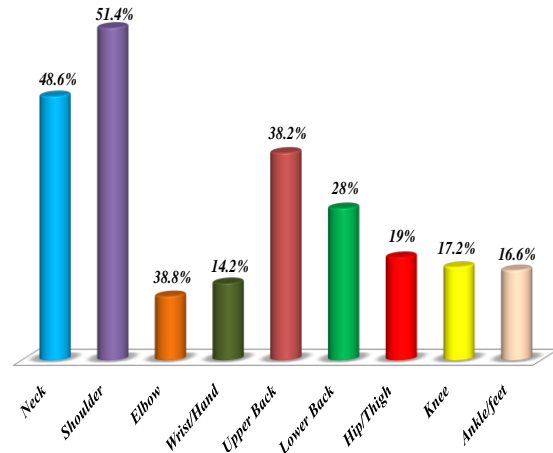
About 43.6% of the students carried their schoolbag twice a day while about 56.4% carried their schoolbag several times a day. About 7.4% carried their schoolbag for approximately less than 10minutes, 30% for 10-20minutes, 29% for 20-30minutes, 12.4% for 30-40minutes, 7% for 40-50minutes, 5.8% for 50-60 minutes and 8.4% for more than 60minutes per day.

Moreover, about 12.8% of respondents felt they carried a light weight schoolbag, 72.1% felt normal weight schoolbag while 16% felt heavy weight schoolbag. Of all the participants, 75.2% of the students were aware that incorrect use of schoolbag could lead to MSDs while 24.6% were not aware.

**Reports of musculoskeletal discomforts**

Overall, 82.2% of the respondents reported having MSDs in the last one month while (17.8%) reported no symptoms. In terms of the nine body regions, 48.6%,

51.4%, 11.8%, 14.2%, 38.2%, 28%, 19%, 17.2%, and 16.6% reported discomfort in the neck, shoulder, elbow, wrist/hand, upper back, lower back, hips/thigh, knee and ankle respectively (figure 1).



**Figure 1: Occurrence of musculoskeletal discomforts in various body regions in the last 1 month.**

**Table 3: Relative risk of correlates of overall MSDs among respondents**

Covariate	P	Odds Ratio	(95% C.I)	
			Lower	Upper
<b>Gender</b>				
Female	0.003*	2.077	1.274	3.385
Male		Reference		
<b>BMI</b>				
< 19		Reference		
19-24	0.965	0.985	0.492	1.973
> 24	0.807	0.932	0.531	1.638
<b>Schoolbag weight%</b>				
< 5%		Reference		
5-10%	0.041*	0.304	0.097	0.955
>10%	0.199	0.483	0.531	1.638
<b>Manner of carriage</b>				
On one shoulder		Reference		
On two shoulders	0.693	0.635	0.067	6.059
Hand-carry	0.468	0.441	0.048	4.022
<b>Frequency of carriage</b>				
Twice		Reference		
> twice/several times	0.019*	0.555	0.339	0.908
<b>Duration of carriage</b>				
< 10 minutes		Reference		
10-20 minutes	0.721	1.231	0.394	3.843
20-30 minutes	0.494	1.366	0.5559	3.336
30-40 minutes	0.939	1.035	0.429	2.496
40-50 minutes	0.771	1.164	0.419	3.233
50-60 minutes	0.101	3.311	0.792	13.839
> 60 minutes	0.236	2.390	0.566	10.090

\*Indicates statistical significance

Logistic regression showed gender, relative schoolbag weight and frequency of carriage were significantly associated ( $P < 0.05$ ) with occurrence of MSDs (Table 3). On the other hand, BMI, method of schoolbag carriage and duration of schoolbag carriage were not significantly associated with occurrence of MSDs ( $P > 0.05$ ).

The results of multiple logistic regression for region-specific discomfort occurrence showed gender was associated ( $P < 0.05$ ) with shoulder, elbow and hip/thigh discomforts. Females were more at risk of suffering discomforts than males, (RR=1.535,  $P = 0.028$ ), (RR = 2.295,  $P = 0.012$ ) and (RR = 2.011,  $P = 0.007$ ) in shoulder, elbow and hip/thigh regions respectively. BMI was associated ( $P < 0.05$ ) with knee and ankle discomforts. Respondents with BMI  $>24$  were more at risk of developing knee (RR = 0.525,  $P = 0.026$ ) and ankle/feet (RR = 0.399,  $P = 0.002$ ) discomforts compared to those with BMI  $<19$ . However, no significant difference in the risk of developing knee (RR = 0.881,  $P = 0.693$ ) and ankle (RR = 0.180,  $P = 0.180$ ) discomforts between respondents with BMI 19-24 and those with  $<19$  was observed.

Relative schoolbag weight was associated ( $P < 0.05$ ) with shoulder and low back discomforts. Respondents carrying 5-10% of their body weight had significantly higher risk of developing shoulder (RR = 0.378,  $P = 0.015$ ) and low back (R = 0.322,  $P = 0.003$ ) discomforts than those carrying bags weighing less than 10% of their body weight. However, there was no significant difference in risk of developing shoulder (RR=0.516,  $P = 0.080$ ) and low back (R = 0.536,  $P = 0.063$ ) discomforts between respondents carrying bags  $>10\%$  of their weight relative to students carrying bags less than 10% of their body weight.

Moreover, frequency of schoolbag carriage was associated ( $P < 0.05$ ) with ankle/feet discomforts. Respondents who carried their schoolbag several times during the day had more risk of developing ankle/feet discomfort (R = 0.570,  $P = 0.037$ ) compared to those who only carried their schoolbags twice a day. No association was observed between discomforts in any specific body region and manner of carriage or duration of carriage ( $P > 0.05$ ).

## DISCUSSION

From our observation 82.2% of the respondents reported some type of discomforts in at least one body region that they related to schoolbag use indicating a high prevalence. This percentage is nearly similar to the proportion reported by Dianat et al [21] and in another cross-sectional study in New England. [7] More females (87.5%) reported discomfort than males (74.2%), agreeing with similar studies. [14,15,22] The most prevalent discomfort was found in shoulder (61.2%), neck (48.6%), upper back (38.2%) and low back (28%) corroborating the results of previous studies. [14,23,24]

Majority of the respondents used the two-strap backpack (82.9%) which is consistent with previous findings. [17,22,25] Ergonomically the two-strap backpack design is the most appropriate to use. [24,26] As shown from the results the mean schoolbag weight 3.69kg less than those found in other studies. [7,27] In contrast previous studies found higher values. [21,24] The student's mean relative schoolbag weight found in this study was 6.5% which is consistent with the findings of Yuing Hu and Jacobs. [7] It was observed that 32 % of the respondents carried schoolbag weighing less than 5% of their body weight and more than half (57.8%) weighing 5-10% of their body weight. This indicates majority of the students carried schoolbag load within the

recommended weight limit of 10% of body weight.

The relative schoolbag weight was also found to be a predictor of shoulder and low back discomforts which are in harmony with a study by Dianat et al. [21] Respondents carrying 5-10% of their body weight had significantly higher risk of developing shoulder and low back discomforts than those carrying bags weighing less than 5% of their body weight. However, there was no significant difference in the risk of developing shoulder and low back discomforts between respondents carrying bags >10% of their weight compared to those carrying bags less than 5% of their body weight. This is in agreement with the work of Heuscher et al [27] who found no evidence of association of annual low back pain with carrying a backpack weight >10% of body weight with those carrying less.

Gender was a predictor of shoulder, elbow, low back, hip/thigh and ankle/feet discomforts. Females seem to have more discomforts than males which is in line with a number of documented findings. [21,24,28] More females carried schoolbags weighing 5-10% of their body weight with higher frequency than their male counterparts.

It was shown that BMI was a predictor of knee and ankle/feet discomforts. This finding is contrary to what was previously documented [7,23,29] wherein no significant relationship between BMI and MSDs in any of the body region examined. In our study, respondents with BMI >24 had more discomfort in knee and ankle/feet. Unexpectedly respondent with BMI <19 were more likely to suffer discomforts than those with 19-24. This is in accordance with the findings by Dianat et al [21] who reported children with lower BMI less than 19 seems to suffer more discomfort than those with higher BMI. These findings may suggest the influence of confounding variables such as age, gender and body composition hence,

these factors should be considered as potential confounders in future analysis of musculoskeletal complaints.

The manner of schoolbag carriage used by most respondents was found to be placement on both shoulders (76.2%) with the two straps backpack similar to that found in the literature. [16,25,26] However, no association was found between manner of schoolbag carriage and occurrence of discomforts in any of the body regions ( $P > 0.05$ ) contrary to the findings of Mwaka et al [30] where a significant association was found between method of schoolbag carriage and low back pain in Ugandan pupils. Studies shows frequent carriage of schoolbag on one shoulder is associated with low back symptoms. [20,26] This could be attributed to the fact that unilateral loading causes more postural deviation than bilateral loading on shoulders.

In addition, frequency of schoolbag carriage was found to be a predictor of hip/thigh, knee and ankle/feet discomforts ( $P > 0.05$ ). Students who carried their schoolbag several times during the day were more likely to experience discomfort compared to those who carried their bags only twice a day in all the three body regions. This is in agreement with previous findings. [2,15,16] Females (61.8%) carried their schoolbag more frequently (several times) during the day than males (48.5%).

There was, however, no association between duration of schoolbag carriage and MSDs in any region of the body in our study agreeing with the work of Yuing Hu and Jacobs who also found no association between time spent carrying backpacks and musculoskeletal symptoms among university students in New England. [7] About 30% (presenting the majority) of the respondents in this study spent 10-20 minutes carrying their schoolbags per day while 8.4% spent more than 60 minutes. This trend may indicates that participants

with discomforts spent less time carrying schoolbags while those without discomforts spent most time carrying schoolbag.

Although we found high prevalence rate of MSDs among the respondents, however, majority (71.2%) felt their schoolbags had normal weight. On the contrary, Haselgrove et al [16] reported that over half of adolescents in Australia reported their schoolbag felt heavy. Interestingly, most of the respondents (75.2%) were aware that incorrect use of schoolbags might lead to occurrence of MSDs or pain comparable to the finding of Yuing Hu and Jacobs [7] who found that majority (84%) of university students of New England were aware that the improper usage of backpacks is a potential cause of musculoskeletal injuries.

One of the limitation of this study was that the student's schoolbag weight was recorded only once which might not capture the average and maximal schoolbag weight by the students on a weekly basis. Also data on MSDs were collected based on self-reported questionnaire, which may be subject to recall biases.

We recommend that ergonomic programs about prevention of MSDs and pain should be established not only in universities but during the earlier stages of education when pupils and students are just beginning to use schoolbags. Moreover, preventive health measures and recommendations on light backpack carriage, correct choice of schoolbag design, manner of carriage, packaging and proper wearing especially for freshers are necessary to tackle this problem. School administrations should also provide lockers in schools for students to keep their schoolbags in order to decrease frequency and duration of carriage.

## CONCLUSION

The study discovered a high prevalence of MSDs with BMI, relative schoolbag weight and frequency of schoolbag carriage found to be predictors of discomforts. Future studies should explore more factors related to schoolbag use and investigate their long-term effect and association with MSDs or pain since musculoskeletal symptoms have multifactorial origin.

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