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# Association of Backpack Weight with Musculoskeletal Status among Adolescents

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## ABSTRACT

**Background:** Adolescence period is a critical stage of musculoskeletal development and carrying heavy backpack to school daily puts them at risk of musculoskeletal discomfort. This study aims to find out the association of backpack weight with musculoskeletal status among adolescents.

**Methods:** A descriptive cross-sectional study was conducted among 291 grade 4 to 8 students from three government schools of Lalitpur. Data was analyzed using descriptive and inferential statistics.

**Results:** Around 68% of the adolescents carried schoolbag of weight greater than 10% of their body weight. Similarly, 66.7% perceived musculoskeletal pain of which 29.9% had ever missed school due to pain, 70.1% felt tired while carrying their schoolbag and 23.4% adopted forward/sideways leaning posture while carrying their schoolbag. Age ( $p < 0.001$ ), backpack percentage to body weight ( $p < 0.001$ ) and perceived weight of schoolbag ( $p = 0.006$ ) were significantly associated with musculoskeletal pain. Similarly, age ( $p = 0.023$ ), sex ( $p = 0.005$ ), grade ( $p = 0.030$ ) and perceived weight of schoolbag ( $p = 0.007$ ) were significantly associated with tiredness while carrying schoolbag. Also, backpack percentage to body weight ( $p = 0.008$ ), duration of carrying schoolbag ( $p = 0.010$ ) and perceived weight of schoolbag ( $p = 0.001$ ) were significantly associated with posture assumed while carrying schoolbag.

**Conclusions:** Students carrying backpack weight more than recommended limit are more likely to develop musculoskeletal pain and change in posture while carrying their schoolbag. Thus, necessary steps must be taken to further analyze the situation and develop management strategies on reducing backpack weight and its possible effect on adolescents.

**Keywords:** Adolescents; backpack weight; musculoskeletal pain; tiredness, fatigue

## INTRODUCTION

The American Chiropractic Association (ACA), the American Occupational Therapy Association (AOTA) and the American Physical Therapy Association (APTA) recommended not carrying a backpack heavier than 10% of the students' body weight.<sup>1</sup> However, various studies showed that many students carry backpacks that exceed 10 to 15% of their body weight.<sup>2,3</sup> The prevalence of school children carrying heavy backpacks as per different studies ranges from 30% to 70%. Children hit their growth spurts between the ages of 12 to 14 yrs. During this time heavy backpack can cause changes in the shape of bones due to which children go into fatigue, pain, changes in posture and finally suffer from chronic back pain which lead to sought medical care. They are not able to concentrate in studies resulting in poor academic performance.<sup>4</sup> The prevalence of musculoskeletal problems as per various international studies on heavy backpack and their musculoskeletal effects among the

students appeared to range from 25% to 80%. This has become a matter of serious concern for every parent, schools and authorities.<sup>5</sup> Considering problems and discomforts faced by the young shoulders, developed countries have already started remedial measures to solve this problem but in developing countries this problem still exists without any adequate measures.<sup>6</sup> This is also becoming a growing issue in our Nepalese society, thus, there is always a need for research in this area. Hence, this study aims to find out association of backpack weight with musculoskeletal status among adolescents.

## METHODS

A descriptive cross-sectional research design was used to conduct this study. The study settings were three different government schools of Lalitpur. The study population consisted students of age group 10 to 19 years studying in grade 4 to 8. Students of these age group

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and grades were selected because they are in period of sensitive body growth and musculoskeletal problems due to heavy backpack use were seen more in adolescents as per different studies. Out of 600 students, 326 were selected using Cochran's formula for cluster sampling technique. The schools were selected purposively and the sections present in each selected grades of all the schools were assumed as clusters. The required number of clusters was calculated by dividing sample size by average number of students in each section i.e.  $326/35=9.3$ . Thus, 10 sections were selected (2 from each grade) by simple random method. All the students from selected sections were included in the study. After collection of data, the questionnaires filled by the students who did not meet inclusion criteria were excluded in data analysis. Students included were those who had written consent signed by their guardian; students present on the day of data collection and willing to participate; students able to ambulate independently and fill the questionnaire; students with no neurological/ rheumatic disease/ muscle/ joint disease/ fracture or dislocation recently or in the past.

The self-administered semi-structured questionnaire was prepared by the researcher on the basis of extensive literature review and consultation with the advisor/experts. Measurement of the students' weight and their backpack weight was done after filling the questionnaire. The study included questions related to socio-demographic information of the students, information related to backpack, information related to musculoskeletal status and measurement of the students' weight and their backpack weight. Content validity of the instrument was established by extensive literature review and consultation with research advisor/experts. The instrument was translated from English to Nepali language and back translation was done. Pre-testing of the instrument was done to check for its clarity, sequencing, feasibility in administration and time needed for completion. Pretesting was done in 10% of the estimated sample size i.e. 33 students in one of the selected schools where only students other than those from the selected clusters for data collection were included.

Ethical clearance was obtained from concerned authorities and institutional review board of Institute of Medicine. Formal permission was obtained from the school authority and written consent was obtained from parents of each respondent through the help of school authority. Code numbers were used to maintain confidentiality. The total duration of data collection was four weeks from 2<sup>nd</sup> July 2017 to 28<sup>th</sup> July 2017.

Total 353 students were distributed the questionnaire of which 62 respondents with missing data and who did not meet the inclusion criteria of the study were excluded in analysis. The analysis was done by using descriptive statistics (percentage, frequency mean and standard deviation) and inferential statistics (chi-square test) to find out the significance of association.

## RESULTS

Of the 291 respondents, highest number of respondents (68.7%) were of age 13 years and below. Almost equal distribution of female (49.5%) and male (50.5%) was seen. Highest numbers of the respondents (25.8%) were from grade five followed by grade six (21.6%).

**Table 1. Respondents' Weight, Backpack Weight and Backpack Percentage to Body Weight (n= 291)**

Variables	Number	Percentage
<b>Respondents' weight (in kg)</b>		
Mean± S.D: 38.41± 9.43		
<b>Backpack weight (in kg)</b>		
Mean± S.D: 4.42± 1.05		
<b>Backpack percentage to body weight</b>		
≤ 10%	94	32.3
10- 15%	134	46
> 15%	63	21.7
Mean± S.D: 12.03± 3.61		

Almost all of the respondents (92.8%) walked to the school followed by those who used bike/bus (5.5%). Highest number of respondents (21.6%) carried their schoolbag for 5 to 10 minutes while coming to school followed by those who carried their schoolbag for 10 to 15 minutes (21.3%). Regarding mode of carrying schoolbag, almost all of the respondents (97.9%) carried their schoolbag on both shoulders and more than one third of the respondents (35.8%) perceived their schoolbag as heavy whereas 36.4% perceived their schoolbag to be of medium weight.

**Table 2. Perceived Musculoskeletal Pain among the Respondents (n= 291).**

Variables	Number	Percentage
<b>Presence of pain</b>		
Yes	194	66.7
No	97	33.3
<b>Area of pain (n= 194)</b>		
Neck pain	90	30.9
Shoulder pain	122	41.9
Upper back pain	63	21.6

Lower back pain	87	29.9
<b>Severity of pain (n= 194)</b>		
Mild	48	24.7
Moderate	127	65.5
Severe	19	9.8
<b>Time of experiencing pain (n= 194)</b>		
While carrying the bag	59	30.4
After keeping the bag down	30	15.5
Always	5	2.6
Only sometimes	100	51.5
<b>Perception of pain due to schoolbag (n= 194)</b>		
Yes	98	50.5
No	96	49.5
<b>Effect of pain (n= 194)</b>		
On household activities	88	45.3
On study	79	40.7
On sleep	83	42.7
On sports	96	49.5
<b>Ever missed school due to pain (n= 194)</b>		
Yes	58	29.9
No	136	70.1
<b>Ever visited doctor due to pain (n= 194)</b>		
Yes	51	26.3
No	143	73.7

**Table 3. Respondents' Posture while Carrying the Schoolbag, Tiredness while Carrying the Schoolbag and Taking Rest in between Way to School (n= 291).**

Variables	Number	Percentage
<b>Feels tired while carrying schoolbag</b>		
Always	51	17.5
Sometimes	153	52.6
Never	87	29.9
<b>Takes rest in between way to school</b>		
Always	23	7.9
Sometimes	80	27.5
Never	188	64.6
<b>Posture while carrying schoolbag</b>		
Walking straight	223	76.6
Leaning forward	54	18.6
Leaning sidew sideways	4	1.4
Leaning both forward and sideways	10	3.4

**Table 4. Association of Musculoskeletal Pain and Backpack related Variables (n= 291).**

Variables	Musculoskeletal Pain		x <sup>2</sup>	P-value
	Yes n(%)	No n(%)		
<b>Age (in completed years)</b>				
≤13	120 (60)	80 (40)	12.791	<0.001
>13	74 (81.3)	17 (18.7)		
<b>Sex</b>				
Female	90 (62.5)	54 (37.5)	2.227	0.136
Male	106 (71.1)	43 (28.9)		
<b>Grade</b>				
Primary	70 (60.3)	46 (39.7)	3.469	0.630
Secondary	124 (70.9)	51 (29.1)		
<b>Backpack percentage to body weight</b>				
≤ 10%	55 (58.5)	39 (41.5)	19.643	<0.001
>10%	148 (75.1)	49 (24.9)		
<b>Means of transportation</b>				
Walking	180 (66.7)	90 (33.3)	<0.001	1
Other means	14 (66.7)	7 (33.3)		
<b>Duration of carrying schoolbag</b>				
≤ 15 minutes	120 (66.7)	60 (33.3)	<0.001	1
> 15 minutes	74 (66.7)	37 (33.3)		
<b>Mode of carrying schoolbag</b>				
Both shoulders	190 (66.7)	95 (33.3)	<0.001	1*
Changing sides	4 (66.7)	2 (33.3)		
<b>Perceived weight of schoolbag</b>				
Light	114 (61)	73 (39)	7.661	0.006
Heavy	80 (76.9)	24 (23.1)		

Level of significance < 0.05

**Table 5. Association of Tiredness and Backpack related Variables (n= 291).**

Variables	Tiredness		x <sup>2</sup>	p- value
	Yes n(%)	No n (%)		
<b>Age (in completed years)</b>				
≤ 13 years	132 (66)	68 (34)	5.137	0.023
>13 years	72 (79.1)	19 (20.9)		
<b>Sex</b>				
Female	112 (77.8)	32 (22.2)	8.011	0.005
Male	92(62.6)	55 (37.4)		
<b>Grade</b>				
Primary	73(62.9)	43 (37.1)	4.734	0.030
Secondary	131(74.9)	44 (25.1)		
<b>Backpack percentage to body weight</b>				

≤ 10%	63 (67)	31 (33)	1.139	0.286
> 10%	142(72.1)	55 (27.9)		
<b>Means of transportation</b>				
Walking	190(70.4)	80 (29.6)	0.128	0.721
Other means	14(66.7)	7 (33.3)		
<b>Duration of carrying school bag</b>				
≤ 15 minutes	119(66.1)	61 (33.9)	3.588	0.058
> 15 minutes	85(76.6)	26 (23.4)		
<b>Mode of carrying schoolbag</b>				
Both shoulders	199(69.8)	86 (30.2)	0.512	0.474
Changing sides	5(83.3)	1 (16.7)		
<b>Perceived weight of schoolbag</b>				
Light	121(64.7)	66 (35.3)	7.272	0.007
Heavy	83 (79.8)	21 (20.2)		

Level of significance < 0.05, \*Continuity Correction

Table 6. Association of Posture and Backpack related Variables (n= 303).

Variables	Posture assumed		x <sup>2</sup>	P-value
	Leaning Forward/ Sideways n (%)	Walking Straight n (%)		
<b>Age (in completed years)</b>				
≤13 years	50 (25)	150 (75)	0.952	0.329
>13 years	18 (19.8)	73 (80.2)		
<b>Sex</b>				
Female	32 (24.0)	117 (76.0)	0.089	0.766
Male	38 (25.5)	111 (74.5)		
<b>Grade</b>				
Primary	22 (19)	94 (81)	2.087	0.149
Secondary	46 (26.3)	129 (73.7)		
<b>Backpack percentage to body weight</b>				
≤ 10%	14 (14.9)	80 (85.1)	7.054	0.008
>10%	55 (27.9)	142 (72.1)		
<b>Means of transportation</b>				
Walking	63 (23.3)	207 (76.7)	0.002	0.960
Other means	5 (23.8)	16 (76.2)		
<b>Duration of carrying schoolbag</b>				
≤ 15 minutes	33 (18.3)	147 (81.7)	6.679	0.010
> 15 minutes	35 (31.5)	76 (68.5)		
<b>Mode of carrying schoolbag</b>				
Both shoulders	65 (22.8)	220 (77.2)	2.427	0.119

Changing sides 3 (50.0) 3 (50.0)

**Perceived weight of schoolbag**

Light 32 (17.1) 155 (82.9) 11.434 0.001  
 Heavy 36 (34.6) 68 (65.4)

Level of Significance < 0.05

**DISCUSSIONS**

In this study, the mean weight (in kg) of the students' backpack was 4.42± 1.05 and the mean backpack percentage to body weight was 12.03± 3.61 with only 32.3% carrying bag weight ≤ 10% of body weight, 46% carrying 10 to 15% of body weight whereas 21.6% carrying more than 15% of body weight. This finding goes along with the findings of the studies conducted in Palestine which found that the mean schoolbag weight was 5.267 kg, the mean percentage of schoolbag weight to body weight was 12.3%, 50% students carried schoolbag weight 10% to 15% of body weight and 23% carried more than 15% of body weight;<sup>5</sup> in Maharashtra which found that 50% students carried backpacks weighing 10- 15% of their body weight and 31.17% carried more than 15% of their body weight.<sup>7,8</sup> In contrast, some studies findings was higher in which students carrying backpack weight more than 10% ranged from 79.5% to 92.5%.<sup>2,9</sup> However, some studies findings showed lesser number of students carrying schoolbag more than 10% of body weight: which ranged from 38.2% to 47.7%.<sup>10, 11</sup> Similarly, some studies findings showed schoolbag weight within recommended limit.<sup>12,13</sup> The differences between the results of the current study and other studies might be due to the differences in the culture, school requirements, school curriculums, number of books and accessories.

Regarding musculoskeletal pain 66.7% of the students suffered from pain since beginning of that academic year of which highest number (41.9%) suffered from shoulder pain followed by neck pain (30.9%), lower back pain (29.9%) and upper back pain (21.6%). This is partially supported by findings from some studies where majority (81.1% to 88.2%) of pupils reported pain; mostly in shoulders (38.1% to 43.3%), neck (24.5% to 32.6%) and back (16.7% to 40%).<sup>12,16-19</sup> Similarly, 50.5% of the students in this study perceived their pain was because of carrying schoolbag. This finding is partially supported by findings from a study conducted in Palestine which found 69.5% of the respondents felt pain was due to carrying of schoolbag.<sup>5</sup> This study finding also showed that 29.9% of the respondents had ever missed school due to pain and 26.3% had ever visited doctor. It is partially supported by findings from a study conducted in Maharashtra which found only 12.6% students required physician's visit and

18.6% students missed school because of back pain<sup>7</sup> and supported by findings from a study done in Uganda which found 26.1% students missed school because of pain.<sup>16</sup> In bivariate analysis this study found significant association of musculoskeletal pain with age ( $p < 0.001$ ), backpack percentage to body weight ( $p < 0.001$ ) and perceived weight of schoolbag ( $p = 0.006$ ). Similarly, some studies findings showed significant association of musculoskeletal pain with backpack percentage to body weight ( $p < 0.05$ ), age ( $p < 0.05$ ) and perceived weight of schoolbag ( $p < 0.001$ ).<sup>13,18,19</sup> In contrast, some studies findings showed no association of musculoskeletal pain with age ( $p = 0.505$ ) and backpack percentage to body weight.<sup>6, 9, 20</sup>

This study found that 17.5% of the students always felt tired whereas 52.6% felt tired sometimes while carrying their schoolbag i.e. in total 70.1% felt tired while carrying their schoolbag and 35.4% took rest in between their way to school. This finding is in line with findings from studies conducted in Palestine which found 38.4% of the students always got tired whereas 35.1% of students felt tired sometimes while carrying their schoolbag and 35.4% took break while carrying their schoolbag<sup>5</sup> and in Milan which found 65.7% students felt tired while carrying their schoolbag.<sup>20</sup>

In bivariate analysis this study found significant association of tiredness while carrying schoolbag with age ( $p = 0.023$ ), sex ( $p = 0.005$ ), grade ( $p = 0.030$ ) and perceived weight of schoolbag ( $p = 0.007$ ). Similar findings was seen in some studies where significant association was found between occurrence of fatigue while carrying schoolbag and age, gender, grade as well as perceived weight of schoolbag ( $p < 0.05$ ).<sup>5,17</sup>

Regarding posture while carrying schoolbag, majority of the students (76.6%) walked straight while carrying schoolbag whereas only 18.6% leaned forward, 1.4% leaned sideways and 3.4% leaned both forward and sideways. This is supported by findings from a study done in USA which found 2.9% of the students leaned sideways and 3.5% leaned forward as well as sideways while carrying their schoolbag. However, in contrast 68.2% of the respondents leaned forward whereas 25.3% always stood up straight while carrying their schoolbag.<sup>18</sup> In bivariate analysis this study found significant association of posture assumed while carrying schoolbag with backpack percentage to body weight ( $p = 0.008$ ), duration of carrying schoolbag ( $p = 0.010$ ) and perceived weight of schoolbag ( $p = 0.001$ ). This finding is partially supported by findings from studies conducted in Dehradun, Pune and Australia ( $p = 0.004$ ) which found that cranio-vertebral angle decreased significantly producing forward head

posture as magnitude of backpack load increases.<sup>21-23</sup>

## CONCLUSIONS

This study concludes that more than two third of the adolescents are carrying schoolbag of weight greater than recommended limit i.e. 10% of their body weight, more than two third perceive musculoskeletal pain, majority of them feel tired while carrying their schoolbag whereas one fourth assume forward/sideways leaning posture while carrying their schoolbag. Age, backpack percentage to body weight and perceived weight of schoolbag were significantly associated with musculoskeletal pain. Similarly, age, sex, grade and perceived weight of schoolbag were significantly associated with tiredness while carrying schoolbag. Also, backpack percentage to body weight, duration of carrying schoolbag and perceived weight of schoolbag were significantly associated with posture while carrying schoolbag. This study also concludes that it is important to conduct the awareness programs and develop IEC materials on recommended weight limit for school children, effect of heavy backpack as well as measures to reduce it in order to change the school authorities, parents and students attitude towards carrying heavy bags and prevent pain and musculoskeletal discomfort among adolescents.

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