

## An Association of Backpack Weight and Postural Habits in School Going Children of Amritsar, Punjab, India

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**ABSTRACT** The aim of the present study was to observe the association between backpack weight and postural habits taken in terms of lumbar flexion, lumbar extension and lumbar lateral flexion in school going children of Amritsar, Punjab, India. A total of 300 randomly selected normal healthy school going children (150 boys and 150 girls) aged 6-15 years of Amritsar were considered as study population. The samples were collected between July to October, 2007 from Khalsa College Public School, Amritsar, Punjab, India. Height, weight, backpack weight, percent backpack weight, lumbar flexion, lumbar extension and lumbar lateral flexion were measured on all the subjects. The results of the present study indicate statistically significant positive correlation between backpack weight and height ( $r=0.73$ ), weight ( $r=0.57$ ) and lumbar flexion ( $r=0.19$ ) in boys and with height ( $r=0.65$ ), weight ( $r=0.42$ ) and lumbar extension ( $r=0.21$ ) in girls. It may be concluded that backpack weight has some strong association with postural habits in the studied samples. The backpack weight carried by the school children was reported to be between 7.48% - 16.83% of their body weight.

### INTRODUCTION

The backpack is an appropriate way to load the spine closely and symmetrically, while maintaining stability (Voll and Klimt 1977). There is a widespread belief that repeated carrying of heavy loads, such as school backpacks, place additional stress on rapidly growing adolescent spinal structures, making them prone to postural change (Grimmer et al. 1999). It is reported that musculo-skeletal symptom in school going children is multifactorial in origin. The carriage of heavy school bag is one of the suspected factors for it (Whittfield et al. 2001). Moreover, external forces such as load carrying in the form of heavy bags may influence the normal growth, development of children and adolescents and also maintenance of alignment of their bodies. Probably, for this reason school children experience a period of accelerated growth and development of skeletal and soft tissues. Hence the spinal structures are quite different from those of adults. As the growth of the spinal structures continues over the long period of time than the other skeletal structures, there are dissimilarities in the rate of tissue development, which can pose a threat to postural integrity. Therefore, load carrying along with irregular spinal growth pattern can affect the adolescent posture and make the adolescent more

susceptible to injury (Mohan et al. 2007). It is also reported that with the load placed posterior to body in the form of backpack and the alteration in the center of gravity, it causes the change in posture. These alterations may lead to back pain and injury by stressing the ligaments or muscles in the back or by changing the forces applied to intervertebral discs (Chansirinukor et al. 2001). A strong association between the backpack use and musculoskeletal problems in school going children had been reported also by other researchers (Balague et al. 1988; Jouko et al. 1995; Negrini and Carabalona 2002). The information regarding the association of backpack weight and postural habits in school going children is scanty from India, especially from the northern part of the country, so the present study was planned.

### MATERIALS AND METHODOLOGY

The present cross – sectional study was based on randomly selected 300 normal healthy school going children (150 boys and 150 girls) from Khalsa College Public School, Amritsar, Punjab, India. Subjects were taken from the age groups 6-15 years with 30 subjects in each group (15 boys and 15 girls). The age of the subjects were recorded from the school record, the subjects were divided in such a way that “age 6”, for

instance refers to the children aged 5 years and 6 months through 6 years and 5 months and 29 days. Demographic information was collected in the form of questionnaire from each subject and in small children, the respective parents provided the required information. The study was approved by the local ethics committee.

The various parameters considered for the study were height, weight, backpack weight, % backpack weight, lumbar flexion, lumbar extension and lumbar lateral flexion. The height was recorded during inspiration using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm, and weight was measured by digital standing scales (Model DS-410, Seiko, Tokyo, Japan) to the nearest 0.1 kg after Wiener and Lourie (1969); backpack weight was taken with electronic weighing machine and lumbar flexion, lumbar extension and lumbar lateral flexion after Mayer et al. (1997) with inclinometer. Descriptive statistics (mean  $\pm$  standard deviation) were determined for all directly measured variables. Comparisons between school going boys and girls for all the measured variables were made using an independent t-test. Pearson's correlation coefficients were used for correlation coefficient test. Data were analyzed using SPSS (Statistical Package for Social Science) version 7.5. A 5% level of probability was used to indicate statistical significance.

## RESULTS AND DISCUSSION

Table 1 shows the descriptive statistics of height and weight in school going boys and girls of Amritsar. In height, both boys and girls have a specific trend of age wise increment with girls having higher height than the boys do until the

age of 9 years after which boys attained higher height. The minimum mean values for height were recorded as 117.93cm in boys and 120.01cm in girls in the age group 6+ years and the maximum mean values 168.23cm in boys and 157.78cm in girls in the age group 15+ years with highly significant differences ( $p < 0.001$ ) in the age group 9+ years ( $t = 4.66$ ) and 15+ years ( $t = 4.46$ ) between boys and girls. In case of weight, girls had higher mean weight than boys corresponding to their higher heights, the minimum mean values (21.30kg in boys and 23.19kg in girls) were found in the age group 6+ years and the maximum mean values (53.70kg in boys and 50.11kg in girls) were noted in age group 15+ years with statistically significant differences ( $p < 0.05$ ) in age group 7+ years ( $t = 3.25$ ) and age group 8+ years ( $t = 3.58$ ) and highly significant differences ( $p < 0.001$ ) in age group 9+ years ( $t = 5.75$ ) between them.

The descriptive statistics of lumbar flexion, lumbar extension and lumbar lateral flexion of school going boys and girls of Amritsar are given in table 2. In case of lumbar flexion, the minimum mean values (58.33° in boys and 57.80° in girls) were noted in the age group 7+ years in boys and age group 11+ years in girls and the maximum mean values (62.33° in boys and 60.00° in girls) were found in the age group 12+ years in boys and age group 6+ years in girls. Statistically significant differences ( $p < 0.05$ ) were found in age group 9+ years ( $t = 3.24$ ), 10+ years ( $t = 2.23$ ) and 11+ years ( $t = 3.56$ ). In case of lumbar extension, the minimum mean values (29.13° in boys and 29.27° in girls) were noted in the age group 12+ years in boys and age group 15+ years in girls and the maximum mean values (33.07° in boys and 36.13° in girls) were recorded in the age group 13+ years in boys and age group 10+ years in

**Table1: Descriptive statistics of height and weight in boys and girls aged 6-15 years**

Age group (years)	Height (in cm)			Weight (in kg)		
	Boys		t-value	Boys		t-value
	Mean	S.D		Mean	S.D	
6+	117.93	4.83	1.07	21.30	2.85	1.62
7+	123.15	8.11	1.83	22.73	3.81	3.25*
8+	126.71	4.01	1.81	24.47	2.74	3.58*
9+	126.71	4.01	4.66**	24.47	2.74	5.75**
10+	137.57	2.08	0.75	28.07	4.22	0.35
11+	144.64	4.52	0.42	35.00	8.97	0.30
12+	149.01	12.07	0.57	38.07	7.08	0.58
13+	152.51	9.67	0.42	40.43	7.68	1.44
14+	158.26	7.42	0.44	48.74	12.78	0.81
15+	168.23	7.15	4.46**	53.70	13.35	0.84

\*indicates  $P < 0.05$  \*\* indicates  $P < 0.001$

**Table 2: Descriptive statistics of lumbar flexion, lumbar extension and lumbar lateral flexion in boys and girls aged 6-15 years**

Age group (years)	Lumbar flexion (in degree)			Lumbar extension (in degree)			Lumbar lateral flexion (in degree)		
	Boys		t-value	Boys		t-value	Boys		t-value
	Mean	S.D		Mean	S.D		Mean	S.D	
6+	60.60±2.56	60.00±1.65	0.76	30.80±2.36	31.07±2.81	0.28	22.07±3.17	19.27±2.49	2.69*
7+	58.23±2.09	58.07±2.52	0.31	32.40±1.80	31.20±3.59	1.16	22.93±1.83	21.33±4.37	1.31
8+	60.60±1.25	59.47±1.36	1.12	29.40±1.80	30.00±1.31	1.04	18.33±2.19	17.73±1.75	0.83
9+	60.00±1.25	58.00±2.04	3.24*	29.40±1.80	33.07±1.22	6.51**	18.33±2.19	18.60±1.18	0.41
10+	61.40±1.96	57.80±1.90	2.23	30.73±1.58	36.13±8.89	5.90**	17.40±1.88	19.47±1.50	3.32*
11+	60.07±1.58	57.80±8.82	3.56*	32.27±1.83	29.67±0.98	4.85*	16.47±0.91	17.27±1.44	1.82
12+	62.33±2.02	58.00±8.82	1.85	29.13±2.59	32.00±2.39	3.15*	17.47±2.29	18.60±1.24	1.68
13+	61.00±1.69	58.93±3.63	2.00	33.07±2.60	29.87±2.92	3.16*	18.80±1.42	18.73±2.94	0.08
14+	59.87±2.17	59.27±2.34	0.73	32.13±2.67	29.53±3.02	2.50	17.13±4.85	19.13±1.73	1.50
15+	59.47±3.09	59.27±2.41	0.17	31.93±3.15	29.27±3.63	2.15	18.00±2.70	21.80±3.59	3.28*

\*indicates P<0.05 \*\* indicates P<0.001

girls. Statistically significant differences (p<0.05) were found in age group 12+ years (t=3.15), 13+ years (t=3.16), 14+ years (t=2.50) and 15+ years (t=2.15). Highly significant differences (p<0.001) were noted in the age group 9+ years (t=6.51), 10+ years (t=5.90) and 11+ years (t=4.85) between them. In case of lumbar lateral flexion, the minimum mean values (16.47° in boys and 17.27° in girls) were noted in the age group 11+ years and the maximum mean values (22.93° in boys and 21.80° in girls) were found in the age group 7+ years in boys and age group 15+ years in girls. Statistically significant differences (p<0.05) were found in age group 6+ years (t=2.69), 10+ years (t=3.32) and 15+ years (t=3.28) between them.

Table 3 shows the descriptive statistics of backpack weight and percent backpack weight in school going boys and girls of Amritsar. In case of backpack weight, the minimum mean values (1.67kg in boys and 1.40kg in girls) were found in the age group 6+ years and maximum mean values

(4.80kg in boys and 4.77kg in girls) in age group 15+ years with statistically significant differences (p<0.05) in age group 9+ years (t=4.72) and highly significant differences (p<0.001) in age group 7+ years (t=4.72) between boys and girls. In case of percent backpack weight, the minimum mean values (7.48% in boys and 8.59% in girls) were noted in the age group 7+ years in boys and age group 14+ years in girls and the maximum mean values (16.83% in boys and 16.72% in girls) were recorded in age group 10+ years with statistically significant differences (p<0.05) in age group 8+ years (t=2.07) between them.

The correlation co-efficient of backpack weight, percent backpack weight and their ratios with other five parameters in school going boys and girls of Amritsar are shown in table 4. In boys, statistically significant positive correlations were observed between backpack weight and height (r=0.73), weight (r=0.57) and lumbar flexion (r=0.19). In girls statistically significant positive

**Table 3: Descriptive statistics of backpack weight and percent backpack weight in boys and girls aged 6-15 years**

Age group (years)	Backpack weight (in kg)			Percent backpack weight		
	Boys		t-value	Boys		t-value
	Mean	S.D		Mean	S.D	
6+	1.80±0.62	1.40±0.66	1.70	-	-	-
7+	1.67±0.59	2.43±0.53	3.75	7.48±2.93	8.95±3.10	1.34
8+	2.57±0.32	2.67±0.24	0.96	10.64±1.76	9.23±1.97	2.07*
9+	2.57±0.32	3.80±0.96	4.72**	10.64±1.76	12.31±3.60	1.62
10+	4.60±0.47	4.50±0.78	0.42	16.83±2.98	16.72±4.05	0.08
11+	4.80±0.73	4.77±0.32	0.16	14.48±3.85	14.35±2.35	0.11
12+	4.57±0.18	4.73±0.32	1.77	13.04±2.41	13.36±2.35	0.37
13+	4.33±0.59	4.00±0.73	1.37	11.00±2.89	9.24±2.41	1.82
14+	4.10±0.87	3.83±0.72	0.91	8.99±2.88	8.59±2.24	0.42
15+	4.67±0.24	4.70±0.25	0.37	9.14±2.04	9.71±1.95	0.78

\*indicates P<0.05 \*\* indicates P<0.001

correlations were observed with height ( $r=0.65$ ), weight ( $r=0.42$ ) and lumbar extension ( $r=0.21$ ). In boys, statistically significant negative correlations were observed between percent backpack weight and lumbar flexion ( $r=-0.40$ ) and lumbar lateral flexion ( $r=-0.27$ ). In girls statistically significant positive correlations were observed with lumbar extension ( $r=0.54$ ) and statistically significant negative correlations with weight ( $r=-0.26$ ). In boys, statistically significant positive correlations were observed between ratio of backpack weight and percent backpack weight and lumbar lateral flexion ( $r=0.26$ ) and statistically significant negative correlation was found with height ( $r=-0.21$ ) and lumbar flexion ( $r=-0.38$ ). In girls statistically significant negative correlations were observed with height ( $r=-0.26$ ) and lumbar extension ( $r=-0.36$ ).

The purpose of the study was to observe the association between backpack weight and postural habits taken in terms of lumbar flexion, lumbar extension and lumbar lateral flexion in school going children of Amritsar, Punjab, India. In fact children's backs are both strong and flexible. It is also mention worthy that spine is not a single bone; rather it is a stack of bony doughnuts, with the spinal cord running up and down through the central spinal canal. The bones of the spine, the vertebrae, fit neatly together like a loose-fitting three dimensional puzzle, allowing the individual to bend forward, backward, or to either side. In addition, there are soft, spongy discs between each of the vertebrae; these serve as shock absorbers, adding to the spine's strength and flexibility. The vertebrae remain neatly stacked when we run, jump, run, swim, play or carry a backpack – because strong ligaments and supporting muscles hold everything in place. The results of carrying too much backpack weight in case of adolescent school going students for too long is muscle soreness and strained ligaments, causing back discomfort anywhere

from the shoulders to the lower back (Siambanes et al. 2004).

The results of the present study revealed that statistically significantly positive correlations were observed between backpack weight and height, weight and lumbar flexion and extension in school going boys and girls of this district place. An interesting findings of the study revealed that the backpack weight carried by the school children was reported to be between 7.48%-16.83% of their body weight which followed the findings of some earlier studies (Pascoe et al. 1997; Iyer 2001; Negrini and Carabalona 2002). Iyer (2001) in her study found that Indian children carried school bags weighing 18.5% of their body weight. Whereas, Pascoe et al. (1997) in their study carried in America found that mean weight of the school bag carried by the school children in the age group 11-13 years was 17% of their body weight. Also, Negrini and Carabalona (2002) in their study conducted in Italy found that average load carried by school children aged 11.29 years  $\pm 0.33$  was 9.3 kg, which was calculated to be 22% of their body weight. However, Forjuoh et al. (2003) in their study carried in Texas reported the backpack weight 6.2% among kindergarteners and 12% among fifth graders, and Whittfield et al. (2001) in their study carried in New Zealand reported 13.2% of body weight for third grade and 10.2% for sixth grade school children which were reported to be lesser than the findings of the present study where backpack weight of the students of all the age groups were reported to be more than 10% of their body weight except age group 6+ and 7+ years in boys and age group 6+, 7+ and 8+ years in girls. It is reported that postural habits are altered while constant loading (static as well as dynamic) with more than 10% of body weight in young children (Chansirinukor et al. 2001; Mohan et al. 2007). This extra load influences the structure of neck on upper trunk position. In fact, rounded

**Table 4: Correlation co-efficients (r) of backpack weight, percent backpack weight and their ratios with 5 parameters in boys and girls**

Parameters	Backpack weight		Percent backpack weight		Ratios	
	Boys	Girls	Boys	Girls	Boys	Girls
Height	0.73*	0.65**	0.10	0.07	-0.21**	-0.26**
Weight	0.57*	0.42**	-0.14	-0.26**	-0.03	0.33
Lumbar flexion	0.19*	-0.01	-0.40**	0.16	-0.38**	-0.11
Lumbar extension	0.11	0.21*	0.11	0.54**	-0.12	-0.36**
Lumbar lateral flexion	-0.46	0.01	-0.27**	0.09	0.26**	-0.13

\*indicates  $P < 0.05$  \*\* indicates  $P < 0.001$

posture of the shoulder is associated with imbalanced muscle performance, impingement syndrome, neck pain, headache and craniomandibular disorders (Travell and Simmons 1992; Janda 1986; Mannheimmer and Rosenthal 1991). Though it is still debatable that more than 10% of extra load (in the form of backpack) leads to rounded shoulder or not, because number of other factors may play role for its roundness, still it has more than a chance association that craniohorizontal angle indicates the position of upper cervical segment (Mohan et al. 2007). Sheir-Neiss et al. (2003) also reported that heavier backpack weights were independently associated with back pain. Female gender and larger body mass index also were associated with back pain. Structural changes in spine due to extra backpack loading in childhood may cause anatomical as well as physiological complications in their later lives. Thus, the findings of the present study will certainly help the health professionals to plan more effective preventive strategies for school children to avoid their back and neck complications.

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