Effect of backpack use on musculoskeletal discomfort among preadolescents school children

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ABSTRACT : The main aim of this study was to investigate the work-related musculoskeletal disorders (WMSDs) by using Nordic musculoskeletal discomfort and VAS scale in different body parts of 7th class students while carrying the heavy back packs. It was a descriptive study conducted in CBSE affiliated schools of Meerut and total selected samples were 100 students, 50 boys (50%) and 50 girls (50%). They all were selected by using the random sampling method. To investigate WMSDs, it included detailed questions on work-related pain in different body parts. Work-related pain/discomfort was reported in 12 month, one month and prevalence in 7 days. All the selected students had given their responses, which were analyzed by statistical analysis i.e. frequency, percentage, mean score, SD, range and ranking order. The results showed that majority of respondents expressed severe pain in both shoulders (32 percent), lower back (30 percent), neck (26 percent), upper back (18 percent), right shoulder and legs (16 percent), knees (14 percent), elbows (6 percent) left shoulder (2 percent), wrist and hands just because of heavy backpacks. Data revealed that during the last 12 months cent percent of the boys reported pain and discomfort in upper back. Revealed that 83.33 percent girls and 90 percent boys reported pain in upper back whereas 73.33 percent in ankles and feet during last 7 days.

Key words: Back pain, discomfort, MSD, trauma

Next to home, school has the most strategic importance germane to meeting the health needs of children. School is the basic foundation of knowledge being imparted to a child. Other than that, Today in this competitive world students from very young age have to teach numerous subjects to gain knowledge, it is nothing but essential to use the right of books. The problem rising in this scenario is that although these books provide knowledge, they are rather heavy for children. The heavy school backpacks are more of a burden than a means of imparting knowledge for these kids. The backpack is one of the several forms of manual load carriage that provides flexibility and is often used by hikers, and soldiers, as well as by the school children (Knapik *et al.,* 1996).

Although backpacks are the best, but it is essential to make sure that they are not too big or too heavy. Children's back are both strong and flexible. The muscles excessive weight on the back of the children is a serious issue, most especially considering that the spinal structures of the child are markedly different from those of adults. As growth of the spinal structures extends over a longer period of time than the other skeletal tissues, incongruities in rate of tissue development can pose a threat to overall postural integrity.

Therefore young children are suffering from back pain much earlier than previous generations and the use of overweight backpacks is a contributing factor. Most often students carry their belongings with only one strap slung loosely over the shoulder. What they do not realize is that the use of bag packs is not just a fashion statement. School backpack alter the student's unloaded posture and reposition it into a more strained and stressed, improper, potentially unbalanced posture, with the addition of external force. The weight of the bags varied considerably, even within one class. It is clear that most of the school children (89.5%) had heavier bags than the 10% norm issued in Austria and Germany (Mehta, 2010). It also appears that time spent in carrying the backpack as well as its weight is an important factor favoring back pain. Backpacks can injure the head or face, as well as the hands, the elbow, the wrist, the shoulder, the foot and the ankle. Back trauma is observed as the sixth most common injury. The 'weak point' is the shoulder and not the back. A poorly positioned backpack can modify posture and gait. Carrying the backpack with two shoulder straps affects posture and gait less than carrying it on one shoulder. The posture of the spine changes when the weight of the backpack increases. Therefore lifting heavy burdens for a long time or distance is not good for children. Carrying a

heavy backpack on the back causes forward leaning and bad posture, which can lead to improper weight bearing on the spine, and pains and aches in the back and shoulders. Children could get into bad habits like poor posture and slouching. Because of these students may experience fatigue, rounding of the shoulders, back pain, along with muscle strain (Seassoms, 2011).

Unfortunately in most of the Indian school authorities do not take any proactive approach or provide any solution to control musculoskeletal disorders in school children. It has been found in several studies that many children carry backpacks weighing more than 10% of their body weight (Whittfield *et al.,* 2003). Several researches further stated that students carrying more than 10 – 20 % of their body weight are more susceptible to low back pain (Rateau, 2004). Moreover when heavy backpacks are carried by only one shoulder, children tend to affected more (Mackenzie *et al.,* 2006).

MATERIALS AND METHODS

Present descriptive study was conducted on total 100 students, 50 (50%) boys and 50 (50%) girls aged between 10 to 13 years. For the selection of students random sampling method was used. The children were students of 7th class of CBSE affiliated school in Meerut. Data was collected by taking the consent from the school principal. The main aim of this study was to investigate the work-related musculoskeletal disorders (WMSDs) by using Nordic musculoskeletal discomfort and VAS scale in different body parts of both boys and girls students while carrying the heavy back packs and to analyze the causes of discomfort. The scale consisted of a series of objective questions with yes or no response and some were in multiple choice questions. To investigate WMSDs, it included detailed questions on work-related pain in different body parts. Work-related pain/discomfort was reported in 12 month, one month and prevalence in 7 days. The participants were interviewed about any kind of discomfort affecting different body parts during carrying of heavy backpacks. All the selected students had given their responses, which were analyzed by statistical analysis i.e. frequency, percentage, mean score, SD, range and ranking order.

RESULTS AND DISCUSSION

Assessment of pain while carrying heavy backpacks

Today, back pain in school children is becoming a new topic of growing health problem raising a red flag and an alarm about the dangers associated with improper childhood school bag weight and use. Regarding the musculoskeletal development of school age children, the weight of school bag and the negative consequences of such a heavy load may cause a problem on the spine. According to Young *et al.* (2006) a large number of school children and adolescents were reported to have pain in upper limb including back, neck, and shoulder.

Identification of severity of pain through body map in respondents

The results depict (Table 1) the prevalence of musculoskeletal problems among the selected female respondents while carrying of heavy school back pack. The majority of respondents expressed severe pain in both shoulders (32 percent) followed by 30 percent had severe pain in lower back, 26 percent in neck, 18 percent

Table 1: Identification of severity of pain in girls through body map **(n_3=50)**

S.No	Body Parts		Discomfort {x (y %)}*			
		Rank	Total	Low	Moderate	Severe
1.	Neck	2	32 (64)	12 (24)	07 (14)	13 (26)
2.	Shoulder	1	43 (86)			
	Right		12 (24)	-	04 (08)	08 (16)
	Left		01 (02)	-	-	01 (02)
	Both		30 (60)	06 (12)	08 (16)	16 (32)
3.	Upper Back	3	25 (50)	06 (12)	10 (20)	09 (18)
4.	Elbows	6	08 (16)	-	05 (10)	03 (06)
5.	Wrist/Hands	7	05 (10)	03 (06)	01 (02)	01 (02)
6.	Lower Back	5	19 (38)	03 (06)	01 (02)	15 (30)
7.	Hips/Thighs	8	03 (06)	02 (04)	01 (02)	-
8.	Knees	4	20 (40)	10(20)	03 (06)	07 (14)
9.	Legs	5	19 (38)	06 (12)	05 (10)	08 (16)

x (y%) = x denotes frequency/ y denotes Percentage in parenthesis

in upper back,16 percent in right shoulder and legs, 14 percent in knees, 6 percent in elbows and only 2 percent in left shoulder, wrist and hands.

As per the finding, it could be seen from the table 1 that twenty percent girls had moderate pain in upper back followed by 16 percent had moderate pain in both shoulders, 14 percent in neck, 10 percent in elbows and legs, 8 percent in right shoulder, 6 percent in knees and two percent in lower back, wrists, hands, hips and thighs respectively. With respect to the use of heavy school backpacks twenty four percent respondents experienced low pain in neck, 20 percent in knees, 12 percent in both shoulders, upper back, and legs, 6 percent in wrists, hands and legs and only four percent reported low pain in knees. According to Gent *et al.* (2003) heavy backpacks which carried improperly on the backs or shoulders of school children can put pressure on their joints and ligaments and may be associated with several potential health consequences including bad posture, back strain, and eventual low back pain.

It could be concluded from the above observations (Table 2) that the male respondents expressed very severe pain in both shoulders (20 percent) followed by16 percent in lower back, 14 percent in upper back, 8 percent in neck, 6 percent in right shoulder, wrist, hands, knees and legs and only 4 percent respondents had pain in left shoulder.

As per the findings twenty eight percent boys had moderate pain in upper back followed by 26 percent in neck, 20 percent in knees, 16 percent in both shoulders, 12 percent in lower back and legs, 10 percent in right shoulder and 6 percent in elbows.

Tabulating the responses of the respondents as envisaged in Table 2, it was found that majority of respondents (14 percent) had low pain in neck, wrists and hands followed by 10 percent who had pain in both shoulders, 8 percent reported pain in knees, upper back and elbows. Six percent had pain in legs. It was also clear from the table 2 that 4 percent boys had pain in right shoulders and 2 percent reported in left shoulder, hips and thighs.

Negrini *et al.* (2004) found that back and neck pain have a substantial economic impact either direct medical care costs or indirect costs of disability. Goh *et al.* (1998) studied backpack use in children and observed that all students while carrying heavier backpack load adopted a compensatory trunk flexion posture.

Thus it can be concluded from Table 1 and 2 that while ranking the severity of pain, girls and boys had more pain in shoulder then neck, upper back, knees, lower back. It was also revealed that girls had more pain than boys. Burton *et al.* (1996) revealed that approximately 16 percent to 23 percent of school-aged children have missed school activities or sought medical attention due to the severity of back pain.

Postural discomfort determined by VAS scale

The postural discomfort analysis questionnaire was used to find out the discomforts of different body parts due to heavy school backpack carried by the children. The questionnaire was given to each subject and asked to put the mark on the line, which was then being analyzed. The descriptive (mean and SD values) were determined for

Table 2: Identification of severity of pain in Boys through body map **(n_3=50)**

S.No	Body Parts		Discomfort {x (y %)}*			
		Rank	Total	Low	Moderate	Severe
1.	Neck	3	24 (48)	07 (14)	13 (26)	04 (8)
2.	Shoulder	1	36 (72)			
	Right		10 (20)	02 (04)	05 (10)	03 (06)
	Left		03 (06)	01 (02)	-	02 (04)
	Both		23 (46)	05 (10)	08 (16)	10 (20)
3.	Upper Back	2	25 (50)	04 (08)	14 (28)	07 (14)
4.	Elbows	7	10 (20)	04 (08)	03 (06)	03 (06)
5.	Wrist/Hands	7	10 (20)	07 (14)	-	03 (06)
6.	Lower Back	5	14 (28)	-	06 (12)	08 (16)
7.	Hips/Thighs	8	01 (02)	01 (02)	-	-
8.	Knees	4	17 (34)	04 (08)	10 (20)	03 (06)
9.	Legs	6	12 (24)	03 (06)	06 (12)	03 (06)

* x (y%) = x denotes frequency/ y denotes percentage in parenthesis

VAS (Visual Analogue Scale) validated by Huskisson (1983). Similar work was reported by Newell (2003). She conducted studies to find out the comparison of instantaneous and cumulative loads of the low, back and neck in orthodontists. She applied the VAS scale ranging from 0-10, with '0' meaning 'no discomfort' and 10 meaning severe discomfort. Her individual values ranged between 0.6-9. The neck had the highest mean value 2.6, with shoulder and lower back closest behind at the 2.3 and 1.6 respectively. The mean and SD results of the postural discomfort questionnaire were analyzed.

Ibrahim H.A. (2012) conducted a study on effect of school back weight on back of 254 Egyptian girls divided in group A, 136 girls from 6-10 years and group B, 118 girls from 11 to 14 years He reported that the perception of pain intensity in girls of group A was 3.4 to 7.7 on VAS scale and 4.5 to 8.8 for group B. Only seven girls from group A and eleven girls from B recorded no pain. He concluded that young girls are at the age of growth and their bones are soft and carrying heavy school bag may cause more physical stress and strain on their back. Siambanes *et al.* (2004) reported that females are more likely to report higher level of pain then boys while carrying heavy backpacks.

The results depicts that the mean value was highest in the neck (3.14) followed by shoulder (2.74), upper back (1.70) and lower back (1.54) among the girls. The pain and discomfort in legs was higher (1.38), whereas discomfort in buttock/thighs and knees (0.39, 0.88) were comparatively low. This revealed that the respondents suffered from pain and discomforts more in neck and upper back due to carrying of heavy bag for long duration, which also cause musculoskeletal disorders. The pain in lower arm was also noticed but was very low.

Croft *et al.* (2001) reported that approximately one third of adults will experience neck pain within a 12 month time period, while Fejer *et al.* (2006) examined neck pain is a common complaint, with one year prevalence over 37 percent for adults, and women reporting neck pain more frequently than men.

It can be evidenced from the Table 4 that mean value of discomfort in boys was highest in neck (1.56) followed by lower and upper back (1.36, 1.14) and shoulders (1.10) among the male respondents. The pain and discomfort in legs was higher (0.82) while it was slightly less in thighs, lower arm, upper arm and knees (0.56, 0.44, 0.32, o.24). Backpacks and load carriage have been linked to low back problems and pain in youth.

Negrini *et al.* (2002) examined the Italian youth and found 46.1% of the 6th graders studied reported back pain caused by their school backpacks. Additionally, Korovessis (2005) in a study of spinal curvature with backpack loads found that taller children reported less pain than shorter children carrying the same load. (Appendix V)

Perceived body discomfort identified through Standardized Nordic Questionnaire

The physical demands of schoolbag carriage are likely to depend not only on school bag weight. Schoolbag design, school bag adjustment, duration and frequency of carriage and the manner in which the weight

Table 3: Mean Score and Ranking of postural discomfort in girls due to carrying of heavy backpack according to VAS rating (n_3=50)

S.No	Body parts	Rank*	Relative #	Mean	SD	Range
			Percentage %	Score		
1.	Neck	1	25.32	3.14	±2.86	0-10
2.	Shoulder	2	22.09	2.74	±2.97	0-10
3.	Upper back	3	13.71	1.70	±2.53	0-9
4.	Upper Arm	7	03.95	0.49	±1.14	0-5
5.	Lower Arm	9	01.13	0.14	±0.54	0-3
6.	Lower Back	4	12.42	1.54	±2.57	0-8
7.	Thighs	8	03.15	0.39	±1.08	0-4
8.	Knees	6	07.09	0.88	±1.64	0-7
9.	Legs	5	11.13	1.38	±1.99	0-7
		Total discomfort Score^		12.4		
		Total Score of 1-4 Rank		73.54		

*Rank indicates highest to lowest discomfort level.
Relative Percentage indicates the fraction of discomfort in body part relative to total discomfort score.
^ Sum of all mean score.

is carried all affects the demands on the musculoskeletal system and may affect a student's susceptibility to musculoskeletal disorder.

Many studies of risk factors associated with musculoskeletal disorders in school children have involved participants of between 11-14 years as this age of rapid growth is when adolescents appear to be vulnerable to developing musculoskeletal problems. Datta (2009) explained that adolescents are more susceptible to musculoskeletal injury due to growth cartilage being present at epiphyseal plate, joint surfaces and epiphyses. These can be put under increased strain due to relative tightness across joints as a result of growth spurts. This age is also when school children are carrying the heaviest school bag loads relative to their body mass (Grimmer *et al.,* 2002; Whitefield *et al.,* 2001), which may be putting them at further risk of developing MSD.

The musculoskeletal problems and the perceived body discomfort by the students (boys and girls) were determined by administering of standardized Nordic questionnaire. Students were asked few questions about perceived pain/discomfort, which was prolonged for at least 24 hours. Pain was measured for past 12 months, one month and for 7 days.

Prevalence of musculoskeletal pain/discomfort in last 12 months

All the selected male students had given their responses, which were analyzed and the results (Table 5) depicts that the majority of the respondents were feeling pain and discomfort in different body parts.

Table 4: Mean Score and Ranking of postural discomfort in Boys due to carrying of backpack according to VAS rating (n_3=50)

S.No	Body parts	Rank*	Relative # Percentage %	Mean Score	SD	Range
1.	Neck	1	20.69	1.56	±2.21	0-9
2.	Shoulder	4	14.59	1.10	±2.02	0-7
3.	Upper back	3	15.12	1.14	±2.15	0-8
4.	Upper Arm	8	04.24	0.32	±1.19	0-6
5.	Lower Arm	7	05.84	0.44	±1.64	0-8
6.	Lower Back	2	18.04	1.36	±2.65	0-9
7.	Thighs	6	07.43	0.56	±1.39	0-6
8.	Knees	9	03.18	0.24	±0.92	0-5
9.	Legs	5	10.86	0.82	±1.77	0-7
	Total discomfort Score^			07.54		
	Total Score of 1-4 Rank			68.44		

*Rank indicates highest to lowest discomfort level.
Relative Percentage indicates the fraction of discomfort in body part relative to total discomfort score.
^ Sum of all mean score.

Table 5: Distribution of respondents (boys) as per prevalence of musculoskeletal pain/discomfort in last 12 month (n_3=50)

Body parts	Frequency
Neck	25 (83.33)
Shoulder	
• Right	6 (20.00)
• Left	6 (20.00)
• Both	14 (46.67)
• Both	27 (90.0)
Upper back	30 (100.0)
Low back	22 (73.33)
Hips/thighs	24 (80.00)
Knees	6 (20.00)
Ankles/feet	24 (80.00)

* Percentage is given in parentheses

Data revealed that during the last 12 months cent percent of the boys reported pain and discomfort in upper back. When asked about pain in shoulders, 46.67 percent of the respondents had pain in both shoulders, whereas 20 percent had complained pain in right shoulder and the same number of respondents reported pain in left shoulder. Ninety percent boys reported pain in wrist and 80 percent in hips or thighs. Almost 84 percent respondents complained pain in neck. 73.33 percent students felt pain in lower back. Concerning about pain in knees 20 percent felt pain and discomfort while 80 percent of all the respondents reported pain in ankle and feet.

As per the findings of Table 6, all the girls reported that they have pain or discomfort in their shoulders and upper back due to carrying of backpack. It was also depicted from the above table that 90 percent respondents have pain in their neck. Almost 67 percent respondents feel pain in their lower back. Half of the total female respondents complain of pain in their knees, ankles and feet due to the weight of backpack. One third of the total female respondents (33.33 percent) reported pain in their hips and thighs. Only 16.66 per cent respondents feel pain in their both elbows.

Prevalence of perceived musculoskeletal pain/discomfort for last one month

When enquired about the occurrence/feeling of pain and discomfort during last month total of 66.66 percent of the boys complained of pain in neck and both shoulders. Regarding pain in upper back, all of the male students reported discomfort. On the other hand 80 percent respondents complained pain in right ankles, feet, hips and thighs; whereas almost 74 percent of the respondents reported pain in lower back. Seventy percent of the respondents felt pain in both wrists while only 10 percent reported pain in knees.

The school bag carried by the school children as a daily load now become a health problem as the table showed that ninety percent girls feeling pain and discomfort in their upper back, while 60 percent girls in their lower back. It was also revealed from the Table 7 that 80 percent girls felt pain in their both shoulders. These findings were supported in part by results of Ibrahim H. (2012) conducted a study on influence of back pain in 254 Egyptian girls. He found that almost 50 percent of the total respondents had low back pain and about 74 percent female respondents reported pain in their neck.

Table 6: Distribution of respondents (girls) as per prevalence of musculoskeletal pain/discomfort in last 12 months (n_3=50)

Body parts	Frequency
Neck	27 (90)
Both Shoulder	30 (100)
Both Elbow	5 (16.66)
Upper back	30 (100)
Low back	20 (66.66)
Hips/thighs	10 (33.33)
Knees	15 (50)
Ankles/feet	15 (50)

* Percentage is given in parentheses

Table 7: Distribution of respondents (boys) as per prevalence of musculoskeletal pain/discomfort in last 1 month (n_3=50)

Body parts	Frequency
Neck	20 (66.66)
Both Shoulder	20 (66.66)
Both Wrist/hands	21 (70.00)
Upper back	30 (100.0)
Low back	22(73.33)
Hips/thighs	24 (80.00)
Knees	3 (10.00)
Ankles/feet	24 (80.00)

* Percentage is given in parentheses

Regarding pain in ankles and feet 40 percent of total respondents reported discomfort. Only 30 percent girls complained of pain and discomfort in knees.

Reporting of feeling of trouble to the adolescents at any time during last 7 days

Present investigation (Table 8) revealed that 90 percent boys reported pain in upper back whereas 73.33 percent in ankles and feet during last 7 days. On the other hand only 70 percent respondents had hip and thighs pain, whereas 66.66 percent complained pain in neck and lower back. About 60 percent boys suffered from pain in wrist. Further 50 percent boys were complaining about pain in both shoulders during last 7 days. Only 3.33 percent boys felt pain in knees. Similarly in a study Pandey and Vats (2012) found that brick factory workers were involved in carrying of heavy loads on their shoulders and head and reported to have a severe musculoskeletal discomfort in different body parts.

When enquired about the occurrence/feeling of pain and discomfort during last seven days total of 83.33 percent of the girls complained of shoulder pain due to carrying of heavy backpack. **Negrini (2002)** found that the mean of school bag weight were 9.06 and 9.30 kg respectively. Regarding pain in upper back eighty percent of female respondents reported discomfort. On the other hand 60 percent of the girls complained pain in neck.

Table 8: Distribution of respondents (girls) as per prevalence of musculoskeletal pain/discomfort in last 1 month (n_3=50)

Body parts	Frequency
Neck	22 (73.33)
Both Shoulder	24 (80.00)
Upper back	27 (90.00)
Low back	18 (60.00)
Hips/thighs	-
Knees	9 (30.00)
Ankles/feet	12 (40.00)

* Percentage is given in parentheses

Table 9: Distribution of respondents (boys) as per prevalence of musculoskeletal pain/discomfort during last 7 days (n_3=50)

Body parts	Frequency
Neck	20 66.66)
Both shoulder	15 (50.00)
Both wrist/hands	18 (60.00)
Upper back	27 (90.00)
Low back	20 (66.66)
Hips/thighs	21 (70.00)
Knees	1 (3.33)
Ankles/feet	22 (73.33)

* Percentage is given in parentheses

Table 10: Distribution of respondents (girls) as per prevalence of musculoskeletal pain/discomfort during last 7 days (n_3=50)

Body parts	Frequency
Neck	18 (60.00)
Both shoulder	25 (83.33)
Upper back	24 (80.00)
Lower back	16 (53.33)
Ankles/feet	9 (30.00)

* Percentage is given in parentheses

Almost 54 percent of the respondents felt pain and discomfort in lower back whereas only 30 percent girls reported pain in ankle and feet.

CONCLUSION

Based on the descriptive results it could be concluded that the students carrying heavy backpack for a longer period of time and they suffer from discomfort and pain in different parts of their body, specifically in neck, back, knees, and elbow regions. The feeling is aggravated if those heavy backpacks will be carried for a prolonged time. Consequently they are fatigued after such arduous tasks. This not only hampers their education and normal physical activity but it may also result in the development of a serious musculoskeletal disorder in the near future.

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