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A Study to Find the Relation Between School Bag Weight and Musculoskeletal Discomfort in School Going Children

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Abstract

Background: *School bags are one of the several forms of manual load carriage used by school children. Carrying school bags that exceed 10% of body weight can lead to heightened energy expenditure, causing increased forward lean of the neck and trunk, reduced lung capacity and elevated cardio-respiratory measures. Musculoskeletal disorders (MSDs) are characterized by injuries or disorders affecting muscles, tendons, ligaments, cartilage, or spinal discs, as diagnosed by healthcare providers, excluding injuries resulting from slips, falls, or accidents. Various factors contribute to school children's health issues, including carrying heavy school bags, maintaining improper sitting posture and inadequate environmental conditions. Recent attention has primarily centered on the impact of school bag weight on back pain. Studies indicate that carrying a school bag exceeding 15% of body weight elevates the likelihood of experiencing back pain. The purpose of the study was to find out the relationship between school bag weight (SBW) and MSD in school-going children.* ***Objective:*** *To correlate the SBW and musculoskeletal discomfort in school-going children.* ***Method:*** *A total of 500 children, comprising both boys and girls who met the specified inclusion and exclusion criteria, were recruited for the study. Before participation, informed consent was obtained from the parents and teachers of the children. The initial meeting with the students takes place and an explanation of the study is given. Afterward, their school bags' weight was assessed using an electronic weighing scale. The weight and height of students will be measured using an inch tap and weighing scale. BMI was calculated using these measurements. Cornell musculoskeletal discomfort questionnaire was given to the students and asked to fill the questionnaire. The questionnaire served as a means to assess musculoskeletal discomfort in children. The data obtained from the questionnaire and bag weight and BMI were subjected to statistical analysis. Statistical Analysis Statistical analysis was done by using the Karl Pearson correlation coefficient (r-value) to predict the score on SBW with musculoskeletal discomfort. P value <0.002 was taken as the level of statistical significance.* ***Results:*** *The negative Pearson correlation between SBWT and STBMI of –1.35 and the positive person correlation between SBWT and CMDQ of .256. The negative correlation states that as the SBWT increases the STBMI decreases. And the positive correlation states that as the SBWT increases the CMDQ also increases.* ***Conclusion:*** *SBW had a strong correlation with Musculoskeletal discomfort (MSD) in school-going children.*

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INTRODUCTION

The school bag is one among various methods of manual load carrying utilized by school children. In India, nearly 220 million students [1], and in Karnataka, 10.23 million students go to school out of which 24.11 crore students are there in 8^{th}–10^{th} (12–18 age group) standard, students undergo rapid musculoskeletal development [2,3] Maintaining an

efficient upright posture is thought to necessitate the least physical exertion to uphold body position and reduce strain on body tissues. External forces, such as school bags, can lead to postural deviations and musculoskeletal issues. Hence, it is important to investigate the etiology of school-going adolescent problems related to school bags as it is a predictor for musculoskeletal disorder (MSD) in adulthood [4]. When the load of school bags exceeds 10% of body weight, it elevates energy expenditure, causes forward leaning of the neck and trunk, reduces lung volumes and raises cardio-respiratory parameters [6]. Some studies state that the neck, shoulder and back pain are due to the load on the spine by school bags [7], whereas few studies state that it is due to obesity,[5] static and faulty postures[8], and psychosomatic factors. When using school bags, the neck and trunk move in a forward position placing abnormal forces on the body [9].

MSDs are defined as injuries or disorders of the muscle, tendons, ligaments, cartilage or spinal discs as diagnosed by healthcare professionals and do not include injuries resulting from slips, falls or accidents. MSD constitutes an important health problem globally. More than 20% of patient visits to primary care and emergency medical practitioners in the United States of America are due to injuries and diseases of the musculoskeletal system. Screening programs can identify most cases of previously undiagnosed orthopedic abnormalities and improve our knowledge of the prevalence and pattern of MSD. It can lead to early diagnosis which often is beneficial in altering the natural history of disease [11–13].

Musculoskeletal symptoms in school children arise from multiple factors, including carrying heavy school bags, adopting inappropriate sitting posture and environmental conditions, as indicated by research. School students undergo rapid growth and development of skeletal and soft tissues, resulting in distinct differences in spinal structures compared to adults. Since spinal structure growth extends over a prolonged period compared to other skeletal tissues, discrepancies in the rate of tissue development can jeopardize postural stability [15].

According to the 1999 census in India, 45% of children are reported to suffer from spondylosis, with 4.4% experiencing spondylolisthesis and 33.4% having scoliosis. Paraplegia and cold abscess formation are identified as the primary complications associated with back pain in children [16]

In a recent study investigating the association between backpacks and back pain in school children, selected statistics reveal that the average weight of backpacks exceeds the legal load-bearing limit for adults on a proportional basis. Additionally, 79.1% of children indicate that their backpacks feel heavy, 65.7% report feeling fatigued due to the weight of their backpacks, and 46.1% report experiencing back pain caused by their backpacks [17].

The daily routine of most of the school-going children across the globe starts with carrying the load in the form of a backpack and this continues for years. In recent times parents have expressed concern about weight of children's backpacks and the consequences of carrying such loads[18] which gave scope for wide range of studies on children wearing backpacks.

Furthermore, the mode of transportation to school, whether it involves active methods like walking and cycling or passive means such as being driven by car or taking the bus, could also contribute to back and neck pain. Previous research has shown that students who actively walked to and from school reported lower incidences of low back pain compared to those who were passively transported [19].

Nevertheless, have contradicted this finding by discovering that an active commute to school was linked with a higher prevalence of back pain. This discrepancy in evidence could be attributed to variables such as the duration of carrying school bags, the weight of school bags, and how these factors interact with variables like the time taken and method of transportation to school in impacting back and neck pain.

The studies were done in various countries data with parameters like musculoskeletal pain, biomechanical changes in gait, posture, cardio-respiratory adjustments energy expenditure and fatigue while carrying schoolbags.

The perception of the load of school bags could serve as a valuable overall measure of burden, as individuals' perceptions consider personal attributes like strength and stamina. Describing the school bag as heavy or tiring may suggest inadequate endurance and control of trunk muscles, which are recognized as risk factors for back pain. Reduced trunk muscle strength has been linked to back pain in adolescents, highlighting the relevance of these personal characteristics in the onset or persistence of spinal discomfort. However, the relationship between perceived school bag load and back and neck pain is not yet known.33 A recent literature review concluded that the lifetime prevalence of back pain in adolescents ranged from 30% to 51%, and medical attention was sought by approximately 4% to 31% of equal concern is the rate of recurrent and chronic pain being reported by schoolchildren. Hence, it is crucial to identify risk factors in this figure to alleviate the impact of spinal pain on both adolescents and adults. School bags have long been implicated in back and neck pain among adolescents and clinicians are often sought out for guidance regarding the carriage of school bags and their association with back and neck discomfort.

REVIEW OF LITERATURE

Conducted a cross-sectional study on Sagittal Standing Posture and Its Association With Spinal Pain. They concluded that there is wide interindividual variation in sagittal posture. Studied the neck, upper back and lower back pain and associated risk factors among primary school children. 2 questionnaires were completed by 100 students and their height and weight were noted. They concluded that school bag load and classroom furniture significantly influenced the prevalence of MSDs. A Study on Factors Affecting Low Back Pain in Adolescents. As per the findings disclosed by [citation], back pain was observed to be more prevalent among girls aged 12 to 14 compared to boys within the same age group. Similarly, The results also indicated that those children with a lower body mass index (e.g. BMI less than 19) were more likely to suffer from shoulder symptoms than those children with a higher body mass index were. They undertook a study using standing magnetic resonance imaging to investigate the impact of backpacks on the lumbar spine in children. The objective of the study was to measure the lumbar spine response to school bag loads in healthy children. T_2 weighted sagittal and coronal MRI scans of the lumbar spine in standing with 4, 8, 12 kg backpacks were taken. They determined that the weight of backpacks contributes significantly to back pain in children, potentially resulting from alterations in lumbar disc height or curvature. Investigated cardio-respiratory effects of backpack carriage in 15 male children (12.5+ 0.5 years) and stated that the systolic blood pressure, minute volume and diastolic blood pressure varied with varied backpack loads and recommended the weight of school backpacks for high school students as 8% of their body weight. In a study on the effects of carrying schoolbags on posture and subjective experiences, findings indicate a significant correlation between musculoskeletal discomfort in developing children and the weight of backpacks. It has been observed that heavy backpacks can lead to alterations in posture. However, the number of these studies are few. Studied the prevalence of musculoskeletal symptoms among 140 students from 5 secondary schools. The weight of school bags and students' body weight were measured. They concluded that the carriage of heavy school bags is a contributing factor for symptoms in the neck, shoulder, upper back and lower back. Research conducted on the impact of load and carrying techniques on children's stair walking found that lifting, carrying and managing a heavy backpack on the back can result in forward-leaning and poor posture. This may subsequently increase strain on the spine and contribute to discomfort and pain in the neck, shoulders, and back. Additionally, a study investigated the prevalence of neck, shoulder and back pain in young adolescents. A questionnaire was answered by 745 adolescents about the complaints of neck, shoulder, back and psychosomatic factors. The researchers measured the weight of school bags along with the height and weight of the children. Their analysis led to the conclusion that psychosomatic factors demonstrate a stronger correlation with the prevalence of neck, shoulder and back complaints. A study investigated the relationship between backpack usage and back pain in adolescents. 1126 adolescents completed a questionnaire regarding their health, activities and backpack

usage, while their height, body weight and backpack weight were measured. The study concluded that both the use of backpacks during the school day and the weight of the backpacks are independently linked to back pain. Another study explored the correlation between schoolbag weight and the prevalence of neck, shoulder and back pain in young adolescents. It revealed a high incidence of these complaints among secondary students. (45.1%) reported discomforts in shoulder, back and upper and lower extremities. This percentage is nearly like the percentage found in another study. However, 45.1% of secondary students have expressed musculoskeletal complaints such as pain, discomfort, aching shoulders, numbness and muscle soreness. On this basis, rate of discomfort in the shoulders area 38.1 %, in the neck 27.6 % and in the back 16.7 % has been reported. A study investigated the occurrence and characteristics of low back pain in schoolchildren, concluding that carrying and manipulating heavy backpacks causes secondary students to struggle to maintain proper standing and walking posture. Additionally, research on the weight and usage of schoolbags in New Zealand secondary schools highlighted the potential long-term musculoskeletal issues associated with carrying excessive weight or wearing backpacks incorrectly among all.

TECHNIQUE OF APPLICATION

500 school children with fulfilling the inclusion criteria were selected. The purpose, method and procedure of the study were explained to the children in a language understood by them and after meeting the inclusion and exclusion criteria, a prior written concern form from the children was obtained for study from various schools in and around Mangalore. All subjects were assessed using a specific proforma. The study was approved by ethical committee for the ethical clearance, constituted by Laxmi Memorial College Of Physiotherapy, Mangalore. The first encounter with the students occurred, during which they were briefed on the study. Subsequently, their school bag weights were measured utilizing an electronic weighing scale. The height of students was measured using inch tap and weighing scale.

BMI was calculated using these measurements.

$$BMI = \text{weight(kg)}/\text{height}^2\text{(meter)}$$

The Cornell musculoskeletal discomfort questionnaire was given to the students and they were asked to fill the questionnaire. The questionnaire served as a tool for assessing musculoskeletal discomfort in children. The data obtained from questionnaire and bag weight and BMI was subjected to statistical analysis.

OUTCOME MEASURES

1. Weighing machine for assessing the weight of bags and students
2. Cornell musculoskeletal discomfort questionnaires for assessing musculoskeletal discomfort.

Cornell Questionnaire

Cornell MS Discomfort Questionnaire (CMDQ) is a well-designed data collection tool which was developed by Professor Alan Hedge and ergonomics graduate students at Cornell University. CMDQ Addresses 7-day frequency, severity and working ability interference effects of MS discomfort across 20 body parts. It has been used in the assessment of MS discomfort among different working populations such as nursing personnel and data entry employees in a large Canadian telecommunication company.

Scoring Guidelines-Cornell Musculoskeletal Questionnaires

These questionnaires are for research screening purposes and not for diagnostic purposes. Scores can be analyzed in 4 ways:

1. By simply counting the number of symptoms per person.
2. By summing the rating values for each person.

3. By weighting the rating scores to more easily identify the most serious problems as follows:
   - Never = 0
   - 1–2 times/week = 1.5
   - 3–4 times/week = 3.5
   - Every day = 5
   - Several times every day = 10
4. by multiplying the above frequency score (0, 1.5, 3.5, 5, 10) by the discomfort score (1, 2, 3) by the interference score (1, 2, 3).

In computational analyses, missing values can be represented as 0. If the missing value is for the frequency score, it should be treated as zero when multiplying, making all combinations of Frequency, Discomfort and Interference equal to 0. However, if the missing value is in the Discomfort or Interference score, it should be treated as missing, ensuring that the multiplied score is at least equal to the Frequency score.

STATISTICAL ANALYSIS

Statistical analysis was done by using the Karl Pearson correlation coefficient (r-value) to predict the score on school bag weight with musculoskeletal discomfort. P value <0.002 was taken as the level of statistical significance.

Table 1 and Figure 1 indicates:

- At the age of 12 years, the frequency is 90 with 18.0 percent.
- At the age of 13 years, the frequency is 130 with 26.0 percent.
- At the age of 14 years, the frequency is 105 with 21.0 percent.
- At the age of 15 years, the frequency is 90 with 18.0 percent.
- At the age of 16 years, the frequency is 85 with 17.0 percent.

Table 1. Age distribution.

Age	In (years)	Frequency	Percent	Valid Percent	Cumulative Percent
	12.00	90	18.0	18.0	18.0
	13.00	130	26.0	26.0	44.0
Valid	14.00	105	21.0	21.0	65.0
	15.00	90	18.0	18.0	83.0
	16.00	85	17.0	17.0	100.0
	Total	500	100.0	100.0	

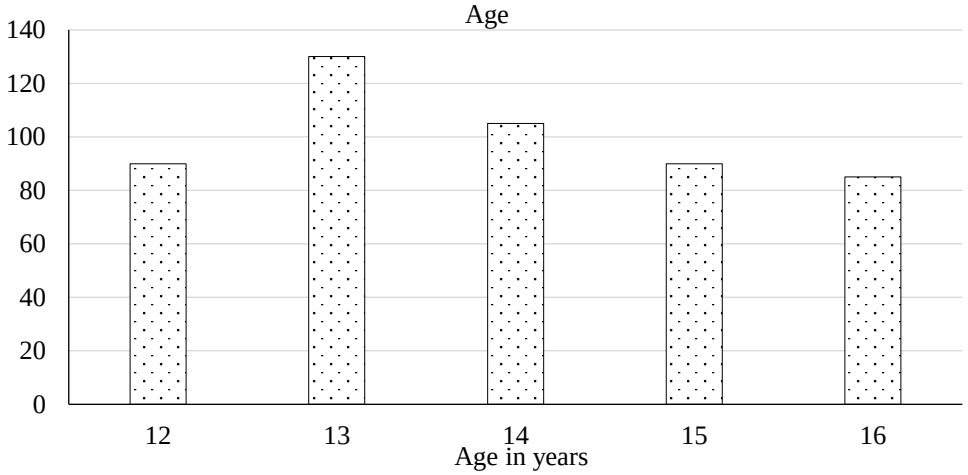

Figure 1. Figure of age distribution.

Table 2. Gender distribution.

	Frequency	Percent	Valid Percent	Cumulative Percent
Female	280	56.0	56.0	56.0
Male	220	44.0	44.0	100.0
Total	500	100.0	100.0	

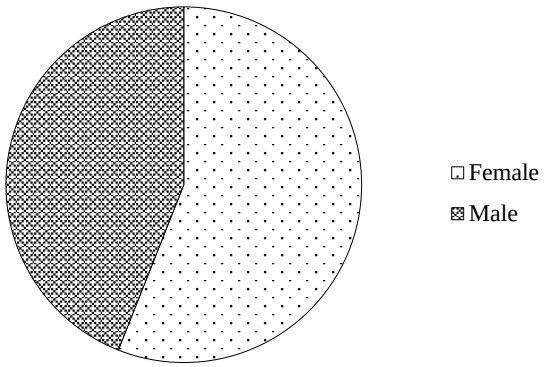

Figure 2. Figure of gender distribution.

Table 2 and Figure 2: female frequency is 280 with 56 percent and male frequency is 220 with 44 percent. So, the total frequency is of 500 with 100 percent.

Table 3. Comparison between CMDQ and Subjective Parameter.

	N	Minimum	Maximum	Mean	Standard Deviation
SBWT	500	4.50	7.10	5.6330	.60128
ST HEIGHT	500	1.40	1.79	1.5807	.09281
ST WEIGHT	500	30.00	66.00	46.0500	7.31399
ST BMI	500	14.10	22.80	18.3630	2.06282
CMDQ	500	1.50	20.00	8.9500	5.09995

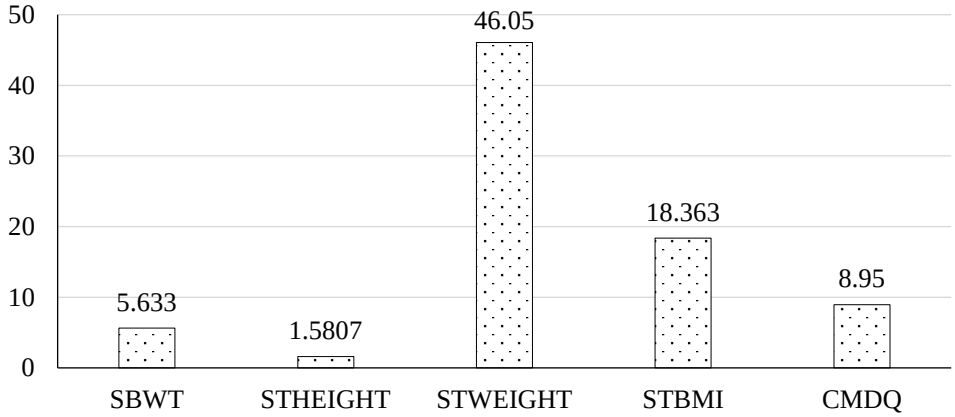

Figure 3. Figure of comparison between CMDQ and subjective parameter.

Table 3 and Figure 3 indicates:

- With the school bag weight of 500 subjects, the minimum weight is of 4.50 kgs and the maximum is 7.10 kgs with a mean of 5.6330 + .060128.
- With the student height of 500 subjects, the minimum height is of 1.40 meters and the maximum is 1.79 meters with a mean of 1.5807 + .09281.
- With the student weight of 500 subjects, the minimum weight is 30 kgs and the maximum is 66 kgs with a mean of 46.0500 + 7.31399.

- With the student BMI of 500 subjects, the minimum BMI is 14.10 and the maximum is 22.80 with a mean of 18.3630 + 2.06282.
- With the CMDQ score of 500 subjects, the minimum score is 1.50 and the maximum is 20.00 with a mean of 8.9500 + 5.09995.

Table 4. Comparison between SBWT with STBMI and CMDQ.

	STBMI	**CMDQ**
Pearson Correlation (r) SBWT p-value N	-.135** .002sig 500	.256** .000sig 500

Table 4 & 5 and Figure 4 & 5 indicates the negative Pearson correlation between SBWT and STBMI of -1.35 and positive person correlation between SBWT and CMDQ of .256.

- The p-value between SBWT and STBMI is .002 which states a significant correlation.
- The p-value between SBWT and CMDQ is .000 which states a significant correlation.

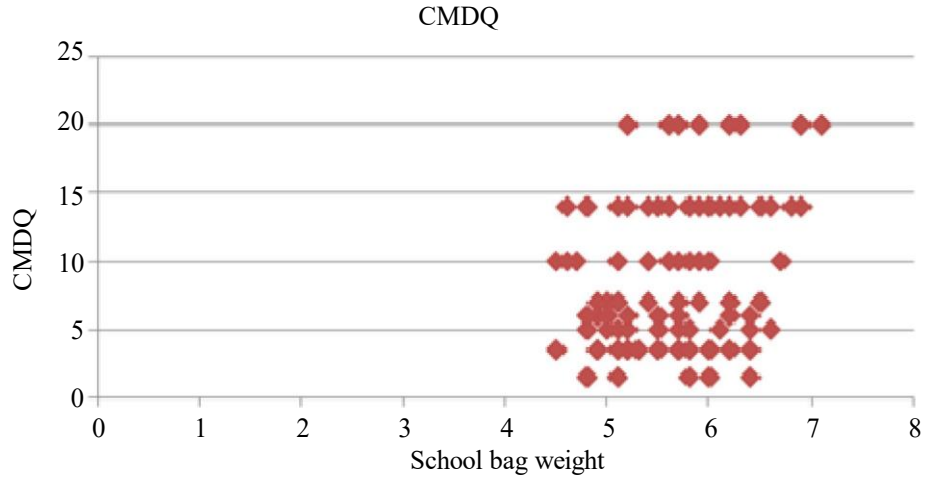

Figure 4. Comparison between SBWT with STBMI.

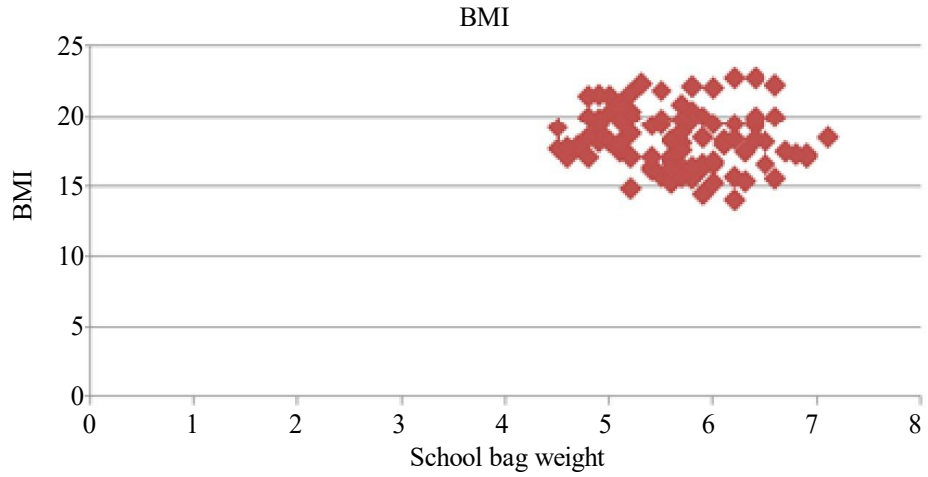

Figure 5. Comparison between SBWT with CMDQ.

Table 5. Comparison between Age and Subjective Parameter.

Age	SBWT	STHEIGHT	STWEIGHT	STBMI	CMDQ
Mean	5.5056	1.5750	45.6667	18.3389	9.2222
12.00 N	90	90	90	90	90
Standard Deviation	.56237	.07791	6.15347	1.80142	4.70841
Mean	5.6846	1.5688	46.5769	18.8808	8.3462
13.00 N	130	130	130	130	130
Standard Deviation	.59695	.10125	7.50283	2.32146	4.98985
Mean	5.7810	1.6129	46.9524	17.9810	8.4524
14.00 N	105	105	105	105	105
Standard Deviation	.59211	.09401	8.50043	2.05656	5.39298
Mean	5.3444	1.5444	43.0556	17.9889	9.7500
15.00 N	90	90	90	90	90
Standard Deviation	.53864	.05671	5.15460	1.72323	4.88419
Mean	5.8118	1.6035	47.7059	18.4647	9.3529
16.00 N	85	85	85	85	85
Standard Deviation	.59450	.10567	7.72107	2.10299	5.44935
Mean	5.6330	1.5807	46.0500	18.3630	8.9500
Total N	500	500	500	500	500
Standard Deviation	.60128	.09281	7.31399	2.06282	5.09995

The negative correlation states that as the SBWT increases the STBMI decreases. And the positive correlation states that as the SBWT increases the CMDQ also increases.

DISCUSSION

The present prevalence study was done to find the relation between schoolbag weight and musculoskeletal discomfort in school-going children of 12-16 years of the effect of bag packs. The study involved children from multiple schools located in and around Mangalore. A total of 500 children between the ages of 12 and 16 were chosen to participate in the research.

The result was analyzed using the Karl Pearson correlation coefficient test. The result showed the prevalence of musculoskeletal discomfort was common in school children. It also seen that male and female children had almost similar prevalence of the discomfort. This showed gender did not have much of impact on the discomfort.

In current study, girls (28%) and boys (29.7%) had approximately same risk for the development of musculoskeletal discomfort. While this correlation was found to be only borderline, it is improbable that this association is limited, given the narrow confidence interval and the substantial evidence in the majority, though not all, of previous studies.

Limitation of the Study

1. No rural children were involved.
2. The study's cross-sectional design prevented an assessment of the cause-and-effect relationship.
3. No objective method to measure pain has evolved.

Further Recommendation

1. To investigate the effect of carrying and manipulating on musculoskeletal children.
2. A study can be done by using pain measurement by VAS scale.
3. A study can be done by using other questionnaires, that is, McGill pain questionnaire.
4. A study can be done between rural students and urban students.
5. A study can be done between higher secondary and college students.

6. A need for further research in this area to investigate the effect of carrying and manipulating on children's musculoskeletal system.

CONCLUSION

The results of this study suggest that greater attention should be given to students aged 12-16 regarding musculoskeletal disorders, and they should receive comprehensive training on preventive measures. It is particularly crucial to explore the relationship between school bag weight and musculoskeletal discomfort in school-going children.

The results of this current study offer supplementary insights into the utilization of school bags and musculoskeletal symptoms among elementary school children.

The study's conclusion highlights a significant prevalence of musculoskeletal complaints among schoolchildren, indicating a pressing need for preventive measures and proper guidelines regarding safe load carriage for this age group.

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