

Relationship Between School Bag Weight And Musculoskeletal Effects In School-Going Children

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ABSTRACT :

Background: Excessive school bag weight among children is a growing public health concern, particularly due to its potential impact on musculoskeletal health. Despite established guidelines recommending that school bags should not exceed 10% of body weight, many children continue to carry heavier loads. This study aimed to assess the prevalence of heavy school bags, their association with musculoskeletal pain (MSP), and the influence of teacher knowledge, attitude, and practices (KAP).

Materials & Methods: A cross-sectional study was conducted among 260 primary school children. School bag weight was measured and categorized relative to body weight. Data on MSP, demographic characteristics, and ergonomic features were collected using structured tools. Teacher KAP regarding school bag safety was assessed using a validated questionnaire. Statistical analysis included chi-square test, Fisher's exact test, and correlation analysis.

Results: Of the participants, 20.4% carried school bags exceeding 10% of their body weight. MSP was reported by 18.8% of students, with shoulder pain being the most common complaint. Students carrying heavier bags had a higher prevalence of MSP (28.3%) compared to those with lighter bags (16.4%); however, the association was not statistically significant (OR = 2.01; p = 0.075). Girls showed higher prevalence of both heavy bag carriage and MSP. Ergonomic features were inadequately used. Most teachers were aware of health consequences, but only one-third knew the recommended weight limit. A significant negative correlation was found between teacher awareness and MSP prevalence.

Conclusions: Heavy school bags and MSP are prevalent among children. Enhancing teacher awareness and promoting ergonomic practices may help reduce musculoskeletal problems.

Keywords: Backpack load; Body weight ratio; Ergonomics; KAP (Knowledge, Attitude, Practice); Musculoskeletal pain; School children; Teacher knowledge.

INTRODUCTION

In India, school-aged children often transport backpacks that are above prescribed weight limits, prompting increasing concerns over their effects on musculoskeletal health and overall well-being (1,2). The 10% guideline has become a generally accepted international standard for schoolbag weight. International organizations, including the American Occupational Therapy Association (AOTA), the American Physical Therapy Association (APTA), and the American Chiropractic Association (ACA), advise that a schoolbag should not surpass 10% of a child's body weight, with recommendations varying from 5% to 15% depending on age and capability. The Government of India's National Policy on School Bags (2020) stipulates that children in Grades I–X should carry no more than 10% of their body weight, with specific criteria indicating no bags for pre-primary and around 4.5 kg for later grades (3). Numerous studies indicate that schoolchildren in India often transport bags above the advised limit of 10% of their body weight (2,4,5). These excessive loads have been associated with a range of musculoskeletal complaints, including back discomfort, shoulder strain, neck stiffness, postural deviations, and weariness, especially in younger children whose musculoskeletal systems are still maturing (1,5). Evidence suggests that the extended carrying of heavy bags may lead to altered posture, biomechanical strain, and diminished respiratory efficiency (6). These symptoms are linked not only to the weight of the schoolbag but also to carrying methods, absence of lockers, inadequate ergonomic design of bags, and duration of carriage. Moreover, felt heaviness, surpassing actual weight, has been associated with heightened pain reports, underscoring possible psychosocial factors affecting symptom reporting (7).

There is an absence of consistent enforcement of school bag policies that could alleviate weight burdens (8). Suggested measures encompass rigorous compliance with schedule-based packing, educational initiatives about safe load thresholds, availability of lockers, and investigation of digital and curriculum-reducing options (9). Moreover, the educational attainment of parents significantly affects their awareness and advocacy, as parents with lower levels of education are less inclined to participate with schools or challenge established norms (10). There is an urgent necessity for joint initiatives among parents, educational institutions, healthcare practitioners, and legislators to tackle the issue and advocate for safer schoolbag usage.

To bridge the apparent disparity between established recommendations and actual conditions, it is essential to investigate the impact of schoolbag weight on children in standard educational settings. Although policy frameworks are established, their execution is inconsistent, and issues such as bag carriage time, ergonomic practices, school infrastructure, and adult supervision are inadequately examined. Educators and guardians, sometimes the principal decision-makers in a child's educational routine, may possess insufficient knowledge or training to successfully manage dangers. In the absence of prompt therapies, children may experience early musculoskeletal discomfort that could evolve into chronic health issues. This study assessed these issues holistically by evaluating both the physical burden of schoolbags and the awareness levels among educators, with the goal of informing sustainable, school-level preventive strategies.

Materials and Methods

Study Design

This study is designed as a cross-sectional observational study conducted in selected schools to assess the relationship between school bag weight and musculoskeletal complaints among school-going children aged 6 to 14 years. As an integrated component of the same observational design, a structured KAP survey was administered to primary school teachers to evaluate their awareness, perceptions, and practices related to school bag weight and its implications on child health.

Study Setting

The study was conducted in selected government and private schools within the designated geographic region.

Study Population

- **Students:** Children aged 6–14 years who regularly carry school bags to school.
- **Teachers:** Primary school teachers (Grades I–V) teaching in the selected schools.

Sample Size

The sample size for the student component of this cross-sectional observational study has been calculated based on the primary objective of estimating the prevalence of musculoskeletal complaints among school-going children in relation to school bag weight.

A study conducted by Sankaran et al. at the All-India Institute of Medical Sciences (AIIMS), Bhubaneswar, reported a prevalence of musculoskeletal pain of 18.8% among school children aged 10–16 years due to heavy school bags (1). Given the similarity in context and population, this prevalence estimate has been adopted for the current study.

Sample Size Formula:

$$n = \frac{Z^2 \cdot p \cdot (1 - p)}{d^2}$$

Where:

- n = required sample size
- Z = 1.96 (for 95% confidence level)
- p = estimated prevalence (18.8% or 0.188)
- d = absolute precision (5% or 0.05)

$$n = \frac{(1.96)^2 \cdot 0.188 \cdot (1 - 0.188)}{(0.05)^2} = \frac{3.8416 \cdot 0.188 \cdot 0.812}{0.0025} \approx 235.08$$

Adjustment for Non-Response or Incomplete Data (10%):

$$n_{adjusted} = \frac{235.08}{0.9} \approx 261$$

Final Sample Size:

A total of 260 students were recruited for the study.

This sample size is considered adequate to estimate the prevalence of musculoskeletal complaints with a 95% confidence level and 5% precision, while accounting for potential non-response.

For the KAP survey, total population sampling was used. All eligible primary school teachers (Grades I–V) from the selected schools were invited to participate.

Sampling Technique

Stratified random sampling was employed (e.g., by grade or school type) and the total sample was proportionately allocated across the strata. Since the study's primary aim is to estimate overall prevalence rather than to conduct subgroup comparisons, no further inflation of the sample size is required for stratification.

Inclusion Criteria

Students:

- Children aged 6–14 years.
- Regularly carrying school bags.
- Parental informed consent and child assent obtained.

Teachers:

- Currently teaching in Grades I to V in the selected schools.
- Provided written informed consent for participation.

Exclusion Criteria

Students:

- Presence of pre-existing musculoskeletal or orthopaedic disorders.
- History of recent injury affecting posture or mobility.

Teachers:

- Non-teaching staff or administrative personnel.
- Decline or fail to provide informed consent.

Ethical Considerations

Ethical clearance was obtained from the Institutional Ethics Committee of xxxxxxxxxxxxxxxx. Permission was secured from the respective school authorities to conduct the study. Written informed consent was obtained from parents/guardians and teachers, along with assent from participating children. Participation was voluntary, and participants were informed of their right to withdraw at any time without consequences. Confidentiality was maintained by anonymizing data using unique identifiers, and no personal information was disclosed. Data were stored securely and used solely for research purposes. Children identified with significant musculoskeletal symptoms or postural abnormalities were referred for further evaluation and management.

Data Collection Tools

For Students:

- Anthropometric tools: Calibrated digital weighing scales to measure body weight and school bag weight.
- Structured questionnaire: To document musculoskeletal symptoms, adapted from validated tools.
- Postural assessment checklist: For observational evaluation of posture.

For Teachers (as part of the same study):

A pre-validated Knowledge, Attitude, and Practice (KAP) questionnaire developed by Chettinad Academy of Research and Education, comprising:

- Knowledge: Understanding of recommended school bag weight limits, health consequences of heavy bags, and awareness of guidelines (e.g., CBSE/WHO).
- Attitude: Perception of school responsibility, parental involvement, and feasibility of interventions.

- Practice: Reported actions such as advising parents, monitoring bag weight, or encouraging bag-reducing strategies.

Data Collection Procedure

Upon obtaining ethical clearance and administrative permissions, data collection was conducted onsite at the selected schools. Weight measurements and clinical/postural assessments were carried out for students. The KAP questionnaire was self-administered by teachers under supervision. All data were anonymized and coded to maintain confidentiality.

Data Analysis

- Descriptive statistics were used to summarize demographic characteristics, body weight-to-bag weight ratios, prevalence of musculoskeletal complaints, and teacher KAP scores.
- Inferential statistics: Chi-square test and logistic regression were employed to determine associations between bag weight and musculoskeletal outcomes.
- KAP responses were scored and categorized (Good, Moderate, Poor) based on standardized scoring criteria.
- Comparative analyses were performed to explore potential associations between teacher KAP levels and student health outcomes within the same schools.

RESULTS

1. Proportion of Children Carrying Bags >10% Body Weight

Of the 260 students enrolled in the study, 53 (20.4%) were found to carry school bags weighing more than 10% of their body weight, exceeding the recommended safety threshold. The remaining 207 students (79.6%) carried bags within the acceptable limit ($\leq 10\%$ body weight).

Grade-wise distribution showed that the proportion carrying heavy bags was highest in 1st Standard (20.5%) and declined progressively with increasing grade. Among girls, 38 (26.6%) carried bags exceeding 10% of their body weight, compared to 15 (12.8%) among boys. Table 1 presents the distribution by grade, gender, and bag ergonomic features.

2. Types and Distribution of Musculoskeletal Symptoms

Of the 260 students, 49 (18.8%) reported at least one musculoskeletal symptom. The shoulder was the most commonly affected site ($n = 19$, 38.8%), followed by knee pain ($n = 10$, 20.4%), back pain ($n = 9$, 18.4%), other regions ($n = 6$, 12.2%), and neck pain ($n = 5$, 10.2%). Table 2 details the distribution of musculoskeletal pain (MSP) by site, bag weight category, and BMI group.

3. Association Between School Bag Weight and Musculoskeletal Symptoms (Primary Objective)

Students carrying bags weighing more than 10% of their body weight had a higher MSP prevalence (28.3%) compared to those carrying lighter bags (16.4%). However, this association did not reach statistical significance on Fisher's exact test (OR = 2.01, 95% CI: 1.00–4.05, $p = 0.075$). Given that the expected cell frequencies in this 2x2 table approached the lower threshold conventionally recommended for standard chi-square testing, Fisher's exact test was adopted a priori as the primary test of association; the uncorrected chi-square result is reported in Table 3 for comparison only and was not used for inferential conclusions. Table 3 presents the full test statistics.

4. Influence of Demographic Factors on Musculoskeletal Symptoms

MSP prevalence was higher among girls (21.0%) than boys (16.2%), higher in students carrying heavy bags (28.3% vs 16.4%), and showed a marginal declining trend with increasing grade level. However, only the bag weight category approached statistical significance ($p = 0.075$); sex and grade level did not show statistically significant associations ($p > 0.05$). Table 3 presents the detailed analysis, including the primary bag-weight test statistics.

5. Teacher Knowledge, Attitude, and Practices (KAP) Regarding Schoolbags

5a. Awareness of Health Consequences

A large majority of teachers recognised back pain (89.1%) and shoulder pain (81.3%) as consequences of excessive bag weight. Awareness of neck pain was moderate (69.5%), while awareness of spinal deformity as a consequence was considerably lower (37.1%). Table 4 (below) summarises teacher awareness, knowledge, and practice, together with their correlation with student MSP prevalence.

5b. Knowledge of Schoolbag Specifications and Safe Practices

Only 87 teachers (33.3%) were aware of the recommended bag weight limit of 10% of body weight. In contrast, awareness of correct strap use was higher — 231 (88.8%) knew that two shoulder straps should be used, and 179 (69.0%) knew that bags should be carried on both shoulders. Awareness of official rules and penalties was minimal, with only 18 (7.1%) of teachers informed (Table 4).

6. Correlation Between Teacher KAP and Student MSP Prevalence

Higher teacher awareness and correct practices showed a negative correlation with MSP prevalence across all KAP variables, suggesting that better teacher knowledge may be associated with fewer musculoskeletal symptoms in students. However, statistical significance was observed only for knowledge of the recommended bag weight limit ($r = -0.25$, $p < 0.05$). All other KAP variables showed negative but non-significant correlations (Table 4).

Discussion

The present study demonstrated that 20.4% of students carried school bags exceeding 10% of their body weight. This prevalence is lower than that reported in other international studies. For instance, Mwaka et al. reported that 30.8% of Ugandan pupils carried bags beyond recommended limits (11), while studies from Malta and Saudi Arabia showed much higher proportions, with over 70% and 72% of students respectively exceeding safe thresholds (12,13). The relatively lower prevalence in the present study may reflect better adherence to guidelines or differences in school systems, though the burden remains clinically relevant.

The grade-wise decline in heavy bag carriage observed in this study is consistent with findings from previous research, where younger children were shown to carry proportionately heavier loads compared to older students (11). This could be attributed to lack of awareness, poor supervision, or disproportionate curriculum requirements in lower grades. Furthermore, the higher prevalence of heavy bag carriage among girls (26.6%) compared to boys (12.8%) aligns with earlier studies that reported greater load carriage and higher susceptibility to musculoskeletal symptoms among female students (13,14).

In the present study, 18.8% of students reported musculoskeletal pain, which is comparable to the findings of Sankaran et al. (18.8%) in an Indian population (15). However, this prevalence is considerably lower than that reported in studies from Uganda (88.2%) and Saudi Arabia (42%) (11,13). Such variation may be due to differences in methodology, age groups, perception of pain, and environmental or ergonomic factors. The predominance of shoulder pain (38.8%) in this study is in agreement with previous literature, which consistently identifies the shoulder and upper back as the most affected regions due to backpack load (14).

Although a higher prevalence of MSP was observed among students carrying heavier bags (28.3% vs 16.4%), the association did not reach statistical significance. This finding is consistent with studies from Kuwait and India, which also reported no significant association between bag weight and musculoskeletal pain after adjusting for confounders (1,15). These findings suggest that factors beyond absolute bag weight, such as duration of carriage, posture, physical activity, and perceived heaviness, may play a more important role in the development of symptoms.

The study also highlighted inadequate use of ergonomic features such as hip belts and cushioned backs, which is similar to previous studies emphasizing poor ergonomic practices among schoolchildren. Additionally, teacher awareness was high regarding common symptoms like back and shoulder pain, but knowledge of recommended weight limits was low (33.3%). This gap mirrors findings in other studies where awareness of guidelines was limited despite recognition of health consequences. Importantly, the observed negative correlation between teacher KAP and MSP prevalence suggests a potential association between improved teacher awareness/practices and reduced musculoskeletal problems among students, though causal inference cannot be drawn from this cross-sectional design.

Overall, the findings of this study are in line with existing literature, reinforcing that while heavy school bags are a potential risk factor, musculoskeletal pain in children is multifactorial. Preventive strategies should therefore focus not only on limiting bag weight but also on improving ergonomic practices, enhancing awareness among teachers and parents, and implementing school-level interventions such as lockers and timetable optimization.

Conclusion

This cross-sectional study found that one in five school-going children carried bags exceeding 10% of their body weight, and nearly one in five reported musculoskeletal symptoms, most commonly shoulder pain. While the association between bag weight and musculoskeletal pain did not reach statistical significance, teacher knowledge of the recommended weight limit was significantly and negatively correlated with student symptom prevalence. Strengthening teacher awareness, alongside

improved ergonomic practices and school-level infrastructure such as lockers, represents a practical, low-cost strategy that merits further evaluation in interventional and longitudinal studies.

Acknowledgment

The authors thank the school management and teachers of the participating schools for their cooperation and support during the conduct of this study.

Financial Support and Sponsorship

Nil.

Conflicts of Interest

There are no conflicts of interest.

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Table 1: Distribution of school bag weight category by grade, gender, and bag ergonomic features

Category	>10% Body Weight	≤10% Body Weight	Total
By Grade			
1st Standard	16 (20.5%)	62 (79.5%)	78
2nd Standard	12 (20.0%)	48 (80.0%)	60
3rd Standard	10 (20.0%)	40 (80.0%)	50
4th Standard	8 (19.0%)	34 (81.0%)	42
5th Standard	7 (23.3%)	23 (76.7%)	30
By Gender			
Girls	38 (26.6%)	105 (73.4%)	143
Boys	15 (12.8%)	102 (87.2%)	117
By Ergonomic Feature (n with feature present)			
Broad strap	18 (34.0%)	24 (11.6%)	42
Hip belt	1 (1.9%)	4 (1.9%)	5
Cushion at back	0 (0.0%)	5 (2.4%)	5
Total	53 (20.4%)	207 (79.6%)	260

BW = Body Weight; the overall Total row (n=260) applies to the grade and gender groupings; ergonomic-feature counts are out of n=53 (>10% BW) and n=207 (≤10% BW) bags

Table 2: Distribution of musculoskeletal pain sites by bag weight category and BMI group (n=49)

Pain Site	Total (n)	>10% BW	≤10% BW	Normal BMI	Abnormal BMI*
Shoulder pain	19	5	14	12	7
Knee pain	10	2	8	7	3
Back pain	9	2	7	5	4
Neck pain	5	1	4	3	2
Others	6	1	5	5	1
Total	49	11	38	32	17

NB = Normal BMI; *Abnormal BMI includes underweight, overweight, and obese; BW = Body Weight

Table 3: Association of musculoskeletal pain with sex, bag weight, and grade level

Variable	Category	Total (n)	MSP (n)	MSP (%)	p-value
Sex	Girls	143	30	21.0%	>0.05 (NS)
	Boys	117	19	16.2%	
Bag Weight	≤10% Body Weight	207	34	16.4%	0.075 (NS)†
	>10% Body Weight	53	15	28.3%	
Grade Level	1st Standard	78	16	20.5%	>0.05 (NS)
	2nd Standard	60	12	20.0%	

3rd Standard	50	9	18.0%
4th Standard	42	7	16.7%
5th Standard	30	5	16.7%

NS = Not Significant; †Bag weight vs MSP: Fisher's exact test (two-tailed), OR = 2.01 (95% CI: 1.00–4.05); expected cell frequencies approached the threshold for standard chi-square testing, so Fisher's exact test was used as the primary test (uncorrected $\chi^2 = 3.892$, $p = 0.049$, shown for comparison only; Yates-corrected $\chi^2 = 3.154$, $p = 0.076$). Chi-square test used for sex and grade level

Table 4: Teacher knowledge, attitude, and practice (KAP) regarding schoolbags, and correlation with student MSP prevalence

Teacher KAP Variable	Teachers Aware, n (%)	Students with MSP, n (%)	Correlation (r)	p-value
Awareness of back pain due to heavy bags	232 (89.1%)	49 (18.8%)	−0.21	>0.05
Awareness of shoulder pain	212 (81.3%)	49 (18.8%)	−0.18	>0.05
Awareness of neck pain	181 (69.5%)	49 (18.8%)	−0.15	>0.05
Awareness of spinal deformity	96 (37.1%)	49 (18.8%)	−0.10	>0.05
Knowledge of correct bag weight (<10%)	87 (33.3%)	49 (18.8%)	−0.25	<0.05*
Knowledge of two shoulder straps	231 (88.8%)	49 (18.8%)	−0.20	>0.05
Practice of carrying bag on both shoulders	179 (69.0%)	49 (18.8%)	−0.22	>0.05
Awareness of official rules and penalties	18 (7.1%)	49 (18.8%)	N/A	N/A

*Statistically significant at $p < 0.05$; Negative r indicates that higher teacher awareness is associated with lower student MSP prevalence; N/A = correlation with MSP prevalence was not computed for this item