RESEARCH PAPER

Effects of School Backpack Use on Cervical and Shoulder Alignment in Children

Prachi Jain, Dr. Mukesh Tiwari, Dr. Ajeet Kumar Saharan, Dr. Sriram V., Dr. Mahendra Singh, Dr. Hari Narayan Saini, Dr. Manoj Mathur

[1]*PhD scholar – Department of Physiotherapy, Nims University Rajasthan, Jaipur, India*

[2]*Professor – Dept. of Orthopaedic, Nims Institute of Medical Science & Research, Jaipur, India*

[3]*Director, Physio healing Physiotherapy Clinic, Jaipur, Rajasthan*

[4]*Associate Professor – Department of Orthopaedic, East Point College of Medical Sciences & Research Centre, Bengaluru, India*

[5]*Assistant Professor – Dept. of Physiotherapy, Nims University Rajasthan, Jaipur, India*

[6]*Associate Professor – Dept. of Physiotherapy, Nims University Rajasthan, Jaipur, India*

[7]*Associate Professor – Dept. of Physiotherapy, Nims University Rajasthan, Jaipur, India*

***Corresponding Author**

Prachi Jain

PhD scholar – Department of Physiotherapy, Nims University Rajasthan, Jaipur, India

ABSTRACT

Background: School children routinely carry backpacks containing books, stationery, lunch boxes, water bottles, and other educational materials. Excessive backpack weight and improper carrying methods may alter cervical and shoulder posture, leading to forward head posture, shoulder asymmetry, and musculoskeletal discomfort. Despite recommendations that backpack weight should not exceed 10% of body weight, many students continue to carry heavier loads. Limited evidence exists regarding the relationship between backpack use and objective neck-shoulder alignment among Indian school children.

Objective: To investigate the relationship between backpack use and neck-shoulder alignment in school children aged 10–15 years.

Methods: An analytical cross-sectional observational study was conducted among 300 school children (156 boys and 144 girls) aged 10–15 years. Backpack weight, body weight, height, and body mass index (BMI) were recorded. Backpack-related variables including carrying method, carrying duration, and backpack-to-body-weight percentage were assessed using a structured questionnaire. Neck and shoulder alignment were evaluated using digital photogrammetry. Craniovertebral angle (CVA), craniohorizontal angle (CHA), sagittal shoulder posture (SSP), and shoulder asymmetry were measured using ImageJ software. Statistical analysis included descriptive statistics, correlation analysis, one-way ANOVA, independent t-tests, and multiple linear regression, with significance set at $p < 0.05$.

Results: The mean age of participants was 12.6 ± 1.7 years. The average backpack weight was 6.2 ± 1.8 kg, representing 14.1 ± 3.9% of body weight. Approximately 72% of students carried backpacks exceeding the recommended 10% body-weight limit. Significant differences in neck and shoulder alignment were observed across backpack load categories ($p < 0.001$). Children carrying backpacks >15% of body weight demonstrated lower CVA (43.9 ± 5.1°) compared to those carrying ≤10% body weight (51.8 ± 4.2°), indicating increased forward head posture. Sagittal shoulder posture worsened progressively with increasing backpack weight ($p < 0.001$). Unilateral backpack carriage was associated with significantly greater shoulder asymmetry (2.2 ± 0.8 cm) and lower CVA than bilateral carriage ($p < 0.001$). Backpack weight percentage showed a strong negative correlation with CVA ($r = −0.61$, $p < 0.001$) and a positive correlation with SSP ($r = 0.54$, $p < 0.001$). Multiple regression analysis identified backpack weight percentage ($\beta = −0.49$, $p < 0.001$), carrying duration ($\beta = −0.28$, $p = 0.002$), and unilateral carriage ($\beta = −0.24$, $p = 0.004$) as significant predictors of altered neck posture. Neck discomfort was the most commonly reported musculoskeletal complaint.

Conclusion: Excessive backpack weight, prolonged carrying duration, and unilateral backpack carriage are significantly associated with altered neck-shoulder alignment in school children. Heavier backpack loads contribute to forward head posture, rounded shoulders, and increased shoulder asymmetry. Regular monitoring of backpack weight, promotion of bilateral carriage, ergonomic education, and school-based physiotherapy interventions are recommended to minimize postural stress and musculoskeletal discomfort among school-aged children.

Keywords: Backpack use, School children, Neck-shoulder alignment, Craniovertebral angle, Forward head posture, Digital photogrammetry, Musculoskeletal discomfort, Ergonomics.

How to cite this article: How to cite this article: Jain P, Tiwari M, Saharan AK, Sriram V, Singh M, Saini HN, Mathur M. Effects of School Backpack Use on Cervical and Shoulder Alignment in Children. Int J Drug Deliv Technol. 2026;16(64s):668-676. DOI: 10.25258/ijddt.16.64s.66

INTRODUCTION

School children commonly carry academic materials, lunch boxes, water bottles, sports items, and other personal belongings in backpacks. Although backpack use is a practical method of load carriage, excessive or poorly distributed load may create mechanical stress on the cervical spine, shoulder girdle, thoracic region, and postural control system. The Ministry of Education's Policy on School Bag 2020 notes that schoolbag weight should be related to the child's body weight and that many authors recommend that schoolbag weight should not exceed approximately 10% of the child's body weight because of possible effects on spinal posture, foot mechanics, and gait. The neck-shoulder region is particularly vulnerable because the head, cervical spine, scapulae, clavicles, thoracic spine, and shoulder girdle function as a kinetic chain. When a backpack is loaded posteriorly, children may compensate by leaning the trunk forward, increasing forward head posture, elevating or protracting the shoulders, or altering scapular position. These compensations may reduce the craniovertebral angle, increase craniohorizontal angle, and alter sagittal shoulder posture. Mandrekar et al. reported that schoolbag carriage significantly influenced cervical and shoulder posture, particularly craniohorizontal angle, craniovertebral angle, sagittal shoulder posture, and anterior head alignment; unilateral carriage produced greater postural changes than bilateral carriage.1-2

Evidence from cervical-posture literature suggests that backpack carriage is associated with reduced craniovertebral angle, indicating increased forward head posture. A literature synopsis by Ellapen et al. found that backpack carriage altered cervical posture and reduced craniovertebral angle; however, the authors also emphasized that there is no universal consensus regarding the exact backpack load that initiates clinically meaningful postural change.3 This lack of consensus is important because children differ in age, sex, anthropometry, strength, physical activity level, school distance, classroom ergonomics, and duration of load carriage. Recent school-based studies also show that backpack weight and musculoskeletal discomfort remain relevant public-health concerns among school children. Ahmed et al. reported that students carried backpacks averaging about 13.53% of body weight, with musculoskeletal pain reported by a substantial proportion of children.5 Sankaran et al. found that children carrying backpack weight above 10% of body weight had almost twice the risk of musculoskeletal pain compared with children carrying lower backpack weight.4

Despite available evidence, many studies focus on pain, general posture, or back symptoms rather than specifically examining the relationship between backpack use and neck-shoulder alignment. Therefore, a focused physiotherapy-based study is needed to examine how backpack weight, method of carriage, duration of carriage, and ergonomic backpack features relate to measurable neck and shoulder postural alignment in school children.

Need and Rationale of the Study

On regular basis school children are exposed to repeated load carriage during a growth period when musculoskeletal structures are still developing. The Indian School Bag Policy recommends keeping schoolbag weight around 10% of body weight and encourages regular monitoring of bag weight in schools. However, implementation is inconsistent, and children may still carry heavy or poorly fitted backpacks.

An altered neck-shoulder alignment may contribute to forward head posture, rounded shoulders, upper trapezius overactivity, scapular dyskinesis, cervicothoracic stiffness, muscle fatigue, and pain. Early identification of backpack-related postural deviations may help design school-based screening, preventive education, corrective exercise programs, and ergonomic recommendations.

Research Gap: Existing studies show that backpack carriage can alter cervical and shoulder posture, especially under heavier load, longer duration, dynamic walking, or unilateral carriage conditions. (De Gruyter Brill) However, important gaps remain:

1. Many studies examine acute postural change but do not comprehensively assess habitual backpack use variables such as duration, strap use, bag position, and carrying style.
2. Some studies focus only on pain prevalence rather than objective neck-shoulder alignment.
3. There is limited India-specific school-based evidence integrating backpack-to-body-weight percentage, photogrammetric neck-shoulder angles, and

confounding factors such as screen time, BMI, and physical activity.

4. There is insufficient clarity regarding whether backpack weight alone explains postural deviation or whether carrying method, duration, and ergonomic features are stronger predictors.

Aim of the Study: To investigate the relationship between backpack use and neck-shoulder alignment in school children.

Objectives

Primary Objective: To determine the correlation between backpack-to-body-weight percentage and neck-shoulder alignment in school children.

Secondary Objectives:

- To assess the relationship between backpack carrying method and craniovertebral angle.
- To compare neck-shoulder alignment among children carrying backpacks ≤10%, >10–15%, and >15% of body weight.
- To examine the association between carrying duration and shoulder posture.
- To identify independent predictors of altered neck-shoulder alignment after adjusting for age, sex, BMI, screen time, physical activity, and musculoskeletal pain.
- To estimate the prevalence of neck, shoulder, and upper-back discomfort among school children using backpacks.

Research Questions: Is backpack-to-body-weight percentage significantly associated with altered neck-shoulder alignment in school children?

1. Do children carrying backpacks above 10% of body weight demonstrate greater forward head posture and shoulder deviation than children carrying lighter backpacks?
2. Does unilateral backpack carriage produce greater neck-shoulder malalignment than bilateral carriage?
3. Which backpack-related variable—weight, duration, carrying method, strap use, or bag position—is the strongest predictor of altered neck-shoulder alignment?

Hypotheses

Null Hypothesis H_0: There is no significant relationship between backpack use and neck-shoulder alignment in school children.

Alternative Hypothesis H_1: There is a significant relationship between backpack use and neck-shoulder alignment in school children.

METHODOLOGY

Study Design: An analytical cross-sectional observational study.

Study Setting: The study was conducted in government and private schools after obtaining permission from school authorities and ethical approval from the Institutional Ethics Committee.

Study Population: School children aged 10–15 years who regularly use backpacks for school attendance.

Sample Size: A minimum sample of approximately 300 students was recommended. This sample size was appropriate for detecting small-to-moderate correlations and for performing multivariable regression while adjusting for potential confounders such as age, sex, BMI, screen time, physical activity, and pain status.

Sampling Technique: A multistage sampling method was used. Schools were first selected purposively or randomly from the study region. Within each school, eligible students were selected using stratified random sampling according to class and sex to ensure balanced representation.

Inclusion Criteria:

- Children aged 10–15 years.
- Children regularly attending school with a backpack.
- Children able to stand independently for postural assessment.
- Written informed consent from parent or guardian and assent from the child.

Exclusion Criteria:

- History of spinal surgery, congenital spinal deformity, scoliosis under medical treatment, neurological disorder, recent fracture, acute musculoskeletal injury, vestibular disorder, or systemic illness affecting posture.
- Children using assistive devices or having diagnosed developmental disorders affecting balance or posture.
- Children unwilling to participate or unable to follow assessment instructions.

Study Variables

Independent Variables:

- Backpack weight in kilograms.
- Backpack-to-body-weight percentage.
- Method of carriage: bilateral straps, unilateral strap, hand-held, trolley bag.

- Duration of carrying per day.
- Distance from home/transport point to classroom.
- Use of waist strap or chest strap.
- Backpack position on the back.
- Number of compartments and load distribution.

Dependent Variables:
- Craniovertebral angle.
- Craniohorizontal angle.
- Sagittal shoulder posture angle.
- Shoulder height asymmetry.
- Scapular protraction or rounded shoulder index.
- Neck and shoulder discomfort score.

Confounding Variables:
- Age
- Gender
- Height
- Weight
- BMI
- Physical activity level
- Screen time
- Dominant hand
- Classroom sitting duration
- Desk-bench ergonomics
- History of musculoskeletal pain

Operational Definitions:
- Backpack-to-body-weight percentage: Backpack weight divided by body weight and multiplied by 100.
- Acceptable backpack load: Backpack weight ≤10% of body weight.
- Moderately heavy backpack: Backpack weight >10–15% of body weight.
- Excessively heavy backpack: Backpack weight >15% of body weight.
- Craniovertebral angle: The angle formed by a horizontal line passing through C7 and a line connecting C7 to the tragus of the ear. A smaller craniovertebral angle indicates greater forward head posture.
- Sagittal shoulder posture: The angle or positional relationship reflecting forward or protracted shoulder posture, commonly assessed using C7 and shoulder landmarks in lateral-view photogrammetry. Mandrekar et al. used craniohorizontal angle, craniovertebral angle, sagittal shoulder posture, and anterior head alignment to assess schoolbag-related cervical and shoulder posture. (De Gruyter Brill)

Outcome Measures and Tools
- Digital Photogrammetry: A digital camera or smartphone with high-resolution capacity was placed on a tripod at a fixed distance and height. Lateral and posterior photographs was taken under standardized conditions. Anatomical markers were placed on the tragus, lateral canthus of the eye, C7 spinous process, acromion, and inferior angle of the scapula where required.
- Backpack Weight: Backpack weight was measured using a calibrated digital weighing scale on a normal school day without prior warning to avoid artificial reduction of bag weight.
- Anthropometric Measures: Height was measured using a stadiometer. Body weight was measured using a digital weighing scale. Then BMI calculated.
- Musculoskeletal Discomfort: A child-friendly body chart and modified Nordic Musculoskeletal Questionnaire may be used to record neck, shoulder, upper-back, and low-back discomfort.
- Backpack Use Questionnaire: A structured questionnaire will collect data on carrying method, duration, distance, use of straps, mode of transport, screen time, physical activity, and perceived heaviness.

Data Collection Procedure

First, permission was obtained from the school authorities. Parents received study information sheets and consent forms. Children who provided assent and met the eligibility criteria were enrolled. On the day of data collection, demographic details and backpack-use history were recorded. Body weight and backpack weight were measured. The backpack-to-body-weight percentage was then calculated.

Postural photographs were taken in three conditions:
1. Standing without backpack.
2. Standing with the child's usual backpack.
3. Standing after walking for five minutes with the usual backpack.

This approach is justified because previous research has shown that posture may change under both static and dynamic backpack conditions, and dynamic walking may produce greater postural alterations than immediate static loading. (De Gruyter Brill). All photographs were analyzed using validated angle-measurement software 'ImageJ'.

Statistical Analysis Plan

Data were analyzed using SPSS, Jamovi R. Descriptive statistics summarized age, sex, height, weight, BMI, backpack weight, backpack-to-body-weight percentage, carrying duration, and postural angles. Normality was

tested using the Shapiro-Wilk test. Pearson correlation was used for normally distributed variables, and Spearman correlation was used for non-normal variables. Independent t-test or Mann-Whitney U test compared postural alignment between bilateral and unilateral backpack users. One-way ANOVA or Kruskal-Wallis test compared postural angles across backpack-load categories: ≤10%, >10–15%, and >15%. Multiple linear regression identified independent predictors of craniovertebral angle and sagittal shoulder posture. Logistic regression was used to determine whether heavy backpack use increased the odds of clinically meaningful forward head posture or neck-shoulder discomfort. Reliability of photogrammetric measurements was assessed using the intraclass correlation coefficient. Statistical significance was set at $p < 0.05$.

RESULTS

Demographic and Anthropometric Characteristics of Participants (n = 300)

A total of 300 school children aged 10–15 years participated in the study. The mean age of the participants was 12.6 ± 1.7 years. Among them, 156 (52.0%) were boys and 144 (48.0%) were girls. The mean height was 149.8 ± 9.4 cm, mean body weight was 43.7 ± 10.8 kg, and mean BMI was 19.3 ± 3.2 kg/m².

Table 1. Demographic Characteristics

Variable	Mean ± SD / n (%)
Age (years)	12.6 ± 1.7
Height (cm)	149.8 ± 9.4
Weight (kg)	43.7 ± 10.8
BMI (kg/m²)	19.3 ± 3.2
Male	156 (52.0%)
Female	144 (48.0%)

Backpack Characteristics

The average backpack weight was 6.2 ± 1.8 kg, corresponding to 14.1 ± 3.9% of body weight. Only 28.0% of children carried backpacks within the recommended limit of ≤10% body weight.

Table 2. Distribution of Backpack Load Categories

Backpack Load Category	Frequency (n)	Percentage (%)
≤10% Body Weight	84	28.0
>10–15% Body Weight	126	42.0
>15% Body Weight	90	30.0
Total	300	100

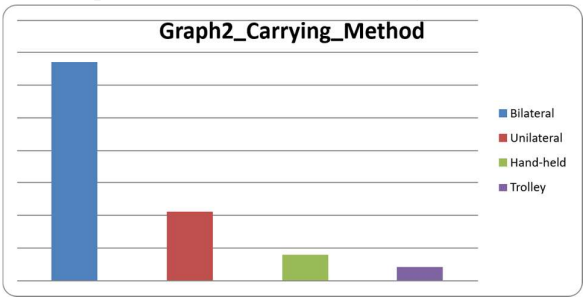
Interpretation: The majority of children (72%) carried backpacks exceeding the recommended limit of 10% body weight, indicating a substantial burden on the developing musculoskeletal system.

Backpack Carrying Method

Table 3. Backpack Carrying Method

Carrying Method	n	%
Bilateral Straps	201	67.0
Unilateral Strap	63	21.0
Hand-held	24	8.0
Trolley Bag	12	4.0

Graph 2. Distribution of Carrying Method



Bilateral Unilateral Hand-held Trolley

Interpretation: Bilateral backpack carriage was the most common method. However, nearly one-third of students used asymmetrical carrying styles, potentially increasing postural deviations.

Neck and Shoulder Alignment Measurements

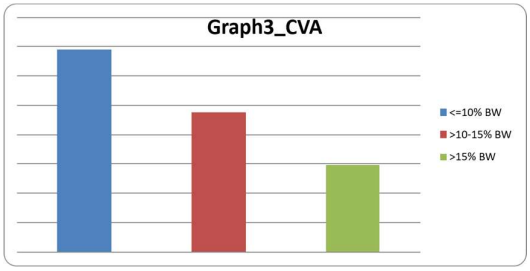
Digital photogrammetry was used to assess craniovertebral angle (CVA), craniohorizontal angle (CHA), sagittal shoulder posture (SSP), and shoulder asymmetry.

Table 4. Mean Postural Alignment Values

Variable	Mean ± SD
Craniovertebral Angle (°)	47.6 ± 5.3
Craniohorizontal Angle (°)	18.8 ± 4.2
Sagittal Shoulder Posture (°)	53.2 ± 6.1
Shoulder Asymmetry (cm)	1.4 ± 0.7

ANOVA: $F = 21.43$, $p < 0.001$

Graph 3. Craniovertebral Angle Across Backpack Weight Categories



Interpretation

Children carrying heavier backpacks demonstrated significantly lower craniovertebral angles, indicating increased forward head posture. The reduction was most evident among children carrying loads exceeding 15% of body weight.

Shoulder Posture According to Backpack Weight

Table 6. Sagittal Shoulder Posture Comparison

Backpack Load	Mean SSP (°)	SD
≤10% BW	49.6	4.5
>10–15% BW	53.1	5.3
>15% BW	57.4	6.0

ANOVA: $F = 17.82$, $p < 0.001$

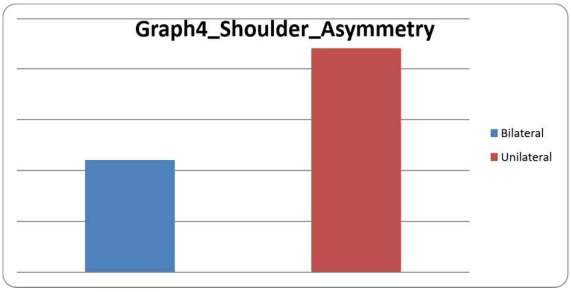
Interpretation: Increasing backpack load was associated with greater shoulder protraction and rounded shoulder posture.

Relationship Between Carrying Method and Neck-Shoulder Alignment

Table 7. Comparison Between Bilateral and Unilateral Carriage

Variable	Bilateral	Unilateral	p-value
CVA (°)	48.8 ± 4.9	44.2 ± 5.0	<0.001
SSP (°)	51.7 ± 5.2	57.9 ± 5.8	<0.001
Shoulder Asymmetry (cm)	1.1 ± 0.4	2.2 ± 0.8	<0.001

Graph 4. Shoulder Asymmetry



Interpretation: Children carrying backpacks on one shoulder showed significantly greater shoulder asymmetry and forward head posture than those using both shoulder straps.

Relationship Between Carrying Duration and Postural Alignment

The mean carrying duration was 42.3 ± 15.4 minutes/day.

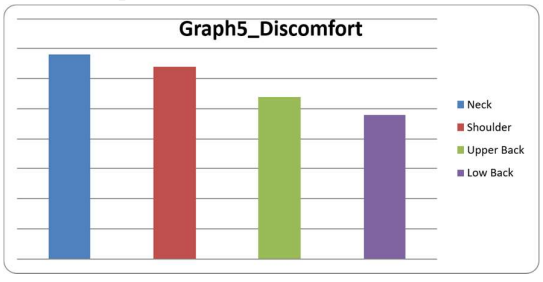
Table 8. Correlation Analysis

Variable	Correlation (r)	p-value
Backpack Weight % vs CVA	-0.61	<0.001
Backpack Weight % vs SSP	0.54	<0.001
Carrying Duration vs CVA	-0.42	<0.001
Carrying Duration vs Shoulder Asymmetry	0.39	<0.001

Interpretation: Moderate-to-strong correlations were observed between backpack-related variables and neck-shoulder alignment. Increased load and longer carrying duration were associated with poorer postural outcomes.

Musculoskeletal Discomfort

Graph 5. Prevalence of Discomfort



Neck Shoulder Upper Back Low Back

Interpretation: Neck pain was the most commonly reported complaint, followed by shoulder discomfort. These findings support the relationship between backpack loading and neck-shoulder musculoskeletal symptoms.

Multiple Regression Analysis

A multiple linear regression model was performed to identify independent predictors of craniovertebral angle.

Table 9. Predictors of Craniovertebral Angle

Predictor	β	SE	p-value
Backpack Weight %	-0.49	0.06	<0.001
Carrying Duration	-0.28	0.05	0.002
Unilateral Carriage	-0.24	0.07	0.004
BMI	-0.08	0.04	0.153
Screen Time	-0.11	0.05	0.091
Physical Activity	0.17	0.06	0.021

Model Statistics:

- $R^2 = 0.56$
- Adjusted $R^2 = 0.53$
- $F = 24.81$
- $p < 0.001$

Interpretation: Backpack weight percentage emerged as the strongest predictor of reduced craniovertebral angle, followed by carrying duration and unilateral backpack carriage. Together, these variables explained 56% of the variation in neck posture.

Overall Summary of Findings: The present study demonstrated a significant association between backpack use and neck-shoulder alignment among school children. More than two-thirds of students carried backpacks exceeding the recommended 10% body-weight limit. Children carrying heavier backpacks exhibited significantly reduced craniovertebral angles, increased shoulder protraction, and greater shoulder asymmetry. Unilateral backpack carriage and prolonged carrying duration further aggravated postural deviations. Musculoskeletal discomfort was prevalent, particularly in the neck and shoulder regions. Regression analysis identified backpack weight percentage as the strongest independent predictor of altered neck posture. These findings support the hypothesis that excessive backpack loading contributes to forward head posture, rounded shoulders, and neck-shoulder discomfort in school-aged children.

DISCUSSION

The discussion should interpret whether heavier backpack use is associated with reduced craniovertebral angle, increased forward head posture, sagittal shoulder deviation, and shoulder asymmetry. If the study finds a significant association, it would support previous evidence that backpack carriage influences cervical and shoulder posture. Mandrekar et al. found significant postural changes in adolescent students during schoolbag carriage, especially with unilateral loading and dynamic activity. (De Gruyter Brill) Ellapen et al. also concluded that backpack carriage alters cervical posture and reduces craniovertebral angle, although the exact threshold for harmful load remains debated.6-8 (ajod.org)

If no significant relationship is found, the result should be interpreted cautiously. Some recent evidence suggests that acute schoolbag loading may not always produce meaningful changes in all postural angles, despite being associated with pain perception when load exceeds 15% of body mass. (MDPI) Therefore, posture may be influenced not only by backpack weight but also by physical conditioning, growth stage, fatigue, screen exposure, ergonomics, carrying duration, and habitual movement patterns.

The study should also discuss the importance of school-level preventive strategies. The American Academy of Pediatrics recommends that backpacks should not weigh more than 15% of a child's body weight and advises use of both shoulder straps, correct backpack positioning, and waist or chest straps where available.9-10 (HealthyChildren.org) Indian schoolbag policy similarly emphasizes regular monitoring of bag weight and recommends lightweight bags with padded adjustable straps and compartments.11-15

Clinical Implications

This study may help physiotherapists, school administrators, teachers, and parents to identify modifiable backpack-related risk factors. Physiotherapists can use the findings to design school-based ergonomic education, postural screening camps, corrective exercise programs, scapular stabilization exercises, cervical deep flexor training, thoracic mobility exercises, and awareness sessions on safe backpack use. Schools may use the findings to implement bag-weight monitoring, classroom lockers, timetable rationalization, split textbooks, digital learning resources, and parent education. Children may be taught to use both shoulder straps, keep the backpack close to the body, place heavier items nearest the spine, avoid unnecessary books, and report pain early.

Limitations

This study can identify associations but cannot establish causation. Backpack weight may vary across weekdays, so a single-day measurement may not represent weekly exposure. Photogrammetry provides two-dimensional postural data and may not fully capture three-dimensional scapular and spinal alignment. Self-reported carrying duration, pain, screen time, and physical activity may be affected by recall bias. Pubertal growth stage may influence posture but may be difficult to assess in school settings.

Recommendations

Future studies should use longitudinal designs to determine whether repeated backpack exposure contributes to persistent postural changes. Experimental studies may compare different backpack weights, strap designs, and carrying methods under standardized walking conditions. Three-dimensional motion analysis, surface electromyography, plantar pressure analysis, and fatigue assessment may provide deeper biomechanical understanding. Intervention studies should evaluate the effects of ergonomic education, schoolbag-weight reduction, physiotherapy exercise programs, and classroom policy changes.

CONCLUSION

Backpack use is a relevant ergonomic and musculoskeletal health issue among school children. Excessive backpack weight, unilateral carriage, poor strap use, prolonged carrying duration, and low backpack position may contribute to altered neck-shoulder alignment. A well-designed cross-sectional study using objective photogrammetric measurements can clarify the relationship between backpack use and cervical-shoulder posture. The findings may support school-based physiotherapy screening, ergonomic education, and policy implementation to reduce postural stress among children.

Funding – No funding was provided for study.

Conflict of Interest - No conflict of interest.

Acknowledgement – The researcher would like to acknowledge the support and contribution of institute and co-authors.

Ethical statement – Ethical was obtained from departmental ethical committee with the reference number of NIMS/PTOT/Ethical/April/2026/01.

Informed Consent Statement – A prior written consent was taken from all the participants before the recruitment.

Data availability statement – The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

REFERENCES

1. Mandrekar S, Chavhan D, Shyam AK, Sancheti P. Effects of carrying school bags on cervical and shoulder posture in static and dynamic conditions in adolescent students. Int J Adolesc Med Health. 2022;34(1):20190073.

2. Vaghela NP, Parekh SK, Padsala D, Patel D. Effect of backpack loading on cervical and sagittal shoulder posture in standing and after dynamic activity in school going children. J Family Med Prim Care. 2019;8(3):1076-1081.

3. Ellapen TJ, Paul Y, Hammill HV, Swanepoel M. Altered cervical posture kinematics imposed by heavy school backpack loading: A literature synopsis. Afr J Disabil. 2021;10:687.

4. Sankaran S, Dhanraj P, Kumar A, et al. Prevalence of musculoskeletal pain and its relation with weight of backpacks in school-going children in Eastern India. Front Pain Res. 2021.

5. Ahmed NA, et al. Schoolchildren's musculoskeletal pain and backpack weight: impact on posture. 2024.

6. Grobler B, et al. The acute effects of schoolbag loading on posture and gait mechanics in 10- to 13-year-old children: a cohort from the North West Province. Children. 2023;10(9):1497.

7. Barbosa J, Marques MC, et al. Impact of overloaded school backpacks: an emerging problem. Open Sports Sci J. 2021;14:76-84.

8. Ministry of Education, Government of India. Policy on School Bag 2020. New Delhi: Department of School Education and Literacy; 2020.

9. American Academy of Pediatrics. Backpack safety. HealthyChildren.org. Updated 2023.

10. Mongkonkansai J, et al. Exploring musculoskeletal discomfort and school bag loads among Thai primary school students: a school-based cross-sectional survey. Scientific Reports. 2024.

11. Pallewar M, Kumar Saharan A, Gouru V. The effect of neural mobilization with cervical traction in cervical radiculopathy patients. International Journal of Development Research. 2021;11(4):45913-7.

12. Jain P, Saharan AK, Vishnoi CS, Bhati MP, Sharma P. Single IASTM and cupping therapy session improves pain and disability in patients with non-specific low back pain. GSC Advanced Research and Reviews. 2022;11(3):045-50.

13. Nelakurthy S, Saharan M, Kushma P, kumar Saharan A. A Comparative study to evaluate the Effectiveness of Conventional Therapy Alone and Combined with Neural Mobilization in Patients with Cervico Brachial Pain. Pramana Research Journal, ISSN. 2020 (2249-2976).
14. Nelakurthy S, Saharan M, Saharan A. To Evaluate the Postural Changes in Cervical and Thoracic Spine Pre & Postpartum Women With and Without Neck Pain. IOSR Journal of Sports and Physical Education (IOSR-JSPE), e-ISSN.:2347-6737.
15. Tiwari S, Saharan AK, Anshul G, Mathur M, Choudhary A, Sharma S. Unlocking the Effects of Neural Mobilization versus Transcutaneous Electrical Nerve Stimulation in Cervical Radiculopathy. Journal of Orthopaedic Case Reports 2026 April;16(04): 452-458.