Research Article

Relationship Between Backpack Carrying Habits and Musculoskeletal Pain in School-Aged Children

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Abstract

Background: Backpack carrying habits are recognized as an important factor influencing musculoskeletal health in school-aged children. Excessive backpack weight, prolonged carrying duration, improper carrying techniques, and poor backpack ergonomics may contribute to postural deviations, muscle lethargy, neck pain, shoulders pain, and back pain. As children undergo rapid musculoskeletal growth, these factors may adversely affect spinal health, physical function, and academic performance, highlighting the need to investigate backpack-related risks.

Objective: To identify risk factors for neck, shoulder and back pain associated with backpacks among school-aged children, to provide evidence to support preventive ergonomic interventions in schools.

Methods: A cross-sectional study was carried out among 100 children (65 boys and 35 girls) in the age group of 10–16 years by multistage stratified random sampling. Backpack characteristics, carrying habits, and musculoskeletal pain were assessed using standardized questionnaires and anthropometric measurements. Descriptive statistics and Chi-square test for independence were used for data analysis.

Results: The findings indicated a significant association between improper backpack carrying habits and musculoskeletal pain.

Conclusion: Promoting ergonomic backpack use may reduce musculoskeletal pain and improve spinal health among school-aged children.

Keywords: Backpack carrying habits, Musculoskeletal pain, School-aged children, Ergonomics, Neck pain, Back pain, Posture, Backpack weight.

Introduction

School-aged children are required to carry backpacks daily for transporting textbooks, notebooks, electronic devices, lunch boxes, and other educational materials. While backpacks provide a convenient and practical means of carrying school supplies, inappropriate carrying habits including excessive backpack weight, prolonged duration of carriage, use of a single shoulder strap, and poor ergonomic design have become increasingly recognized as potential contributors to musculoskeletal discomfort and postural alterations among children and adolescents. Musculoskeletal pain during childhood is no longer considered a transient condition, as accumulating evidence suggests that early onset of neck, shoulder, and back pain may persist into adulthood and adversely affect physical function, academic performance, and overall quality of life. Consequently, understanding the relationship between backpack carrying habits and musculoskeletal pain has become an important public health concern and an area of interest for clinicians, educators, and researchers alike. [1-3]

From an anatomical perspective, the vertebral column serves as the principal structural support of the human body and comprises 33 vertebrae from cervical to coccygeal regions. The cervical spine provides mobility and supports the head, whereas the thoracic and lumbar regions contribute to trunk stability and load transmission. Intervertebral discs, facet joints, spinal ligaments, and surrounding musculature including the trapezius, levator scapulae, rhomboids, erector spinae, latissimus dorsi, multifidus, and abdominal muscles work synergistically to maintain spinal alignment and facilitate movement. The shoulder complex, consist of the clavicle, scapula, acromioclavicular and sternoclavicular joints, provides the attachment site for backpack straps and plays a vital role in distributing external loads. In school-aged children, these musculoskeletal structures are still developing, making them more

susceptible to mechanical stress imposed by repetitive heavy backpack use. Growth-related changes in bone mineralization, muscle strength, and ligamentous flexibility may further increase vulnerability to postural adaptations and overuse injuries. [4–6]

Physiologically, the maintenance of an upright posture is achieved thru the continuous integration of the musculoskeletal and neuromuscular systems. Proprioceptive information from muscles, tendons, joints and the vestibular apparatus is fed to the central nervous system to control postural control thru coordinated muscle activation. When a backpack is loaded, the body's centre of gravity shifts posteriorly. To maintain equilibrium, compensatory responses such as forward head posture, anterior trunk inclination, increased cervical muscle activity, altered lumbar curvature, and changes in lower-limb alignment are initiated. These adaptive mechanisms increase the metabolic demand on postural muscles and may result in muscle fatigue, reduced endurance, localized ischemia, and mechanical strain on passive structures if maintained for prolonged periods. Repeated exposure to these physiological stresses may lead to the development of neck pain, shoulder pain, thoracic pain and low back pain in school children[7–9].

Biomechanically, backpack carriage represents an external load applied to the body's centre of mass, thereby influencing spinal loading patterns, joint reaction forces, and gait characteristics. The magnitude of biomechanical stress depends on several factors, including backpack weight relative to body weight, backpack position on the trunk, strap configuration, duration of carriage, walking speed, and individual anthropometric characteristics. Excessive backpack loads increase compressive and shear forces across the spinal column, particularly in the cervical and lumbar area, while also elevating muscle activation in the upper trapezius and paraspinal muscles. Carrying a backpack over one shoulder creates asymmetrical loading, resulting in lateral trunk deviation, shoulder elevation, altered pelvic alignment, and uneven weight distribution. These biomechanical compensations may reduce movement efficiency and increase the risk of cumulative musculoskeletal strain. International guidelines recommend that the weight of the backpack should not exceed 10-15% of body weight; however, many studies have reported that many school kids routinely carry loads in excess of these recommendations, especially in developing countries [2, 9-12].

Despite growing awareness regarding backpack-associated musculoskeletal disorders, inconsistencies remain regarding the relative contribution of carrying habits, backpack weight, duration of use, and ergonomic practices to pain development. Variations in educational systems, school infrastructure, anthropometric characteristics, and lifestyle factors necessitate further investigation within different populations. Therefore, examining the 'relationship between backpack carrying habits and musculoskeletal pain among school-aged children' is essential to generate evidence that can guide preventive strategies, ergonomic recommendations, school health policies, and physiotherapy interventions aimed at reducing the burden of musculoskeletal disorders during childhood.

Aim: 'To find the relationship between backpack habits and the prevalence of musculoskeletal pain in school children'.

Objectives

1. To assess backpack carrying habits, including backpack weight, carrying duration, method of carriage, and frequency of use.
2. To assess the generality and distribution of 'musculoskeletal pain' among school children.
3. To examine the 'association between backpack carrying habits and musculoskeletal pain'.
4. To identify ergonomic risk factors associated with backpack-related musculoskeletal discomfort.

Research Question

Is there a 'significant relationship between backpack habits and musculoskeletal pain in school children?

Null Hypothesis (H_o)

'No significant relationship between backpack carrying habits & musculoskeletal pain' among school children.

Alternative Hypothesis (H_1)

There is a 'Significant relationship between backpack carrying habits & musculoskeletal pain among schoolchildren, with improper carrying habits being associated with an increased prevalence of musculoskeletal pain'.

Need and Rationale of the Study

The research aims to determine the 'relationship between backpack carrying habits and musculoskeletal pain among school-aged children' to support evidence-based ergonomic interventions, promote spinal health, and prevent long-term musculoskeletal disorders.

Research Gap: Although numerous studies have examined backpack use and musculoskeletal pain, findings remain inconsistent regarding the influence of backpack carrying habits, weight, duration, and carrying method. Limited evidence exists in school-aged children from diverse populations, highlighting the need for population-specific research to establish evidence-based ergonomic recommendations and preventive strategies.

METHODS

Study-Design: "Cross-sectional observational study"
Study Setting: Selected 'government & private schools.
Study Population: School-aged children (10–16 years) who regularly carry backpacks.
Sample Size: 100 participants (determined using appropriate sample size calculation).
Sampling Technique: Multistage stratified random sampling.
Eligibility Criteria:

Inclusion Criteria: Students aged 10–16 years, carrying a backpack to school for at least 6 months, and provided parental consent with child assent.

Exclusion Criteria: Children with congenital spinal deformities, previous spinal surgery, recent musculoskeletal injury, neurological disorders, or diagnosed rheumatological conditions affecting posture or pain perception.

Study Variables
Independent Variables: Backpack weight, carrying duration, carrying method (single strap/double straps).
Dependent Variables: Musculoskeletal pain (neck, shoulder, and back pain).
Outcome Measures and Tools: 'Nordic Musculoskeletal Questionnaire' (NMQ), 'Numeric Pain Rating Scale' (NPRS).
Data Collection Procedure: Data will be collected from 100 school-aged children after obtaining informed consent. Anthropometric measurements, backpack characteristics, and pain-related information will be recorded using standardized questionnaires.
Statistical Analysis Plan: 'Data was analyzed using SPSS version 26.0'. 'Descriptive Statistics, Chi-square test, Independent t-test, Pearson's correlation, and multiple linear regression was performed. Statistical significance was set at $p < 0.05$'.

RESULTS

'Descriptive statistics were used to inform participant's demographic characteristics and backpack carrying habits. The association between backpack carrying habits (backpack weight, and carrying duration) and musculoskeletal pain was assessed using the Pearson correlation coefficient formula. 'The p-value < 0.05 was considered statistically significant'. The findings were displayed in table and graphic forms for facilitating the understanding of the relation between backpack carrying habits and musculoskeletal pain in school aged children.
All the participants (65 male & 35 female) were use to with double strap backpack as their choice and trend. The Backpack carrying duration was 10 minute minimum, 35 minute maximum and average duration was 20.67 minutes. The backpack weight was 6 kg minimum, 9 kg maximum and average weight carrying was 7.70 kg noted.
The Nordic Musculoskeletal Questionnaire (NMQ) reviled that study stated that, 90% students had complained about Neck pain, 74% students had complained about Back pain and only 45% students complained about shoulder pain. Students also stated that neck and back pain persist for longer duration which affect their academic, recreation and resting activity while shoulder pain is a very short duration pain with very low intensity.

Table: 1 'Mean and Standard Deviation'

	Age	Bodyweight	Height
Mean	12.58	36.47	4.74

N	100	100	100
Std. Deviation	1.44376	3.78582	0.215

Table 2: Correlation between Backpack Weight with Neck Pain&Back Pain

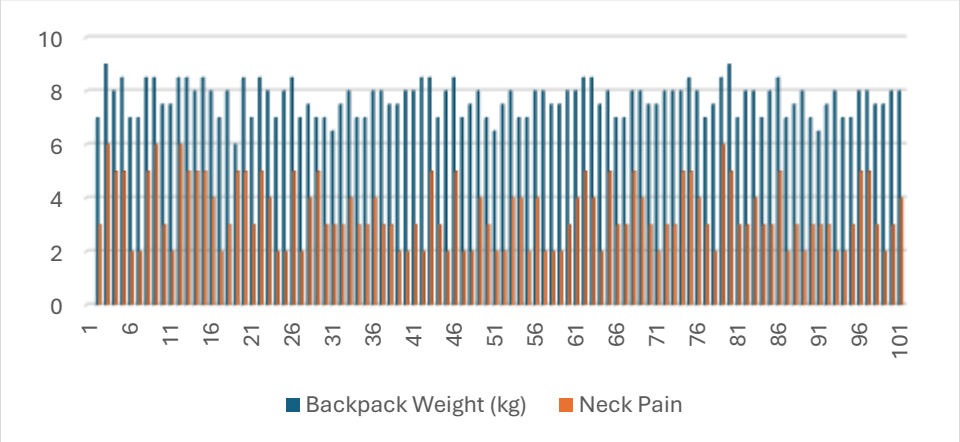
Parameter	Neck Pain	Back Pain
Pearson Correlation Coefficient (r)	0.5758	0.3698
Correlation Strength	Large	Medium
r^2	0.3316	0.1368
p-value	0.03	0.000
Covariance	0.4313	0.202
Sample Size (n)	100	100
Statistic	6.9722	3.9401

A 'Pearson correlation analysis was conducted to examine the relationship between backpack weight and physical pain (Table 2)'. There was a 'statistically significant, large positive correlation between backpack weight and neck pain, \(r(98) = .58, p = .03\). Backpack weight accounted for approximately 33.2% of the variance in neck pain (\(r^2 = .332\))'. Additionally, a 'statistically significant, medium positive correlation was found between backpack weight and back pain', \(r(98) = .37, p < .001\), accounting for 13.7% of the variance (\(r^2 = .137\)). These results indicate that 'heavier backpacks are associated with higher levels of both neck and back pain'.

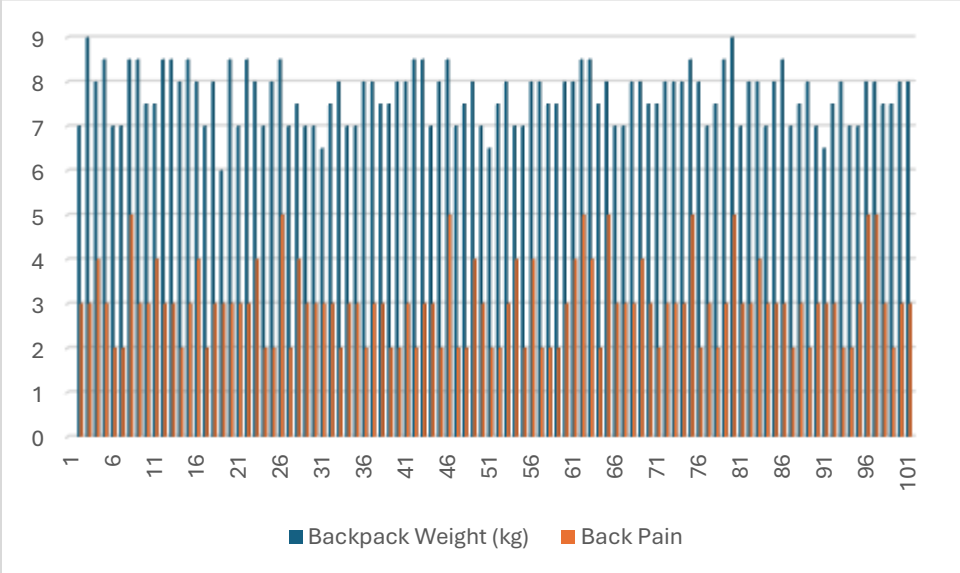
Table 3: Correlation between Carrying Duration with Neck Pain & Back Pain

Parameter	Neck Pain	Back Pain
Pearson Correlation Coefficient (r)	-0.058	0.044
Correlation Strength	Very Small	Very Small
r^2	0.003	0.001979
p-value	0.56	0.66
Covariance	-0.398	0.222
Sample Size (n)	100	100
Statistic	-0.577	0.4408

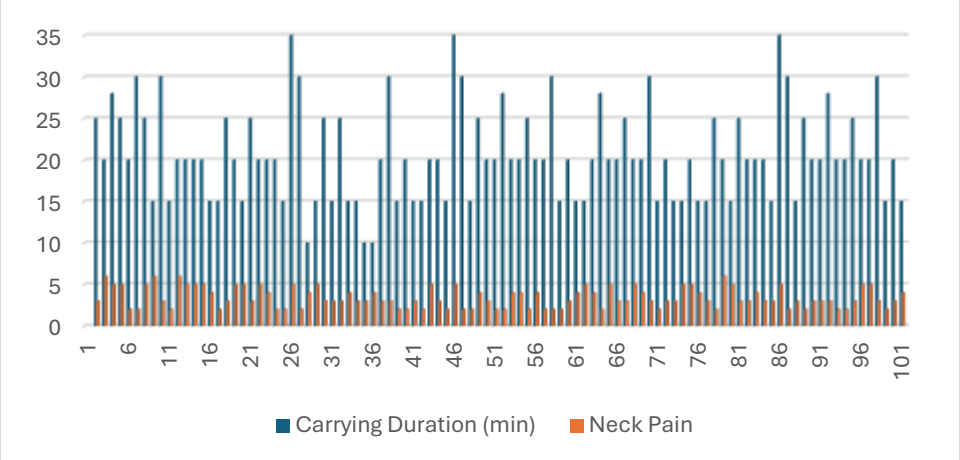
A 'Pearson correlation analysis was conducted to examine the relationship between carrying duration and two types of physical discomfort': neck pain and back pain. The results indicated a 'very weak, negative correlation between carrying duration and neck pain (r(98) = -.06, p = .56)', which was not statistically significant. Similarly, there was a very-weak, positive correlation between carrying duration and back pain (r(98) = .04, p = .66), which also failed to reach statistical significance. In both cases, carrying duration accounted for less than 1% of the variance ($r^2 < .01$) in pain scores. These findings suggest that carrying duration is not a meaningful predictor of neck or back pain in this sample (N =100)



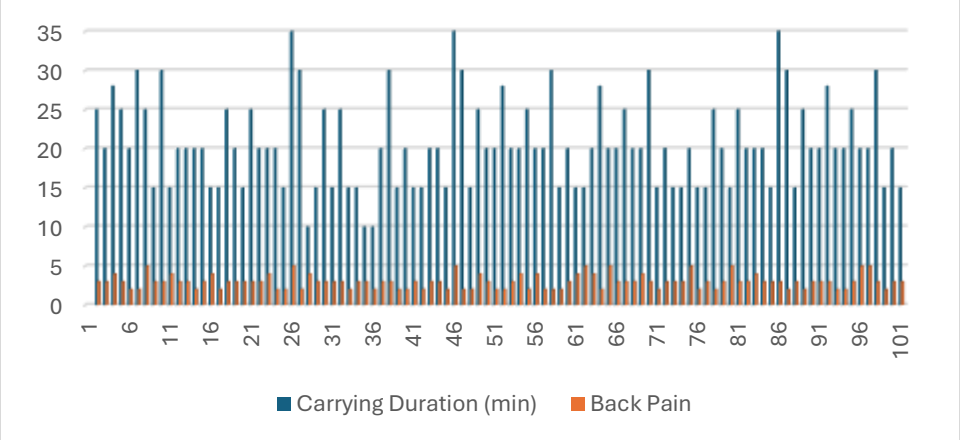
Graph 1: Graphical Presentation of Backpack weight & Neck Pain



Graph 2: Graphical Presentation of Backpack weight &Back Pain



Graph 3: Graphical Presentation of Carrying Duration& Neck Pain



Graph 4: Graphical Presentation of Carrying Duration &Back Pain

Discussion

This 'study demonstrated a significant association between backpack carrying habits and musculoskeletal pain' among school-aged children. Participants carrying heavier backpacks, using a single shoulder strap, or carrying backpacks for 'prolonged durations reported a higher spread of neck, shoulder, and back pain'. Above said 'results are consistent with previous studies', suggest that improper backpack use contributes to increased mechanical loading and postural stress on the developing musculoskeletal system. 'Therefore, the Null hypothesis (H_o) was rejected, while the alternative hypothesis (H_1) was accepted', indicating that inappropriate backpack carrying habits are significantly associated with musculoskeletal pain among school-aged children and warrant targeted ergonomic interventions and awareness programs.

Limitations

The 'cross-sectional design limits the ability to establish a causal relationship between backpack carrying habits and musculoskeletal pain'. Data on 'pain and backpack use were partly self-reported, which may have introduced recall and reporting bias'. The 'study was conducted among a limited sample of school-aged children from selected schools', which may affect the findings. Additionally, other factors influencing musculoskeletal pain, such as physical activity, screen time, and psychosocial factors, were not comprehensively evaluated.

Recommendations

Further, these studies should elaborate with longitudinal or prospective cohort designs to establish causal relationships between backpack carrying habits and musculoskeletal pain. Larger, multicenter studies involving diverse geographical regions are recommended to improve generalizability. Further research should investigate the effectiveness of ergonomic education, school-based intervention programs, and backpack weight reduction strategies in preventing musculoskeletal disorders. Additionally, incorporating objective assessments such as posture analysis, gait evaluation, and muscle activity using electromyography (EMG) may provide a more comprehensive understanding of backpack-related musculoskeletal health in children.

Conclusion

The 'present study highlights a significant relationship between backpack carrying habits and musculoskeletal pain' among school-aged children. Improper backpack use, including excessive weight and poor carrying methods, may increase the risk of pain in neck-shoulder-back. Promoting ergonomic backpack practices and school-based awareness programs can help prevent musculoskeletal disorders and improve children's overall spinal health and well-being.

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Informed Consent - A prior written consent was taken from all the participants.
Data availability statement – 'The datasets generated during and/or analyzed during the current study are available from the corresponding author'.

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