



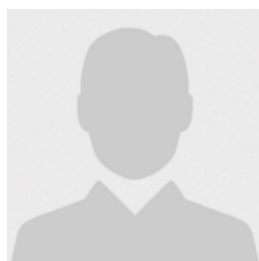
Prevalence, Risk Factors, and Postural-Ergonomic Exercise Intervention for Musculoskeletal Pain among School-Going Children



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ergonomic education;
Musculoskeletal pain
(MSP);
physical activity;
postural exercise;
smartphone usage;

Abstract

Background: Musculoskeletal pain (MSP) among school-going children is a significant concern globally, with varying prevalence rates and associated factors. This study aimed to determine the prevalence of musculoskeletal pain among school-going children, evaluate associated risk factors, and propose a school-based postural and ergonomic exercise education programme to address the identified risk factors. Methods: A cross-sectional study was conducted among 303 students aged 12–15 years from schools around Chidambaram. Data were collected using the modified Nordic musculoskeletal questionnaire (M-NMQ), numeric pain rating scale (NPRS), and youth physical activity questionnaire (Y-PAQ), along with demographic details and environmental factors. Statistical analysis was performed to identify significant associations. Results: This study revealed a high prevalence of musculoskeletal pain (90.09%) among participants, with significant correlations ($p < 0.001$). This study also suggests that increased backpack weight, screen time, and physical activity are associated with a higher risk of MSP. Conclusion: This study emphasises the need for education on proper backpack use, responsible screen time, and physical activity to mitigate the risk of pain among school-going children. A structured postural and ergonomic exercise education programme, incorporating backpack ergonomics, screen-time breaks, and corrective exercises, low-cost strategy to reduce this burden.

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1 Introduction

Musculoskeletal pain (MSP) among school-going children is a significant concern globally, with varying prevalence rates and associated factors. MSP is the most common problem that affects the muscles, tendons, ligaments, joints, and bones, resulting in severe limitations in mobility and maneuverability (Mongkonkansai et al., 2022). Children above 11 years of age have more MSP than those below, and several studies have reported pain in the spine, upper limbs, and lower limbs ranging from 7% to 74%. These symptoms, when neglected, become a major contributor to the development of musculoskeletal disorders in adulthood (Kanjilal et al., 2020).

The overall lifetime prevalence of musculoskeletal symptoms among school children in developed countries ranges from 16 to 86%, and in developing countries from 46.3 to 88%.³ A study conducted in Eastern India by Sankaran et al. (2021) shows that the prevalence of MSP and its relation to the weight of backpacks in school-going children in Eastern India was found to be 18.8% over the preceding year.

Basically, not moving enough and sitting around all day are big reasons for most of these issues, as kids often sit for long stretches without getting any physical activity (Kanjilal et al., 2020). It is also stated that 16 minutes after using a smartphone, upper neck and back pain signs were observed. Heavy backpack weight, particularly those weighing more than 10% of a child's body weight, was strongly associated with increased MSP (Delele et al., 2018). This was evident in India, where children carrying heavier backpacks reported nearly twice the risk of MSP compared to those with lighter loads. Research indicates that adolescents with obesity experience higher rates of localized musculoskeletal pain, particularly affecting the lower limbs and lumbar region (Wang et al., 2023). Most of the studies were done in urban areas. Chidambaram is a rural area with different ergonomic and environmental factors.

2 Materials and Methods

An observational cross-sectional study was conducted in the year 2024 after obtaining ethical clearance approval from the Institutional Human Ethics Committee of the Government Medical College and Hospital, Cuddalore District. The register number of the IEC is EC/NEW/INST/2020/1249, and its number is IHEC/1403/2024. A total of 303 students were selected from government schools in Chidambaram. The children were selected by convenience sampling, and after obtaining informed consent from parents and proper permission from the school principal, the study was carried out on school premises. Children included were aged between 12–14 years, volunteers, and of both genders. Children with acute illness, a history of recent injuries, a history of recent surgery, and physically challenged students were excluded (Beer et al., 2012).

Eligible students were asked to respond to basic demographic details such as their age, gender, and standard. Students' height, weight, and backpack weights were measured using a digital weighing machine and stadiometer. Their body mass index (BMI) was calculated using the formula weight in kg/height in m².

Ergonomic factors such as how they carry their backpacks, the location of the classroom, and mode of transportation from home to school were also asked and recorded ([Schmidt et al., 2021](#)).

Students were asked to fill in the Modified Nordic Musculoskeletal Pain (NMQ) questionnaire to identify the site of pain they had in the past one year or one week, in a YES or NO format. If the answer was YES, the Numeric Pain Rating Scale (NPRS) was used to determine the intensity of pain from '0' to '10'. The Youth Physical Activity Questionnaire (Y-PAQ) was administered to assess their level of physical activity, such as playing games and leisure-time activities including watching television, household chores, and smartphone usage during weekdays/weekends, expressed in hours/minutes. The data were collected and analyzed with appropriate statistical tools ([Denadai et al., 2021](#)).

3 Results and Discussions

3.1 Results

This study investigated the prevalence and risk factors of musculoskeletal pain (MSP) in school children. Descriptive analysis was done to evaluate the basic characteristics of the students, shown in Tables 1 and 2. Backpack weight, duration of time spent on television, smartphone usage, and physical activity were considered independent variables, and musculoskeletal pain severity reported in the last 12 months and 7 days on the MNMQ and NPRS were considered dependent variables. Pearson correlation analysis, shown in Table 3, was done to analyse the association between the above variables. SPSS-21 (Statistical Package for Social Sciences) software was used in this study.

Table 1
Basic demographic details of study participants

Variables	N (303)	Percentage (%)
Age (in years)		
12	42	13.86%
13	122	40.26%
14	139	45.87%
Sex		
Male	184	60.72%
Female	119	39.27%
	MEAN	SD
Height (cm)	138.28	13.31
Weight (kg)	38.2	8.75
BMI – children		
Underweight (<18.5)	122	40.26%
Normal weight (18.5–24.9)	135	44.55%
Overweight (25–29.9)	44	14.52%
Obese (>30)	2	0.66%
School grade		
VII	80	26.40%
VIII	122	40.26%
IX	101	33.33%

Table 1 shows the age distribution of the study population: 12 years (13.86%), 13 years (40.26%), and 14 years (45.87%). There were more males (60.72%) than females (39.27%) in this study. The mean height was

138.28 cm, and the mean weight was 38.2 kg, typical for the age group studied. The BMI distribution indicates that 40.26% of participants are underweight, 44.55% have a normal weight, 14.52% are overweight, and 0.66% are obese. Participants were fairly evenly distributed across three school grades: Grade VII (26.40%), Grade VIII (40.26%), and Grade IX (33.33%).

Table 2
Environmental factors of the study participants

Variables	N	Percentage
Mode of transport		
By walk	76	25.08%
By cycle	70	23.10%
By two-wheeler (with parent)	56	18.48%
By private van	30	9.90%
By public auto	23	7.59%
By bus	48	15.84%
Preference for carrying a backpack		
Double strap	263	86.79%
Single strap	40	13.20%
Location of classroom		
Ground floor	202	66.6%
First floor	101	33.3%

Table 2 shows the distribution of study participants based on environmental factors. The majority of students either walk (25.08%) or cycle (23.10%) to school, with a significant number using public transport or private vehicles. A significant majority (86.79%) prefer carrying their backpacks with double straps, while 13.20% use a single strap. Two-thirds (66.6%) of the classrooms are on the ground floor, while the rest (33.3%) are on the first floor.

Table 3
Correlation of pain with other study variables

Variables	Mean	SD	r-Value	P-Value
NPRS	3.47	2.16	-	-
Backpack weight (kg)	6.92	2.50	0.86	0.001
Watching television – weekdays (h)	6.97	2.60	0.83	0.001
Watching television – weekend (h)	7.83	2.79	0.84	0.001
Smartphone usage – weekdays (h)	8.05	3.14	0.83	0.001
Smartphone usage – weekend (h)	8.55	3.02	0.81	0.001
Physical activity – weekdays (h)	6.59	2.52	0.82	0.001
Physical activity – weekend (h)	7.92	2.52	0.80	0.001

**** Correlation is significant at the 0.01 level (2-tailed)**

Interpretation:

The p-value of 0.001 for all correlations indicates that these results are statistically significant, suggesting that these variables likely play a role in influencing pain levels.

Swathi, T., Krishna, V. V., Partheeban, S., & Saran, V. (2026). Prevalence, risk factors, and postural-ergonomic exercise intervention for musculoskeletal pain among school-going children. *International Journal of Health Sciences*, 10(3), 226–235. <https://doi.org/10.53730/ijhs.v10n3.16020>

3.2 Discussion

This study investigated MSP prevalence and risk factors among school children in Chidambaram, focusing on demographics, environment, and lifestyle. Findings linked backpack weight, excessive screen time, and low physical activity to pain severity. Most participants were aged 13–14, a developmental window sensitive to growth-related discomfort. Results also suggested that gender differences in body composition and modes of transport—especially affecting the lower extremities—significantly influence musculoskeletal health.

[Dockrell et al. \(2019\)](#) suggested that MSP prevalence increases with age and is more common among girls than boys, which may be attributed to differing growth rates and hormonal changes during adolescence. [Kanjilal et al. \(2020\)](#) also stated that the female gender and the 15–19-year age group had a higher risk of developing MSP, and that excessive use of smartphones, watching television beyond the recommended screen time, and level of physical activity significantly predict the occurrence of MSP among adolescents.

The relatively high percentage of underweight status may indicate nutritional deficiencies impacting musculoskeletal health, while overweight individuals face increased joint and muscle stress, though obese students were less represented in this study.

[Sankaran et al. \(2021\)](#) and other collective research highlight that prevalent musculoskeletal pain—linked to heavy backpacks, modern technology, and sedentary habits—is preventable through ergonomic interventions, weight management, and improved school environments.

Heavy backpacks relative to body weight likely contribute to musculoskeletal pain in the neck, shoulders, and upper back, with physical burden varying by grade level: 3 kg (9.24%), 6 kg (37.95%), and within 9–12 kg (15.84%). While classroom location—particularly navigating stairs—can increase daily strain, this study's findings suggest minimal impact from this factor, since most students were located on the ground floor.

According to the Modified Nordic Musculoskeletal Questionnaire, 85.14% of participants reported musculoskeletal pain—primarily in the shoulders (25.58%), upper back (15.89%), neck (15.50%), and wrists (10.85%)—aligning with findings by [Mwaka et al. \(2014\)](#), who observed similar pain patterns in 88.2% of Ugandan pupils, with the most common areas of pain being the shoulders (42.1%), upper back (35.7%), and neck (24.5%). While the Numeric Pain Rating Scale indicated that most discomfort was mild (47.52%) rather than severe (11.88%), this study identified a strong positive correlation between backpack weight and pain intensity, supporting research by [Gussogo \(2020\)](#) on the negative health impacts of heavy loads. With most students carrying backpacks weighing between 3 and 9 kg, these results underscore how ergonomic stressors—excessive weight, poor posture, and prolonged screen time—drive the prevalence of musculoskeletal issues in school-aged children. Most participants carried backpacks weighing between 3–6 kg (37.95%) and 6–9 kg (36.96%).

The study found significant correlations between increased screen time—including television and smartphone use—and musculoskeletal pain across both weekdays and weekends, as shown in Table 1. Research by [Wang et al. \(2023\)](#) and [Mongkonkansai et al. \(2022\)](#) supports this, suggesting that sedentary lifestyles and poor posture during prolonged device use increase strain on the neck and shoulders.

Interestingly, the study also found a positive correlation between physical activity and pain. This finding may initially seem counterintuitive, since physical activity is generally considered beneficial for musculoskeletal health. However, the type or intensity of physical activity performed by the students may be contributing to overuse injuries or strain. Additionally, the physical activity might involve repetitive or high-impact movements that increase the risk of musculoskeletal discomfort.

Postural and ergonomic exercise education

Given that backpack weight, screen time and posture-related habits were the strongest correlates of pain in this study, a structured postural and ergonomic exercise education programme is proposed as a practical extension of the findings. School-based exercise therapy has been shown to significantly reduce the frequency of musculoskeletal disorders in students who already have symptoms, and to prevent new symptoms from developing in those who do not, when delivered as short, supervised sessions several times a week.¹¹ Similarly, ergonomic education programmes that combine posture training with practical workstation and device-use advice have produced sustained improvements in seated posture and reductions in reported musculoskeletal pain among adolescent learners ([Sellschop et al., 2015](#)).

Backpack ergonomics

Consistent with the strong correlation observed between backpack weight and pain intensity in this study ($r = 0.86$, $p = 0.001$), children should be guided to keep backpack load at no more than 10–15% of their body weight, to always wear both straps evenly rather than slinging the bag over one shoulder, and to keep the pack positioned high and close to the back rather than sagging toward the lumbar region.^{13,14} Children should also be taught to bend at the knees and hips when lifting a loaded backpack from the ground, rather than bending from the waist, to reduce spinal loading (Ramadan & Al-Tayyar, 2020).

Screen-time postural breaks

Since smartphone and television use during both weekdays and weekends showed strong positive correlations with pain ($r = 0.81$ – 0.84 , $p = 0.001$), a simple '20-20-20' break pattern is recommended: every 20 minutes of screen use, the child looks at something roughly 20 feet away for 20 seconds, resets posture, and stands or stretches briefly. Screens should be positioned at eye level and at arm's length to avoid the forward head and rounded shoulder posture associated with frequent computer-related activity and adolescent neck-shoulder and low back pain (Hakala et al., 2006). Prolonged slouched or lying-down device use should be discouraged in favour of an upright, supported sitting posture.

Corrective and postural strengthening exercises

A brief, low-equipment daily exercise routine is suggested for classroom or home use, targeting the neck, shoulder girdle, thoracic spine and core musculature most commonly implicated in this study's pain findings (shoulder, upper back, neck and wrist). The proposed routine is summarised in Table 4 and illustrated in Figure 1.

Table 4
Suggested daily postural and ergonomic exercise routine for school-going children

Exercise	Target region	Dosage
Chin tuck	Deep neck flexors / cervical posture	10 repetitions, hold 3 sec
Shoulder blade squeeze	Mid-trapezius / rhomboids	10 repetitions, hold 5 sec
Doorway chest stretch	Pectoral muscles	1 stretch, hold 20–30 sec
Cat–camel spinal mobility	Thoracic and lumbar spine	10 repetitions
Core bridge	Lumbo-pelvic core stabilisers	3 repetitions, hold 20 sec

These exercises are consistent with the corrective exercise components used in school-based musculoskeletal disorder prevention trials and are intended to be performed once daily, ideally after prolonged sitting or screen use (Shourie et al., 2024).

Postural and Ergonomic Exercise Intervention Framework

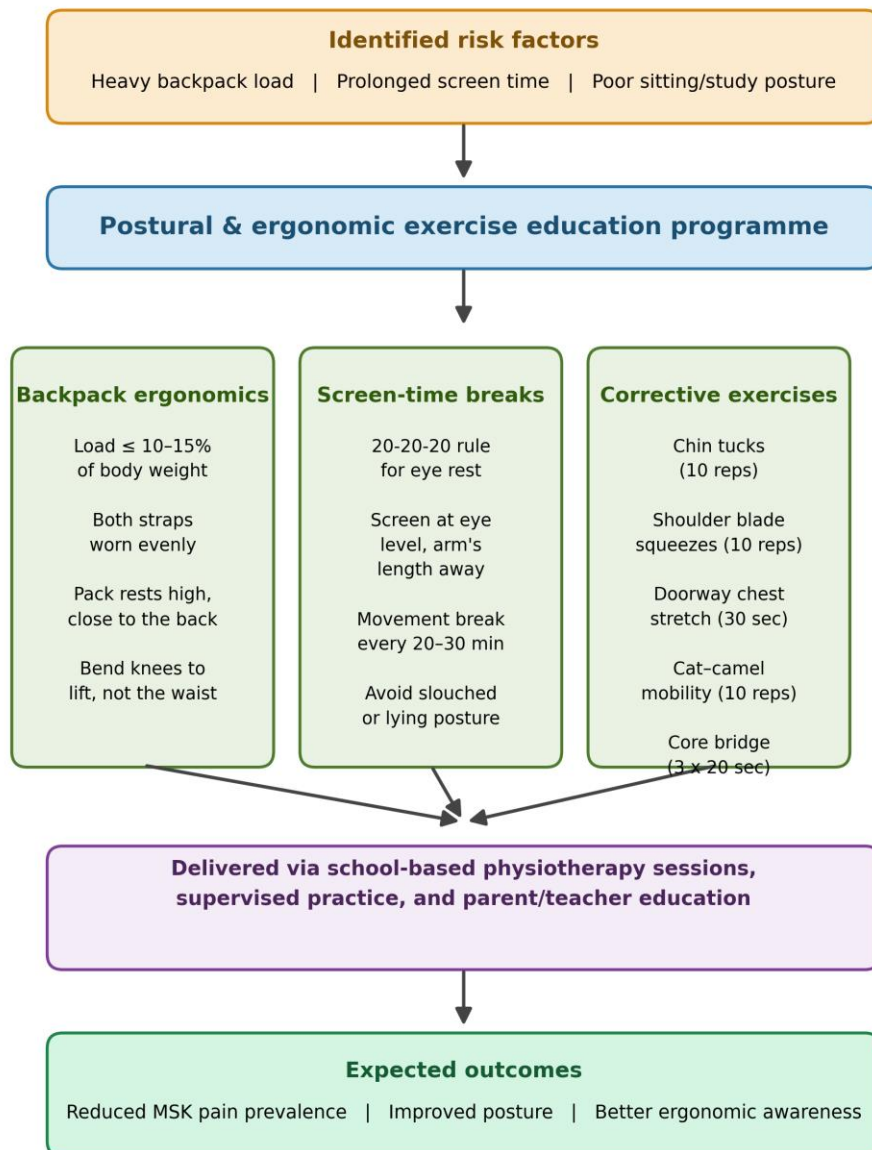


Figure 1. Proposed postural and ergonomic exercise intervention framework for school-going children, linking the risk factors identified in this study to a three-part education programme and expected outcomes.

Delivery and feasibility

Given that this study was conducted in a resource-limited rural setting, the programme is designed for low-cost delivery through school-based physiotherapy or physical-education sessions, supervised initial practice, and take-home education materials for parents and teachers, an approach that has previously improved sustained postural behaviour and reduced musculoskeletal pain in school-based ergonomic intervention trials in comparable developing-country settings.¹² Periodic reassessment using the same M-NMQ, NPRS and Y-PAQ tools used in this study would allow schools to monitor whether the programme reduces pain prevalence over time.

4 Conclusion

This study concluded that excessive use of smartphones, watching television more than the recommended time, and level of physical activity significantly predict the occurrence of musculoskeletal pain among school-going children. Also, carrying heavy backpacks causes pain in various regions of the body, especially the shoulder and upper back. While demographic factors and school logistics influence pain development, high rates of neck and wrist issues suggest a critical need for intervention, such as ergonomic education, promoting better posture, and reducing backpack weight. Balancing screen time, improving ergonomics, and reducing backpack weight are essential strategies to mitigate these physical health risks. Building on these findings, this study proposes a structured, low-cost postural and ergonomic exercise education programme—covering backpack ergonomics, screen-time breaks, and corrective exercises—as a feasible school-based strategy to reduce the burden of musculoskeletal pain in this population; future controlled trials should evaluate its effectiveness.

AUTHOR CONTRIBUTIONS:

TITLE AND DESIGN OF THE RESEARCH, ACQUISITION OF DATA: T. SWATHI

COLLECTION OF DATA AND SAMPLES: S. PARTHEEBAN

DRAFTING THE MANUSCRIPT AND IMPORTANT INTELLECTUAL CONTENT: V. VIJAI KRISHNA

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DEVELOPMENT OF THE POSTURAL AND ERGONOMIC EXERCISE EDUCATION FRAMEWORK: T. SWATHI AND V. VIJAI KRISHNA

Each and every part of this article has been reviewed by every author.

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CONFLICT OF INTEREST

Authors report no conflict of interest for this work.

AI DISCLOSURE

We used Google Gemini and Grammarly for paraphrasing, and a free AI-powered summarising tool to correct grammar, readability and formatting. AI-assisted literature search was also used to identify supporting references for the postural and ergonomic exercise education section; all cited sources were independently verified by the authors.

ETHICAL APPROVAL

Ethical clearance approval was obtained from the Institutional Human Ethics Committee of the Government Medical College and Hospital, Cuddalore District. The register number of the IEC is EC/NEW/INST/2020/1249, and its number is IHEC/1403/2024.

LIST OF ACRONYMS:

MSK – MUSCULOSKELETAL

NPRS – NUMERICAL PAIN RATING SCALE

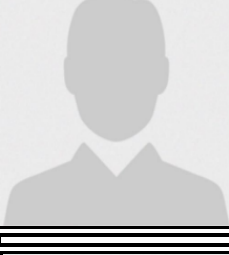
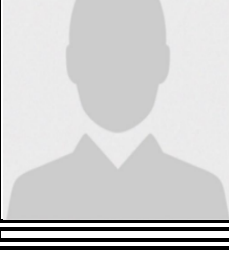
Y-PAQ – YOUTH PHYSICAL ACTIVITY QUESTIONNAIRE

M-NMQ – MODIFIED NORDIC MUSCULOSKELETAL QUESTIONNAIRE

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