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Association of Schoolbag Weight and Walking Terrain with Musculoskeletal Pain among Primary Schoolchildren in Akre City, Iraq: A Cross-sectional Study

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ABSTRACT

Background: Carrying excessively heavy schoolbags can negatively affect children's musculoskeletal health. The daily commute of mountainous residents across steep slopes increases the mechanical stress on their bodies. **Objectives:** The study compares the prevalence of musculoskeletal pain among schoolchildren in different terrain types (flat and non-flat areas) and examines its association with carrying heavy schoolbags. **Methods:** A cross-sectional study using a multistage sampling design was conducted in six primary schools in Akre City. A total of 852 schoolchildren in grades 4–6 were enrolled after obtaining parental informed consent. Schools were classified as being in flat or non-flat areas based on the topography. Data were collected using a structured questionnaire, which assessed self-reported pain during the last month, and anthropometric measurements were obtained for each participant. Data were analyzed using SPSS. **Results:** Overall, 74.1% of 852 schoolchildren felt musculoskeletal pain, with 71.4% of schoolchildren in flat areas and 77.7% in non-flat areas. Both shoulders were the most prevalent pain site among schoolchildren in both terrains, with a prevalence of 53.4% in flat and 57% in non-flat areas. Schoolchildren from non-flat (AOR = 1.61, 95% CI: 1.04-2.49, $P = 0.032$) Female sex (AOR = 1.87, 95% CI: 1.26–2.79, $P = 0.002$) and carrying a schoolbag ≥10% (AOR = 11.09, 95% CI: 5.60-21.76, $P=0.001$) were independently associated with musculoskeletal pain. **Conclusion:** Schoolchildren in non-flat areas have a higher prevalence of musculoskeletal pain than those in flat areas, and females reported a higher prevalence than males. **Recommendation:** Raising awareness among schoolchildren, parents, and teachers about proper bag selection and organization, and suggesting future research to evaluate preventive programs to reduce musculoskeletal pain among schoolchildren.

Keywords: Akre City; Musculoskeletal Pain; Schoolchildren; Schoolbag Weight; Terrain Areas

INTRODUCTION

Carrying excessively heavy schoolbags can negatively affect children's musculoskeletal health, potentially leading to musculoskeletal pain (MSP), specifically shoulder and back pain. Additionally, the excessive weight of the schoolbag can also cause children to lean forward (Meenakshi *et al*., 2023; Malik, 2026). The excessive use of heavy schoolbags may contribute to multiple health issues, such as deformities in the natural curvature of the back (da Rosa *et al*., 2022).

Musculoskeletal pain (MSP) refers to pain affecting the muscles, bones, joints, tendons, and ligaments. In children and adolescents, the most commonly affected sites include the back, neck, and lower extremities (Caes *et al*., 2018). School-age children are more vulnerable to MSP due to the weight of their schoolbags and other external influences that affect their posture and walking pattern (Genitrini *et al*., 2022). MSP in school-aged children has become an increasingly important worldwide health issue, with evidence demonstrating a significant rise in its prevalence, making it a growing health challenge (Nanehkeran & Nourbakhsh, 2025). A recent study conducted in Erbil, Iraq, revealed that 69% of schoolchildren reported MSP related to carrying heavy backpacks

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(Saleh *et al*., 2024). In addition to the physical consequences, there is growing concern about the psychological effect of heavy schoolbags; persistent physical discomfort can lead to fatigue, irritability, poor concentration, stress/anxiety, and truancy (Tiwari *et al*., 2026).

The literature suggested previously that the weight of a schoolbag should be within the limit between 10% and 15% of the body weight (BW) (Chalise *et al.*, 2020). However, recent studies have suggested that a schoolbag weight of no more than 10% of BW has been suggested as an appropriate limit for schoolchildren to avoid negative consequences such as heightened back and neck muscle stress (Ahmed *et al.*, 2024; Hanif *et al*., 2024). A recent study conducted in Erbil city on primary school children showed that many of them carry schoolbags weighing more than 10% of their BW, which was associated with the prevalence of MSP (Mustafa *et al*., 2024). Other recent studies have indicated that the MSP and postural changes occur in schoolchildren when the weight of the backpack exceeds 10–15% of their BW (Hasbiah *et al.*, 2025; Pallavi *et al.*, 2026).

Some factors that increase musculoskeletal symptoms in school-age children, such as schoolbag characteristics and topographical features, have a relationship to the occurrence of pain in schoolchildren, such as the weight of the schoolbag, types of schoolbag, and methods of carrying the schoolbag (Khalafalla *et al*., 2025). Additionally, schoolbags that are not suitable for schoolchildren, such as those that do not have padded shoulder straps, waist belts, and proper back support, concentrate pressure on a specific part of the body, leading to MSP (Grannemann *et al.*, 2021).

Topographical features in non-flat areas (mountainous and hilly), winding roads, and steep slopes increase the distance and difficulty for children traveling to school, which increases their fatigue and physical pain (Zhu *et al.*, 2023). A recent study has shown that prolonged periods of carrying a schoolbag are associated with increased MSP (Harzat *et al*., 2026). People who ascend uphill with a burden carrying typically experience fatigue due to muscle strain. For instance, the dynamic forces on the human body are increased by a backpack load (Sturdy *et al.*, 2023). In addition, the geographical boundaries of mountainous regions limit available transportation options. Topographic constraints in mountainous cities, such as steepness and elevation variations, are closely related to children's walking to school (Tang *et al.*, 2025). A study has revealed that the daily commute of mountainous rural residents across steep slopes increases the mechanical stress on their bodies, potentially leading to MSP, particularly knee and lower back pain (Abe *et al*., 2021). Reducing musculoskeletal disorders and promoting child health from a public health perspective requires preventative strategies to address this issue. In this context, school nurses play a crucial role in the early detection of at-risk schoolchildren, as well as providing health education on the proper use of schoolbags, correct posture, and musculoskeletal health (Saleh & Ali, 2025). The main aim of the study is to compare the prevalence of musculoskeletal pain among schoolchildren in different terrain types (flat and non-flat areas) and to examine its association with carrying heavy schoolbags.

METHODOLOGY

Study Design and Settings

A cross-sectional study was conducted from November 2024 to March 2025. The study was conducted in the Akre City center. Akre is a district located in Duhok Governorate, Kurdistan Region, Iraq. Akre District covers a total area of approximately 1,600 km², while the study area in the central part of Akre City spans about 112.51 km². The study area was classified into flat and non-flat areas based on topographic characteristics derived from a 12.5 m resolution Digital Elevation Model (DEM) using ArcGIS Pro. The classification was performed using a slope threshold of 8%, where areas with slopes of 0–8% (Classes A and B) were considered flat, while areas with slopes greater than 8% (Classes C–F) were classified as non-flat. Elevation values ranging from 516 to 1000 m were also used to define the study area's topographic extent. The GIS slope classification followed the standard criteria dependent on the Food and Agriculture Organization (FAO) classification (FAO, 1986), shown in Table 1:

Table 1: Slope Classification According to (FAO)

Class Symbol	Degree in % slope	Descriptive Term
A	0 – 2	Flat or almost flat
B	2 – 8	Gently slopping
C	8 – 16	Slopping
D	16 – 30	Moderately steep
E	30 – 50	Steep
F	50 +	Very steep

The analysis showed that 71.65 km² (63.67%) of the study area consists of non-flat terrain, while 40.86 km² (36.33%) is classified as flat terrain. Due to the varied topography of Akre City, schools are distributed across both flat and non-flat areas.

Study Participants

The population in this study was schoolchildren in primary schools from grades 4 to 6. Inclusion criteria were generally healthy schoolchildren with no pre-existing musculoskeletal disorders who carry a schoolbag regularly to school. while schoolchildren who were not willing to participate were unable to stand on the weighing scale, and those with disabilities and pain-related health problems were excluded.

Sample Size Determination

The sample size was calculated using Cochran's formula for cross-sectional studies.

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

n – represents the required sample size.

Z= Value corresponding to the desired level of confidence (1.96 for a 95% Cl).

p = expected prevalence of MSP the attribute in question; if it's unknown, it will be estimated at 50% (0.5).

$(1-p)$ = is the complement of the estimated proportion.

d = is the margin of error, or the desired level of precision, typically set at 0.05 for a 5% margin of error.

Assuming a 10% non-response rate, multiply the sample size by 100/90, or 1.11. n adjusted = 384 × 1.11 ≈ 426.24 ≈ 426. As it is a multistage sampling procedure, the authors will multiply the sample size by 2 (design effect) (Chen & Rust, 2017). So, the total sample size will be 426*2=852 schoolchildren.

Sampling Procedure

A multistage sampling was implemented: first, a stratified sampling approach was applied by dividing schools into two strata based on geographic characteristics: flat and non-flat areas. The flat area consisted of 16 schools, while the non-flat area included 25 schools. From each stratum, three schools were selected using simple random sampling. After selecting the schools, the sample size was determined using the proportional allocation method. Schoolchildren from grades four, five, and six in the six selected schools were considered. The total number of schoolchildren across these grades was 1,408. The next step involved determining the number of schoolchildren to be sampled from each school. This was achieved through proportionate allocation, based on the total number of schoolchildren across the selected schools and the overall target sample size of 852 schoolchildren. Finally, schoolchildren were selected using systematic random sampling. The sampling interval (k) was calculated for each grade by dividing the total number of students by the allocated sample size and rounding the result to the nearest whole number. Data were collected on the survey day from schoolchildren who were present at school. There were no refusals to participate, and therefore no replacements were required, as shown in (figure 1).

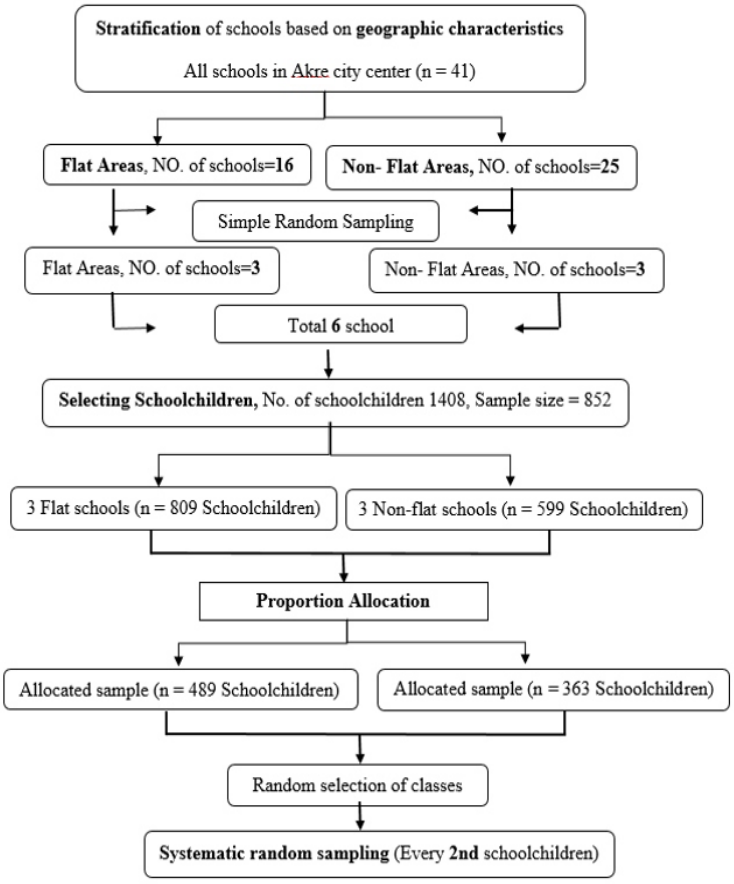


Figure 1: Sampling Procedure Selecting Schools and Schoolchildren in Akre City

Pilot Study

A pilot study was conducted to test the preliminary prepared questionnaire. Two schools were selected for the pilot study: one located in a flat area and the other in a non-flat area. The researcher initially selected 30 schoolchildren from each school. Subsequently, 15 schoolchildren were randomly selected from each school to participate in the pilot study. Based on the findings of the pilot study, the questionnaire was revised and modified before its final administration.

Validity and Reliability of the Study Instrument

The questionnaire was reviewed by five experts in community medicine to establish its content validity. Reliability was assessed using Cronbach's alpha, yielding a coefficient of 0.80.

Data Collection Procedure and Materials

The study used the following research tools:

- Structured schoolchildren questionnaire
- Electronic scale (Uniscale-Secca 874) with double display
- Microtoise height measuring device (0–2 m)
- World Health Organization (WHO) 2007 Growth Charts for ages between 5 and 19 years
- Standardized Nordic Body Map for musculoskeletal symptoms

A structural questionnaire used for data collection was designed by the researchers, including four sections: Section I**:** personal information of the schoolchildren, such as the name of the school, the school

location (flat or non-flat areas), sex, age, and grade level.

Section II: Anthropometric and schoolbag measurements included measuring the weight of schoolchildren and their schoolbags using an electronic scale (Uniscale-Seca 874) placed on a flat surface and set to zero. Each schoolchild was instructed to step onto the scale barefoot and wearing light clothing (World Health Organization [WHO], 2022). BW was measured first without the schoolbag and then while carrying the schoolbag with its contents (books, notebooks, and other school stationery). To ensure accurate measurements, the weighing scale was recalibrated after each measurement. The difference between the two measurements was recorded as the schoolbag weight, and the relative schoolbag weight was calculated using the following equation:

Weight Percentage = (Schoolbag weight / Body weight) × 100.

Measurements were conducted on randomly selected school days in the morning at the beginning of the school day to ensure that schoolbags reflected their usual contents before schoolchildren consumed food or water from their lunch boxes and water bottles. The schoolbag weight as a percentage of BW indicated <10% is not risky and ≥10% is risky (Mustafa *et al*., 2024).

The second height was determined using a microtome height measuring instrument (0-2 m). The procedure for measuring schoolchildren's height involves setting up the instrument securely on a flat vertical surface, ensuring the tape measure aligns accurately from the floor to the maximum height. The schoolchildren stand barefoot on a firm surface with their heels, buttocks, shoulders, and head lightly touching the wall. Their head is aligned in the Frankfort horizontal plane, with the children standing tall and looking straight ahead (WHO, 2022). The measurement is read to the nearest 0.1 cm, avoiding parallax error, and the device is recorded promptly. The device is cleaned after each use to maintain hygiene.

After the height and weight were measured for all schoolchildren, then body mass index (BMI) was calculated using the formula weight (kg) ÷ height squared (m^2). The BMI value was then correlated with the participant's age and sex and interpreted using the 2007 WHO reference growth charts for children and adolescents aged 5–19 years, which are based on BMI-for-age *z*-score categories. Nutritional status was classified as severe thinness (*z*-score < -3 *SD*), thinness (*z*-score < -2 *SD*), normal weight (-2 *SD* ≤ *z*-score ≤ +1 *SD*), overweight (+1 *SD* < *z*-score ≤ +2 *SD), or* obesity (*z*-score > +2 *SD*) (WHO, 2007).

Section III: schoolbag details, including types of schoolbags, carrying methods, travel to school, duration carried, and perceived causes of heaviness. Section IV: include musculoskeletal symptoms. To assess for MSP the Nordic Body Map, divided into nine body regions, was used to allow schoolchildren to identify the body site(s) where they experienced pain during the last month (Kuorinka *et al*., 1987). Pain severity was assessed using a Verbal Rating Scale (no pain, mild, moderate, and severe) (Jensen *et al*., 1986).

Statistical Analysis

Descriptive and inferential statistics were used through the Microsoft Excel database alongside the Statistical Package for Social Sciences (SPSS version 26). The descriptive statistics (means, frequencies, etc.). An independent-samples *t*-test was used to compare continuous variables; a chi-square test was used for categorical variables. Multivariable binary logistic regression analysis was performed to identify factors associated with MSP. A *p*-value of ≤ 0.05 was considered statistically significant.

Ethical Considerations

The study received ethical approval from the Ethical Committee of the General Directorate of Health in Directorate of Planning , Duhok Governorate, Iraq with reference number 31072024-6-55 on 31st July 2024.

RESULTS

Comparison of demographic, anthropometric, and schoolbag characteristics between flat and non-flat areas

Out of 852 schoolchildren, 489 belong to a flat area location and 363 from non-flat areas. The comparison between flat and non-flat areas showed participants very similar mean values for most anthropometric and schoolbag-related variables. The mean age of schoolchildren in flat areas was 10.79 ± 1.19 years, whereas in non-flat areas it was 10.90 ± 1.37 years, showing a very small difference between the two groups. Similarly, the mean weight of schoolbags was comparable (4.68 ±0.91 kg in flat areas and 4.63 ±0.80 kg in non-flat areas for school children). However, height showed a slight difference, with participants from flat areas being slightly taller than those from non-flat areas, as shown in Table 2.

Table 2: Demographic and Anthropometric Characteristics and Schoolbag Weight of Participants

Parameter	Flat areas (Mean± *SD*) (n=489)	Non-flat areas (Mean ± *SD*) (n=363)	*P*-value
Age (years)	10.79±1.19	10.90±1.37	0.209
Body Weight (kg)	35.37±10.48	35.24±10.00	0.859
Height (cm)	141.20±8.51	139.06±9.89	0.001
BMI (kg/m²)	17.48±3.67	17.98±3.45	0.048
Weight of schoolbag (kg)	4.68±0.91	4.63±0.80	0.374
Relative schoolbag weight (%)	14.01±3.86	14.00±4.06	0.975

PMSP was prevalent in various parts of the body among schoolchildren in both flat and non-flat areas. In the flat areas, both shoulders were the most affected region, at 53.4%, followed by the neck pain at 24.9%, while no schoolchildren reported both hands/wrist pain. In non-flat areas, both shoulders were also the most affected area, but with a higher percentage of 57%, followed by both feet and ankles at 54.5%, whereas (right elbow only) and (right hand/wrist only) pain were the least common, both reported at a similar rate of 1.9%, as shown in (figure 2).

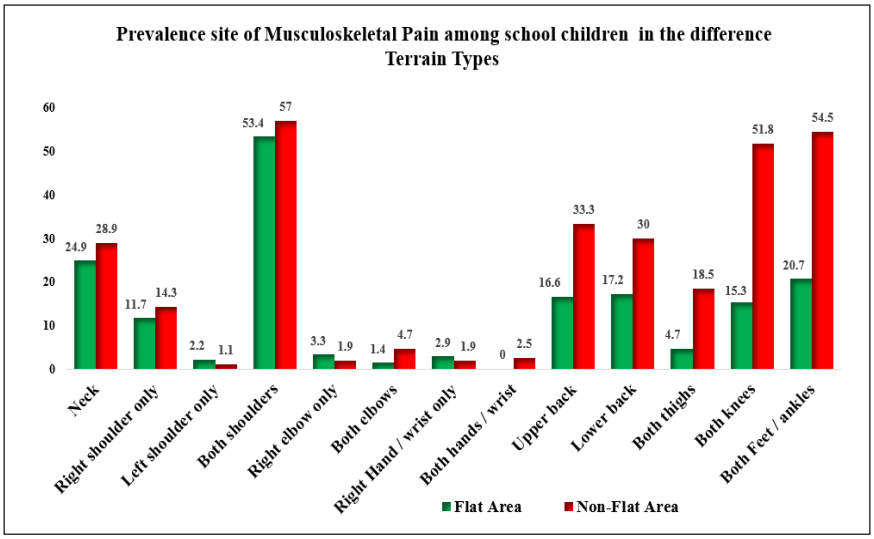


Figure 2: Prevalence of MSP among Schoolchildren in the Difference Terrain Types

There is a statistical association between school location, sex, age, BMI/age according to *Z* score, and schoolbag weight as a percentage of BW with the prevalence of MSP, while there is no statistical association between grade level of schoolchildren with the prevalence of MSP, as shown in Table 3**.**

The overall prevalence of MSP in Akre City was 631 (74.1%), while only 221 (25.9%) of schoolchildren did not experience pain. with a higher prevalence observed among schoolchildren in non-flat areas, 282 (77.7%), compared to schoolchildren in flat areas, 349 (71.4%), as shown in Table 3.

Table 3: Associations between Demographics, Schoolbag Weight, and MSP in Akre City

Variable		Prevalence of musculoskeletal Pain			*P*-value
		Yes	NO	Total	
		No. (%)	No. (%)	No. (%)	
School location	Flat area	349 (71.4)	140 (28.6)	489 (100)	0.038
	Non-flat areas	282 (77.7)	81 (22.3)	363 (100)	
Sex of schoolchildren	Male	294 (68.7)	134 (31.3)	428 (100)	<0.001
	Female	337 (79.5)	87 (20.5)	424 (100)	
Age / Years	9	96 (80.7)	23 (19.3)	119 (100)	0.009
	10	190 (76.0)	60 (24.0)	250 (100)	
	11	193 (75.1)	64 (24.9)	257 (100)	
	12	101 (73.2)	37 (26.8)	138 (100)	
	13	36 (58.1)	26 (41.9)	62 (100)	
	≥14	15 (57.7)	11 (42.3)	26 (100)	
Grade level	Fourth	240 (73.8)	85 (26.2)	325 (100)	0.843
	Fifth	221 (75.2)	73 (24.8)	294 (100)	
	Sixth	170 (73.0)	63 (27.0)	233 (100)	
BMI-for-age *z*-score categories	Obesity	33 (49.3)	34 (50.7)	67 (100)	<0.001
	Overweight	90 (65.7)	47 (34.3)	137 (100)	
	Normal	464 (78.1)	130 (21.9)	594 (100)	
	Thinness	38 (79.2)	10 (20.8)	48 (100)	
	Severe thinness	6 (100.0)	0 (0.0)	6 (100)	
Schoolbag weight as % of BW (Risky)	Not risky (<10%)	22 (17.7)	102 (82.3)	124 (100.0)	<0.001
	Risky (≥10%)	609 (83.7)	119 (16.3)	728 (100.0)	

Univariate and multivariate logistic regression analysis of factors influencing MSP

Table 4 shows the schoolchildren from non-flat (AOR = 1.61, 95% CI: 1.04-2.49, $P = 0.032$), carrying schoolbags ≥10% (AOR = 11.09, 95% CI: 5.60-21.76, $P = 0.001$), and girls (AOR = 1.87, 95% CI: 1.26-2.79, $P = 0.002$) were independently associated with MSP.

Table 4: Crude and Adjusted Logistic Regression Analysis of Factors Associated with Musculoskeletal Pain among Schoolchildren

Factor		COR (95% CI)	*P*-value	AOR (95% CI)	*P*-value
School location	Flat areas [reference]				
	Non-Flat areas	1.4 (1.02- 1.91)	0.038	1.61 (1.04- 2.49)	0.032
Sex of schoolchildren	Boys [reference]				
	Girls	1.77 (1.29- 2.41)	<0.001	1.87 (1.26-2.79)	0.002
Age of schoolchildren	9	3.06 (1.24-7.54)	0.015	3.53 (1.03-12.07)	0.044
	10	2.32 (1.01- 5.33)	0.047	2.17 (0.69-6.82)	0.185
	11	2.21 (.97- 5.06)	0.060	2.55 (0.82-7.98)	0.108
	12	2.00 (.84- 4.75)	0.116	2.49 (0.76-8.15)	0.130
	13	1.02 (.40- 2.57)	0.974	1.27 (0.36-4.47)	0.707
	≥14 [reference]				
BMI/age	Obesity [reference]				
	Overweight	1.97 (1.09- 3.58)	0.025	1.30 (0.54-3.12)	0.552
	Normal	3.68 (2.19- 6.17)	<0.001	1.84 (0.77-4.36)	0.166
	Thinness	3.91 (1.68-9.12)	0.002	2.17 (0.68-6.90)	0.190
Schoolbag weight % of BW	<10% [reference]				
	≥10%	22.٢٥ (13.59- 36.43)	<0.001	11.09 (5.60-21.76)	<0.001

Table 5 illustrates the significant associations that were observed between MSP and sex and schoolbag weight as a percentage of BW. While in non-flat areas, significant associations were observed between MSP and age, grade level, BMI-for-age, and schoolbag weight as a percentage of BW, as shown in Table 5.

Table 5: Associations between Demographics, Schoolbag Weight, and MSP among Schoolchildren in Different Terrain Types in Akre City

Variable		School children in flat area (n=489)		*P*- value	School children in non-flat area(n=363)		*P*- value
		Pain	No Pain		Pain	No Pain	
		No. (%)	No. (%)		No. (%)	No. (%)	
Sex	Male	165 (65.5)	87 (34.5)	0.003	129 (73.3)	47 (26.7)	0.051
	Female	184 (77.6)	53 (22.4)		153 (81.8)	34 (18.2)	
Age group in years	9	49 (73.1)	18 (26.9)	0.263	47 (90.4)	5 (9.6)	<0.001
	10	102 (68.9)	46 (31.1)		88 (86.3)	14 (13.7)	
	11	106 (73.1)	39 (26.9)		87 (77.7)	25 (22.3)	
	12	70 (76.9)	21 (23.1)		31 (66.0)	16 (34.0)	
	13	15 (53.6)	13 (46.4)		21 (61.8)	13 (38.2)	
	≥14	7 (70.0)	3 (30.0)		8 (50.0)	8 (50.0)	
Grade	Fourth	119 (66.1)	61 (33.9)	0.132	121 (83.4)	24 (16.6)	0.031
	Fifth	127 (73.4)	46 (26.6)		94 (77.7)	27 (22.3)	
	Sixth	103 (75.7)	33 (24.3)		67 (69.1)	30 (30.9)	
BMI-for-age *z*-score categories	Obesity	21 (58.3)	15 (41.7)	0.061	12 (38.7)	19 (61.3)	<0.001
	Overweight	47 (62.7)	28 (37.3)		43 (69.4)	19 (30.6)	
	Normal	252 (73.7)	90 (26.3)		212 (84.1)	40 (15.9)	
	Thinness	25 (78.1)	7 (21.9)		13 (81.3)	3 (18.8)	
	Sever thinness	4 (100.0)	0 (0.0)		2 (100.0)	0 (0.0)	
Schoolbag weight as % of BW	< 10%	15 (24.2)	47 (75.8)	<0.001	7 (11.3)	55 (88.7)	<0.001
	≥10%	334 (78.2)	93 (21.8)		275 (91.4)	26 (8.6)	

DISCUSSION

Parents are increasingly concerned about the increasing weight of schoolbags in schoolchildren, which has dramatically increased recently and is associated with MSP, particularly in primary school children. This is the first study conducted in Akre City to compare the prevalence of MSP among schoolchildren in different terrain types and to examine its association with carrying heavy schoolbags.

The present study showed that a high proportion (74.1%) of schoolchildren reported MSP. This finding is similar to a study conducted in Abu Musa Island, Iran, among 269 primary schoolchildren aged 7 to 11 years, which indicated that the prevalence of MSP was 74.3% (Zare *et al.*, 2022). However, other studies have found higher or lower prevalence rates. For instance, a study conducted in Turkey reported a lower prevalence of MSP of 39.0% in 313 primary school children aged 8–12 years old. (Karasel *et al.*, 2022), whereas a higher prevalence of MSP was observed in Baqubah (83%) among 500 elementary schoolchildren (Abood, 2020).

In this study the prevalence of MSP was higher among schoolchildren in non-flat areas (77.7%) compared to those in flat areas (71.4%). In a multivariate regression model in the current study, schoolchildren from non-flat areas were 1.6 times more likely to experience pain than those from flat areas. This result is in agreement with a study conducted in China by Ren *et al.* (2023), which indicated that people in non-flat areas experienced pain 1.5 times more than people in flat areas. This may be attributed to increased physical strain resulting from longer walking distances, uneven terrain, and limited transportation options, which can contribute to greater musculoskeletal stress when carrying schoolbags. These findings indicate that environmental factors, in addition to schoolbag weight, play an important role in the development of MSP among schoolchildren.

Regarding the most common sites of MSP, the current study found that schoolchildren from non-flat areas

most commonly experienced pain in both shoulders, followed by the feet/ankles, whereas schoolchildren from flat areas most commonly reported pain in both shoulders, followed by neck pain. The results of the current study disagree with a study conducted by Sabui *et al*. (2018) in the eastern Himalayas, which reported that back pain was more common among students from hilly areas, while students from plains areas more frequently experienced neck pain.

Regarding the factors associated with the prevalence of MSP in different terrain types. The current study found no association between age and MSP among schoolchildren in flat areas. In contrast, in non-flat areas, a significant association between age and MSP was observed, which reported that younger students had a significance with MSP. This could be explained by the possibility that younger schoolchildren may have less developed musculoskeletal strength. This finding disagrees with a study conducted in Erbil city involving 624 primary school students aged between 6 and 12 years; the prevalence of pain among students increased with increased age (Mustafa *et al*., 2024). Females reported MSP nearly twice as much as males. This finding aligns with the study by Mongkonkansai *et al*. (2024) in Thailand, which reported that females experienced MSP twice as frequently as males (AOR = 1.87, 95% CI = 1.12–3.10). A possible explanation is that the higher prevalence of MSP among females is the occurrence of early puberty and the accompanying hormonal changes that affect the body (Gulati *et al*., 2023).

This study found that 85.4% of the schoolchildren in the study carry schoolbags that weigh 10% or more of their BW, which exceeds the recommended safe limit. This indicates a potential health concern, as excessive schoolbag weight has been related to an increased risk of musculoskeletal problems. The findings of this study are consistent with those reported in two studies. For instance, a study conducted in the western region of Libya found that 91.4% of 2371 primary school students aged between 6 and 9 years carried schoolbags weighing 10% or more of their BW (Sakal *et al*., 2024). A study conducted in Kajang, Selangor, among 81 primary schoolchildren aged between 8 and 11 years, indicated 74.1% of schoolchildren carried schoolbags weighing more than 10% of BW (Shuhaimi & Rahman, 2020).

The present study showed that the prevalence of MSP increased with the increase in the weight of the schoolbag in both flat and non-flat areas. This finding agrees with a study conducted in Islamabad, Pakistan among 274 students aged between 10 and 17 years (Hanif *et al*., 2024). A multivariate regression model in the current study showed that schoolchildren carrying a schoolbag weighing 10% or more of BW were approximated 11 times more likely to experience MSP compared to those who carried a schoolbag less than 10% of BW. However, another study has found a higher result. For instance, in Thailand, children who carried schoolbags weighing ≥10% of BW were found 65 times more likely to experience MSP (Mongkonkansai *et al.*, 2024). That may be explained by the schoolchildren being compelled to carry large quantities of books daily and the absence of lockers, which further adds to the weight of their bags. The repeated pressure on muscles from carrying heavy bags can result in MSP. These results highlight important implications for public health practice in terms of preventing musculoskeletal problems among schoolchildren. In this context, school nurses play a key role in identifying students at risk and supporting early recognition of musculoskeletal symptoms within the school setting, while these findings also suggest the importance of developing school-level policies aimed at reducing excessive schoolbag weight.

Limitations

The cross-sectional design of the study also does not allow reliable conclusions to be drawn about a causal relationship. MSP was self-reported, which may have introduced recall and reporting bias. Schoolchildren in fourth, fifth, and sixth grades were included in this study; therefore, it may not represent all schoolchildren.

Future Scope

Future research is recommended to evaluate the effectiveness of preventive programs for reducing musculoskeletal pain among schoolchildren.

CONCLUSION

The prevalence of MSP among schoolchildren in non-flat areas was higher than that in flat areas. The most common site of MSP in flat areas experienced was both shoulders and neck pain, while in non-flat areas it was both shoulders and foot/ankle pain. MSP is significantly associated with schoolbag weight to child weight as a percentage and school location.

Recommendation

The school nurse plays a crucial role in this educational process within the school by conducting routine schoolbag screening, encouraging schoolchildren to pack their schoolbags according to the daily timetable, educating schoolchildren and parents on proper schoolbag use, monitoring schoolchildren with musculoskeletal pain, paying particular attention to schoolchildren living in non-flat terrain, and collaborating with teachers and school administrators to reduce excessive schoolbag weight. Schools should support these efforts by providing lockers, safe drinking water, and digital learning materials to reduce schoolbag weight.

CRediT Authorship Contribution Statement

D.M.H.: was responsible for developing the research concept, designing the methodology, conducting the investigation, collecting and organizing the data, performing statistical analysis, preparing visual materials, and drafting the manuscript. **M.A.A.:** provided academic supervision, contributed to research design and methodological decisions, verified the findings, and critically revised the manuscript. Both authors reviewed and approved the final manuscript and agreed to be accountable for its contents.

AI Assistance Declaration

During manuscript preparation, AI tools were used solely for English-language editing and grammatical correction. The authors reviewed the manuscript, verified its content, and accepted full responsibility for the final version.

Conflict of Interest

The authors declare that they have no competing interests.

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