Prevalence of musculoskeletal disorders caused by carrying backpacks among primary school pupils in Ondo City, Nigeria

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Background. School-aged children frequently suffer from musculoskeletal disorders (MSDs), and these can be caused by carrying heavy school bags or backpacks.
Objectives. To assess the prevalence of MSDs among primary school pupils and determine the association of MSDs with the type of school the children were attending (private or public), and the average weight of the school bags they carried and its relationship with pain intensity.
Methods. In a cross-sectional study of 240 primary school pupils aged 8 - 12 years (n=118 public and n=122 private), the Nordic Musculoskeletal Questionnaire and a structured questionnaire on school bag use were administered to the respondents. The children's height and weight and the weight of the bags were measured. Data were analysed using descriptive and inferential statistics, and the alpha level was set at 0.05.
Results. Of respondents attending private schools, 68.0% (n=83) reported having experienced pain over the past 12 months and 49.2% (n=60) over the past 7 days. The point prevalence of pain was 22.1% (n=27). For public school respondents, the prevalences were 41.5% (n=49), 36.4% (n=43) and 13.5% (n=16), respectively. The 12-month prevalence for all respondents was 55.0% (n=132). The body parts most affected over the past 12 months were the shoulders in the private schools (37.7%; n=46) and the neck in the public schools (16.1%; n=19). The average weight of the school bags carried by the private and public school pupils was 3.86 kg and 1.91 kg, respectively. There was a significant association between the prevalence of MSDs and the type of school over 12 months (χ^2=149.197; p=0.000) and over 7 days (χ^2=147.241; p=0.000), and for point prevalence (χ^2=150.008; p=0.000). There was a significant relationship between pain intensity and the weight of the backpack (r=0.243; p=0.000).
Conclusion. More than 50% of all the pupils at private and public primary schools had experienced musculoskeletal pain over the past 12 months, but a higher proportion of children attending private schools were affected. Private school pupils carry heavier bags, and the heavier the bag, the more the pain.

Keywords. Musculoskeletal disorders, backpacks, primary school, pupils.

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Musculoskeletal disorders (MSDs) remain a major issue affecting the health of school-aged children.[1] These children frequently need to carry school bags or backpacks,[2] and evidence shows that this activity is a common cause of MSDs and discomfort if the bag is heavy (exceeding 10 - 15% of the child's weight) and the child's posture is incorrect when carrying the bag.[3,4] Daily carrying of heavy school bags by school-aged children and sustained poor posture while doing so are major causes of biomechanical stress on the spine that results in pain.[4] It has even been reported that heavy school bags cause ankle injuries in school-aged children, because the weight of the bag predisposes the carrier to walk with an abnormal gait.[4]

A study conducted in New Zealand[5] showed that pain associated with carrying school bags frequently affects the neck, shoulders, upper back and lower back. MSDs are common among young adults, adolescents and school-aged children. Among school-aged children, MSDs are not only caused by carrying heavy school bags and not carrying them properly; there are other causes such as poor posture generally, poor furniture design, prolonged sitting, lack of exercise, insufficient physical activity, and poor ergonomic conditions.[6] Symptoms of MSDs can affect

a child's physical development, including their biomechanics, anatomical structures and physiological responses. Socially, they can affect a child's relationships, social environment and culture. Psychologically, they can affect a child's mood, emotions, thoughts and beliefs.[7] A study carried out in the eastern part of Nigeria[3] showed that MSDs were common among female secondary school students and that the shoulders were most affected (45.8%), followed by the neck (30.0%), the upper back (22.6%) and the lower back (5.5%).

Prevention of MSDs in school-aged children can reduce the risk of developing MSDs during adulthood.[8] MSDs can be prevented through education, e.g. through presentations and campaigns.[9] Frequent exercise can help prevent MSDs.[8,10] Good ergonomic equipment can also help prevent MSDs if users are properly trained.[11] The findings of an Ibadan study[12] indicated that girls can safely carry 4.91% of their weight and boys 5.18% of their weight. School-aged children should not be allowed to carry school bags that weigh more than 15% of their body weight.[4]

Injury prevention programmes and moderate physical activity are very effective in preventing injuries and accidents in school-aged children.[13]

Management of MSDs in school-aged children is very important to improve their quality of life and academic achievement. MSDs can be managed by physiotherapists using appropriate physiotherapy techniques such as correction of abnormal posture[14] and exercise therapy.[10]

There is limited information on the prevalence of MSDs associated with carrying school bags among primary school pupils in Ondo City, Nigeria. This study aimed to describe the prevalence of MSDs associated with carrying school bags in this population, determine the relationship between the weight of the bag and pain intensity, and determine the association between the prevalence of MSDs and the type of school the children were attending (private or public).

Methods

Study population

This was a study of pupils attending selected primary schools: two private schools and two public schools in Ondo City.

The respondents were primary school pupils aged 8 - 12 years, all of whom regularly carried a school bag at their back (backpack). Children whose parents did not give consent, who did not give assent themselves, or who had an underlying pathology, had experienced physical trauma in the past 12 months, or had congenital anomalies were excluded from the study.

Study instruments

A structured questionnaire adapted from Al-Qato[15] was used. It had two sections. The first part was used to obtain sociodemographic data on the students such as age, gender, class, child's weight and weight of the school bag, while the second part elicited information about school bags and musculoskeletal symptoms using close-ended questions. A visual analogue scale in the form of a 10 cm line with anchor statements on the left (no pain) and on the right (pain as bad as it could be) was attached to the questionnaire.

The Nordic Musculoskeletal Questionnaire was used to assess the body parts affected by MSDs. A tape measure (Goldfish Brand, China) was used to measure the height of the students, and a bathroom weighing scale (FA00337; Camry, China) was used to weigh the students and the school bags filled with books.

Methods

The study was a cross-sectional survey. The schools were selected using convenience sampling. The sample size of 240 was determined using the Cochran formula from Eng[16] (available online at http://coding.samedical.org/file/2333).

Measurements

The structured questionnaire was given to the participants, who filled it in under supervision by the researcher and class teachers. The children were weighed while standing upright on the weighing scale, without shoes and with minimal clothing. The weight (in kg) was documented on the questionnaire. The weight of the backpacks (in kg) was measured by placing the bag on the weighing scale. The tape measure was used to calibrate a metre scale on a wall. Each child's height was measured while standing erect against the wall, without shoes and with minimal clothing. The Nordic Questionnaire was filled out by the participants, under supervision.

Data analysis

Data analysis was done using the Statistical Package for the Social Sciences (SPSS), version 23 (IBM, USA), and the alpha level was set at 0.05. Descriptive statistics using means, standard deviations and percentages were used to analyse the sociodemographic parameters. Inferential statistical tests used were Pearson's product moment correlation coefficient to determine the relationship between the weight of the bag and pain intensity, and the χ^2 test to find the association between the prevalence of MSDs and the type of school attended by the students (private or public).

Ethical considerations

Ethical approval for this study was obtained from the Ethics and Research Committee of the University of Medical Sciences, Ondo City (ref. no. NHREC/TR/UNIMED-HREC-Ondo St/22/06/21), and permission for data collection was obtained from the headmaster of each school**.** A letter of introduction from the Department of Physiotherapy was given to each school asking for permission to carry out the study, and consent was obtained from the pupils' parents and assent from the pupils themselves. Participants were recruited according to the study inclusion criteria, and the procedure and purpose of the study were then explained to them.

Results

Comparison of physical characteristics and pain intensity between public and private schools. Table 1 compares the public and private school pupils' physical characteristics and pain intensity. There was a significant difference in their age (t=–3.986; p=0.000), weight (t=–3.653; p=0.000), school bag weight (t=–10.707; p=0.000), height (t=–3.314; p=0.001) and body mass index (BMI) (t=–2.030; p=0.043).

Prevalence of musculoskeletal pain (MSP) reported. Table 2 shows that the 12-month prevalence of MSP was 41.5% (n=49) in the public schools, 68.0% (n=83) in the private schools, and 55.0% (n=132) for all respondents. The 7-day prevalence was 36.4% (n=43) in the public schools, 49.2% (n=60) in the private schools, and 43.0% (n=103) for all respondents, and the point prevalence was 13.5% (n=16) in the public schools, 22.1% (n=27) in the private schools, and 17.9% (n=43) for all respondents.

Table 1. Comparison of physical characteristics and pain intensity between public and private schools

Variable	Public, mean (SD)	Private, mean (SD)	*t*-value	*p*-value
Age (years)	10.75 (1.05)	10.26 (0.82)	−3.986	0.000
Student weight (kg)	27.74 (5.78)	30.60 (6.32)	−3.653	0.000
School bag weight (kg)	1.91 (1.30)	3.86 (1.51)	−10.707	0.000
Height (m)	1.38 (0.09)	1.43 (0.08)	−3.314	0.001
Body mass index (kg/m2)	14.63 (1.99)	15.14 (1.94)	−2.030	0.043
Duration of commute to school (minutes)	13.68 (6.76)	14.77 (8.70)	−1.083	0.280
Pain intensity*	2.49 (3.30)	2.84 (2.04)	−0.977	0.329

SD = standard deviation.
*On a visual analogue scale in the form of a 10 cm line with anchor statements on the left (no pain) and on the right (pain as bad as it could be).

Table 2. Prevalence of musculoskeletal pain reported

Variable	Public (*n*=118), *n* (%)	Private (*n*=122), *n* (%)	Total (*N*=240), *n* (%)
Past 12 months			
Yes	49 (41.5)	83 (68.0)	132 (55.0)
No	69 (58.4)	39 (32.0)	108 (45.0)
Past 7 days			
Yes	43 (36.4)	60 (49.2)	103 (43.0)
No	75 (63.6)	62 (50.8)	137 (57.1)
Pain currently present			
Yes	16 (13.5)	27 (22.1)	43 (17.9)
No	102 (86.5)	95 (77.9)	197 (82.1)

Twelve-month prevalence of MSP according to body part. Table 3 shows the 12-month prevalence of MSP according to body part. The highest prevalence was reported for the neck in the public schools (16.1%; *n*=19), both shoulders in the private schools (37.7%; *n*=46), and both shoulders in the total population (24.6%; *n*=59).

Seven-day prevalence of MSP according to body part. Table 4 shows the 7-day prevalence of MSP according to body part. The highest prevalence was reported for the neck in the public schools (15.3%; *n*=18), the lower back in the private schools (26.2%; *n*=32), and the lower back in the total population (19.2%; *n*=46).

Association between type of school and prevalence of MSP. Table 5 shows the association between type of school and the prevalence of MSP. There was a significant association between type of school and 12-month prevalence (χ^2=149.197; *p*=0.000), 7-day prevalence (χ^2=147.241; *p*=0.000) and point prevalence of pain (χ^2=150.008; *p*=0.000).

Relationship between the weight of the school bag and pain intensity. There was a significant relationship between the weight of the school bag and pain intensity reported by the respondents (*r*=0.243; *p*=0.000)

Discussion

In this study, we found that in Ondo City, the age of pupils attending private schools was slightly lower than that in public schools (mean (standard deviation) 10.26 (0.82) years v. 10.75 (1.05) years, respectively). The weight, BMI and height of the pupils in the private schools were significantly higher than those of the pupils in the public schools, corresponding with the finding of Juwara *et al.*[17] that private school students are more likely to be overweight or obese than students attending public schools. This finding also corresponds with a study in Benin City, Nigeria, which reported that private school students had 11.8% and 11.7% prevalences of overweight and obesity, respectively, while public school students had 3.3% and 0.9% prevalences.[18] In the present study, the weight of the school bags carried by the pupils attending the private schools was significantly higher than that in the public schools. Private schools have a wider curriculum than public schools, so it is necessary for the pupils to have have more exercise books and textbooks than public school students do.[19]

The 12-month, 7-day and point prevalences of pain were significantly associated with the type of school attended; there were more reports of MSP in private schools than in public ones. This contrasts with the finding of Delele *et al.*[20] that 51% of students in private schools and 68% of students in public schools reported having MSP. This variance may be due to differences in the ages of the respondents; Delele *et al.*'s study was carried out among elementary school pupils aged ≤8 years, while we studied children aged 8 - 12 years.

Our finding of a higher prevalence of MSP in pupils attending private schools may be because school bags tended to be heavier in private schools, with an average of 3.86 kg, which exceeded 2.87 kg and 2.53 kg, the safe backpack weight for males and females, respectively,[12] whereas public school students had an average school bag weight of 1.91 kg. Furthermore, there was a higher prevalence of overweight students in private schools than in public schools. This finding corresponds with Azabagic *et al.*,[21] who reported that both chronic and acute pain were

Table 3. Musculoskeletal pain over the past 12 months according to body part*

Variable	Public (*n*=118), *n* (%) (%)	Private (*n*=122), *n* (%)	Total (*N*=240), *n* (%)
Neck	19 (16.1)	30 (24.6)	49 (20.4)
Right shoulder	9 (7.3)	26 (21.3)	35 (14.6)
Left shoulder	8 (6.8)	19 (15.6)	27 (11.3)
Both shoulders	13 (11.0)	46 (37.7)	59 (24.6)
Right elbow	9 (7.6)	14 (11.5)	23 (9.6)
Left elbow	5 (4.2)	10 (8.2)	15 (6.2)
Both elbows	2 (1.7)	14 (11.5)	16 (6.7)
Right wrist and hand	7 (5.9)	15 (12.3)	22 (9.2)
Left wrist and hand	5 (4.2)	14 (11.5)	19 (7.9)
Both wrists and hands	3 (2.5)	16 (13.1)	19 (7.9)
Upper back	15 (12.7)	28 (23.0)	43 (17.9)
Lower back	7 (5.9)	24 (19.7)	31 (12.9)
Hips, thighs and buttocks	10 (8.5)	19 (15.6)	29 (12.1)
Knees	18 (15.2)	25 (20.5)	43 (18.0)
Ankles and feet	12 (10.2)	33 (27.0)	45 (18.7)

*Pain may have been experienced in more than one body part.

Table 4. Musculoskeletal pain over the past 7 days according to body part*

Variable	Public (*n*=118), *n* (%)	Private (*n*=122), *n* (%)	Total (*N*=240), *n* (%)
Neck	18 (15.3)	22 (18.0)	40 (16.7)
Right shoulder	9 (7.6)	24 (19.7)	33 (13.8)
Left shoulder	10 (8.4)	13 (10.7)	23 (9.6)
Both shoulders	16 (13.6)	29 (23.8)	45 (18.8)
Right elbow	6 (5.1)	11 (9.0)	17 (7.1)
Left elbow	6 (5.1)	10 (8.2)	16 (6.6)
Both elbows	0	13 (10.7)	13 (5.4)
Right wrist and hand	9 (7.6)	17 (13.9)	26 (10.8)
Left wrist and hand	5 (4.2)	10 (8.2)	15 (6.2)
Both wrists and hands	3 (2.5)	12 (9.8)	15 (6.3)
Upper back	11 (9.3)	30 (24.6)	41 (17.1)
Lower back	14 (11.8)	32 (26.2)	46 (19.2)
Hips, thighs and buttocks	16 (13.5)	26 (21.3)	42 (17.5)
Knees	15 (12.7)	23 (18.9)	38 (15.8)
Ankles and feet	17 (14.4)	28 (23.0)	45 (18.8)

*Pain may have been experienced in more than one body part.

Table 5. Association between type of school and musculoskeletal pain (*N*=240)

Variable	Pain, *n*	No pain, *n*	χ^2	*p*-value
12 months			149.197	0.000
Public	49	69		
Private	83	39		
7 days			147.241	0.000
Public	43	75		
Private	60	62		
Pain currently present			150.008	0.000
Public	16	102		
Private	27	95		

more common in obese and overweight students than in students within the normal BMI range. It may also indicate that students in public schools engage in more physical activity than those in private schools, because most public school students walk to school, whereas most private school students commute by car. Further, Papadopoulou *et al.*[22] reported that pain was more common among students who were less physically active, consistent with Fritz *et al.*'s[13] findings that physical activity increases muscle strength in both male and female students and that increased muscle strength increases the pain threshold. An additional factor may be that private school students have more classroom activities because these schools offer more subjects, resulting in longer periods of sitting compared with public schools, and long sitting hours can predispose students to pain.[6]

The relationship between the weight of the school bag and pain intensity in the present study was statistically significant. This finding may mean that the heavier the school bag, the more pain is experienced by the child who carries it, which is in agreement with Haroon *et al.*[23] We found that close to 90% of pupils at both public and private schools carried their bags on both shoulders, which means that double-strap backpacks are far more commonly used than other types of school bag by primary school pupils in Ondo City. This finding corresponds with that of Mohammadi *et al.*,[24] who reported that 92.5% of students in their study used double-strap bags and carried their bags on their backs.

Analysis of MSP according to body part in the present study revealed that both public and private school pupils had a high prevalence of pain in the neck. This may be because of the repeated flexion that occurs when carrying a backpack, i.e. increment in the cranio-horizontal angle.[25] Pain in both shoulders was common in both public and private school pupils, probably because the increase in the anterior positioning of the head when carrying a backpack may in turn increase the sagittal shoulder angle and bring about increased stress on both shoulders, and also because of the biomechanical stress caused by the backpack.[26]

Physically active students have been reported to have lower prevalences of pain,[22] which may be the reason why public school students in the present study had a lower prevalence of pain than the students in the private schools. However, we did not assess the level of participation in physical activity, so it could be suggested that future studies assess physical activity levels when comparing the prevalence of MSP between private and public schools.

Recommendation

It is recommended that teachers and parents ensure that children, especially those attending private schools, carry school bags of a safe weight. The bag should not weigh more than 15% of the child's weight.[4]

Conclusion

More than 50% of pupils attending primary schools in Ondo City had experienced MSP during the past 12 months. The prevalence was higher among the private school pupils than the public school pupils. The private school pupils carried heavier bags, and the heavier the bag, the more the pain.

Declaration. The research for this study was done in partial fulfilment of the requirements for ATT's BPT degree at the University of Medical Sciences, Ondo City.

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Author contributions. ATT designed the study, collected the data, searched the literature, did the initial write-up, interpreted the data and did the final write-up. AOO supervised and designed the study, provided grammatical expertise and was in charge of the research methodology. AAA critically analysed the study and edited the write-up.

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Data availability statement. The datasets generated and analysed during the current study are available from the corresponding author (ATT) upon reasonable request.

Conflicts of interest. None.

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