Prevalence and determinants of musculoskeletal pain among school-going children carrying schoolbags: A cross-sectional study from Central India

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ABSTRACT

Musculoskeletal disorders constitute 1,194 prevalent cases per 1,00,000 among children aged 5 to 19 years in India. School bags with a weight exceeding 10% of the bodyweight is a common cause of backache in school children. Methods: School children aged 8–15 years from four private schools of Bhopal were included, resulting in a sample of 934 participants. An author-assisted questionnaire was used for data collection. Results: The school bags were 16.3% of the average weight of students. 55.9% of the students experienced pain in the last 12 months, 41.6% in the last ten days and 21.3% had visited a doctor for the same. On analysis, bags with ≥ three compartments (AOR: 3.17), using both shoulders to carry bags (AOR: 0.10), and the absence of lockers in schools (AOR: 17.80) were significant predictors of pain in the last ten days (⁠P< 0.05). Conclusion: Massive advocacy and orientation are required at all levels for educational administrators, teachers, parents and students.

Keywords: Musculoskeletal pain, Nordic body map, school bag policy, school bags

Introduction

Globally, the number of children aged 5 to 19 years is 1917.9 million, of which 19.3% (370.2 million) are from India.¹,² Between 5 to 14 years of age, Non Communicable Diseases (NCDs) constitute 84,491 prevalent cases per 1,00,000, of which musculoskeletal disorders constitute 1,194 cases per 1,00,000 (Global, 1,634 per 1,00,000).³

One of the several forms of manual load carriage and the most popular means of carrying books and supplies among school children today are by school bags.⁴ Carrying a schoolbag is a daily activity for most children and is an appropriate way of loading the spine closely and symmetrically while maintaining stability.⁵,⁶ Efficient erect posture is believed to reflect the least amount of physical activity required to maintain body position in space and minimize the stress on the body tissue. An application of external forces in the form of school bags causes postural deviations and musculoskeletal disorders.⁷

The school bag is a common cause of backache in school-going children. A heavy bag may cause a child to compensate by leaning his body forward or through lumbar hyperextension, and this can strain muscles of the neck, shoulders and back.⁸ The child may also find it difficult to put the bag on and take it off, or he/she may fall frequently while carrying his/her schoolbag.⁹ The relative load carried by schoolchildren (expressed as % body weight) has been considered in ergonomic studies as one of the

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contributory factors for developing musculoskeletal problems among this age group.

In India, besides a moving speech by eminent writer R.K Narayan in Rajya Sabha,[8] National Curriculum Framework (NCF) 2005[9] draws insight from the Report ‘Learning without Burden (Yash Pal Committee report, 1993), indicating the school bag as a source of physical discomfort.[10]

Many states and UTs have taken some initiatives to address issues related to heavy school bags, such as creating a semester system in schools (Tamil Nadu)[11,15] and locker systems for keeping textbooks in school (Kendriya Vidyalayas).[16] The state of Telangana and Maharashtra (Measures to be taken to reduce the burden of school bag (Daptar) of the Children) had also circulated guidelines on school bags.[17,18] Further, the Honorable High Court of Jurisdiction at Madras has directed the Union of India to formulate a policy on children’s school bags on the lines of the Children’s School Bag (Limitation on Weight) Bill, 2006[19,20], resulting in Policy on School Bag 2020 by National Council of Educational Research and Training, Ministry of Education, Government of India.[21] The policy recommends weight for school bags as 10% of the bodyweight of the students across Classes I to X.[21] This is in line with recommendations of various international organizations like the American Occupational Therapy Association (AOTA) (10% of body weight),[22] American Physical Therapy Association (APTA) (10%),[23] Health Promotion Board of Singapore (10%),[24] and the American Chiropractic Association (ACA) (5–10%).[25]

School bags load exceeding 10% of the bodyweight increases energy consumption, increases the neck and trunk forward lean, results in decreasing lung volumes and increased cardio-respiratory parameters. It also affects the spinal posture, foot shape and gait.[26,27] Despite the evidence, there is still no awareness and/or practice among children, parents and teachers with the appropriate weight, mode of carrying a schoolbag and factors associated with carrying a heavy school bag and/or associated backache. Besides distress to children, parental concerns, school absenteeism, the burden on the existing primary healthcare system in terms of both case load and economic costs are significant.

The aim of this study was to investigate the weight of schoolbags and the effects of schoolbag carriage on children. The specific objectives were to measure the weights of schoolbags, to determine the percentage of bodyweight carried through schoolbags, to record reported musculoskeletal pain due to schoolbag carriage and to assess the factors associated with reported musculoskeletal pain.

Materials and Methods

This was an observational cross-sectional study done in selected private schools of Bhopal over a period of four months from September 2017 to December 2017. Four schools were selected randomly from all the private schools in the catchment area of Urban Health and Training Centre, Department of Community Medicine, Gandhi Medical College, Bhopal. In each school, children (5–15 years) present on the day of the survey were included. Those with pre-existing orthopedic complaints, inability to stand on a weighing scale and inability to carry a school bag were excluded, resulting in a sample of 934 children/adolescents.

Each school was visited twice; on the first visit, permission was sought from respective school principals, an explanation of the study was given, and consent/assent forms were handed out to all eligible students. On the second visit, the weight of students with and without the bags was recorded. After explaining the objectives of the study, an author-assisted questionnaire was completed by students that included their socio-demographic details, lifestyle factors, medical factors and school bag characteristics. They were then asked to mark the site and grade of pain (A = 1 (no pain felt), B = 2 (moderate pain), C = 3 (pain), D = very painful) using a modified Nordic Body Map Questionnaire. The modified Nordic Body Map Questionnaire is a screening tool that allows the comparison of the low back, neck, shoulder, and general complaints about the use in epidemiological studies. The sensitivity of the tool ranged between 66 and 92% and specificity between 71 and 88%.[21]

Data was entered into Micro Soft Excel and statistical analysis was done using SPSS v23. The descriptive analysis, including percentages, was computed for every variable. Chi-square tests to find associations were performed; variables found significant at P < 0.05 were taken for Multivariate Logistic Regression.

Results

Socio-demographic characteristics: The study included a total of 934 participants between 8 to 15 years of age (11.37 ± 1.36 years). The majority were of early adolescence (69.6) and most students were male (60.6%) [Table 1]. The average weight of students was 38.25 ± 2.08 kilograms (16 to 45 kgs).

School bag characteristics: Bags with double straps were the most commonly used type (95.6%), 83.2% of the bags had padded straps and 81.5% of the bags had less than or equal to two compartments. The majority of the participants used both their shoulders to carry school bags. The average weight of the school bags was 6.31 ± 1.66 kilograms and 44.4% of the participants perceived that the weight of school bags is heavy; 53.9% reported leaning forward while carrying bags. The bags were 16.5% of the average weight of students. Almost two-thirds of the study participants reached school on self; bus (57.9%), auto (35.1%) and on foot (4.3%) being the most common mode of transport. Only 13.6% of the participants had locker facilities in their schools. More than half (55.9%) had experienced pain in the last 12 months, 41.6% in the last ten days and 21.3% had visited a doctor for the same.

Factors associated with musculoskeletal pain: In univariate analysis, bags without padded straps, bags with three or more compartments,
using one shoulder to carry bags, perception of bag weight, the practice of leaning forward while carrying bags and absence of lockers in schools were significantly associated with a history of pain in the last ten days \( (P<0.05) \). In Multiple Logistic Regression, it was found that bags with three or more compartments \( (3.17 \ (2.06 - 4.86)) \), using both shoulders to carry bags \( (0.10 \ (0.02 - 0.46)) \), the practice of leaning forward while carrying bags \( (1.57 \ (1.11 - 2.22)) \) and absence of lockers in schools \( (17.80 \ (8.56 - 37.03)) \) were significant predictors of history of pain in the last ten days \( (P<0.05) \) [Table 2].

The site and grade of pain as reported using the modified Nordic Body Map Questionnaire are given in Table 3 and Figure 1.

### Discussion

The average weight of the school bags in this study was higher than studies done in similar age group children.\([30–34]\) This may be attributed to the loaded syllabus, increasing workloads/homework and growing competition\([31]\), necessitating a review of the National Curriculum Framework (NCF) and syllabus cut down, accounting for total study time that is expected from students (in both face to face and self-study or homework) while planning the syllabus, especially as they go to higher grades. The Negative Influences of Exam-Oriented Education are widely documented\([35]\) and it is the need of the hour to inculcate value education, life skills, experiential learning and physical fitness in the daily life of children.

The relative load (as schoolbags) carried by schoolchildren was found to be 16.5% of body weight. This was similar to the study conducted by Balamurugan J\([32]\), but higher than studies conducted by Panicker R K et al., Dockrell S, Whittfield et al. and Khan R et al.\([34,36–38]\) With the growing spine (Mean age of

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**Table 1: Association between demographic, bag related factors and musculoskeletal pain**

| Pain in last 10 days | Present n (%) | Absent n (%) | Total (%) | \( P \) |
|----------------------|--------------|--------------|-----------|--------|
| **Age (in years)**   |              |              |           |        |
| 8-10                 | 122 (43.0)   | 162 (57.0)   | 284 (30.4) | 0.392  |
| 11-15                | 267 (41.1)   | 383 (58.9)   | 650 (69.6) |        |
| **Gender**           |              |              |           |        |
| Male                 | 241 (42.6)   | 325 (57.4)   | 566 (60.6) | 0.474  |
| Female               | 148 (40.2)   | 220 (59.8)   | 368 (39.4) |        |
| **Class**            |              |              |           |        |
| Primary              | 187 (43.8)   | 240 (56.2)   | 427 (45.7) | 0.222  |
| Middle               | 202 (39.8)   | 305 (60.2)   | 507 (54.3) |        |
| **Type of bag**      |              |              |           |        |
| Single strap         | 12 (40.0)    | 18 (60.0)    | 30 (3.2)  | 0.921  |
| Double strap         | 373 (41.7)   | 520 (58.3)   | 893 (95.6) |        |
| Trolley strap        | 4 (37.5)     | 7 (62.5)     | 11 (1.2)  |        |
| Bag with padded strap|              |              |           |        |
| Yes                  | 306 (39.4)   | 471 (60.6)   | 777 (83.2) | 0.002  |
| No                   | 83 (52.9)    | 74 (47.1)    | 157 (16.8) |        |
| **Number of compartments** |          |              |           |        |
| ≤2                   | 279 (36.7)   | 482 (63.3)   | 761 (81.5) | <0.001 |
| ≥3                   | 110 (63.6)   | 63 (36.4)    | 173 (18.5) |        |
| **Mode of carrying** |              |              |           |        |
| One shoulder         | 153 (79.7)   | 39 (20.3)    | 192 (20.5) | <0.001 |
| Both shoulders       | 230 (31.5)   | 501 (68.5)   | 731 (78.3) |        |
| Via trolley          | 6 (54.5)     | 5 (45.5)     | 11 (1.2)  |        |
| **Perception of bag weight** |        |              |           |        |
| Heavy weight         | 153 (36.9)   | 262 (63.1)   | 415 (44.4) | 0.010  |
| Medium weight        | 219 (44.7)   | 271 (55.3)   | 490 (52.5) |        |
| Light weight         | 17 (58.6)    | 12 (41.4)    | 29 (3.1)  |        |
| **Lean forward while carrying bag** | |              |           | <0.001 |
| Yes                  | 256 (50.9)   | 247 (49.1)   | 503 (53.9) | <0.001 |
| No                   | 133 (30.9)   | 298 (69.1)   | 431 (46.1) |        |
| **Lockers**          |              |              |           |        |
| Yes                  | 20 (15.7)    | 107 (84.3)   | 127 (13.6) | <0.001 |
| No                   | 369 (45.7)   | 438 (54.3)   | 807 (86.4) |        |
| **Time spent on studying** |       |              |           | 0.839  |
| <1 h                 | 66 (43.7)    | 85 (56.3)    | 151 (16.2) |        |
| 1-2 h                | 148 (40.9)   | 214 (59.1)   | 362 (38.8) |        |
| >2 h                 | 175 (41.6)   | 246 (58.4)   | 421 (45.0) |        |
study participants was 11.37 ± 1.36 years) vulnerable to physical stresses, and physical stress (School bags were on an average 16.5% of body weight) being a predisposing factor in adolescent spinal pain, the supposition that the carrying of a backpack is a contributing risk factor to adolescent low back pain bears merit. Adopting best practices like allocating lockers for each child in school has been associated with significantly reduced musculoskeletal pain.

The use of bags with padded straps, less than or equal to two compartments, the practice of using both shoulders to carry bags were significantly associated with no musculoskeletal pain. This is in accordance with studies conducted by Balamurugan J, Dockrell S et al., Arghavani F et al[31,32,34]. This mandates creating awareness among students, parents and teachers regarding appropriate bag design and use. Also, policy decisions in terms of setting minimum schoolbag standards i.e., ergonomics of school bags, restricting the sale of bags not fulfilling these standards and a system for periodic monitoring to sure accountability.

Almost half (44.4%) of the participants perceived the weight of school bags to be heavy, much higher than those reported by similar other studies. The act of leaning forward while carrying a bag was significantly associated with musculoskeletal pain in

| Table 2: Predictors of musculoskeletal pain (Multiple Logistic Regression) |
| Variables | Adjusted odds ratio | 95% CI | P |
| Bag with padded strap | 0.73 | 0.47-1.03 | 0.158 |
| Number of compartments (≥3) | 3.17 | 2.06-4.86 | <0.001 |
| Mode of carrying (One shoulder) | 1.55 | 0.34-7.11 | 0.574 |
| Mode of carrying (Both shoulders) | 0.10 | 0.02-0.46 | 0.003 |
| Perception of bag weight (Heavy) | 0.63 | 0.27-1.51 | 0.304 |
| Perception of bag weight (Medium) | 0.67 | 0.29-1.56 | 0.355 |
| Lean forward while carrying bag | 1.57 | 1.11-2.22 | 0.010 |
| Lockers (No) | 17.80 | 8.56-37.03 | <0.001 |

| Table 3: Pain characteristics based on modified Nordic Body Map |
| Nordic areas | Location | Grade of complaints |
| | | A | B | C | D |
| 0 | Pain/stiff in the upper neck (n=902) | 784 (86.9) | 70 (7.8) | 33 (3.7) | 15 (1.7) |
| 1 | Pain in the lower neck (n=811) | 691 (85.2) | 57 (7.0) | 44 (5.4) | 19 (2.3) |
| 2 | Pain in the left shoulder (n=893) | 676 (75.7) | 130 (14.6) | 70 (7.8) | 17 (1.9) |
| 3 | Pain in the right shoulder (n=820) | 674 (82.2) | 80 (9.8) | 47 (5.7) | 19 (2.3) |
| 4 | Pain in the left upper arm (n=883) | 643 (72.8) | 134 (15.2) | 79 (8.9) | 27 (3.1) |
| 5 | Pain in the back (n=876) | 664 (75.8) | 129 (14.7) | 60 (6.8) | 23 (2.6) |
| 6 | Pain in the right upper arm (n=831) | 658 (79.2) | 88 (10.6) | 54 (6.5) | 31 (3.7) |
| 7 | Pain in the waist (n=837) | 680 (81.2) | 79 (9.4) | 54 (6.5) | 24 (2.9) |
| 10 | Pain in the left elbow (n=897) | 780 (87.0) | 73 (8.1) | 29 (3.2) | 15 (1.7) |
| 11 | Pain in the right elbow (n=816) | 752 (92.2) | 34 (4.2) | 23 (2.8) | 7 (0.9) |
| 12 | Pain in the left lower arm (n=903) | 819 (90.7) | 46 (5.1) | 25 (2.8) | 13 (1.4) |
| 13 | Pain in the right lower arm (n=809) | 756 (93.4) | 26 (3.2) | 18 (2.2) | 9 (1.1) |
| 14 | Pain in the left wrist (n=902) | 845 (93.7) | 39 (4.3) | 13 (1.4) | 5 (0.6) |
| 15 | Pain in the right wrist (n=809) | 774 (95.7) | 12 (1.5) | 15 (1.9) | 8 (1.0) |
| 16 | Pain in the left hand (n=909) | 856 (94.2) | 35 (3.9) | 7 (0.8) | 11 (1.2) |
| 17 | Pain in the right hand (n=804) | 788 (98.0) | 5 (0.6) | 6 (0.7) | 5 (0.6) |

Note: No pain/stiffness were reported in areas 8, 9, 18 to 27 of modified Nordic Body Map
children. But whether children lean forward because of heavy bags or the habit of leaning forward with/without the bag on their shoulders could not be elicited with cross-sectional study design adopted in this study. The time spent on carrying bag to/from school, studying and watching television (activities predominantly done in sitting posture) were not associated with presence/absence of musculoskeletal pain.

More than one in five children had hospital visits for musculoskeletal pain associated with schoolbag carriage. Apart from increasing healthcare costs, it adds to parental concerns resulting in stress and anxiety. In a study conducted by Dianat I et al.,[10] the results of binary logistic regression indicated that the school bag weight (expressed as a percentage of body weight) was significantly associated with hand/wrist symptoms ($P < 0.05$).

The Pain characteristics elicited using the modified Nordic Body Map in this study showed that pain and/or stiffness reported by children were limited to the neck, shoulders, hands, waist and back – the upper body segment. This is similar to studies conducted by Spiteri K et al., Perrone M et al., Mwaka E S et al., Akbar F et al. and Dianat I et al.[10,39–42] The primary healthcare providers and family physicians should be aware of the characteristics of musculoskeletal symptoms due to schoolbag carriage and should look for factors associated with reported musculoskeletal pain.

Further studies to throw insights into efficient school bag designs, the impact of measures taken to reduce school bag weights, healthcare costs associated with heavy school bags, the association between schoolbag weights, scholastic performance of children and parental concerns are a dire necessity.

**Conclusion**

A multitude of research, classroom transaction process studies and/or reports conducted from time to time have revealed that the schoolbags are heavy, resulting in musculoskeletal pain and/or discomfort to children, and the consequences are many. To address this problem, massive advocacy and orientation are required at all levels for educational administrators, school heads, teacher educators, teachers, parents and students. The recently invoked Policy on School Bag 2020 by the National Council of Educational Research and Training, Ministry of Education, Government of India is a breakthrough in the right direction.

**Ethical considerations**

School authorities were approached, the purpose of the study was explained, and the necessary permissions were obtained. In the schools, the purpose of the study was explained to the participants, the confidentiality of the information was assured and consent/assent was obtained.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.

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