Article

British Journal of Pain
2017, Vol 11(2) 81–86

DOI: 10.1177/2049463717695144
journals.sagepub.com/home/bjp

Schoolbags and back pain in children between 8 and 13 years: a national study

Karl Spiteri[1,2], Maria-Louisa Busuttil[1,3], Samuel Aquilina[4], Dorothy Gauci[5], Erin Camilleri[6] and Victor Grech[4]

Abstract

Schoolbag weight in schoolchildren is a recurrent and contentious issue within the educational and health sphere. Excessive schoolbag weight can lead to back pain in children, which increases the risk of chronic back pain in adulthood. There is limited research regarding this among the Maltese paediatric population. A cross-sectional study was undertaken across all schools in Malta among students aged 8–13 years (inclusive). Data were collected using a questionnaire detailing schoolbag characteristics, self-reported pain and demographic variables, such as age and gender. Structured interviews with participants were also carried out by physiotherapists. A total of 4005 participants were included in the study, with 20% of the total Malta schoolchildren population. Over 70% of the subjects had a schoolbag that exceeded the recommended 10% bag weight to body ratio. A total of 32% of the sample complained of back pain, with 74% of these defining it as low in intensity on the face pain scale–revised. The presence of back pain was statistically related to gender, body mass index (BMI), school and bag weight to body weight ratio. After adjusting for other factors, self-reported back pain in schoolchildren is independently linked to carrying heavy schoolbags. This link should be addressed to decrease the occurrence of back pain in this age group.

Keywords

Back pain, obesity, schoolchildren, schoolbags, national

Introduction

Carrying schoolbags and school attendance is a daily routine for students. The incorrect handling of schoolbags with excessive bag weight can lead to back pain in children.[1–4] It is recommended that the total weight of the schoolbag does not exceed 10% of body weight.[1] The development of back pain in children is of concern since it increases the risk of developing chronic back pain in adulthood.[5] Studies have shown that the prevalence of low back pain in schoolchildren ranges from 25% to 55% in those aged between 10 and 15 years.[6–8] In most cases, the pain intensity is relatively low.[7]

Given that back pain may eventually lead to disability, decreased quality of life and time lost from work in adulthood,[9] a national cross-sectional study was undertaken in order to assess the prevalence of back pain in schoolchildren, as well as its association with schoolbags. A previous study in Malta on schoolbags found that 15% of pupils carry a schoolbag with a weight that is more than 20% of their body weight.[10]

This study took a national representative sample of schoolchildren in the Maltese Islands (Malta and the

[1]Malta Association of Physiotherapists, Gzira, Malta
[2]Ministry for the Family and Social Solidarity, Valletta, Malta
[3]Ministry for Social Dialogue, Consumer Affairs and Civil Liberties, Valletta, Malta
[4]Paediatric Department, Mater Dei Hospital, Msida, Malta
[5]Directorate for Health Information and Research, G'Mangia, Malta
[6]EU Affairs and International Relations, Research and Policy Development Directorate, Ministry for Education and Employment, Floriana, Malta

Corresponding author:
Karl Spiteri, Malta Association of Physiotherapists, Professional Building, 3rd Floor, Sliema Road, Gzira GZR 1633, Malta.
Email: karl.b.spiteri@gov.mt

sister Island Gozo) from all education providers, namely, State schools, church-run schools and independent private schools. State schools cover 54% of students in the system, while church-run schools cover 34%. The study was carried out concurrently with the Malta Childhood National Body Mass Index Study.

Methods

Sampling

The target population identified for this study were students in the last two grades of primary school and first three grades of secondary school, aged 8–13 years. This covers a total of 134 schools and 20,359 students in all five grades, with an average of 4000 per grade. Sixty-three schools were primary (grades 5 and 6 only), 48 secondary (grades 7, 8 and 9) and the remaining 23 schools were mixed. On average, there were 20 students per class. Sample size calculation was carried out assuming an overall prevalence of back pain of 30% based on data from previous studies.[2,8] A precision of 5% was taken. A minimum sample of 360 students per grade was needed, resulting in a minimum total population of 1440. Two-stage cluster sampling was used to obtain the required sample with classes being the primary sampling units. To ensure that the sample selected represented all school types within the schooling system and coverage across the Islands was complete, all schools were included at the first stage. Within each school one class per grade was selected. In schools where there were more than one class per grade, the school administration was asked to randomly select one. Administration staff who selected the classes were blind to the aim of the study. All students present in the class on the day of data collection were included. Data collection was carried out between October and December 2015 during weekdays and regular school hours.

Criteria

All students who were in the grades identified were eligible to participate in the study. Children who refused to participate or were sensitive to being measured were excluded from the study. Children who were unable to stand on the scale unaided or used medical devices, such as plaster casts or prostheses, were excluded from the study. Children who were unable to communicate or unable to respond to the questionnaire due to medical and cognitive conditions were also excluded from participation.

Tools

The interview included questions regarding bag type, how the bag is carried, the use of lockers, participation in sport, presence of back pain, pain location through the use of a body chart, pain intensity using a face pain scale–revised (FPS-R),[11] frequency, and consequence of back pain. The FPS-R was used as it provides a simplified tool to measure pain intensity in children. The scale has six facial expressions representing increasing pain. Participants were asked about their perceptions of lockers; whether they felt they had enough time to access their lockers and if they were accessible. This was done using one question per variable with a yes or no answer. These questions were added after piloting the questionnaire with physical education teachers, as they expressed concern that students might not use their lockers. Student weight and bag weight were collected using identical scale stadiometers, which were calibrated prior to the start of data collection. Anthropometric measurements, weight and height in all schools were carried out by physical education teachers, as part of the national body mass index (BMI) study. Each participant (student) was first weighed with light clothing, and then re-measured holding all their schoolbags to obtain the total schoolbag weight. Following measurement, they underwent a face-to-face interview with the assigned physiotherapist, and the procedure was carried out concurrently.

Analysis

Data collected were inputted into Microsoft Access 2007© database. BMI and percentage bag weight were calculated automatically through this database. These were transferred to SPSS Version 21© and analysed.

Pain frequency was considered the dependent variable. In the data collection, pain frequency was collected through an ordinal response scale (no pain, less than monthly, once a month or more and weekly). For the purpose of analysis, this was transformed into a dichotomous variable where it was classified as 'pain once a month or more' and 'no pain'. No pain and pain less than monthly were grouped together and made up 76% of the sample. Pain more than once a month and weekly were grouped together as this was considered as a frequency of pain which could predispose to further back problems. This grouping allowed for a more simplified analysis through the use of a binary outcome. Univariate analysis was done using chi-square and independent *t*-test to assess the independent relationships of the variables with pain frequency. Multivariate analysis was conducted using a logistic regression framework. A p-value of <0.05 was taken to represent a statistically significant difference.

Limitations

Since data were collected on pre-determined dates, the children who were absent on the day could not be

included in the study (no data available). Given that participants were unaware of the date of the study prior to data collection, absenteeism was assumed to be random. All data were inputted through written questionnaires that incorporated a pain assessment. Errors could have occurred while copying data. In case of evident errors, questionnaires were removed from the data analysis. To reduce researchers' bias, researchers underwent training to ensure conformity while asking questions and taking anthropometric measurements on the subjects.

Ethics and data protection

Ethical approval for the study was obtained from the Malta University Research Ethics Committee and the Ethics Committee of the Malta Education Division. Data Protection approval for this study was obtained from the Malta National Commissioner for Data Protection. Separate permissions were obtained from the Central Church Schools authorities and from the Independent schools. The study was also endorsed by the Maltese Director of Public Health, who went on record, stating that this study is of national public health importance, as per Article 4B of the Malta Public Health Act 2003: 'to develop and implement strategies to promote and improve public health'. All data were collected on paper and all participants' identifiable information omitted in order to maintain participant anonymity. Consent for the study was obtained from the participant's guardians. Even when guardians consented, participants had the right to refuse during data collection.

Results

The study population included 100 schools as 34 schools refused participation in the study because data collection coincided with examination period. The number of students included in the study from primary schools was higher than the required due to a high response rate (86%) in these schools. The response rate in secondary schools was 70%, while it was 50% in mixed schools. The final number of respondents was 4005 participants. Of these, 4% (n = 153) of the questionnaires were excluded from the analysis due to missing data, therefore 3852 participants were considered in the analysis. Table 1 shows a breakdown of the population by school type, grade and gender. The distribution of students across the school types was comparable to the distribution across the student population within the school system. The gender distribution was equal overall (50.3% female).

When looking at bag weight to body weight ratios, 71% of the participants carried a bag weight in excess of the recommended 10% of body weight. The median overall bag weight was 5 kg. The mean bag weight varied by school type, with a higher mean bag weight found in non-state-run schools (6.2 kg, ±2.3) when compared to state-run schools (4.7 kg, ±1.9, p-value < 0.001). Table 2 shows the distribution of mean bag weight and mean percentage bag to body weight by grade. An association was found between bag weight ($p < 0.001$) and percentage bag to body weight ratio ($p < 0.001$) when comparing across grades. Bag weight and percentage bag to body weight increased with increasing grade.

Table 1. Background characteristics of the study population.

	n	%
Total	3852	100
School type		
Public	1999	52
Non-public	1846	48
Grade		
5	1274	33.1
6	1171	30.4
7	478	12.4
8	457	11.9
9	472	12.3

The self-reported prevalence of back pain (neck, upper back, thoracic or lumbar area) in the study was 25% (n = 624) in grades 5 and 6 (8 and 9 years), and was 44% (n = 620) in grades 7–9 (10–13 years). In total, 8% of grades 5 and 6 and 17% of grades 7–9 reported pain in multiple sites in their back. When looking at the intensity of pain, 74% of these had pain intensity on the face pain scale of less than 2.

Table 3 shows the one-to-one relationships between the independent variables and the presence of back pain for our binary scale outcome. Participation in sports was not found to be statistically related to the presence of back pain ($p = 0.14$). The remaining variables were all associated with the self-reported prevalence of back pain. The prevalence of back pain was higher among females, those carrying two or more bags and those carrying their bag on one shoulder. Students in non-public school and those in secondary school had a higher prevalence of self-reported back pain. The mean age, BMI and percentage bag weight to body weight were also higher in students reporting back pain.

A logistic regression model was used to assess the relationship between all the independent variables and presence of back pain. A forward stepwise method was used including all two-way interactions between the variables. None of the interactions were significant and were excluded. Table 4 presents the final regression model. Independent of other competing factors in the

Table 2. BMI, bag weight and percentage bag to body weight by grade, one-way ANOVA analysis.

Variable	Grade	Mean	CI	Standard deviation	p-value
Bag weight (kg)	Grade 5	4.5	4.4–4.6	1.6	<0.01**
	Grade 6	4.5	4.4–4.6	1.9	
	Grade 7	6.9	6.7–7.1	2.0	
	Grade 8	6.7	6.5–7.0	2.0	
	Grade 9	6.8	6.6–7.0	2.5	
Percentage bag to body weight	Grade 5	13.9	13.5–14.2	6.0	<0.01**
	Grade 6	13.1	12.8–13.5	6.2	
	Grade 7	16.7	16.1–17.3	6.3	
	Grade 8	14.5	13.8–15.0	6.7	
	Grade 9	12.9	12.4–13.4	5.5	

ANOVA: analysis of variance; BMI: body mass index; CI: confidence interval.
**p-value significant at <0.01.

Table 3. Univariate analysis of relationship demographic and school-related participant characteristics and self-reported presence of back pain (binary outcome).

Presence of back pain at least once a month		No (%)	Yes (%)	p-value
Gender	Male	55	45	<0.01**
	Female	40	60	
No. of bags	1	70	30	<0.01**
	2+	59	41	
Type of bag	Backpack	67	33	0.01*
	Other	74	26	
How bag is carried	Two shoulder	68	32	<0.01**
	One shoulder	56	44	
	Other	68	32	
Sport participation	Yes	68	32	0.14
	No	67	33	
Grade	Grade 5	76	24	<0.01**
	Grade 6	73	27	
	Grade 7	57	43	
	Grade 8	54	46	
	Grade 9	68	32	
School type	Public	55	45	<0.01**
	Non-public	45	55	
		Mean (SD)	Mean (SD)	p-value
BMI (kg/m^2)		19.9 (4.7)	20.7 (4.9)	<0.01**
Percentage bag weight to body weight		13.7 (6.2)	14.5 (6.3)	<0.01**
Age (years)		11.1 (1.4)	11.5 (1.5)	<0.01**

BMI: body mass index; CI: confidence interval; SD, standard deviation.
Chi-square and *t*-test analysis.
**p-value significant at <0.01; *p-value significant at <0.05.

model, an association was found between the presence of back pain and gender, BMI, bag weight to body weight ratio and school grade. Being male and being in primary school are protective factors with respect to self-reported back pain. Males are less likely to report back pain when compared to females (odds ratio (OR) = 0.51, 95% confidence interval (CI) 0.45–0.59), $p < 0.00$), while students in grade 5 (OR = 0.48, 95% CI 0.35–0.57, $p < 0.00$) and grade 6 (OR = 0.49, 95% CI 0.39–0.62, $p < 0.00$) are less likely to report back pain when compared to students in grade 9. There are no differences when comparing the secondary school grades (grades 7 and 8) with the reference group (grade 9). On the other hand, as BMI (OR = 1.04, 95% CI

Table 4. Binary logistic regression model for presence of back pain.

	OR	95% CI	p-value
Gender			
Male	0.51	0.45–0.59	<0.01**
Female	Ref	–	
School grade			
5	0.48	0.35–0.57	<0.01**
6	0.49	0.39–0.62	<0.01**
7	0.96	0.74–1.23	0.79
8	1.1	0.83–1.44	0.50
9	Ref	–	
BMI (kg/m^2)	1.04	1.02–1.05	<0.01**
Percentage bag to body weight	1.03	1.01–1.04	<0.01**

BMI: body mass index; OR: Odds ratio; CI: confidence interval.
Reference category 'no back pain'.
**p-value significant at <0.01.

1.02–1.04, $p < 0.00$) and bag to weight ratio (OR = 1.03, 95% CI 1.01–1.04, $p < 0.00$) increase, the likelihood of reporting back pain also increases.

Discussion

The study was the first national study which looked into the effect of bag weight on back pain in schoolchildren in Malta. It found that bag weight contributes towards back pain in children, together with BMI, gender and grade. Compared to the previous study[8] the prevalence of pain was similar in 8- and 9-year olds, and both studies took into consideration pain in all the spine. In both studies, about 33% of children complained of pain in their spine. Seventy percent of those complaining of pain indicated neck, shoulder and midthoracic as their source of pain.[1] In 10–12 years old, the percentage of females with back pain was lower (50%) than in previous research[8] (60%), while in males the percentages were similar (both 37%). In contrast, the other research[8] included a physical examination, while this study was based on self-reported symptoms.

The study highlights the multi-factorial nature of back pain in schoolchildren. The final statistical model confirms the previous literature that there is a gender difference in the prevalence of back pain in schoolchildren.[1,2,5,12] BMI was also found to be a risk factor towards the development of back pain in children.[2,13] In the final model, bag weight to body weight ratio was analysed as a continuous variable instead of using the recommended 10% bag weight to body weight ratio.[1] The model shows that there is an increased risk of developing back pain with every 1% increase in bag weight to body weight ratio. Unlike the results of other studies, age was not associated with the presence of back pain but school level was.[5,11] The prevalence of back pain was different between primary and secondary schools. This might highlight an environmental factor towards the development of back pain. It is customary for primary schoolchildren to remain in the same class room over the course of a day, while secondary school pupils are expected to change class rooms according to their time table. Even though lockers are available in all secondary schools in Malta, 46% of the sample population pointed out that they did not have enough time to access their locker, which meant that they had to carry their schoolbags with all they required from room to room. In secondary schools, the number of subjects studied increase which would translate in more books to carry.

Similar to a previous study,[2] more than 70% of the studied population carried more than 10% of the recommended bag weight to body ratio. This further highlights our concern about the excessive bag weight carried by Maltese schoolchildren. Compared to a previous study in Malta,[10] the mean bag weight to body ratio increased in secondary grades, while it remained the same in primary grades.

The majority of students (more than 90%, in this study) reported that they used a backpack and carried it strapped to their back using both straps, as generally recommended. This did not allow for comparison of bag handling and bag type. A Hawthorn effect might have developed when asking about how the bag was carried, as this was done through interview and not through observation.

The major strength of this study is that it was a national representative sample from different school types and from all areas around the Island, which included different socio-economic groups. In addition, data collection was carried out throughout the week, which would tend to average out any variation in bag weight which might have occurred during the week.[14] This study did not take the length of time students carried their bag into consideration. The influence of whether parents smoked or suffered from chronic back pain was not factored in either.

The study highlights a strong link between the prevalence of low back pain and the lifting of heavy schoolbags in Malta. The prevalence of back pain in children merits public health action,[9] and attempts to prevent back pain at a young age could help decrease the burden in older age groups. The general recommendation of this study is to step up public health action and develop a monitoring system that is both preventative and proactive. Its aim would be to help children and their support network to identify those factors that could predispose children of this age to back pain and to empower them with the necessary skills to independently monitor the weight of their schoolbags on a

daily basis. This initiative could be further supported by physiotherapists, as specialists in movement and exercise in schools.[15]

Acknowledgements

The authors would like to thank Hon. EvaristBartolo, Minister for Education and Employment; Hon. Christopher Fearne, Minister for Health; Members of the Malta of Association of Physiotherapists who collected all the data; Physical Education teachers for their assistance in data collection; Mr Louis Scerri, Assistant Director, Research and Development Department, Education Division; Dr Francis Fabri, Director, Research and Development Department, Education Division; and Mr Raymond Camilleri, Director, Research and Development Department, Education Division.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship and/or publication of this article.

References

1. Moore M, White G and Moore D. Association of relative backpack weight with reported pain, pain sites, medical utilization, and lost school time in children and adolescents. *J Sch Health* 2007; 77: 232–239.
2. De Paula A, Silva J, Paschoalli L, et al. Backpacks and school children's obesity: challenges for public health and ergonomics. *Work* 2012; 41: 900–906.
3. Puckree T, Silal S and Lin J. School bag carriage and pain in school children. *Disabil Rehabil* 2004; 26: 54–59.
4. Grimmer KA, Williams MT and Gill TK. The associations between adolescent head-on-neck posture, backpack weight, and anthropometric features. *Spine* 1999; 24: 2262–2267.
5. Wirth B and Humphreys K. Pain characteristics of adolescent spinal pain. *BMC Pediatr* 2015; 15: 42.
6. Macedo R, Coelhp-e-Silva MJ, Sousa NF, et al. Quality of life, school backpack weight, and nonspecific low back pain in children and adolescents. *J Pediatr* 2014; 91: 263–269.
7. Aartun E, Hartvigsen J, Wedderkopp N, et al. Spinal pain in adolescents: prevalence, incidence and course: a school-based two-year prospective cohort study in 1,300 Danes aged 11–13. *BMC Musculoskelet Disord* 2014; 15: 1–8.
8. Wirth B, Christina Knecht C and Humphreys K. Spine day 2012: spinal pain in Swiss school children–epidemiology and risk factors. *BMC Pediatr* 2013; 13: 1–10.
9. Duthey B. Background paper 6.24: low back pain. In: World Health Organisation (WHO) (ed.) *Priority medicines for Europe and the world 'A public health approach to innovation'*. Geneva: WHO, 2013, http://apps.who.int/medicinedocs/documents/s20245en/s20245en.pdf
10. Buhagiar AJ, Borg Xeureb C, Camilleri C, et al. *Committee on the handling of heavy school bags 2000*. Report no. 433/2000, 2000. Floriana: Ministry of Education, https://education.gov.mt/en/resources/Documents/Policy%20Documents/handling%20of%20heavy%20schoolbags.pdf
11. Hicks C, von Baeyer C, Spafford P, et al. The Faces Pain Scale-Revised: toward a common metric in pediatric pain measurement. *Pain* 2001; 93: 173–183.
12. Rodríguez-Oviedo P, Ruano-Ravina A, Pérez-Ríos M, et al. School children's backpacks, back pain and back pathologies. *Arch Dis Child* 2012; 97: 730–732.
13. Wilson A, Samuelson B and Palermo TM. Obesity in children and adolescents with chronic pain: associations with pain and activity limitations. *Clin J Pain* 2010; 26: 705–711.
14. Dockrella S, Kanea C and O'Keeffea E. Schoolbag weight and the effects of schoolbag carriage on secondary school students. In: *Proceedings of the international ergonomics association congress: meeting diversity in ergonomics*, Maastricht, 10–14 July 2006.
15. Calvo-Muñoz I, Gómez-Conesa A and Sánchez-Meca J. Preventive physiotherapy interventions for back care in children and adolescents: a meta-analysis. *BMC Musculoskelet Disord* 2012; 13: 1–19.