Research article

Does the weight of the schoolbag influence the occurrence of low back pain in schoolchildren?

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Abstract

Background: There is a global controversy on the role of schoolbag weight in the occurrence of Low Back Pain (LBP) in schoolchildren.
Objectives: To determine whether age and gender influence the relationship between LBP and School bag weight among schoolchildren in Douala, Cameroon.
Methods: We conducted a post hoc analysis of a cross-sectional study. Schoolchildren surveyed completed a self-administered questionnaire with the assistance of trained interviewers. We recorded sociodemographics, usual physical activity, and clinical data. Schoolbags were weighted on the day of the survey. Informed consent was obtained from the parents.
Results: Of the 1075 children (532 girls), 132 (12.3%) had LBP monthly. The median age was 11 years [range, 8–14 years]. There was no relationship between LBP and the weight of the schoolbag, regardless of gender, BMI, duration of pain, type of school, distance and way of transportation from home to school, and age. However, there was a trend toward an association between schoolbag weight in schoolchildren aged 8 to 10 years old carrying a schoolbag weighing > 15% of their body weight ($p = 0.05$). When looking at gender, a significant association was found only in girls aged 8 to 10 with a schoolbag weight > 15% of their body weight ($p = 0.036$).
Conclusion: Schoolbag weight was associated with the development of low back pain only in girls aged 8 to 10 years old carrying a schoolbag weighing more than 15% of their body weight.

Key words: Low back pain, Schoolchildren, Schoolbag, Risk factors, Cameroon

Introduction

Low Back Pain (LBP) is one of the most prevalent musculoskeletal conditions. It is a leading contributor to disease burden and a leading global cause of years lived with disability[1]. Several studies show that LBP is not only the prerogative of adults and elderly people. It also affects children and adolescents with mean LBP point, one-year, and lifetime prevalence of 12%, 33%, and 36%, respectively[2,3]. In addition, the prevalence of LBP also increases with age in children[4]. Their impact can be considerable and significantly restrict children's activities of daily living, including school attendance and participation in recreational and sports activities[5]. Although not well evaluated, the direct costs of LBP are enormous, but the burden also arises from parental missed work and associated lack of productivity[5].

Many risk factors have been identified as associated with the occurrence or persistence of LBP in children and adolescents. These include female gender, rapid growth, overweight and/or obesity, time spent watching television or using a computer (probably smartphones and tablets as well), mood disorders, smoking (even passive), personal history of spinal injury, family history of LBP (especially in parents), and poor seating positions in class[6-8]. Competitive sports are another major risk factor for LBP in children[6-8]. However, the incidence of LBP in children describes a U-shaped association with physical activity: low and high levels of physical activity are associated with a higher risk of developing LBP[9].

There is much controversy in the literature about the role of the schoolbag, particularly the backpack, in the occurrence of LBP in schoolchildren. Indeed, several studies have found an association between LBP and schoolbag

carriage[10-13]. However, this relationship was not found in many other studies[2,8,14-19]. This lack of relationship is reinforced by the results of two systematic reviews of the literature, which did not show an association between schoolbag weight and LBP among schoolchildren aged 9 to 16 years old, despite having been assumed for years and sounding plausible[2,14]. In our primary study, we did not find an association between LBP and backpack weight[8]. However, we did not take into consideration the age groups. Therefore, we conducted this study to determine whether children's age and gender could influence the relationship between LBP and backpack weight among schoolchildren in Cameroon.

Materials and methods

Study design and sample: We conducted a post hoc analysis from a survey of schoolchildren attending primary schools in the city of Douala, Cameroon between December 2015 and May 2016[8]. Its purpose was to determine the prevalence of LBP in Cameroonian schoolchildren and to describe the associated factors. The study was approved by the local ethics committee and complied with the principles of good clinical practice and the Declaration of Helsinki for medical research in humans. Signed informed consent forms were obtained from parents. Schoolchildren were interviewed during free hours, without their parents or guardians. They completed a self-administered questionnaire with the assistance of one or two trained interviewers for this survey.

We randomly selected 10 schools (5 public schools and 5 private schools). Convenience sampling was conducted among schoolchildren in the upper primary category (classes 5 and 6) because we assumed that they were most likely to provide reliable answers to the questions they would be asked.

LBP assessment: Children with LBP at least monthly for the last 3 months were included in this study. LBP was defined as "pain or discomfort in the area located between the lower margin of the twelfth ribs to the lower gluteal folds with or without pain referred into one or both lower limbs that lasts for at least one day"[20]. The questionnaire assessed sociodemographic characteristics, anthropometric data, physical activity, and sport participation, self-reported by schoolchildren of the parental history of LBP, and risk factors for LBP in children. The weight of schoolchildren and schoolbags was measured with a mechanical calibrated scale. The weight of each schoolbag was compared with the weight of its owner. A schoolbag weight of less than 10% was considered normal[21].

Data analysis: Data were analyzed using Epi Info 7.1.5 software (CDC, Atlanta, GA, USA). All variables that were significantly associated with LBP in bivariate analysis were included in a multiple logistic regression model to adjust the confounding effects. Statistical significance was established at $p < 0.05$.

Results

Baseline characteristics of schoolchildren with low back pain: Of the 1075 children included in the study, 132 (12.3%) reported having LBP monthly. They were 32 (2.9%) reported shoulder pain and 8 (0.7%) reported neck pain. Table 1 displays the main demographic, clinical and biological characteristics of schoolchildren experiencing LBP.

Table 1: Baseline characteristics of the schoolchildren with low back pain

Items		Schoolchildren surveyed (n = 1 075) No. (%)	Schoolchildren with low back pain (n = 132) No. (%)
Median age, years [range]		11 [8–16]	10 [8–14]
Gender	Male	543 (50.5)	51 (38.6)
	Female	532 (49.5)	81 (61.4)
Body mass index, kg/m^2	< 18.5	24 (2.1)	4 (3.0)
	18-25	928 (86.5)	110 (83.4)
	> 25	123 (11.4)	18 (13.6)
Eldest sibling		429 (39.9)	45 (34.1)
Type of school	Public	640 (59.5)	53 (40.1)
	Private	435 (40.5)	79 (59.9)
Educational level	Grade 6	434 (40.4)	60 (45.4)
	Grade 7	641 (59.6)	72 (54.6)

Parental history of low back pain	No	580 (53.9)	44 (33.3)
	At least one parent	495 (46.1)	88 (66.7)
Course of low back pain in schoolchildren	< 1 month	4 (0.4)	4 (3)
	1 – 3 months	8 (7.4)	8 (6.1)
	> 3 months	120 (11.2)	120 (90.9)

Factors associated with low back pain: Factors associated with LBP in multivariate analysis are female gender [OR = 1.73; $p = 0.004$], competitive sports [OR = 1.61; $p = 0.038$], parental history of LBP [OR = 3.01; $p = 0.024$], and bad sitting position [OR = 1.89; $p = 0.004$] (Table 2).

Table 2: Factors associated with LBP in schoolchildren in multivariate analysis

Items	OR*	95% CI†	P-value
Sex	1.73	1.19-2,52	0.004
Competitive sports	1.61	1.03-2.53	0.038
Bad sitting position	1.89	1.07-3.33	0.004
Parental low back pain	1.88	1.23-2.89	0.004

*OR: odds ratio; †CI: confidence interval.

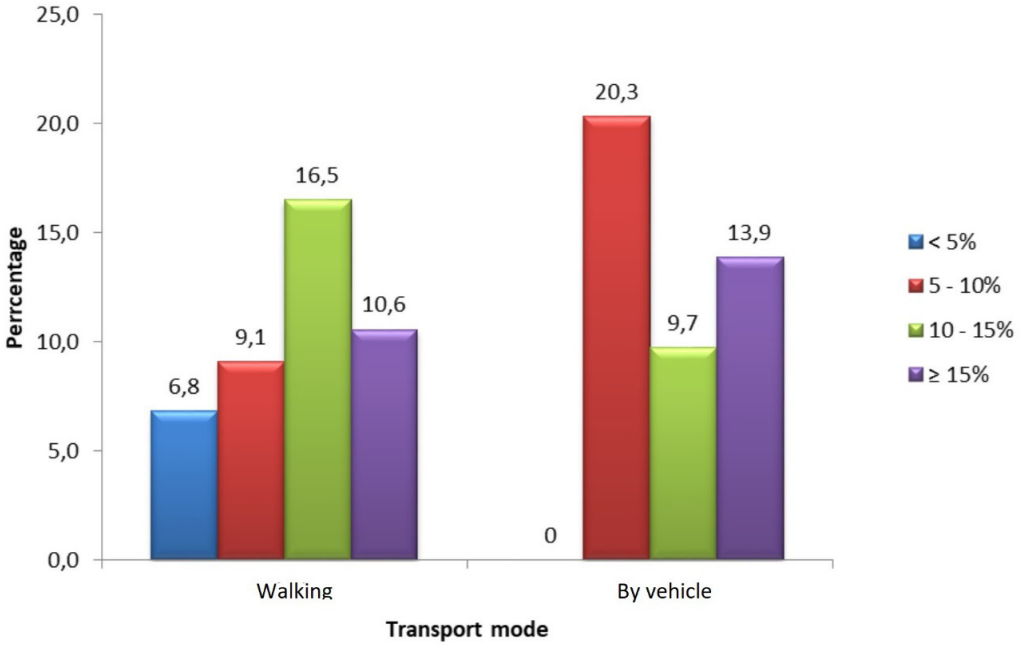
Relationship between low back pain and schoolbag: The type of schoolbag used by all schoolchildren in our study was the backpack. The mean schoolbag weight was 4.9 ± 1.9 kg. It was heavier in women (5.0 ± 1.8 kg *vs*. 4.7 ± 2.0 kg; $p = 0.032$). The mean schoolbag weight as a percentage of body weight was 8.46 ± 5.0%. The mean schoolbag weight of schoolchildren with LBP was 5.5 ± 1.4 kg, with no difference with schoolchildren without LBP ($p = 0.37$). Of the 132 schoolchildren with LBP, 99 had schoolbags weighing ≥ 10% of their body weight. The percentage of schoolbag weight to body weight is summarized in Table 3.

Table 3: Percentage of schoolbag weight to body weight (n = 132)

Percentage of schoolbag weight to body weight	No.	(%)	P-value
< 5%	3	5.5	-
5 - 10%	30	11.7	0.09
10 - 15%	46	13.6	0.10
15%	53	12.5	0.19

As shown in Figure 1, schoolchildren walking to school with a schoolbag weight between 10 and 15% of body weight had significantly more LBP (16.5%) than those with a schoolbag weight greater than 15% and walking (10.6%). Children going to school by car or motorcycle, with a schoolbag weight between 5 and 10% of body weight, had significantly more LBP (20.3%) than those with a schoolbag weight greater than 15% of body weight (13.9%).

Figure 1: Relationship between low back pain, backpack weight and transport mode



There was no relationship ($p > 0.05$) between LBP and the schoolbag weight, regardless of gender, BMI, duration of pain, type of school (public *vs*. private), distance from home to school, way of transportation from home to school, and age. However, there was a trend toward an association between schoolbag weights in schoolchildren aged 8 to 10 years old with a schoolbag weight > 15% of body weight ($p = 0.05$) (Table 4). When considering gender, a significant association was found only in 8-10 years old girls with a schoolbag weight > 15% of their body weight ($p = 0.036$).

Table 4: Relationship between low back pain, age range and schoolbag weight

Age range (years)		School children surveyed No. (%)	School children with low back pain No. (%)	P-value
8 – 10	< 5%	3 (0.3)	1 (33.3)	
	5 - 10%	20 (1.9)	2 (10.0)	
	10 - 15%	61 (5.7)	5 (8.2)	
	≥ 15%	125 (11.6)	15 (12.0)	0.05
10 – 12	< 5%	17 (1.6)	1 (5.9)	
	5 - 10%	118 (11.0)	18 (15.3)	
	10 - 15%	197 (18.3)	30 (15.2)	
	≥ 15%	256 (23.8)	34 (13.3)	0.7
12 – 14	< 5%	25 (2.3)	1 (4.0)	
	5 - 10%	97 (9.0)	8 (8.2)	
	10 - 15%	74 (6.9)	10 (13.5)	
	≥ 15%	43 (4.0)	4 (9.3)	0.4
> 14	< 5%	6 (0.6)	0 (0.0)	
	5 - 10%	22 (2.0)	2 (9.1)	
	10 - 15%	10 (0.9)	1 (16.7)	
	≥ 15%	1 (0.1)	0 (0.0)	0.646

Discussion

Three-quarters of children with LBP in Cameroonian schools had a schoolbag weight greater than 10% of their body weight. Despite this high rate, we confirm that there is globally no relationship between schoolbag weight and LBP. However, this post hoc analysis found an association between LBP and schoolbags in girls aged 8 to 10 years carrying a schoolbag weighing more than 15% of their body weight. This result reopens the debate concerning the involvement of schoolbag carriage in the development of LBP in schoolchildren. At this stage, we cannot know whether a larger sample or the inclusion of children under 8 years of age would have confirmed or refuted these findings. The systematic reviews with meta-analysis published on this subject have shown that schoolbag weight is not a risk factor for LBP among schoolchildren aged 9 to 16 years old [2,14]. Given the limitations in the study designs included in these systematic reviews on one hand and the contradictory data on this subject on the other hand, it would be desirable and necessary to carry out further large-scale longitudinal studies with rigorous design[2]. Cross-sectional studies do not seem to be appropriate because the schoolbag's weight varies from one day to another[22] and the weight reported in this type of study does not accurately reflect the schoolbag weight gathered most of the days[2]. These further studies should include some modalities other than the schoolbag weight to evaluate the impact of the schoolbag on LBP: hanging the schoolbag on one or both straps, time spent bearing the schoolbag to and from school, and type of schoolbag use (backpack, cross-body bag, plastic bags or rucksacks)[23]. Also, the perception of heaviness or difficulty in carrying the schoolbag as well as other psychosocial factors deserves a careful evaluation[2,22,23]. It would also be imperative to assess other potential pain points in children such as the shoulders, neck, head, and knee[11,24,25]. In addition, the analysis of spinal deformities such as scoliosis, lordosis, and kyphosis should be included in these studies[26]. Although the link between the existence of spinal statics abnormalities and LBP has not been clearly demonstrated, there is a shift in the centre of gravity in the direction of the load when children carry a backpack. To compensate for this stress, the child usually leans in a direction opposite to the force with resulting in the alteration of gait and posture[27,28].

On another level, a schoolbag's weight that is considered heavy could have an impact on the child's health. Indeed, studies have shown that carrying a schoolbag that is more than 10% of the child's weight could increase the forward tilt of the trunk, increase energy consumption, and lead to a decrease in lung volumes[29]. This would contribute to a reduction in partial oxygen pressure resulting in anaerobic breathing and fatigue[29]. Prospective studies should be conducted to determine whether reducing schoolbag weight could have an impact on the occurrence of LBP in particular, and the overall health of children in general. This could be easily implemented if schools had (i) functional libraries where schoolchildren can borrow textbooks instead of carrying them in their bags every day, and/or (ii) lockers to allow schoolchildren to keep their books at school and keep only the minimum of materials in the classroom bag[11]. None of the schools included in our study had lockers for their schoolchildren. Also, for those who use backpacks, ergonomics in the design of the backpack should be taken into consideration. Indeed, in order to reduce the impact of the backpack on the spine, it is desirable to have a backpack with several compartments for load distribution, wide and padded shoulder straps for comfort and greater weight distribution across the shoulders, and a padded back for comfort and protection[11].

These studies should be conducted before formal and uncritical recommendations on the characteristics of children's schoolbags are made. These recommendations should also take into consideration the other risk factors for LBP in children that have been previously described and are less prone to controversy. Let's not forget that the schoolbag and its characteristics is only one of many risk factors associated with the occurrence of LBP in children. The clinical impression is that LBP in children is related to the presence of several risk factors and not just the prerogative of a single risk factor.

The main limitations of this study have been previously described, including a convenience sample, a lack of physical examination during the survey, a lack of spine imaging, a lack of long-term follow-up for LBP, and an assessment of psychological factors[8]. In addition, this study is an ancillary study with some data that were not included in the initial analysis plan. However, this opens the door for many subsequent studies as presented above, also related to the limitations of the present study: evaluation of schoolbag characteristics other than weight, evaluation of the perception of heaviness in carrying the schoolbag, and other psychosocial factors, the effect of spinal statics abnormalities, the impact of schoolbag weight reduction on LBP.

Conclusions

Among the risk factors for the occurrence of LBP, the weight of the schoolbag is one of the most studied but also the most controversial. In this study, LBP was associated with schoolbag weight only in girls aged 8 to 10 years carrying a schoolbag weighing more than 15% of their body weight. Despite the lack of relationship between schoolbags and LBP suggested by published systematic reviews, a definitive recommendation could

not be made. Indeed, in addition to the schoolbag weight, many other components associated with the schoolbag should be incorporated in further studies, which must have a more rigorous design and a large sample size selected from populations with diverse characteristics.

Significances and innovations

(i) Three-quarters of children with low back pain in Cameroonian schools had a schoolbag weight greater than 10% of their body weight

(ii) There is no relationship between schoolbag weight and low back pain in schoolchildren aged 8 to 14 years old

(iii) Low back pain was associated with schoolbag weight only in girls aged 8 to 10 years carrying a schoolbag weighing more than 15% of their body weight

(iv) Low back pain in schoolchildren seems to be related to the presence of several risk factors and is not exclusively associated with a single risk factor

(v) Further studies are needed before a definitive conclusion can be reached on the link between schoolbags and low back pain.

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Conflicts of interest: The authors declare that they have no conflict of interest.

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References

1. Maher C, Underwood M, Buchbinder R. Non-specific low back pain. *Lancet.* 2017; **389**(10070):736-747.
2. Calvo-Muñoz I, Gómez-Conesa A, Sánchez-Meca J. Prevalence of low back pain in children and adolescents: a meta-analysis. *BMC Pediatr*. 2013; **13**:14.
3. Morris LD, Daniels KJ, Ganguli B, Louw QA. An update on the prevalence of low back pain in Africa: a systematic review and meta-analyses. *BMC Musculoskelet Disord*. 2018; **19**(1):196.
4. Taimela S, Kujala UM, Salminen JJ, Viljanen T. The prevalence of low back pain among children and adolescents. A nationwide, cohort-based questionnaire survey in Finland. *Spine* (Phila Pa 1976). 1997; **22**(10):1132-36.
5. Hwang J, Louie PK, Phillips FM, An HS, Samartzis D. Low back pain in children: a rising concern. *Eur Spine J*. 2019; **28**(2):211-213.
6. Balagué F, Troussier B, Salminen JJ. Non-specific low back pain in children and adolescents: risk factors. *Eur Spine J*. 1999; **8**(6):429-438.
7. Szita J, Boja S, Szilagyi A, Somhegyi A, Varga PP, Lazary A. Risk factors of non-specific spinal pain in childhood. *Eur Spine J*. 2018; **27**(5):1119-26.
8. Kemta Lekpa F, Enyama D, Noukeu Njinkui D, Ngongang Chiedjio A, Simeni Njonnou SR, *et al*. Prevalence and factors associated with low back pain in schoolchildren in Cameroon, sub-Saharan Africa. *Int J Rheum Dis*. 2021; **24**(9):1186-91.
9. Heneweer H, Vanhees L, Picavet HS. Physical activity and low back pain: a U-shaped relation? *Pain*. 2009; **143**(1-2):21-25.
10. Ayanniyi O, Mbada CE, Muolokwu CA. Prevalence and profile of back pain in Nigerian adolescents. *Med Princ Pract Int J Kuwait Univ Health Sci Cent*. 2011; **20**(4):368–373.
11. Mwaka ES, Munabi IG, Buwembo W, Kukkiriza J, Ochieng J. Musculoskeletal pain and school bag use: a cross-sectional study among Ugandan pupils. *BMC Res Notes*. 2014; **7**: 222. doi: 10.1186 / 1756-0500-7-222.
12. Skaggs DL, Early SD, D'Ambra P, Tolo VT, Kay RM. Back pain and backpacks in school children. *J Pediatr Orthop*. 2006; **26**(3):358–363.
13. Sheir-Neiss GI, Kruse RW, Rahman T, Jacobson LP, Pelli JA. The association of backpack use and back pain in adolescents. *Spine*. 2003; **28**(9):922–930.
14. Yamato TP, Maher CG, Traeger AC, Wiliams CM, Kamper SJ. Do schoolbags cause back pain in children and adolescents? A systematic review. *Br J Sports Med*. 2018; **52**(19):1241-45.
15. Korovessis P, Koureas G, Papazisis Z. Correlation between backpack weight and way of carrying, sagittal and frontal spinal curvatures, athletic activity, and dorsal and low back pain in schoolchildren and adolescents. *J Spinal Disord Tech*. 2004; **17**(1): 33–40.
16. Dianat I, Sorkhi N, Pourhossein A, Alipour A, Asghari-Jafarabadi M. Neck, shoulder and low back pain in secondary schoolchildren in relation to schoolbag carriage: should the recommended weight limits be gender-specific? *Appl Ergon*. 2014; **45**(3):437–442.
17. Assiri A, Mahfouz AA, Awadalla NJ, Abolyazid AY, Shalaby M. Back pain and schoolbags among adolescents in Abha City, Southwestern Saudi Arabia. *Int J Environ Res Public Health*. 2019; **17**(1):5.

18. van Gent C, Dols JJCM, de Rover CM, Hira Sing RA, de Vet HCW. The weight of schoolbags and the occurrence of neck, shoulder, and back pain in young adolescents. *Spine*. 2003; **28**(9):916–921.
19. Tiendrebeogo WJZ, Ouédraogo S, Yago ISE, Zabsonré DS, Tiaho Y, *et al*. Low back pain among primary school children: prevalence and risk factors. a cross-sectional study in Ouagadougou (Burkina Faso). *J Rheumatol Res*. 2020; **2**(2):98-106.
20. Hoy D, March L, Brooks P, Blyth F, Woolf A, Bain C, *et al.* The global burden of low back pain: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis*. 2014; **73**(6):968-974.
21. Dockrell S, Simms C, Blake C. Schoolbag weight limit: can it be defined? *J Sch Health*. 2013; **83**(5):368–377.
22. Negrini S, Carabalona R. Backpacks on schoolchildren's perceptions of load, associations with back pain and factors determining the load. *Spine* (Phila Pa 1976). 2002; **27**(2):187-195.
23. Dockrell S, Simms C, Blake C. Schoolbag carriage and schoolbag-related musculoskeletal discomfort among primary school children. *Appl Ergon*. 2015; **51**:281-290.
24. van Gent C, Dols JJ, de Rover CM, Hira Sing RA, de Vet HC. The weight of schoolbags and the occurrence of neck, shoulder, and back pain in young adolescents. *Spine* (Phila Pa 1976). 2003; **28**(9): 916-921.
25. Swain MS, Henschke N, Kamper SJ, Gobina I, Ottová-Jordan V, Maher CG. An international survey of pain in adolescents. *BMC Public Health*. 2014; **14**:447.
26. Cottalorda J, Bourelle S, Gautheron V, Kohler R. Backpack and spinal disease: myth or reality? *Rev Chir Orthop Reparatrice Appar Mot*. 2004; **90**(3):207–214.
27. Pascoe DD, Pascoe DE, Wang YT, Shim DM, Kim CK. Influence of carrying book bags on gait cycle and posture of youths. *Ergonomics.* 1997; **40**(6): 631-641.
28. Grimmer KA, Williams MT, Gill TK. The associations between adolescent head-on-neck posture, backpack weight, and anthropometric features. *Spine* (Phila Pa 1976). 1999; **24**(21):2262-67.
29. Lai JP, Jones AY. The effect of shoulder-girdle loading by a school bag on lung volumes in Chinese primary school children. *Early Hum Dev*. 2001; **62**(1):79-86.