Association of Backpack Use and Back Pain in Adolescents

Geraldine I. Sheir-Neiss, PhD, Richard W. Kruse, DO, Tariq Rahman, PhD, Lisa P. Jacobson, ScD, Jennifer A. Pelli, MS

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Study Design: A cross-sectional study comprising the first phase of an ongoing, longitudinal prospective study was conducted.

Objective: To investigate the relation between backpack use and back pain in adolescents.

Summary of Background Data: The prevalence of nonspecific back pain increases dramatically during adolescence from less than 10% in the pre-teen-age years up to 50% in 15- to 16-year-olds. There is widespread concern that heavy backpacks carried by adolescents contribute to the development of back pain.

Methods: A total of 1126 children, ages 12 to 18 years, participated by completing a questionnaire about their health, activities, and backpack use. Each child's body weight, height, and backpack weight were measured. A child was classified as having back pain if one or more of the following were reported during the preceding month: neck or back pain that had interfered with school or leisure, neck or back pain with a severity rating of 2 or more on a scale 0 to 10, a visit to a physician or therapist for neck or back pain, or exemption from physical education or sports because of neck or back pain.

Results: Of 1122 backpack users, 74.4% were classified as having back pain, validated by significantly poorer general health, more limited physical functioning, and more bodily pain. As compared with no or low use of backpacks at school, heavy use (odds ratio, 1.98; $P < 0.0001$) was independently associated with back pain. Female gender and larger body mass index also were significantly associated with back pain. As compared with adolescents who had no back pain, adolescents with back pain carried significantly heavier backpacks that represented a significantly greater percentage of their body weights.

Conclusion: The use of backpacks during the school day and backpack weights are independently associated with back pain.

Recent worldwide attention has focused on the role of backpacks in the development of adolescent nonspecific low back pain. Researchers have explored whether there is a critical backpack weight-to-body ratio that if exceeded affects health. Backpack loads exceeding 10% of body weight have been shown to increase energy consumption,[1] increase trunk forward lean,[2, 3] and result in decreased lung volumes.[4] A large proportion of French elementary, middle, and high school students,[5, 6] Italian school children,[7] United States middle school students,[3] and Australian high school students[8] carry backpacks with loads exceeding 10% of their body weight. Among French middle school and Australian high school students, carrying a heavy backpack was significantly associated with the occurrence of back pain.[6, 8]

Previous studies on the health effects of backpack use by children have been limited either to small numbers of middle school students homogeneous in age and grade[3, 6, 9] or to larger groups from public schools in the same city.[8, 10]

For this study, subjects, ages 12 to 18 years, were recruited from 12 middle schools and 10 high schools. The schools differed in physical layout (single building or campus-like facility with multiple buildings), daytime backpack use policy (permitted or prohibited), and type (public or private). This cross-sectional analysis was derived from the baseline survey of an ongoing longitudinal prospective study and was conducted between November 2000 and May 2001.

The Institutional Review Board of The Nemours Foundation approved this protocol. Information packets were mailed to administrators of 16 public school districts and 28 private schools located in Delaware and Pennsylvania near Alfred I. duPont Hospital for Children. Administrators of 4 public schools and 18 private schools consented for the study to be conducted at their schools. At five private high schools, all the students in grades 9 to 11, and at two private middle schools, all students in grades 7 to 8 were invited to participate in the study. For all other schools, school personnel decided that a subset of students would be invited to participate in the study on the basis of the students' schedules. Informed consent/assent was obtained from the parents and adolescents.

Information about backpack use, activities, and health was obtained from a self-administered questionnaire distributed directly to subjects by the study authors. Self-administered questionnaires have been shown to give information comparable with face-to-face interviews regarding the back pain of adolescents.[11] The questionnaire contained general health questions from the Child Health Questionnaire (CHQ CF 87).[12] Specific questions relating to back pain in adolescents were adapted from a validated questionnaire used by Salminen[13] in a study of back pain in children between the ages of 11 and 17 years. The questions regarding backpack use, recreational activities, and transportation were adapted from Troussier *et al* [5] and slightly modified on the basis of information from the literature on characteristics associated with back pain in children.[14-17] A recall period of 1 month for adolescents was used because back pain questionnaires requiring recall periods longer than 1 month yield unreliable information.[18, 19] A pain diagram and a pain scale were included to increase the accuracy and consistency of pain reporting.[20-23]

Researchers made arrangements with individual schools to administer the questionnaire and obtain each student's body weight, height, and backpack weight. Students who attended schools that permitted daytime backpack use (n = 852) were instructed to report to the study site without altering the contents of their backpacks. Students in schools that prohibited the use of backpacks during the day (n = 274) were told to pack their backpacks with the books that they normally would be carrying home that day. The children and their backpacks were weighed on calibrated digital scales (Thinner, Measurement Specialties, Fairfield, NJ). At two high schools (schools 20 and 22,), students in advanced placement statistics courses collected data at their respective schools after counsel by researchers and under the supervision of high school teachers.

Table 1. Description of Schools and Percentage of Eligible Students Participating in Study

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School Type		Backpack Use Allowed During Day	Multiple Buildings	No. Forms Distributed	No. Subjects	% Participation
Private middle school						
#1	Male only	No	No	75	22	29.3
#2	Male only	Yes	No	60	44	73.3
#3	Coed	Yes	No	64	31	48.4
#4	Coed	Yes	No	67	31	46.3
#5	Coed	No	No	112	24	21.4
#6	Coed	No	No	140	24	17.1
#7	Coed	Yes	No	102	24	23.5
#8	Female only	No	No	75	31	41.3
#9	Coed	Yes	No	58	15	25.9
#10	Coed	No	No	55	28	50.9
Public middle school						
#11	Coed	No	No	790	101	12.8
#12	Coed	No	No	270	24	8.9
Total middle school				1868	399	21.4
Private high school						
#13	Coed	Yes	No	172	21	12.2
#14	Coed	Yes	Yes	355	84	23.7
#15	Male only	Yes	No	275	74	26.9
#16	Coed	No	No	300	20	6.7
#17	Female only	Yes	No	470	192	40.9
#18	Coed	Yes	Yes	176	44	25.0
#19	Female only	Yes	Yes	332	104	31.3
#20	Coed	Yes	No	150	67	44.7
Public high school						
#21	Coed	Yes	No	550	52	9.5
#22	Coed	Yes	No	200	69	34.5
Total high school				2980	727	24.4
Overall				4848	1126	23.2

For the purpose of this study, an individual was classified as having back pain if any one of the following conditions were met:

- The subject reported neck or back pain that had interfered with school or leisure in the preceding 4 weeks.
- The subject rated the severity of neck or back pain in the preceding 4 weeks as at least a 2 on a scale of 0 to 10.
- The subject reported seeing a physician or therapist in the preceding 4 weeks for neck or back pain.
- The subject was excused from physical education class or sports in the preceding 4 weeks because of neck or back pain.

Individuals classified as having back pain were compared with those who had no back pain for age, gender, body mass index (BMI [weight/height^2]), backpack weight, backpack use during the school day, school type, method of travel to and from school, sports participation, leisure time activities, and activity level. Measures of general functional status and well-being were assessed by scales obtained from the Child Health Questionnaire (CHQ) and used to describe general quality of life and to validate the back pain classification.

Univariately,

^{2} tests were used to assess statistically the independence of categorical factors and back pain, and Wilcoxon rank sum tests (nonparametric) were used for variables distributed continuously. Multivariate logistic regression, incorporating factors univariately found to be associated with back pain, was used to examine the independent association of factors and back pain. For the multivariate analysis, backpack use at school was defined as follows:

- No backpack use: "does not wear backpack between classes and does not carry backpack while waiting"
- Low backpack use: "does not wear backpack between classes, but carries backpack while waiting"
- Medium backpack use: "wears backpack between classes, but not while standing"
- Heavy backpack use: "wears backpack between classes and while standing."

Stratification of models was used to determine the presence of effect modification. Parsimonious final models are presented in the Results section.

A summary of the participating schools, their backpack use policies, and the number of subjects from each school is found in . The subjects (n = 1126) were from 12 middle schools (grades 6 to 8; n = 399; 35.4%) and 10 high schools (grades 9 to 12; n = 727; 64.6%). Eighteen schools were private schools (n = 880; 78.2%) and four were public schools (n = 246; 21.8%). Eight schools (n = 274; 24.3%) did not allow backpack use during the academic day. At 11 schools (n = 620; 55.1%), students carried their backpacks between classes during the day within one building. At three schools (n = 232; 20.6%), students carried their backpacks between classes during the day between multiple buildings. Most of the students (96% to 98%) who participated in the study traveled to and from school by car or bus. The overall participation of eligible students was 23.2% (range, 6.7-73.3%). Descriptive information regarding age, weight, height, and BMI is given in , sorted by the highest grade completed and by gender.

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Overall				4848	1126	23.2

Source: Spine © 2003 Lippincott Williams & Wilkins

Table 2. Description of the Participants' Body Habitus by Grade and Gender

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School Type		Backpack Use Allowed During Day	Multiple Buildings	No. Forms Distributed	No. Subjects	% Participation
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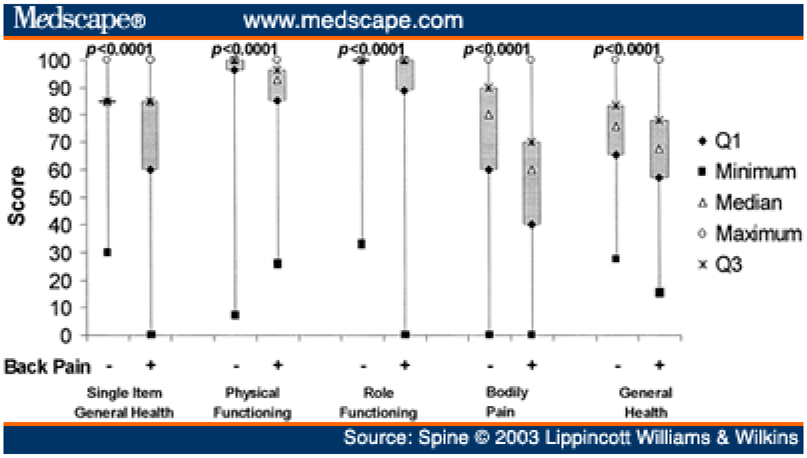
Source: Spine © 2003 Lippincott Williams & Wilkins

Among the 1122 students who indicated that they used backpacks or had a backpack weighed and answered other backpack questions, 835 (74.4%) self-reported back pain. According to the CHQ scales, children with back pain reported significantly poorer single-item general health, poorer general health, more limitations in performing physical activities, and more bodily pain, as assessed by the CHQ scales (Figure 1). There also was an association between four of the five scales on the Child Health Questionnaire (single-item general health, physical functioning, bodily pain, and general health) and backpack use, with the lowest values associated with the heaviest backpack use (data not shown). The results from the univariate comparisons are presented in

Table 3. Distribution of Self-Reported Back Pain Among Backpack Users According to Gender, Grade, School Type, Backpack Variables, and Leisure Time Activities

	Back Pain			
	No [no. (%)]	Yes [no. (%)]	Total	$P(\chi^2)$
	287 (25.6)	835 (74.4)	1122	
Gender				<0.0001
Male	153 (35.3)	280 (64.7)	433	
Female	134 (19.4)	555 (80.6)	689	
Highest grade completed				<0.0001
5	6 (31.6)	13 (68.4)	19	
6	95 (33.9)	185 (66.1)	280	
7	35 (35.7)	63 (64.3)	98	
8	63 (21.8)	228 (78.2)	291	
9	61 (25.1)	182 (74.9)	243	
10	27 (14.1)	164 (85.9)	191	
School type				<0.0001
Public, high, coed	34 (28.1)	87 (71.9)	121	
Public, middle, coed	48 (38.4)	77 (61.6)	125	
Private, high, coed	72 (30.6)	163 (69.4)	235	
Private, high, male only	15 (20.6)	58 (79.4)	73	
Private, high, female only	30 (10.2)	265 (89.8)	295	
Private, middle, coed	54 (30.7)	122 (69.3)	176	
Private, middle, male only	27 (40.9)	39 (59.1)	66	
Private, middle, female only	7 (22.6)	24 (77.4)	31	
School description				<0.0001
One building; backpacks not allowed during day	100 (36.6)	173 (63.4)	273	
One building; backpacks used during day	143 (23.2)	474 (76.8)	617	
Campuslike with multiple buildings; backpacks used during day	44 (19.0)	188 (81.0)	232	
Backpacks used between classes				<0.0001
No	106 (36.4)	185 (63.6)	291	
Yes	180 (21.7)	648 (78.2)	828	
Backpack use while standing/waiting				<0.0001
Backpack worn	136 (21.4)	500 (78.6)	636	
Backpack taken off	75 (25.2)	223 (74.8)	298	
Backpack not used during day	68 (39.2)	106 (60.9)	174	
Stair use while carrying backpack				0.001
Never	30 (35.3)	55 (64.7)	85	
Once a day	13 (31.0)	29 (69.0)	42	
Twice a day	64 (34.8)	120 (65.2)	184	
Three times a day	15 (19.0)	64 (81.0)	78	
Four times a day	37 (25.3)	109 (74.7)	146	
Five or more times a day	123 (21.4)	451 (78.6)	574	
Method of carrying				0.990
One shoulder	34 (25.8)	98 (74.2)	132	
Two shoulders	249 (25.8)	715 (74.2)	964	
Hands	1 (25.0)	3 (75.0)	4	
Carrying a purse in addition to backpack (girls only)				0.003
Never	88 (23.2)	291 (76.8)	379	
Once a wk	13 (24.1)	41 (75.9)	54	
Twice a wk	8 (26.7)	22 (73.3)	30	
Three times a wk	3 (27.3)	8 (72.7)	11	
Four or more times a wk	20 (10.2)	177 (89.8)	197	
Carrying an athletic bag in addition to backpack				0.271
Never	114 (24.7)	347 (75.3)	461	
Once a wk	33 (23.4)	108 (76.6)	141	
Twice a wk	37 (25.2)	110 (74.8)	147	
Three times a wk	20 (21.3)	74 (78.7)	94	
Four or more times a wk	79 (30.9)	177 (69.7)	256	
Hrs/wkday watching television				0.048
0–1	147 (29.5)	351 (70.5)	498	
2	82 (23.2)	272 (76.8)	354	
3	27 (18.6)	118 (81.4)	145	
4	11 (21.6)	40 (78.4)	51	
5 or more	19 (29.8)	47 (71.2)	66	
Hrs/wkend day watching television				0.035
0–1	70 (31.5)	152 (68.5)	222	
2	93 (27.4)	247 (72.7)	340	
3	58 (22.3)	202 (77.7)	260	
4	27 (18.2)	121 (81.8)	148	
5 or more	38 (25.9)	109 (74.1)	147	



Box plots depicting the distribution of health scores (Child Health Questionnaire CHQ CF 87) of children with (+) and without (-) back pain in the preceding 4 weeks.

Overall, significantly more girls than boys reported back pain experienced in the preceding 4 weeks, and there was a direct association between back pain and the highest grade completed. Significant differences in the reporting of back pain were observed when the 22 schools were grouped into eight types based on grade levels served (middle or high), manner of funding (private or public), and gender served (male only, female only, or coeducational).

The extent of backpack use correlated with the reporting of back pain in the preceding 4 weeks. This relation was noted across all indexes of backpack use. The adolescents who attended schools that permitted daytime backpack use reported significantly more back pain in the preceding 4 weeks than the adolescents who attended schools that restricted backpack use. Similarly, adolescents who indicated that they carried a backpack between classes during the day reported significantly more back pain than those who did not.

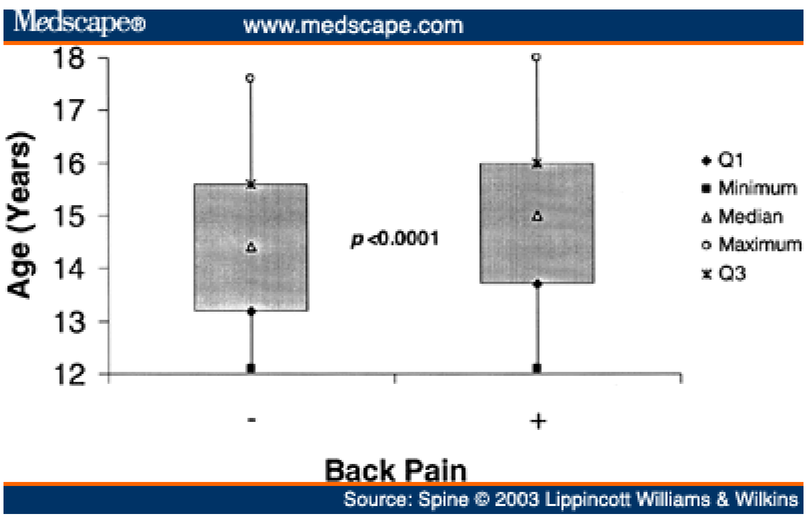
Back pain also was associated both with students' increased use of stairs while carrying backpacks and with the wearing of backpacks during standing and waiting. Overall, 51.7% of the adolescents used stairs at least five times per day. This group contained 43.6% of the adolescents without back pain and 55.4% of the adolescents with back pain ($P = 0.002$).

Most of the students (87.6%) carried their backpacks using both shoulder straps. There was no significant difference in the reporting of back pain between those who used one strap and those who used two straps. Carrying a sports bag in addition to a backpack was not associated with back pain.

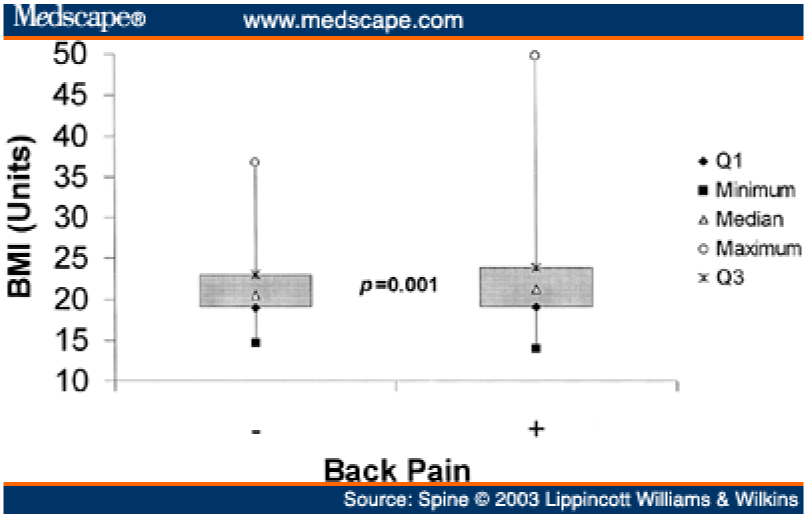
Girls who carried a purse every day in addition to a backpack reported significantly more back pain than those who did not. Although not assessed systematically, it was observed that the purses used by backpack-toting girls usually were shoulder purses carried on one shoulder. Both girls and boys who had sports bags generally carried them by hand. The current authors believe that the difference between methods of carrying the extra weight (asymmetrically over the shoulder *vs.* by hand) should be investigated further to determine whether the additional asymmetrical pressure on girls' shoulders contributed to the observed association between back pain and purse carrying. Almost half (46%) of the girls with back pain and one third (33.3%) of the girls without back pain carried a purse while using a backpack (*P* = 0.009). When controlled for age, purse-carrying remained associated with back pain (odds ratio, 1.59; *P* = 0.026).

There was an association between the number of hours spent engaging in sedentary leisure time activities and the reporting of back pain. The adolescents with back pain reported significantly more hours watching television, both during the week and also on weekends, than those without back pain. Overall, 55.3% of the adolescents watched television more than 1 hour per weekday. This group contained 48.6% of the adolescents without back pain and 57.6% of those with back pain (*P* = 0.0083). Although 49.7% of the adolescents watched television more than 2 hours per weekend day, this group differed with respect to back pain. More than 2 hours of television watching per day on the weekend was reported by 43% of the adolescents without back pain and 52% of those with back pain (*P* = 0.009).

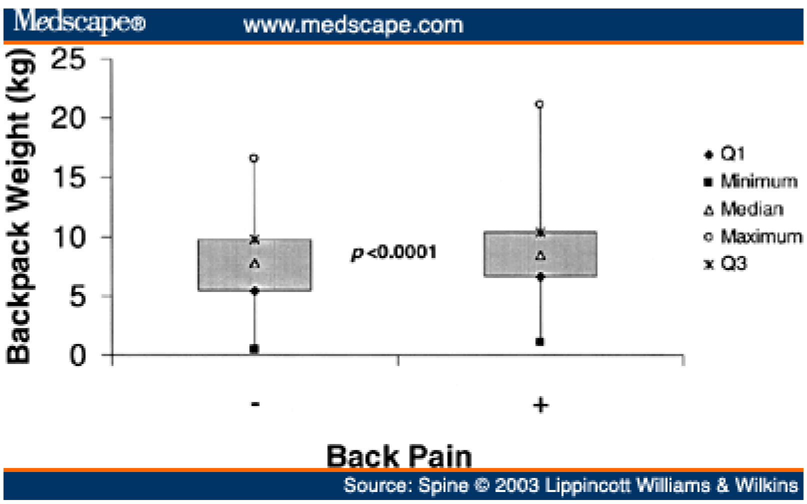
Adolescents with back pain were significantly older and had significantly higher BMIs, as determined by univariate analysis (Figure 2, Figure 3). Those with back pain carried significantly heavier backpacks representing a significantly greater percentage of their body weights (Figure 4, Figure 5). The mean backpack weight of all the adolescents surveyed was 8.3 kg (median, 8.4 kg; range, 0.5-21.1 kg). The mean weight carried by the adolescents was 14.7% of their body weight (median, 14.4%; range: 1-41%). Most of the students (79.6%) carried more than 10% of their body weight; 47% of the students carried more than 15% of their body weight; and 18.9% of the students carried more than 20% of their body weight.



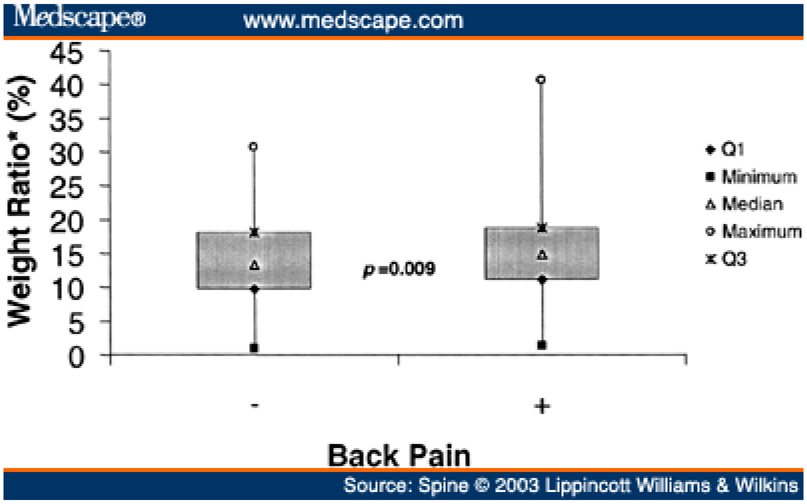
Box plots depicting the distribution of the ages of adolescents with (+) and without (-) back pain in the preceding 4 weeks.



Box plots depicting the distribution of body mass indexes of adolescents with (+) and without (-) back pain in the preceding 4 weeks.



Box plots depicting the distribution of backpack weights of adolescents with (+) and without (-) back pain in the preceding 4 weeks.



Box plots depicting the distribution of weight ratios (backpack weight/body weight × 100) of adolescents with (+) and without (-) back pain in the preceding 4 weeks.

The results of multivariate analysis are presented in . Female gender, heavy backpack use, heavier body mass index, and an increased ratio of backpack weight to body weight remained significantly ($P < 0.01$) associated with back pain when simultaneously adjusted for the other characteristics. Age alone (*i.e.*, after adjustment for other variables) was not independently associated with back pain, although the direction was toward a decreased association with younger ages. These associations also were similar across age groups (*i.e.*, age did not significantly modify the observed associations). Inclusion of school type (public *vs.* private) in the model also did not affect the odds ratios, and school type was not a significant independent covariate.

Table 4. Adjusted Odds Ratios for Characteristics Associated With Back Pain Among Adolescents Ages 12 to 18 Years

	Odds Ratio	95% Confidence Interval	*P* Value
Female	2.18	1.64, 2.90	<0.0001
Body mass index (for each unit > 22)	1.08	1.03, 1.12	0.0005
Heavy backpack use at school	1.98	1.42, 2.76	<0.0001
Medium backpack use at school	1.42	0.96, 2.09	0.0767
Backpack weight/body weight*100	1.04	1.02, 1.07	0.002

Back pain was examined further by the localization of pain to the lower or upper back. To do this, the authors excluded the individuals who reported pain in both locations. More females than males reported upper back pain (odds ratio, 2.19; 95% confidence limits, 1.59-3.0). Heavy and medium backpack use were associated significantly with lower back pain (odds ratio, 1.79; 95% confidence limits, 1.23-2.62 and odds ratio, 2.03; 95% confidence limits, 1.32-3.13, respectively). Stratification by the location of back pain affected neither the magnitude nor the directionality of the associations with BMI and backpack weight as a percentage of body weight.

The large sample and variety of schools with different rules regarding daytime backpack use and different physical layouts yielded significant numbers of adolescents with back pain and the heterogeneity to explore potential determinants. The findings from this study indicate that adolescents with back pain are more likely to be female, have a higher body mass index, report poorer health, spend more time watching television, have a heavier backpack, and carry a backpack more frequently than adolescents without back pain. Others have previously reported the following associations with back pain: female gender,[6, 8, 17, 24-28] psychological profile,[15, 25, 26, 29] time spent watching television,[14, 17, 24] obesity,[27] and age.[17, 18, 24, 30, 31] In some studies, there was no observed association of gender with back pain,[16, 32] and in at least one study, back pain was reported to be more common in boys.[18] Associations also have been reported between back pain in adolescents and the following conditions: sitting,[8] parents with back pain,[25, 30] and previous back injury.[5, 17] A prospective study investigating a cohort of Canadian high school students showed that a high growth rate, tight hamstrings, and tight quadriceps femoris were risk factors for the development of low back pain.[29] Grimmer and Williams,[8] who studied a large group of Australian high school students, did not find an association between body mass index and low back pain. They did find an association between back pain and the ratio of backpack weight to body weight, as well as an association between back pain and the length of time spent carrying the backpack.[8] Studying a small cohort of 11-year-old children, Negrini and Carabalona[9] found an association between back pain and time spent carrying backpacks, but not backpack weight. Viry *et al* [6] found an association between back pain and walking to and from school, only if the relative backpack weight was greater than 20% of body weight.

In the current study of 1126 U.S. adolescents, ages 12 to 18 years, the 1-month point prevalence of back pain was 74.4%. This extremely high rate may result from a bias in participation, whereby those with back pain were more likely to participate than those without back pain, possibly indicated by the low overall participation rate of 23.2%. The 1-month point prevalence of back pain (74.4%) in this study was similar to the lifetime prevalence of 74% reported for Swiss adolescents,[15] but was much higher than the 2-week point prevalence of low back pain (15.2-44.3%) found for Australian adolescents[8] or the 1-month point prevalence of back pain in both the lower and upper back and neck (45-49.7%) reported for Danish adolescents.[33]

Furthermore, the low participation rate may have affected the validity of the associations between back pain and backpack use if the adolescents with back pain who participated in the study were different from those with back pain in the sampled population regarding the attributes in question. For example, if the participation of girls differed according to back pain status and boys participated regardless of back pain, the observed association between back pain and gender may be spurious. Continued follow-up evaluation of this cohort will allow examination of the development of back pain and persistent back pain, two outcomes that may have greater sensitivity and more relevance for studies of risk factors.

For all the schools that allowed backpacks during the day, the current sampling method obtained a random weight for each child's backpack. In the schools that prohibited backpack use during the day, the students were asked to pack their bags as if they were going home for the day. Seven of the eight schools that did not allow backpack use were middle schools. Because the mean backpack weight for the students who did not use backpacks during the day (7.4 kg) was lower than the mean backpack weight for all the students from middle schools (8 kg.), the authors believe that the children followed their directions and did not overpack their bags for the sake of the study.

Although many characteristics were assessed for their association with back pain, most related to the same underlying mechanism. For example, three different characteristics related to backpack use during the day. One measure was based on the individual school's policy toward backpack use during the day, and thus was objective. Among the students who attended schools that did not permit backpack use during the day, 63.4% reported back pain. The survey included two questions about backpack use during the day. Among the students who indicated that they did not use backpacks between classes during the day (question 19), 63.6% reported back pain. Among students who chose "backpack not used during day" (question 22), 60.9% reported back pain. These consistent results demonstrate that students were self-reporting both back pain and backpack use reliably and reinforce the finding that daytime backpack use by adolescents was associated with back pain.

Likewise, the significant associations between back pain and the five CHQ scales provided external validation for self-reported back pain and showed that adolescents with back pain reported a lower quality of life. The association between four of the five scales on the CHQ and backpack use showed that adolescents who reported the heaviest use of backpacks also reported a lower quality of life. Also, the significant associations between back pain and both backpack weight and the ratio of backpack weight to body weight demonstrated that both backpack use and weight are important.

It has been pointed out that attending school may be considered the occupation of most children and adolescents.[9] Among working adults, there is evidence that occupational risk factors for back pain include bending, twisting, forceful lifting, and whole-body vibrations.[34, 35] Observations of students putting on backpacks suggest that bending and/or twisting may be involved. Physiologic studies of children and adolescents carrying loaded backpacks have not investigated the process of getting the loaded backpack onto the subject.[1-3, 36]

Although one study suggested that low levels of physical activity are associated with back pain in adolescents,[37] other researchers have found that high levels of physical activity[17, 31] and competitive sports[8, 14, 17, 24, 27, 30, 38] are associated with back pain in adolescents or, in one study, adolescent boys only.[18] In some studies among adults[39] and children,[27, 36] poor physical fitness has been associated with increased reporting of back pain. Merati *et al* [36] reported that the cardiovascular effort required to carry a backpack load weighing 17.6% to 21.1% of body weight by 11-year-old children was minimal but was significantly higher in children who had experienced back pain in the past. These authors suggested that improving general physical fitness levels might reduce the occurrence of back pain in children while they are carrying backpacks.[36]

In conclusion, an association was found between the occurrence of back pain and both the weight of the backpack load and the amount of backpack use. Back pain is epidemic in the adult population, with the lifetime prevalence reported as 67% to 74%.[32, 40-42] Because the most rapid rate of increase in the prevalence of nonspecific back pain among adolescents occurs during the period of puberty and maximal linear growth,[29, 30, 32] and because adolescents who have experienced back pain are at increased risk for experiencing back pain as adults,[42, 43] efforts to minimize adolescents' backpack use are recommended. The ongoing longitudinal phase of this study will investigate further the role of backpacks in the development of adolescent back pain.

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- The use of backpacks during school by adolescents was found to be associated with back pain.
- Adolescents with back pain were more likely to be female, to report poorer general health, and to have a larger body mass index than adolescents without back pain.
- Adolescents with back pain were more likely to carry a heavier backpack and to use their backpack more during the school day than adolescents without back pain.
- Adolescents without back pain were more likely to attend schools that had banned the carrying of backpacks between classes.

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Reprint Address

Address correspondence and reprint requests to Richard W. Kruse, DO, Department of Orthopaedics, Alfred I. duPont Hospital for Children, P.O. Box 269, Wilmington, DE 19899, USA; E-mail: rkruse@nemours.org