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Brief Communication

The association between backpack use and low back pain among pre-university students: A pilot study

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Abstract

Background: Individuals aged 30–60 years have a high possibility of experiencing low back pain. However, children and adolescents are not exempted from this problem. This study aimed to determine the relationship between backpack usage and the frequency of low back pain in pre-university students.

Methods: A total of 101 currently enrolled pre-university students were recruited for this cross-sectional study. They answered a questionnaire about their demographic details and their frequency of backpack usage. Their backpacks were weighed for four consecutive school days. The Roland–Morris Disability Questionnaire and Body Discomfort Chart were used to rate discomfort levels.

Results: The use and weight of a backpack were not significantly associated with low back pain, as indicated by the Roland–Morris Disability Questionnaire and Body Discomfort Chart ($p > 0.05$).

Conclusion: This study did not find an association between the use of a backpack and low back pain in Malaysian pre-university students.

Keywords: Bone; Mechanical loading; Pain; Teenager; Vertebrae

Introduction

Low back pain is a communal problem defined as pain located between the lower ribs and the buttock folds.[1,2] It is an important contributor to disability globally, and children are no exception. A study has shown that the prevalence of low back pain among children and teenagers varies between 11% and 52.1%.[3] Low back pain is a significant health problem because it predisposes youths to musculoskeletal problems in the later stages of their lives.

The use of a backpack is the most important factor causing low back pain among students. The weight of backpacks has increased significantly due to the necessity of carrying academic materials.[4] The occurrence of low back pain is associated with a backpack weight greater than 15% of total body mass and a prolonged period of carrying the bag.[3,5,6] The type of backpack also influences low back pain among students. The two-strap backpack is the most ergonomic design.[7] One-strapped and hand-held bags may cause stress and strain on the back muscles due to an imbalanced load distribution between the shoulders.[8] Roller-bags also contribute to low back pain due to improper posture changes during their use.[9] Carrying a backpack on one shoulder instead of both shoulders also

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increases the risk of low back pain due to postural deviation.[10–12] Similarly, asymmetrical carriage contributes to low back pain as well.[13]

Apart from backpacks, other factors such as body mass index (BMI), sex and physical activity status also contribute to low back pain. Non-ideal BMI, either underweight or overweight, is a predictor of low back pain.[14–16] Most studies indicate that female students have a greater tendency to experience low back pain than their male counterparts.[3,7,11,13–17] This may due to a higher tendency for females to carry heavier backpacks, as well as physical and physiological sex differences.[15,17–19] Individuals with inappropriate sitting positions and a sedentary lifestyle have low back muscle endurance.[19] Inversely, exercise and vigorous activity can strengthen the back muscles, thus lowering the risk for low back pain.[18]

There are limited studies on backpack load and low back pain amongst Malaysian youths because most studies involved school children.[17] We attempted to bridge this research gap by examining the effects of backpack use and related risk factors on low back pain in a group of pre-university students in Malaysia. The main reasons for selecting these individuals were the paucity of data on low back pain among Malaysians youths, the homogeneity of this group in term of age, and the convenience of sampling.

Materials and Methods

Subjects

A cross-sectional study was performed on 101 (49 male, 52 female) students attending a bridging programme designed to prepare high-school graduates to enter university (pre-university) in a Malaysian higher learning institution. The age range of the students was 16–18 years, with a median age of 18 years. Recruitment was performed from 5th December 2016 to 9th December 2016. Universal sampling of all the pre-university students of the institution was conducted. The students were briefed on the details of this study, and informed written consent was obtained. The included subjects were physically healthy and had no major deformities. They could walk and carry loads on their own. Those with severe orthopaedic problems or who were ill during the study were excluded.

Ethical considerations

The protocol was reviewed and approved by the Universiti Kebangsaan Malaysia Research Ethics Committee (Code Number: UKM PPI/111/8/JEP-2016-599). All subjects were informed of the details of this study, and their queries were answered. Individual consent was obtained before the participation. Consent from parents/guardians was obtained for subjects younger than 18 years.

Measurement

The Virgo Analog Weighing Scale (Model 9811b, Virgo, Maharashtra, India) was used in this study to measure the weight of the students without their backpack load, students with their backpack load, and students with their backpack load and an additional load such as hand bags, water bottles or lunch boxes. These weight measurements were repeated for four days, and the average was used in the final analysis. The height of students was measured using a stadiometer. Body mass index was calculated as per convention.

A self-administered questionnaire was used to obtain general information on demographic details (age and gender), physical activity and backpack usage, including the type of schoolbag used, the method of carriage, and any discomfort experienced due to schoolbag carriage. The Roland–Morris Disability Questionnaire, which is freely accessible online (permission not required for use) (http://www.rmdq.org/), was used to assess low back pain among the subjects. This questionnaire has been used in previous studies to investigate the relationship between backpack weight and low back pain.[20] The daily report of body discomfort was recorded by the subjects at the end of each school day using a numerical Daily Pain Intensity Scale for four days.

Statistical analysis

Statistical analysis was performed using SPSS 23.0 (IBM, Armonk, USA). The normality of the data was assessed using a Kolmogorov–Smirnov test. Most data were not normally distributed, so a non-parametric analysis approach was used. Comparisons of backpack weight and the scores from the Roland–Morris Disability Questionnaire and the Daily Pain Intensity Scale between sexes, types of backpack, method of carriage and history of low back pain were conducted using Mann–Whitney U tests. The associations between variables of interest were analysed using the Spearman correlation test. Statistical significance was defined as $p < 0.05$. Data are presented as the median [interquartile range (IQR)].

Results

A total of 101 (42 male and 59 female) subjects participated in this study. The age range of the subjects was 16–18 years (median = 18; IQR = 1 year). Most of the students were 18 years old (86.1%), followed by 17 years old (12.9%). Only one subject was 16 years old. Most students had a normal BMI (72.9%). More than half of the subjects were physically active (59.4%) (Table 1).

The median backpack weight carried by students was 3.50 kg (IQR = 1.86 kg; range = 0–11.00 kg), while the median backpack weight/body weight percentage was 5.87% (IQR = 3.48%) Male students carried heavier bags (median = 3.63 kg, IQR = 2.41 kg) than female students (median = 3.25 kg, IQR = 1.38 kg). The median percentage backpack weight per body mass over four days was 5.87% (IQR = 3.48%; range = 0.00–13.46%). Female students carried higher median percentage mass (6.19%, IQR = 2.97) than male students (5.42%, IQR = 3.58%). Eighty-seven per cent of the subjects carried a two-strapped bag using both shoulders. More female students (10.9%) favoured one strapped bags than males (2.0%).

A total of 61.4% of the subjects indicated that they had a history of low back pain. This pain occurred more frequently in females (36.6%) than males (24.8%). Most subjects (62.4%) indicated that none of their family members suffered from low back pain.

Table 1: Characteristics of the subjects.

Variable of interest	N	Median	Interquartile range
Age (years)	101	18.00	1.00
Body weight (kg)	101	55.00	17.05
Height (cm)	101	161.00	12.30
BMI (kg/m^2)	101	21.38	4.92
Backpack weight (kg)	101	3.50	1.86
Percentage weight of backpack per body weight (%)	101	5.87	3.48
Score of Daily Pain Intensity	101	0.75	1.50
Score of Roland−Morris Disability Questionnaire	101	3.00	5.00
		N	%
Sex	Male	42	41.6
	Female	59	58.4
Pain experience	Yes	39	38.6
	No	62	61.4
Family history	Yes	63	62.4
	No	38	37.6
Physical activeness	Yes	41	40.6
	No	60	59.4
Type of bag	One-strapped	13	12.9
	Two-strapped	88	87.1
Method of carriage	One-shouldered	22	21.8
	Two-shouldered	79	78.2

Most of the subjects scored from 1 to 6 (56.4%) on the Roland−Morris Disability Questionnaire, followed next by 0 (23.7%), and then from 7 to 14 (19.9%). No subjects scored above 14. The Daily Pain Intensity score of the subjects ranged from 0 to 10, with a median score of 0.75 (IQR = 1.50) (Table 1). Physically active subjects had a significantly higher low back pain score assessed by the Roland−Morris Questionnaire than the sedentary subjects ($p < 0.05$). Other categorizations of subjects did not produce a significant difference in low back pain scores ($p > 0.05$) (Table 2).

There were no significant correlations between the Daily Pain Intensity and any of the risk factors, including the weight of backpack ($p > 0.05$). Only physical activity was positively correlated with scores on the Roland−Morris Questionnaire ($r_s = 0.209$ $p = 0.036$), where subjects who claimed to be physically active had a higher degree of low back pain. No significant correlations were observed between scores on the Roland−Morris Questionnaire and the other risk factors ($p < 0.05$). Of note, body weight ($r_s = 0.188$; $p = 0.060$) and BMI ($r_s = 0.168$; $p = 0.094$) were marginally not significantly associated with back pain score (Table 3).

Discussion

Our study shows that backpack weight is not significantly correlated with low back pain score and Daily Pain Intensity. These results contradict other reports.[21] The backpack weight of our subjects was lighter (median backpack weight/body weight percentage = 5.86%) than in other studies.[6,16,22,23] This is because the pre-university students in this study carried less study materials in their bags than the primary or high school students in other studies. They also had comparatively fewer school subjects and hours per day. In addition, as mentioned by Papadopoulou et al. (2014), the duration of carrying a backpack was a more important determinant of low back pain,[3] but this factor was not examined in our study.

Table 2: Comparison between low back pain score between subjects with different characteristics.

Low back pain score		Roland−Morris Disability Questionnaire			Daily Pain Intensity		
Variable	Category	Median	IQR	p	Median	IQR	p
Sex	Male	2.500	4.000	0.555	0.750	1.750	0.664
	Female	3.000	6.000		0.750	1.500	
Previous experience of low back pain	Yes	3.000	4.000	0.152	0.875	1.750	0.118
	No	2.000	6.000		0.500	1.250	
Family history of low back pain	Yes	3.000	6.000	0.114	0.750	1.630	0.832
	No	2.000	4.000		0.750	1.500	
Physical activity	Active	3.000	6.000	**0.036**	0.750	1.690	0.978
	Sedentary	2.000	5.000		0.750	1.380	
Type of backpack	Two-strapped	2.000	4.000	0.355	0.750	1.440	0.992
	One-strapped	3.000	5.000		0.500	2.380	
Method of carriage	Two-shouldered	3.000	4.000	0.772	0.750	1.250	0.601
	One-shouldered	3.000	5.000		0.750	2.060	

Bold represents statistically significant p-value < 0.05.

Table 3: Spearman correlation results between low back pain score and risk factors of interest.

Low back pain assessment	Daily Pain Intensity		Roland−Morris Disability Questionnaire	
Risk factor	r_s	p	r_s	p
Backpack weight	0.013	0.901	−0.131	0.192
Percentage weight of backpack per body weight (%)	−0.042	0.675	−0.194	0.052
Type of backpack (reference = one-strapped)	0.001	0.992	−0.093	0.357
Method of carrying backpack (reference = one-shouldered)	−0.052	0.603	0.029	0.773
Age	0.077	0.444	0.046	0.645
Sex (reference = female)	0.043	0.666	−0.059	0.557
Body weight	0.098	0.331	0.188	0.060
Height	−0.057	0.573	0.063	0.530
Body mass index	0.163	0.104	0.168	0.094
Previous history of low back pain (reference = no)	0.156	0.118	0.143	0.153
Family history of low back pain (reference = no)	0.021	0.833	0.158	0.115
Physical activity (reference = sedentary)	0.003	0.978	0.209	**0.036**

Bold represents statistically significant p-value < 0.05.

In this study, sex has no significant association with low back pain based on the Daily Pain Intensity Scale and the Roland−Morris Disability Questionnaire. This did not agree with most previous studies, which showed a higher prevalence of low back pain among female students than among male students.[16,24] These studies postulated that females have less muscle mass and strength than males and thus are more prone to strain-induced muscle pain. It was reasoned that the students recruited in this study generally carried lighter bags, thus bearing less strain on their back muscle.

The type of backpack and the method of carrying had no significant associations with low back pain assessed by both scales. These results were again different from previous studies, which showed that carrying a one-shouldered bag caused more low back pain than wearing a two-shouldered bag.[9,11−13,23] In a study by Hong et al. (2011), the spinal posture deviates greatly when loading of the bag increased.[25] We suggest that the lighter backpack load (median 3.5 kg) relative to body mass (median 55.0 kg) weakens these associations in this study.

A significant association between subjects who claimed to be physically active and low back pain as assessed by the Roland−Morris Disability Questionnaire was observed in this study. This could be a secondary association due to muscle injury sustained from strenuous exercise. This is similar to the findings of Yao et al. (2012), who found that regular sports tend to cause low back pain among students.[26] However, other studies showed that physically active individuals tend to experience less low back pain than sedentary ones.[3,13,27,28] It was postulated that physical activity could strengthen the back muscles to carry an extra load. We did not study the type and intensity of physical activity. Therefore, the positive correlation between physical activity and low back pain was not conclusive, and further studies are needed to validate this relationship. We also did not perform physical examination and estimation of muscle mass in our subjects. Thus, we cannot investigate which factors (i.e., muscle strength or muscle injury) play a more important role in determining low back pain in our subjects.

Previous studies demonstrated that subjects with a higher BMI had a higher degree of low back pain.[27−29] This was probably due to the extra loading exerted on the musculoskeletal system in individuals with a large body size. In our study, body weight and BMI were positively associated with low back pain despite not being statistically significant. We suggest that a larger sample size would enhance the power of the association.

This study is not without its limitations. This was a cross-sectional study, where causality between risk factors of interest and low back pain cannot be inferred directly. This is a single-centre study, which prevents the generalization of the results. We also realized that the subjects in this study carried lighter backpacks in relation to their body weight (median percentage of backpack weight/body weight = 5.87%). In comparison, previous study indicated that a backpack/body weight percentage of more than 15% predisposed subjects to low back pain.[6] Thus, subjects in this study have a lower risk of suffering from low back pain induced by backpack usage. A case control study might better highlight the differences between subjects with and without low back pain. We did not calculate sample size for this pilot study, so some of the statistical analysis might be underpowered. However, this study provides a reference for future studies in terms of effect size. In the future, we propose to expand the study to increase the sample size and adopt a longitudinal design to better decipher the relationship between low back pain and its various risk factors among youths.

Conclusion

The use of backpacks among Malaysian pre-university students is not associated with low back pain, according to this study. However, these observations should be validated by a more comprehensive study in the future.

Conflict of interest

The authors have no conflict of interest to declare.

Authors' contribution

ANA and ASA recruited the subjects, performed the study, analysed the data and drafted the manuscript.

SNDMK, INS and CKY supervised the projects and provided critical review of the manuscript. INS and CKY provided final approval for the manuscript. CKY revised the manuscript.

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