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Neck, Upper Back and Lower Back Pain and Associated Risk Factors among Primary School Children

Mohd Azuan K., Zailina H., Shamsul B.M.T., Nurul Asyiqin M.A.,
Mohd Azhar M.N. and Syazwan Aizat I.
Department of Community Health, Faculty of Medicine and Health Sciences,
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

Abstract: Ergonomic among children is important as it will influence their growth, which mainly results from the development of the musculoskeletal system. Their anthropometric characteristics are totally different from adults. A cross-sectional study was conducted on 100 school children from two primary schools in Malaysia. Year 2 and 5 children were randomly selected and were given questionnaires to obtain information on their background, musculoskeletal pain/discomfort complaints, previous skeletal injuries and satisfaction with classroom furniture. A TANITA electronic weighing scale was used to measure their body weights, schoolbag load and relative schoolbag weight. A Harpenden anthropometer was used to measure their standing height. Neck pain (NP) was the most prevalent musculoskeletal disorder (MSD) with lifetime prevalence (LP) of 33% and a periodic prevalence (PP) of 15.3%, followed by the upper back pain (UBP) with a LP of 20.2% and a PP of 9.1% and lastly low back pain (LBP) with a LP of 13.1% and a PP of 8.1%. Binary logistic regression performed, showed the LP of neck pain were significantly influenced by factors namely: overall satisfaction with the classroom furniture, satisfaction with the backrest shape and desk height. Results showed that the schoolbag load and classroom furniture significantly influenced the prevalence of MSD.

Key words: Schoolchildren, musculoskeletal disorder, schoolbag weight, classroom furniture

INTRODUCTION

Ergonomics is a science that focus on the comfort of the workstation and all of its physiological aspects to the human (Geotsch, 2008). In Malaysia, all children with school-age of 6-18 years old attend school, except on weekends and public holidays. However, if the school environment is not a safe for them, injuries as well as illness results. Among them, is musculoskeletal disorder (MSD) arising from the school's unsafe environment. In this country, ergonomics issues among school children have not been widely addressed and documented compared to other issues such as air, water pollution, food safety and other physical hazards in school (Syazwan *et al*., 2009).

The MSD is a condition where a part of the musculoskeletal system is injured over time. It affects tendons, muscles, nerves and joints in the neck, upper and lower back, chest, shoulders, arms and hands. The MSD arised from the non-ergonomic conditions of the environment. In the case of school children, schools are part of environment their environment, as they spend at least 5 h daily in school. Among these were the classroom furniture as well as schoolbags. Population-based studies had demonstrated that the lifetime prevalence of musculoskeletal disorder in children and adolescents varies between 7 and 63% (Kovacs *et al*., 2003). Wedderkopp *et al*. (2001) suggested that the spine and MDS should be considered as 3 distinct entities (the neck, upper back and low back pain) as thoracic pain is more common in younger children.

Neck pain is second only to low back pain as the most common musculoskeletal disorder in population surveys and primary care and as in low back pain, it poses a significant health and economic burden and a frequent source of disability (Ferrari and Russell, 2003). Research suggests that back pain has a significant effect on school-aged children's participation in daily activities (Taimela *et al*.,1997). Musculoskeletal complaints, such as low back pain, among school-age students are believed to be from multiple causal factors (Chiang *et al*., 2006). The associated risk factors varied and sometimes contradictory between the studies done. Among the associated risk factors were age, gender, schoolbag weight, sitting, anthropometric parameters and many other factors. Among school children today, the most popular

Corresponding Author: Prof. Dr. Zailina Hashim, Environmental and Occupational Health Science Unit, Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400, UPM Serdang, Malaysia Tel: +603-89472406 Fax: +603-89472585

means of carrying books and supplies are by schoolbags. Previous research found a relationship between schoolbag use and musculoskeletal pain in students (Grimmer and Williams, 2000).

Generally in normal school environments, many factors can influence students' sitting posture, this include the anthropometric dimensions of schoolchildren, the measurement and design features of the school furniture (Murphy *et al*., 2007). Musculoskeletal pain has been cited to be associated with school furniture (chair/desk) (Parcells *et al*., 1999; Knight and Noyes, 1999). A number of studies have demonstrated that there was a mismatch between the design of school furniture and the anthropometric dimensions of school children (Parcells *et al*., 1999; Whittfield *et al*., 2005). This study was conducted to identify and characterize the hazards and adverse impacts of non-ergonomic school environment arising from schoolbags and furniture use among the Malaysian children.

MATERIALS AND METHODS

Study design and location: A cross-sectional study involving 100 primary school children was conducted at two different schools located at Pengkalan Hulu, Perak, Malaysia on 2007. The school was selected randomly from the Ministry of Education Malaysia list. Study involved data collection of reported lifetime and a periodic prevalence of musculoskeletal disorder (i.e., neck pain, upper back pain and lower back pain) among primary school children and the associated risk factors.

Stratified random sampling was used to sample subjects for the study with the inclusive criteria such as; Year 2 and 5 (non examination classes), carry books in schoolbags and was not diagnosed with any acute or chronic illness at the time of study. The sampling frame was the name list of students obtained from the class teachers or the school administrative office.

Instrumentation: Harpenden anthropometer was used to measure the standing height of the subjects. A TANITA electronic weighing scale was used to measure the weight and their schoolbag load. Two sets of questionnaires were used in this study. The first set was used to determine the children's background, compliance with school schedule, participation in physical activities, previous skeletal injuries (broken/fractured bones), methods of carrying schoolbags and perception on the weight of their schoolbag.

To obtain information on the MSD, a second set of self-administered questionnaire translated into Malay language from the Standardized Nordic Questionnaire (SNQ) (Kuorinka *et al*., 1987), was used. The questionnaire included a diagram of 9 body parts divided into neck, shoulder, upper back, lower back, elbow, arm, hand, thigh, knee and leg so as to assist the students in identifying the right body parts when answering the questions. The questions consisted of simple phrase such as for the past 1 month ago, do you experience problem on muscle or bone (ache, pain and discomfort) in these areas? 1) neck (No = 0, Yes = 1). Another section in the SNQ includes the Chair Feature Checklist which provides information on the suitability and comfort of the furniture.

RESULTS

Socio-demographic information: There were 100 children involved in the study. However, only 75 of them had a complete data set with no missing values, thus the response rate was 75%. Majority of the sample population were females constituting 53.3% while the males constituted 46.7% of the sample population. About 58.7% of the children were 8 years old (Year 2) while 41.3% of them were 11 years old (Year 5). Majority of the children were of Malay ethnicity (60%). The children complied with their school schedule in bringing their books to school (85.3%). Most of the students also participated in physical activities during leisure time (90.7%). One student (1.3%) was involved in accident that caused broken bone/fractures.

Anthropometric, bag load measurement and perceived complaint: The mean (standard deviation) for height was 125.48 (10.17) cm, for weight was 28.46 (9.84) kg and for body mass index (BMI) was 17.7 (4.32) kg m^{-2}. The mean for schoolbag weight was 4.35 (1.37) kg while the mean for relative schoolbag weight was 16.57 (7.09) %. A total of 56% children perceived their schoolbag weight as moderately heavy, 32% as heavy and 12% as light. Majority of the students carried their schoolbags on both shoulders (84%), use trolley bags (12%), carry on one shoulder (2.7%) and others (1.3%). About 68% of the subject was satisfied with the overall comfort of their classrooms' chairs and desks.

Prevalence of MSD: Neck pain was the most prevalent musculoskeletal disorder among schoolchildren, followed by upper back pain and then, lower back pain (Table 1). Males reported higher lifetime prevalence of neck and lower back pain than the females. Females however, reported higher periodic prevalence of neck, upper back

Table 1: Lifetime and period prevalence of musculoskeletal disorder

Musculoskeletal disorder	Lifetime prevalence (%)	Periodic prevalence (last 7 days) (%)
Neck pain	37.3	14.7
Upper back pain	22.7	9.3
Low back pain	13.3	6.7

N = 75

Table 2: Prevalence of neck, upper back and lower back pain according to gender, age and ethnic

	Neck pain		Upper back pain		Lower back pain	
	LP	PP	LP	PP	LP	PP
Criteria	(100%)					
Gender						
Male	53.6	45.5	47.1	28.6	70	40
Female	46.4	54.5	52.9	71.4	30	60
Age						
8 years old	64.3	72.7	58.8	57.1	60	100
11 years old	35.7	27.3	41.2	42.9	40	0
Ethnic						
Malay	57.1	45.5	76.5	100	80	80
Chinese	0	0	0	0	0	0
Indian	3.6	9.1	0	0	0	0
Thai	17.9	27.3	0	0	20	20
Orang asli	0	18.2	23.5	0	0	0

LP: Lifetime prevalence of musculoskeletal pain complaint. PP: Periodic prevalence of musculoskeletal pain complain in last then 7 days. Significant at p<0.05, (N = 75)

and lower back pain than the males. Younger (8 year olds) children reported higher for all prevalence of neck, upper back and lower back pain compared to the older (11 year olds) children. Malay children reported higher for all prevalence of neck pain, upper back pain and lower back pain than other ethnics (Table 2).

Factors associated with neck pain, upper back pain and lower back pain: For the neck pain, 2 factors that were significantly associated were the backrest shape and satisfaction with the desk heights. Besides, the upper back pain were significantly associated with the relative schoolbag weight, while the lower back pain were significantly associated with age and schoolbag weight (Table 3).

The factors influencing the occurrence of MSD after controlling for confounders: Logistic regression analysis was done to determine the factors influencing the occurrence of MSD after controlling the confounders in this study namely; compliance with school schedule (in bringing books), physical activities and previous skeletal injuries (broken/fractured bones). Results showed that neck pain had significant associations with 3 factors namely the backrest shape (OR = 4.488 [CI: 1.38-14.61], p = 0.013); the desk height (OR = 3.475 [CI: 1.09-11.09], p = 0.035) and the classroom chair and desk ([CI: 2.631], p = 0.035) (Table 4).

Table 3: Factors associated with neck, upper back and lower back pain

	Neck pain			
Variables	Yes (%)	No (%)	χ^2-value	p-value
Satisfaction with backrest shape				
Yes	7 (11.3)	55 (88.7)	7.518	0.012*
No	4 (30.8)	9 (69.2)		
Satisfaction with desk height				
Yes	7 (11.1)	56 (88.9)	5.306	0.041*
No	4 (33.3)	8 (66.7)		
	Upper back pain			
Variables	Yes (%)	No (%)	χ^2-value	p-value
Relative schoolbag weight				
Below 15%	6 (16.2)	31 (83.8)	4.850	0.048*
Above 15%	1 (2.6)	37 (979.4)		
	Low back pain			
Variables	Yes (%)	No (%)	χ^2-value	p-value
Age				
8 years old	5 (11.4)	39 (88.6)	4.552	0.048*
11 years old	0 (0)	31 (100)		
Schoolbag weight				
Below 4.35 kg	4 (12.9)	27 (87.1)	4.639	0.048*
Above 4.35 kg	1 (2.3)	43 (97.7)		

N = 75. Fisher's exact test. *Significant at p<0.05

Table 4: Factors influencing the prevalence of neck pain

	Neck pain			
Variables	Yes (%)	No (%)	Odds ratio (95% CI)	p-value
Satisfaction with backrest shape				
Yes	7 (11.3)	55 (88.7)	4.488	0.013*
No	4 (30.8)	9 (69.2)	(1.38-14.61)	
Satisfaction with desk height				
Yes	7 (11.1)	56 (88.9)	3.475	0.035*
No	4 (33.3)	8 (66.7)	(1.09-11.09)	
Satisfaction with classroom chair and desk				
Yes	6 (11.8)	45 (88.2)	2.631	0.035*
No	5 (20.8)	19 (79.2)	(1.07-6.48)	

N = 75. Binary logistic regression, adjusted with compliance with school schedule, physical activities and previous skeletal injuries. (Method: Enter) Classification cutoff: 0.15. *Significant at p<0.05

DISCUSSION

The prevalence of musculoskeletal disorder according to gender, age and ethnicity: Prevalence of MSD increases as it goes up the spine. Neck pain was the highest symptom reported followed by upper back pain and then lower back pain. The high prevalence of neck pain suggested that there was a high level of neck flexion as well as static and awkward postures during sitting as suggested in the literature by Grimmer *et al.* (1999). Sitting may well be the strongest factor that influenced MSD among school children. However, the occurrence of MSD may also be contributed by the way schoolbags are carried, which induced the forward leaning of the head and trunk as suggested by Pascoe *et al.* (1997). The MSD can also be caused by other factors as it is multifactor in nature (Chiang *et al.* 2006).

Females experienced more musculoskeletal pain than males. This could be due to gender differences as the physical and physiological characteristics of males and

females are different. Males and females differ in their muscle strength as females tend to have lower muscle strength than males, particularly in the upper limb musculature as supported by Katzmarzyk *et al.* (1998). Females also have a greater body awareness and lower pain threshold (Breithecker *et al.*, 2004) and thus tend to complaint more than males. Results showed 8 year olds had higher incidence of musculoskeletal pain compared to 11 year olds, maybe due to the strength and endurance of the musculoskeletal system of the younger group who are weaker than the older group when their growth accelerated. Malay students reported the highest incidence of musculoskeletal pain, followed by other races. The difference observed could be best explained by genetic, physiological and psychosocial differences among the races.

Comparison between schoolchildren with and without MSD with respect to height, weight, BMI, schoolbag weight and relative schoolbag weight: The load of schoolbags for schoolchildren with upper back pain was found to be significantly lighter than those without any MSD. The results in this study were contrary with findings from the literature where all of them found significant association between MSD and excessive loads (Grimmer *et al.*, 1999; Pascoe *et al.*, 1997; Troussier *et al.*, 2004). However, this could be explained by the questionnaire response with regard the pain that the children were suffering. These children with musculoskeletal disorder brought lighter loads (books, utensils, etc.) probably because they had suffered from prolonged episodes of musculoskeletal pain due to carrying heavy loads. As a result, they tried to reduce these episodes of pain from occurring by bringing lesser loads.

The association between MSD with several factors: For neck pain, 2 factors related to furniture comfort was significantly associated, that is satisfaction with backrest shape ($p = 0.012$) and satisfaction with desk height ($p = 0.041$). This showed that the shape of the backrest and height of the desk in the classroom had significant influence on the incidence of neck pain. Murphy *et al.* (2007) stated that when children feel uncomfortable, they may have to adopt flexed or static postures for prolonged periods of time, increasing muscular fatigue in the neck thus causing pain in those areas.

The relative schoolbag weight was the only factor significantly associated with the upper back pain ($p = 0.048$). However, it should be noted in this study that those with upper back pain carried lighter bags relative to their body weight than those without upper back pain. Carrying a schoolbag causes counter rotation of the pelvis and thorax (Lai and Jones, 2001). The counter rotation is decreased as the weight in the bag is increased. This limitation of movement is a risk factor for back pain as stated by Grimmer and Williams (2000). Age was one of the factors significantly associated with low back pain ($p = 0.048$). This study also found that younger 8 year olds reported higher prevalence of lower back pain than the 11 year olds. This is similar with previous study by Chow *et al.* (2006), who showed, inexperience or inability of this group in deciding the necessary books or supplies to take to school and also their inability to adjust to prolonged sitting.

Schoolbag weight was significantly associated with lower back pain ($p = 0.048$). However, it should be noticed that children with lower back pain carried lighter bags (mean weight = 3.21 kg) than those without lower back pain (mean weight = 4.44 kg). The prolonged pain caused them to respond by bringing less load to avoid pain attributed to carrying heavy loads. Heavy bags also cause a significantly increased flexion of the trunk in relation to the pelvis and extension of the head in relation to the trunk (Chow *et al.*, 2006). This could cause the onset of lower back pain and spinal injuries.

Factors influencing the occurrence of neck pain: From the logistic regression carried out on all the selected variables, controlling for compliance with school schedule (in bringing books to school), participation in physical activities and previous skeletal injuries (broken/fractured bones), it was found that neck pain was significantly influenced by satisfaction with the backrest shape and the desk height. The pain could be contributed by sitting with awkward or static postures, as well as sitting for prolonged periods of time (Murphy *et al.*, 2007).

Higher percentage of children who were dissatisfied with the features of the furniture (chair and desk) were among those with musculoskeletal pain. A possible explanation can be found in biomechanical studies, showing that sitting with a flexed trunk increases the spinal load, compared to standing and prolonged static sitting increases intradiscal pressure, resulting in decreased nutrition to the disc and also causing pain (Breithecker *et al.*, 2004). A high level of dissatisfaction with classroom furniture means that there is anthropometric mismatch between the dimensions of the furniture available and anthropometric characteristics of children as stated by Murphy *et al.* (2007). Furthermore, the variability that exists among children means that it is very unlikely that furniture of fixed dimensions will fit the majority of students as suggested by Parcells *et al.* (1999). Thus, there should be improvements in the design of the classroom chairs

and desks that are used by school children. This is to ensure the wellbeing of the children's growth during their schooling years and thus will determine their future body posture.

CONCLUSION

This study found that the prevalence of neck pain was the highest among schoolchildren, followed by upper back pain and lower back pain. The factors associated with MSD were age, load of schoolbag and satisfaction with the features of classroom furniture. However, after adjusting for the confounders, it was found that dissatisfaction with the features of classroom furniture such as backrest and table height significantly influenced the occurrence of MSD especially neck pain.

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