The Association between Ergonomic Risk Factors, RULA Score, and Musculoskeletal Pain among School Children: A Preliminary Result

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Abstract

A study was done to investigate the risk factors associated with musculoskeletal disorder (MSD) among school children in Malaysia. Two schools in the Klang Valley and one in Johor Bahru were selected. A cross sectional study was done baginning February 2009 until May 2009. Two hundred and twenty nine pupils among 2nd Grade (age 8 years) and 5th Grade (age 11 years) from three school were selected to participate in this study. Musculoskeletal symptoms were recorded using Modified Nordiq Body Map Questionnaires; Tanita weight measurement was used to measure school bag weight and students' weight. Modified Rapid Upper Limb Assessment (RULA) was used to assess the awkward posture of the students' torso namely bending forward movement, leaning, sitting and twisting. A high prevalence of MSD among school children aged 11 years old (5th grade) was found (68.0%) compared to 8 years old (2nd grade) with 36.4%. Result also showed that 31.8% of 2nd grade and 62.2% of 5th grade students experience upper MSD. Lower MSD complains showed 5th grade students are at higher percentage than 2nd grade with 45.5% and 20.9% respectively. Logistic regression analysis controlling for body mass index, sport injuries and history of major accidents revealed that the following factors were related to MSD: home activities (involving television (TV) watching and personal computer (PC) used) [1.889, 95% CI 1.081 – 3.301] and bag perception complain among school children [2.148, 95% CI 1.086 – 4.247]. For specific MSD symptoms it was found that the duration of home activities using PC or TV exceeding 2 hours was the main the risk factor of upper MSD among school children [4.923, 95% CI 1.188-20.389]. In conclusion, combination of risks leads to high increase of MSD among school children in Malaysia.

Keywords: Musculoskeletal Disorder (MSD), Rapid Upper Limb Assessment (RULA), School children, Home activities

1. Introduction

Ergonomics is a science that seeks to comfort the workstation and all of its physiological aspects to the human (David, 2008). In Malaysia ergonomics issues among school children are not documented widely compare to other issues such as air pollution, water pollution and other hazards in school. School furniture is among several factors that may contribute to musculoskeletal pain (MP) among school children. In the classroom, children often sit in poor postures with trunk, back and neck flexed or rotated even for longer periods of time. Generally in normal school environments, many factor can influence students' sitting posture, this include the anthropometric dimensions of school children, the measurement and design features of school the furniture (Murphy et al. 2004, Yeats, 1997). Sitting posture perform by students in school can contribute to the development of MP among them. When posture of the students were compromise with awkward body position when sitting adding with the heavy lifting of school bag can introduce harm and danger to the student musculoskeletal system (Murphy et al. 2004). School children lugging bags packed with books have been a perennial problem in Malaysia. Nowadays, Ministry of Education has introduced periodic table and serial textbooks to reduce the weight of school backpacks. The changes were done when many teachers and parents voiced their concern about the load in school bags especially in early 2002. However, heavy school bags remain a yearly problem as some subject that requires five or six exercise books, excluding the textbooks (Furjuoh et al. 2003).

The bags could weight up to 10 kg each which is about 50% of student body weight. The rolling backpacks have been recommended by United Kingdom health professionals, but lead to other challenges, such as difficult manipulation on stairs, storage within school and passage through crowded hallways and buses (Furjuoh et al. 2003). Ergonomics awareness in school environment have not being implemented seriously in Malaysia, and as the result most of the children poses greater risk to ergonomics hazard due to the heavy lifting of school bag and incorrect sitting posture in classrooms. This can lead to development of MP at any body part in the future. In promoting safety and health among school children pertaining to ergonomic issues, the teachers play major role enhancing healthy behaviors. Intention to adopt healthy behaviors, like any other type of behaviors, is motivated or 'trigger' by stimuli in an individual's environment (Egger et al. 2004).

Many factors can increase the risk on developing of low back pain (LBP) after exposure to the ergonomic hazard. For the school children, structurally they are small and need special chair design for them to sit for a long period of time without experiencing any back injury (Yanto et al. 2008). In Yanto et al. (2008) study, mismatch occurs among the school children where their furniture in class does not match with their body dimension and thus complained on back of body due to their buttock and back pain. The second factor of ergonomic stressor in the school environment among school children are the bad horizontal and vertical movement on their school furniture in class session. In Indonesia, Riyadina (2001) studied the effect of mismatch between school furniture dimensions with painful at neck (61.3%), shoulder (57.0%), waist (49.2%), posterior (54.5%) and arm (72.3%).

Many researchers have concluded that the awkward posture status, bag weight and lack of ergonomics awareness were the major factors that contribute to the development of musculoskeletal disorder (MSD) among school children. Therefore, this national cross sectional study among the school children was carried out to determine the prevalence of MSD, risk factor associated with MSD and posture score. This preliminary study is a part of cohort study with the aim to determine the effectiveness of ergonomically designed furniture for Malaysian schools.

2. Methods and materials

2.1 Subject recruiting and selection

A cross sectional study was conducted involving 229 school children in 3 locations from February to May 2009 in two state in Peninsular Malaysia, namely Selangor State in the Central region (2 schools), and Johor State in the Southern region). Two classes were randomly selected from each school, where one class from second grade (2nd Grade) which aged 8 years old, and fifth grade (5th Grade) which aged 11 years old. Systematic random sample was used in selecting the student in each class when Rapid Upper Limb Assessment (RULA) was performed on selected students'. The student selection was based on the specific criteria which exclude the student with major accidental injury and mental illness. The sampling frame was a list of government primary schools in Selangor and Johor, which was obtained through the Ministry of Education, Malaysia. The list of students studying in primary two and five from the selected schools obtained. The schools were selected based on its medium of teaching, which is Malay Language, and multiracial and coeducational characteristics. Student name was obtained from the school management based of their respective class.

2.2 Questionnaires

Two sets of questionnaires were used in this study. The first set was used to determine the children's background such as ethnic, transportation to school, type of school bag and home activities. To obtain information on the MSD, a set of self-administered questionnaire translated into Malay language from the Standardized Nordic questionnaire (SNQ) (Kourinka et al., 1987), was used. The questionnaire contained a diagram of 9 body parts divided into neck, shoulder,

upper back, lower back, elbow, arm, hand, thigh, knee and leg so to assist the students in identifying the correct body parts when answering the questions. The questions consist of simple phrase such as "For the past 1 month ago, do you experience problem on muscle or bone (aching, pain and discomfort) in these areas? 1) neck" (No=0, Yes=1).

2.3 Rapid Upper Limb Assessment (RULA)

The posture analysis among student was performed using Rapid Upper Limb Assessment (RULA). RULA was developed by McAtamney and Corlett of the University of Nottingham's Institute of Occupational Ergonomics (McAtamney et al, 1993). Rapid upper limb assessment was used to evaluate the awkward posture of students in their class activities when in sitting position. Posture of the student in this study was assessed and good inter reliability result were obtained (α Cronbach = 0.8120, 0.7951, 0.7851, 0.8141, 0.8310, 0.7931 for arm analysis, wrist, neck, trunk, leg and muscle, respectively). Modified RULA checklist forms translated into Malay language were used and observations were recorded as numerical scores. The score was then translated using specific RULA matrix of scoring whereby a high grand score indicate a severe awkward posture (Figure 1).

2.4 Bag weight

The bag weight measurement was performed to evaluate the schoolbag load status among the respondents. The weight of each respondent's schoolbag load (including everything that the was brought to school on the day of measurement such as water bottle, books, stationeries and food) was measured using an electronic weighting scale (Tanita Model) with an accuracy of ± 0.1 kg. The schoolbags were placed at the centre of the weighing scale with the loads evenly distributed over the surface. The measurement was then, recorded to the nearest 0.1 kg. Time, date and place on which the measurements were conducted were recorded. Three measurements were made daily (early morning, morning and evening) to obtain representative weight of the schoolbag load.

2.5 Statistical Analysis

For univariate analysis, distribution and frequency of socio-demographic factors under study was determined. Logistic regression analysis was performed by adjusting the Body Mass Index (BMI), sport injuries and accident injury when determining the risk factors of MSD. Statistical Package for Social Science (SPSS®) version 13.0 was used in data analysis with the significant value ($p < 0.05$).

2.6 Quality control

Pre-test questionnaires was performed on 10% of sample size before the start of the study on school children aged 8 and 11 years old to ensure the understanding of the questions (face validity). In order to control the selection bias, matching procedure was conducted controlling for; i) the mode of transportation of the school children to school, ii) the distance of the school, iii) the school bag and the method of carrying school bag daily. To ensure that analysis was done correctly, a video camera was used to capture the motion of the students for the morning session only. The video were then analyzed for one minute using a RULA cycle.

2.7 Ethical issues

Approval from Medical Researcher Ethic Committee, UPM was obtained. Written consent from the parents/ guardians of the school children were obtained before data collection. Reference item of Ethical Approval was (UPM/FPSK/PADS/T7-MJKEtikaPer/F01_(JKK_APR (09) 01).

3. Results

3.1 Socio-demographic information

Demographic information of respondents is shown in Table 1. All anthropometric measurements were significant different between 2nd grade and 5th grade group (Table 2). Modified RULA assessment for school children showed there were significant different in RULA score between two groups with the higher scores among 2nd grade than 5th grade students (Table 2).

3.2 Comparison of MSD prevalence among school children

The study showed that from the 9 body parts, the lifetime prevalence of MSD showed that the highest complain was shoulder pain (16.4%) among the 2nd grade children and neck pain (38.0%) was the highest complained among the 5th grade. The overall MSD pained shows that the 5th grade reported the higher complaint (67.0%) than the 2nd grade (36.0%) (Table 3). The study also showed that the 5th grade school children recorded higher sports injury (47.1%) compared to the 2nd grade school children (16.4%). The injury were mainly due to sport injury was leg pain among the 2nd grade (33.3%) and 5th grade school children (64.3%) (Figure 2.0).

3.3 The association between MSD with risk variables

Risk determination was carried out, controlling for sport injury, history of previous accident or major injury and body mass index (BMI). Results showed that home activities and perception of bag weight had significant association with

the MSD prevalence among study group (Table 4). The study showed that those who used personal computer or watch television (TV) had higher risk (OR=1.889) of developing MSD compared to those without these activities. Study also showed that the students with heavy bag weight had higher risk (OR=2.148) in developing MSD compared to those with light bag weight. Others risk factors showed no significant association between MSD and risk factors either for the 2nd grade students (Table 5) or 5th grade (Table 6).

Form the risk determine in this study, further analysis was conducted and risk variables data were grouped into 3 main factors namely time consume for home activities (more or less than 2 hours), bag weight (more or less than 10% of each students body weight) and RULA score (more or less than awkward position score =5). Results for overall analysis of risk factors and MSD showed that, time spent (more than 2 hours) for home activities influence MSD occurrence among school children after adjusting for sport injury, history of accident and BMI. This study suggested that the students who use PC or watch TV more than 2 hours had higher risk (OR=4.923) of developing MSD on the Upper Back (OR=2.259) compared to those without these activities.

4. Discussion

4.1 Prevalence of MSD

This study was to determine the rate of musculoskeletal disorders amongst schoolchildren and the role of physical and psychological factors in which evaluation and association with subsequent symptomology were made. The primary aim of the study was to estimate the prevelance of students having musculoskeletal pain, and to calculate risk associated with the pain including bag weight, home activities, and awkward position and posture. Higher prevalance of MSD reported pain occur more frequent among female then the male students. Simialr findings by Troussier et al. (1999) who found that MSD for back pain common among female than in male (25.4% versus 15.2%; p<0.001).

This study showed a high prevalence of MSD among Malaysian schools children from 9 body parts. This findings by Gary A. et al. (2006), reported the highest prevalence of MSD associated with demoghrapic and behaviour factors in which the prevalence of MSD pain was much higher (55.9%) than the present study (36.6%). Higher MSD pain reported in lifetime for 5th grade (67.2%) compared to 2nd grade (36.4%) for this study. Dominant pain location for lifetime prevalence recorded for 5th grade was the neck (37.8%) followed by the shoulder (31.9%) and thigh (19.3%). Total reported MSD pain in one week was also recorded higher at the neck area (22.7%) for the 5th grade as compared to the 2nd grade (8.2%). However outcome from this study as comapred to that observed by Yanto et al. (2008) who reported most of the 2nd grade (11 – 12 years) school children in Indonesia reported as having higher thigh pain (>30%). For the 2nd grade students, the highest reported musculoskeletal pain was the shoulder area (16.4%) followed by the neck (14.5%) and leg (12.7%).

The strongest complaints in this cross-sectional study were observed in the neck, upper back and low back pain. Jones et al. (2003) concluded that the musculoskeletal pain complaints may relate to childhood somatic symptoms. Mikkelsson et al. (1997) showed that 30.5% of children in their study reported headache at least once a week compared with 54% of children who also reported musculoskeletal pain, while Wickman (1992) and Brattberg (1992) found students with any body part of muscle pain especially at lower back and headache reported higher stomach ache than those who had no symptoms. There are other factors that may influence the reporting of pain symptoms among the children and need to be thoroughly understood when interpreting the findings from musculoskeletal pain studies.

4.2 Bag weight

From this study, the mean of school bag weight of the 5th grade students showed significantly higher mean than the (mean = 4.89kg ± SD = 1.43kg) 2nd grade students (mean = 4.63 kg ± SD 1.03kg). Whittfield et al (2005) reported the mean of school bag weight was 6.6kg (SD 2.2kg) for all groups. Several authors reported a significant relationship between musculoskeletal pain and school bag weight (Viry et al., 1999; Whittfield et al., 2005), however, the findings in this study were inconclusive because of the timetable issues and lack of storage area in school. These lead to the habit of children to bring excess books in their bag to school daily.

Despite from the findings there were no significant association between the method of carrying bag and MSD but Troussier et al. (1994) reported a significant correlation between presence of pain at the back and the position in which the bag was carried (i.e. in hand or on one shoulder). No significant association between the school bag weights amongst the 2nd grade as compared to 5th grade. This may be due to the weight of subject being studied. In Malaysia, the second level students (aged 10 to 12 years old) were required to take extra subject for language and science. As a result, more books might cause the bag weight to be above allowable weight of 10% above the body weight.

The small body measurement of the 5th grade may also influence the MSD reported symptoms. From the result, there were significant different between 2nd grade and 5th grade students for all anthropometric measurements which might influence the bag weight carrying habits among the 5th graders. Similar findings by Yanto et al. (2008) there were significant difference in anthropometric measurements amongst 10 – 12 years old school children when compared to younger age group.

4.3 Rapid Upper Limb Assessment (RULA) score

Rapid upper limb assessment is an obeservational method of assessing postural health among human workers (McAtamney et al. 1993). This techniques was used in this study as the student may possess greater risk of prolong sitting and performing awkward posture in the class environment. From this study, both groups showed no significant association between MSD and the increment of RULA score (above 5). Previously, studies have demonstrated that there were a mismatch between the dimensions of school furniture (chair/desk) and the anthropometric measurements of school students (Parcells et al. 1999; Legg et al. 2003). Several studies also have found an association between musculoskeletal pain of lower back with sitting position (Balague´ et al. 1988; Salminen, 1984; Viry et al. 1999). Nissinen et al. (1994) studied a cohort of fourth-grade school children and found those with low back pain in the last month sitting (55.6%) was cited as the most common provoking factor, as reported by 30.2% of subjects.

Troussier et al. (1994) found that of 1178 subjects included in their study, 41.6% of the respondents (490 children) experienced pain while sitting in the classroom. They also noted that 69.5% of the back pain occurred after 1 h of sitting and that MSD pain on back increases with the duration of the sitting position in school. In another study by Balague´ et al. (1988) found that, out of the students sufferers MSD included in their study (i.e. 27% of 1715 school children), 42% experienced pain when sitting and 28% when bending forwards. In a study of 370 children aged 11–17 years, Salminen (1984) observed that 59.9% of those reporting current neck and/or back symptoms (20% of sample) complained of pain while sitting.

4.4 Ergonomics and home activities

Previous study showed that the postural behaviour of school children may affect MSD prevalence (S. Hakimi et al. 2008). Hakimi et al. (2008) had showed that the majority of school children (62%) had poor sitting posture while writing and reading. Previous findings also indicated that 50% of respondents from the study subject did not have enough information about proper sitting in class (S. Hakimi et al. 2008). Studies found an increased risk of MSD as a result of watching television or using PC at home (Balague´ et al. 1988, 1994; Troussier et al. 1994).

This study result showed strong a significant association between watching television and MSD among all study groups. Balague´ et al. (1988) reported prevalence rates of over 50% among those who spent more than 2 h per day watching television. This study suggested that the main risk factor associate with the MSD was the using PC or watching TV at home for 2nd grade and 5th grade [OR=4.923, 95% CI 1.188-20.389]. However Troussier et al. (1994) suggested that the risk of musculoskeletal pain (R.R= 1.71) increases when watching TV for more than 1 h per day, proposing that the effect of TV on the musculoskeletal health is secondary to prolonged postural pain. Result from this study, recorded the time consume by the student using PC at home more than 2 h or not. It showed that the highest risk of developing MSD symptoms were the using of PC for prolonged sitting habits. Although many studies showed significant association between TV watching habit and MSD rather than PC, but another study showed null association as reported the same (Gunzburg et al. 1999a) between musculoskeletal pain and television watching; although in this study, significantly more musculoskeletal pain was observed in children who reported playing video games for more than 2 h per day. As far as we are aware of, it is not known whether the risk associated with TV viewing is due to sitting or inactivity.

In future research, it is important to recognize the influence of psychological and family factors in children pain especially the onset of musculoskeletal pain. It would be helpful to better understand these risk factors, and interactions that may exist between them to ascertain their relative importance and predictive ability in terms of back pain among schoolchildren. While it may be possible to influence physical risk factors acting in the school environment, it is important that psychological factors are also included in a preventative strategy aimed at reducing the occurrence of MP amongst schoolchildren.

Physical factors seem to play an important role in the development of children's pain, and prolonged periods of sitting may increase pain reporting. This study also suggests that school furniture may contribute to the onset of pain in schoolchildren. There are also serious implications for the future workforce with many young adults entering the workplace already having neck and back pain already present.

Finally, further research is required to examine the association between sitting posture and pain reported at different spinal locations. Unsuitable school furniture may contribute to the onset of pain and those children with psychological difficulties may go on to develop more long term and serious pain. Children are also more likely to report pain if there is a family history of such pain.

4.5 Study Limitation

The main limitation of the present study was that it was cross sectional design and not all risk factors assumed as being important were predictive and seen as exploratory rather than an examination of pain and causal factors. Posture assessments should have been done for all subjects. The results were also limited to 3 schools in 3 different cities. As the present study was preliminary for our cohort study; risk factors for MSD will be revealed further when the whole study is completed.

Acknowledgment

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Table 1. Demographic information among 229 school children

Variables		Frequency	Percentage (%)
Grade	2nd Grade	110	48.0
	5th Grade	119	52.0
Gender	Male	94	41.0
	Female	135	59.0
Race	Malay	197	86.0
	Indian	22	9.6
	Chinese	2	0.9
	Others	8	3.5
Transportation	Bus/ Car	214	93.4
	Walk	15	6.6
Time for Travel	< 15 minutes	187	81.7
	> 15 minutes	42	18.3
Home activities[a]	Yes	154	67.2
	No	75	32.8
Perception of bag	Light	42	18.3
	Medium	150	65.5
	Heavy	37	16.2
Bring Food	Yes	188	82.1
	No	41	17.9
Comfort of Chair	Yes	171	74.7
	No	58	25.3
Comfort of Desk	Yes	184	80.3
	No	45	19.7

[a] Use personal computer at home (PC) and watch TV

Table 2. Anthropometric, bag weight and RULA scores between 2 groups

Variables		2nd Grade [n=110] Mean (SD)	5th Grade [n=119] Mean (SD)	t value	p value
Anthropometric	Weight	23.61 (6.20)	35.54 (10.30)	-10.524	p<0.001
	Height	122.10 (6.71)	132.14 (12.51)	-7.453	p<0.001
	BMI	15.63 (2.55)	20.52 (6.00)	-7.912	p<0.001
Bag Weight		4.63 (1.03)	4.89 (1.43)	-1.606	0.110
		[n=56] (SD)	[n=61] (SD)		
RULA Score[a]		5.35 (0.47)	4.94 (0.64)	3.901	p < 0.001*

[a]The RULA assessment was performed by selected students only to represent their class using systematic random sampling.

Table 3. Lifetime prevalence and 7 days prevalence of body part complaint among respondents

	Life time			7 days		
Body Parts	2nd Grade (n=110)	5th Grade (n=119)	All	2nd Grade (n=110)	5th Grade (n=119)	All
Neck	14.5	37.8	61	8.2	22.7	36
Shoulder	16.4	31.9	56	9.1	16.8	30
Elbow	11.8	3.4	17	7.3	2.5	11
Arm	10.9	17.6	33	5.5	5.0	12
Upper Back	8.2	17.6	30	3.6	6.7	12
Lower Back	6.4	18.5	29	1.8	8.4	12
Hip and Thigh	6.4	19.3	30	4.5	10.1	17
Knee	8.2	14.3	26	6.4	5.0	13
Leg	12.7	19.3	37	7.3	8.4	18
MSD Experience in lifetime	36.4	67.2	120	24.7	47.9	84
MSD Prevalence (1 month)						
Yes (%)	41 (37.3)	87 (73.1)	128			
No (%)	69 (62.7)	32 (26.9)	101			
Injured During Physical Education Class						
Yes (%)	18 (16.4)	56 (47.1)	74			
No (%)	92 (83.6)	63 (52.9)	155			

Table 4. Association between risk factor and MSD prevalence

Risk Variables	With MSD n= 128 (%)	Without MSD n=101 (%)	χ^2	Odd Ratio (OR)	95.0% C.I
Grade					
2nd Grade	41 (32.0)	69 (68.3)	29.778*	4.575	2.614 – 8.010
5th Grade	87 (68.0)	32 (31.7)			
Sex					
Male	52 (40.6)	42 (41.6)	0.021	1.040	0.612 – 1.768
Female	76 (59.4)	59 (58.4)			
Transportation					
Bus/Car/Bike	121 (94.5)	93 (92.1)	0.555	0.673	0.235 – 1.921
Walking	7 (5.5)	8 (7.9)			
Time Consume					
< 15 minutes	100 (78.1)	87 (86.1)	2.421	1.740	0.862 – 3.514
> 15 minutes	28 (21.9)	14 (13.9)			
Home activities					
Using PC	94 (73.4)	60 (59.4)	5.047*	1.889 [a]	1.081 – 3.301
Not Using PC	34 (26.6)	41 (40.6)			
Perception of bag					
Light	17 (13.3)	25 (24.8)	4.960*	2.148 [a]	1.086 – 4.247
Heavy/Medium	111 (86.7)	76 (75.2)			
Attitude bring					
Bring food/water	108 (84.4)	80 (79.2)	1.025	1.418	0.720 – 2.790
Not bringing	20 (15.6)	21 (20.8)			
Chair Complain					
Comfort	88 (68.8)	83 (82.2)	5.382*	0.477	0.254 – 0.898
Discomfort	40 (31.3)	18 (17.8)			
Desk Complain					
Comfort	98 (76.6)	86 (85.1)	2.636	0.570	0.287 – 1.129
Discomfort	30 (23.4)	15 (14.9)			

* Significant at $p<0.05$

[a] Significant at OR=1, 95% CI

Table 5. Association between risk variables and MSD prevalence for 2nd grade study group

Risk Variables	Mean (SD)	OR	95.0% CI
Anthropometric			
Weight	23.59 (6.20)	1.032	0.929 – 1.146
Height	122.13 (6.70)	1.007	0.914 – 1.109
BMI	15.62 (2.55)	1.063	0.910 – 1.242
Bag Load Status			
Bag Weight	4.63 (1.03)	1.129	0.768 – 1.661
RULA Assessment			
RULA score	5.35 (0.47)	1.788	0.530 – 6.028

Table 6. Association between risk variables and MSD prevalence for 5th grade study group

Risk Variables	Mean (SD)	OR	95.0% CI
Anthropometric			
Weight	35.51 (10.28)	1.031	0.966 – 1.101
Height	132.13 (12.51)	0.970	0.914 – 1.029
BMI	20.50 (6.00)	1.078	0.991 – 1.174
Bag Load Status			
Bag Weight	4.89 (1.43)	0.950	0.605 – 1.492
RULA Assessment			
RULA Score	4.94 (0.64)	1.132	0.410 – 3.217

Table 7. Association between risk factors and MSD prevalence among all respondents

Body Parts	Home Activities[a] (OR)	Heavy Bag[b] (OR)	Incorrect Posture (RULA)[c] (OR)
Neck	2.356 (0.930-5.968)	0.887 (0.633-1.243)	0.656 (0.324-1.327)
Shoulder	2.000 (0.800-4.998)	0.793 (0.561-1.121)	1.131 (0.561-2.282)
Hand/Arm	2.067 (0.574-7.436)	1.118 (0.711-1.760)	0.512 (0.198-1.325)
Upper back	**4.923 (1.188-20.389)**	0.850 (0.537-1.347)	1.017 (0.385-2.682)
Low back	1.145 (0.393-3.336)	0.778 (0.512-1.183)	0.709 (0.306-1.641)
Tights	2.011 (0.577-7.012)	1.142 (0.742-1.759)	0.595 (0.239-1.481)
Knee	3.062 (0.727-12.894)	0.766 (0.475-1.233)	0.442 (0.164-1.191)
Leg/ Ankle	1.212 (0.417-3.526)	1.127 (0.748-1.698)	1.593 (0.677-3.752)
Elbow	3.334 (0.629-17.663)	0.994 (0.549-1.622)	2.047 (0.619-17.663)
MSD overall	**2.259 (1.161-5.780)**	0.886 (0.634-181)	0.906 (0.483-1.701)

[a]Home activities including time spent for using PC and watching television more or less than 2   hours

[b]Bag exceed 10% of student body weight categories as heavy bag

[c]Exceed scoring of 5 indicate awkward posture when sitting and ergonomic risk present

Figure 1. Modified RULA Assessment Form

Reported Sport Injuries For 2 and 5 Grade School Children
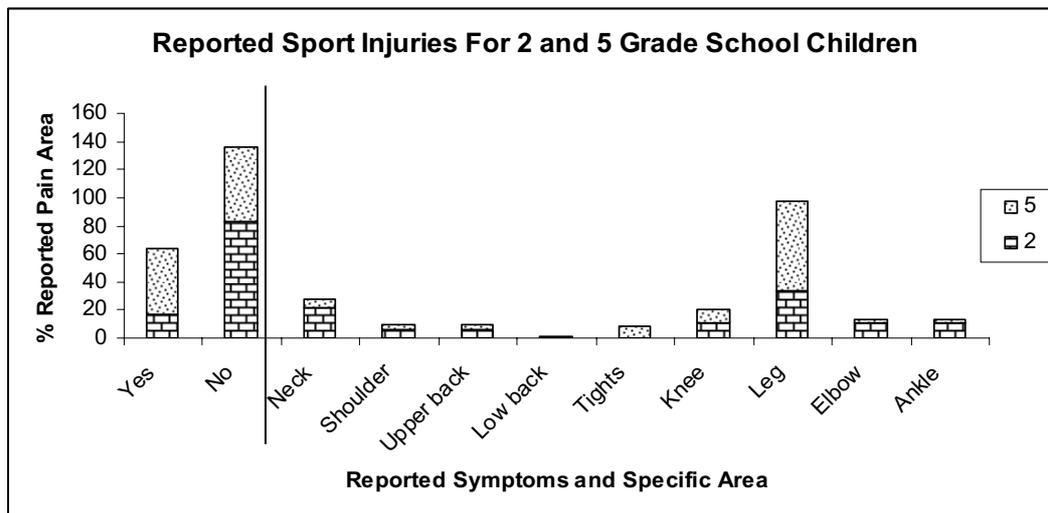
% Reported Pain Area

Reported Symptoms and Specific Area

Figure 2. Prevalence of MSD pain due to sports injuries