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Ergonomic and Sociodemographic Factors as Predictors of Bag-Use Related Musculoskeletal Pain among School Going Children

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Abstract: ***Objective: The objective of the study was to determine if sociodemographic factors and ergonomic factors influence bag use related musculoskeletal pain in Kenyan school going children population. Design: The study was a descriptive cross-sectional study and Quantitative methods were adopted. Setting: The study was carried out in Nairobi County Sample: Systematic random sampling was used in selecting children who used backpacks. Starehe Sub –county was purposively selected for the study due to the diverse nature of the population in terms of socio-economic status (n = 248) Analysis: Data was analyzed through descriptive statistics, chi-square test of independence and logistic regression. Main outcome measures: Bag-use related musculoskeletal pain, socio demographic factors and ergonomic factors. Results: Most of the participants (25.1%) reported lower back pain while 16.9% had neck pains. 247 (65%) were from the public primary schools while 132 (35%) were drawn from private primary schools. There was almost equal representation from both gender, 194 (51.2%) of the respondents were males and 185 (48.8%) females. Majority, 279 (73.6%) reported that they experienced pain when carrying school bag. There was no significant association between gender and pain (p>0.05). However, age and pupil's weight were significantly associated with pain (p<0.05). Chi square test also indicated that factors such as backpack weight, rest breaks from carrying backpack, academic stress, method of backpack carriage, body posture on carriage were significantly associated with pain (p<0.05). Conclusion: Musculoskeletal pain was significantly associated with school bag weight, rest breaks from carrying bag, method of bag carriage and body posture on carriage. Recommendations: The school management including the teachers should encourage pupils to carry lighter backpack (less than 15% of pupil's body weight) and wearing bag on both shoulders. Future studies should focus on differences in pain among pupils in the urban and rural settings.***

Keywords: Musculoskeletal pain, prevalence, Nairobi county, bag use, weight-bearing, child, Back pain

1. Background

Backpacks constitute a significant daily amount of "occupational" load for school children (Negrini*et al.*, 2007).Regionally, there are very few studies that have explored the problem of musculoskeletal pain among school going children, much less the link between backpack use and musculoskeletal pain (Mwaka *et al*., 2014; Johnson *et al.*, 2011). Within the Eastern Africa region only one study by Mwaka*et al*., (2014) explored the topic on musculoskeletal pain and backpack weight to some considerable length. Results from the study on Ugandan students revealed that musculoskeletal pain was associated with carrying heavy backpack as noted from complaints among majority of students thus recommended the provision of libraries and lockers to minimize unnecessary loading and recurring strain injury among students (Mwaka *et al*., 2014).

Various ergonomic and socio demographic factors contribute to Musculoskeletal pain among children. heavier the backpack, the more pressure it exerts on the spinal column and back muscles as the children bend forward in an attempt to support the weight on the back rather than on their shoulders hence development of neck and back pain (Puck Ree*et al.*, 2004).Studies have shown that many children carry bags weighing more than 10% of their body weight (Mwaka*et al.*, 2014). Backpack weights as high as 20% of the respective body weights of the children have been documented (Iyer*et al.*, 2001).Wang *et al.*, (2001) in a separate study report that even a school bag weighing 10% of the body weight of the school child caused the trunk to lean forward. It can therefore be inferred that if body inclination causes low back problems, school bags of 10% body weight exceed the recommended carrying weight for the child (Wang *et al.*, 2001).

Methods of carrying backpack have also been reported to contribute. Recommendations have been made by professionals that backpacks should be carried on both shoulders (Zimbler, 2000; Cavallo *et al.*, 2002; Mwaka *et al.*, 2014). By placing the backpack straps on both shoulders, the weight of the backpack is distributed evenly and supported by back and abdominal muscles (Zimbler, 2000). In a study by Pascoe *et al*., (1997) it was found that the use of one strap led to a marked elevation of the supporting shoulder with notable deviation of the spine away from the backpack's weight. However, when both straps of the backpack were used, there was no change in position different from the unloaded situation. Chiang *et al.*, (2006) posit that even a heavy two-strap bag can affect both posture and gait. Troussier *et al.*, (1994) in their study concluded that there is a significant correlation between the presence of pain and the position of carrying the backpack.

Research suggests that heavy schoolbags, long durations of carriage and lack of access to lockers might be factors of musculoskeletal symptoms (Mwaka *et al.*, 2014). Students' backpacks are often loaded with books and supplies for the entire day particularly in schools without lockers (Chiang *et al.*, 2006). Previous studies (Chiang *et al.*, 2006) that have investigated on duration of carriage have found that less time spent carrying backpack is associated with minimal number of children complaining of low back pain. Mwaka *et al.*, (2014) noted that carrying a heavy school bag for long periods of time could result in repetitive stress injuries to the growing body. This follows the shifting of the child's centre of gravity

in the direction of the load when carrying a backpack. The longer the children carry bags to schools, the more predisposed they become to the musculoskeletal pain and disorders (Neuschwander *et al*., 2010). It has been found that most school-going children are forced to carry heavy bags every time they go to school and this makes it possible for the development of the musculoskeletal disorders as well as back pains (Neuschwander *et al*., 2010).

Concern has been raised globally and regionally about the rising cases of musculoskeletal pain associated with backpack use among school children. However, the extent of this problem in Kenya was not documented as of the time of this study. Studies that were conducted elsewhere focused on finding associations of musculoskeletal pain with the school bag factors. The objective of the study was to determine if sociodemographic factors and ergonomic factors influence bag use related musculoskeletal pain in Kenyan school going children population in which such relevant literature is limited.

2. Methods

The study was conducted in Starehe Sub-county, Nairobi county and ethics approval were obtained from Kenyatta University Ethics and Review Committee and NACOSTI. Authority was obtained from County Education Office. No further approval was needed since the project did not require access to personal data.

Research Design

The research design adopted for this study was descriptive cross-sectional design where interviewer administered questionnaires were used for data collection. This particular design was ideal since the research entailed collecting and comparing data from the phenomena at the same time of study. Even though this design is marred by difficulty to make causal inference, it was chosen for the study since it is relatively inexpensive, takes little time, provides estimate of the prevalence of outcome, and can be used to assess several outcomes and risk factors at the same time, among many other advantages (Levin, 2006)

Study setting

Starehe Sub –county is situated in the central part of Nairobi County within the former Pumwani District. It covers an area of 20.0 sq km and has a population of 166,041 as per the 2009 census (Infotrack East Africa, n.d.). There are 28 public and about 35 private primary schools in the Sub -county. The Sub –county is made up of a diverse population in terms of socioeconomic class (lower, middle lower, middle upper). This factor led to the choice of this location thereby enabling sampling of school going children from different social classes hence taking into account all the aspects of the independent variable under study.

Participants

The study population was the primary school children in Starehe Sub-County. Data held by the County Education Office in Starehe Sub-county showed that there were about 25,000 upper primary school going children in the Sub county. This study targeted upper primary school going children from class 4 to 8 in Starehe Sub -county, Nairobi County. The content of the school backpack tends to increase when pupils get to upper primary due to the dictate of the curriculum and hence the choice of the study population.

The study used systematic random sampling in selecting children who used backpacks. Starehe Sub –county was purposively selected for the study due to the diverse nature of the population in terms of socio-economic status as explained earlier. The sixty-three schools in the sub county were stratified as public and private. Using a proportion of 3 to 1 based on the high pupil population in the public schools, a sample of six public and two private schools in the sub county were selected through simple random sampling. Data was collected from pupils in class four to eight (five strata). Listing forms were administered in each class in the selected schools to identify those who used backpacks. A final single list for each school was then drawn of the pupils who used backpack. The list was arranged from the first to the last pupil starting with the pupils in class four to class eight in each school. Systematic random sampling was used to select the requisite number of pupils in each school. The sampling distribution was based on the probability proportionate to size (PPS). K^{th} interval was calculated by dividing the total upper primary pupil population from the 8 schools (5897 pupils) by the sample size (379 pupils). With the first respondent being selected randomly, every 15^{th} pupil in the list drawn in each school was selected. Therefore, the total number of pupils selected per class varied in each school. A total of 379 pupils were drawn from all the schools.

Questionnaire

Questionnaires were selected as data collection instruments. A questionnaire is a printed self-report form designed to elicit information that can be obtained through the written responses of subjects. A structured questionnaire was used to get relevant information from the school going children from various schools in Starehe Sub -county. The questionnaire was used to get the socio- demographic factors of the school going children as well as means of travel to school, duration of backpack carriage and pupil's perception of the weight of school backpack. This questionnaire was also used to find out the influence of parent and/or teacher on type and content of load in the backpack. For Musculoskeletal discomfort the CMDQ was used. CMDQ is a questionnaire which contains sets of questions alongside a body map drawing indicating the prevalence of musculoskeletal pains or aches in specific regions of the body. CMDQ is not for diagnostic purpose, it is only used for screening purpose. The tool was developed by Professor Alan Hedge and ergonomics graduate students at Cornell University (Cornell University Ergonomics Web, Hedge *et al*., 1999). The CMDQ tool used in the study particularly focused on musculoskeletal pain related to backpack use.

3. Data Analysis

Data analysis was done using the statistical program for social sciences (SPSS) version 21. Inferential and descriptive statistics were used to analyze data. Descriptive analysis of data was done using the mean, frequencies and percentages. Chi square test was used to determine

associations between pupil's weight, age, backpack weight and occurrence of musculoskeletal pain. Logistic regression model was used to determine association of school backpack weight, carriage method and break from carrying backpack as well as school backpack weight as percentage of body weight with musculoskeletal pain. Cross-tabulations and descriptive statistics such as frequencies and mean were used to describe socio-demographic factors pertaining to school backpack use and musculoskeletal pain. Statistical significance was set at 0.05 to test the hypotheses.

4. Results

A total of 379 questionnaires were correctly filled and returned which represented a response rate of one hundred percent. From the total number of 379 school children interviewed, 247 (65%) were from the public primary schools while 132 (35%) were drawn from private primary schools. There was almost equal representation from both gender, 194 (51.2%) of the respondents were males and 185 (48.8%) females. The average age and weight of the participants was 11.97 years and 39.69 kilograms respectively. The maximum age of participants was 16 years and maximum weight was 65 kg. A majority of the participants (21.4%) were aged 13 years while very few (1.8%) were aged 16 years. The summary of their responses is given in Table 1.

Table 1: Background characteristics of respondents (n=379)

Variable	Response	Frequency	Percent
Type of School	Public	247	65
	Private	132	35
Gender	Male	194	51.2
	Female	185	48.8
Age	8 – 11yrs	159	42.0
	12 – 15 yrs.	213	56.0
	≥16 yrs.	7	2
Class	Class 4	82	21.6
	Class 5	76	20.1
	Class 6	71	18.7
	Class 7	77	20.3
	Class 8	73	19.3
Pupil's weight	26-35 kg	176	46.4
	36-45 kg	62	16.4
	46-55 kg	106	28.0
	56-65 kg	35	9.2
Distance from home	<500 m	190	53
	500 m -1 km	164	45
	>1 km	6	2
Time taken to travel to/from school	<5 min	38	11.9
	5-10min	122	32.2
	11-15 min	86	20.6
	16-30 min	80	25.0
	>30 min	34	10.6
Mode of transport	Walking	338	89.2
	Motor bike	4	1.1
	Car	6	1.6
	Bus	31	8.2

Bivariate analysis of the relationship between Socio demographic characteristics and Musculoskeletal Pain

Out of the 379 school children interviewed in this study, majority, 279 (73.6%) reported that they experienced pain when carrying school bag.Most of the participants (25.1%) reported lower back pain while 16.9% had neck pains as presented in Table 2.

Table 2: Prevalence of musculoskeletal pain by site of occurrence (N=379)

Site of pain	Frequency	Percent (%)
Neck	64	16.9
Right shoulder	54	14.2
Left shoulder	55	14.5
Upper back	76	7.5
Lower back	95	25.1
Right Upper arm	31	8.2
Left Upper arm	37	9.8
Right wrist	3	0.8
Left wrist	8	2.1

There was no significant association between gender and pain ($p>0.05$). However, age and pupil's weight were significantly associated with pain ($p<0.05$) as shown in Table 3. The results also showed that majority of the school going children who experienced pain were in the age category of 11-13 years. Most of the respondents who had musculoskeletal pain were of the lowest weight category between 26-35 kg.

Table 3: Socio-demographic factors associated with musculoskeletal pain among study respondents (N = 379)

Variable	Category	Presence of Pain		P – Value
		Yes (%)	No (%)	
Gender	Male	140(36.93)	54(14.25)	χ^2=0.430, df=1
	Female	139(36.66)	46(12.14)	*P*=0.512
Age	8 – 10yrs	58 (15.30)	34 (8.97)	χ^2= 9.391, df=2
	11 – 13 yrs.	155 (40.90)	53 (13.98)	*P*=0.009
	14 – 16 yrs.	66 (17.41)	13(3.43)	
Pupil's weight	26-35 kg	116(30.61)	60(15.83)	χ^2= 0.590, df=3,
	36-45 kg	50(31.19)	22(5.80)	*P*=0.017
	46-55 kg	86(22.69)	23(6.07)	
	56-65 kg	19(5.01)	3(0.79)	

Bivariate analysis of the relationship between ergonomic factors and Musculoskeletal Pain

Chi square test also indicated that factors such as backpack weight, rest breaks from carrying backpack, academic stress, method of backpack carriage, body posture on carriage were significantly associated with pain ($p<0.05$) as shown in Table 4.

Table 4: Factors associated with backpack usage

Variable	Category	Presence of Pain		P – Value
		Yes (%)	No (%)	
Backpack weight	1.5-4.4 kg	111(29.29)	61(16.09)	χ^2 =26.22, df= 3 *P*=0.001
	4.5-7.4 kg	138(36.41)	34(8.97)	
	>7.5 kg	30(7.91)	5(1.32)	
Rest breaks from carrying backpack	Yes	64(16.89)	45(11.87)	χ^2= 8.667, df=1, *P*=0.0032
	No	200(52.77)	70(18.50)	
Academic Stress	Yes	227(59.89)	64(16.89)	χ^2= 6.311, df=2 *P*=0.043
	No	41(10.82)	22(5.80)	
	Some times	16(4.22)	9(2.37)	
Method of backpack carriage	Single strap	14(3.69)	16(4.22)	χ^2= 12.181, df=1, *P*=0.001
	2 straps	265(69.92)	84(22.16)	
Body posture on carriage	Stoops	217(57.26)	31(8.18)	χ^2=71.22, df=1 *P*=0.001
	Upright	62(16.36)	69(18.21)	

Logistic regression was conducted to assess whether the six-predictor variables including age, pupil's weight, backpack weight, backpack weight as percentage of body weight, rest breaks and carriage method significantly predict whether a pupil felt pain (Table 5).When the four variables were considered together, there was a significant association between backpack weight and the presence of musculoskeletal pain (p<0.05) and an association between rest breaks and method of backpack carriage and musculoskeletal pain (p<0.05) as shown in Table 5. There was also a significant association between backpack weight as percentage of body weight and the presence of musculoskeletal pain (p<0.05) (Table 5). Therefore, the null hypothesis that there is no significant association between backpack weight as percentage of body weight and musculoskeletal pain among upper primary school going children was rejected.

Table 5: Regression Analysis- Pain as per backpack usage characteristics in the respondents (N=379)

Variable	SE	odds	95% CI	*P* value
Backpack weight	.157	.456	.336-.620	χ^2 = 51.95 *P* = 0.001
Rest breaks	.303	1.931	1.065 - 3.500	
Carriage method	.385	5.263	2.475 – 11.192	
BTSW%	.047	1.218	1.107 – 1.339	

5. Discussion

The objective of the study was to determine if sociodemographic factors and ergonomic factors influence bag use related musculoskeletal pain in Kenyan school going children population. The prevalence of 73.6% in this study can be compared to overall prevalence of 65% (Neuschwander *et al.*, 2010) and 51.2% as reported by Chiang *et al.*, (2006). Similar studies have reported much lower prevalence of 46.1% (Negrini *et al.*, 2002). The study reconfirmed the high prevalence of lower back pain and neck pain as indicated in other studies (Chiang *et al*, 2006; Mwaka *et al.*, 2014). In general, there was an association between backpack weight and the presence of musculoskeletal pain, particularly lower back pain (p<0.05). This result confirms the findings of the study by Johnson *et al.*, (2011) which noted an upsurge in lower back pain among children and adolescents carrying heavy backpacks. Other studies, which found significant association between backpack weight and presence of pain, included those by Javadivala *et al.*, (2012) and Neuschwander*et al.*, (2010) which showed increase in lower back pain. Heavy backpack therefore adversely affects pupils' health, especially leading to increased lower back pain.

The study also found an association between musculoskeletal pain and backpack weight as percentage of body weight (p<0.05). This result is similar to the study by Mwaka *et al.*, (2014), which indicated that prolonged backpack use is associated with neck pain among children who carry backpacks weighing more than 8.5% of their body weight. Thus, the null hypothesis, which indicated no significant association between backpack weight as percentage of BW and musculoskeletal pain, was rejected. This implies that backpack weight has to be limited to a load of between 10% and 15% of body weight.The study investigated the effect of rest breaks and method of backpack carriage on the presence of musculoskeletal pain among pupils who use backpacks. The results indicated a significant association between method of backpack carriage and pain (p<0.05). Association between rest break taken and pain was also significant (p<0.05). Thus, the null hypotheses that there was no significant link between rest breaks and musculoskeletal pain and no significant relationship between method of backpack carriage and musculoskeletal pain were rejected. There appears to be evidence that time spent carrying a backpack is associated with back pain (Grimmer & Williams, 2000; Negrini & Carabalona, 2007) hence rest breaks is recommended.

Musculoskeletal discomfort among pupils may also be influenced by carrying heavy backpacks to and from school as reported in this study. Other studies have also confirmed increased fatigue with weighty backpacks (Chiang *et al*., 2006; Dianat *et al*., 2012; Mwaka *et al*., 2014; Johnson *et al*., 2011). Even though this study did not investigate the impact of short-term musculoskeletal pain and development of musculoskeletal disorders in the future, there is evidence that back pain at a young age can be predictive of back pain later in life, through adolescence and adulthood (El-Metwally*et al.*, 2004; Reneman *et al.*, 2006). In addition, this study did not find any association between gender and musculoskeletal pain (p >0.05). This is inconsistent with the study by Cottalorda *et al*., (2003) which indicated that girls are more prone to musculoskeletal pains due to their weaker and more sensitive muscle tissues.

6. Conclusion & Recommendation

The study established that musculoskeletal pain was significantly associated with school bag weight, rest breaks from carrying bag, method of bag carriage and body posture on carriage. It is worth noting that musculoskeletal pain is experienced by school children carrying school bags for longer duration without rest breaks and who stoop while carrying the bags.From the findings of the study, the following recommendations were established; The government through the Ministry of Education should ensure that teachers are informed on the association between backpack weights and other ergonomic factors on musculoskeletal pain in order to help reduce content of school bag in terms of learning materials that they instruct the pupils to carry to and from home on a daily basis. Also, the parents and guardians should ensure children have backpacks that are proportionate to their body size and age. Whereas backpacks with adjustable straps are recommended, children need to be provided with information on musculoskeletal pain associated with backpack use

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