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Evaluation of Abdominal Obesity, Body Fat Percentage and its Correlation with Occurrences of School Bag Carriage Related Pain among Rural Children of West Bengal, India

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Abstract

School going children are exposed to carry heavy schoolbags which have adverse consequences on their rapidly developing spine. There is large number of children carry schoolbag greater than 10% of body weight (BW) and are susceptible to musculoskeletal pain. Nutritional status and perception of pain is different among rural and urban children. This study aimed to evaluate abdominal obesity and its association along with body fat percentage with occurrences of pain. **Methods:** Nutritional anthropometric parameters of 160 randomly selected rural (n=80) and urban children (control group, n=80) of 8-15 years of West Bengal, India were measured. Waist to height ratio (WHtR) was considered to determine abdominal obesity. Body fat percentage of rural boys and girls (n=24 and n= 23 respectively) was directly measured by bioelectrical impedance. Perception of pain was evaluated by 10 point subjective scale. Point biserial r between the parameters was calculated. **Results:** Result showed that mean weight carriage (% of BW) was higher than the recommended limit among rural and urban boys and girls (12.6, 12.9, 11.6, 12.0 respectively). Percentage of urban children exposed to pain was much higher than rural children. Rural children were vulnerable to abdominal obesity (40 % and 45% boys and girls respectively exceeded the cut off value). No correlation was observed between WHtR and pain. But significant negative correlation was observed between fat % and neck pain and among girls (r=-0.35), significant positive correlation was observed between fat % and neck and back pain (r=0.42 and 0.41 respectively) ($p<0.05$ for both boys and girls). **Conclusion:** This study revealed the necessity of nutritional status and thus habitat specific load limit optimization to reduce schoolbag carriage related stress.

Keywords: Rural children, Schoolbag carriage, Abdominal obesity, Body fat %, Pain.

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INTRODUCTION

School going children regardless of their socioeconomic status are exposed to school bag carriage related postural and physiological stress. Ergonomic stressors like heavy schoolbag, inappropriate distribution of load, long duration of carriage imposes physical loading. This has potential to produce musculoskeletal disorders (Negrini & Carabalona, 2002). Survey of Associated Chambers of Commerce and Industry of India (ASSOCHAM), conducted in ten cities of India, revealed that heavy and uneven distribution of load exerts detrimental effects on back and spinal health of the children School going age is a period of life span characterised by significant growth, spinal development and maturity. Nutrition is a core pillar of human growth and development (NFHS 2 and 3, 2005-2006). Socioeconomic condition is the major predictor of nutritional status (Bhasin et al, 2005). There is scarcity of studies to evaluate the abdominal obesity pattern and its association along with body fat percentage with occurrences of pain among rural children of low Socio Economic Status (SES).

Approximately 19% (190 million) of the population in India comprise of children in the school going age (Sarva Shiksha Abhiyan, 2005). Nutritional transition in developing nations as a result of increased economic development and market globalisation has led to rapid changes in lifestyle and dietary habits. Combination of poor dietary habits along with reduction in physical activity has led to an increase in overweight and obesity among adults and children (WHO, 2003). Today, India is the epicentre of Coronary Heart Disease (CHD), Type II Diabetes Mellitus and insulin resistance (syndrome X) (Bhave, Bavdekar & Otiv, 2004). This is now evident that these disorders embark on childhood thus evaluation and screening of predictors of abdominal obesity among children is of significant importance.

In India, it is recommended that children should not carry schoolbag load more than 10% of their Body Weight (BW) (The children school bag, limitation on weight bill, Rajya Sabha, Bill No. LXXXVI. 2006). There is notably large number of children carrying school bag more than 10% of their BW and are susceptible to musculoskeletal symptoms.

Nutritional status varies with socioeconomic condition, habitat i.e., rural or urban. Perception of pain on the other hand may be related to nutritional status. A prevalence of plethora of socioeconomic condition in India is a cause of different narratives ultimately culminating to mal-nutrition with the manifestation of obesity on one hand or wasting, stunting, deficiency

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symptoms on the other. Hence nutritional status specific load limit optimization and recommendation of remedial measures are of significant importance. Thus it is hypothesized that magnitude of perceived pain may be different among children of different socioeconomic status and according to rural-urban division. Therefore, nutritional status and thus habitat specific load limit optimization is essential to reduce schoolbag carriage related stress. There is lacunae of research on school bag carriage related perceived pain among rural children. Objectives of the study were to evaluate parameters for determination of abdominal obesity along with body fat percentage among rural children of low SES and to correlate body fat % with occurrences of school bag carriage related pain in different body parts of the rural children.

METHODOLOGY

School children (n=160) of the age group of 8-15 years were randomly selected for the study. The subjects were randomly taken out from different rural and urban locality. Children having low socioeconomic status were considered for this study. Consent letters were filled up by the participants before the collection of data. All data were collected following Institutional Ethical Committee (Human) and Declaration of Helsinki guidelines. Urban children were considered as control group in this study. This study was conducted on the following groups: Rural male children of low SES (n=40), Rural female children of low SES (n=40); Urban male children of low SES (n=40), Urban female children of low SES (n=40)

Nutritional anthropometry:

Height, weight, Waist Circumference (WC) of the children was measured by standardized technique. Body Mass Index (BMI) was calculated by height and weight (Key et al, 1972). Waist to Height Ratio (WHtR) was measured from WC and height.

Body composition analysis:

Nutritional status was evaluated by assessing body composition of the children. Body composition analysis was done to find out the actual percentage of fat and lean mass (Linda & Houtkooper, 1992)

Pain Mapping:

Subjective quantification of pain was done using questionnaire method of 10 point scale (Wilson & Corlette, 1985). Pain in neck, back and shoulder region were considered for statistical analysis because majority of the children were exposed to pain in these segments.

Volume 28 June 2022
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Statistical analysis:

Statistical calculation was performed using SPSS and different sets of values were arranged. Two tailed (unpaired) Student's t test was performed to find out the significant difference between the parameters of different groups. This was followed by one tailed t test to assess which one was significantly higher or lower. All the sets were computed for male and females separately. Point biserial r between body fat %, and occurrences of pain in different body parts were calculated (Das & Das, 2005). Significance was set at $p<0.05$.

RESULTS

Table 1 shows the characteristics of different physical parameters of different groups.

Table 1: Characteristics of different physical parameters (Mean, SD up to weight carriage as % of body weight) of different groups of subjects

Parameters	Rural male children of low SES	Urban male children of low SES	Rural female children of low SES	Urban female children of low SES
Age (years)	11.5 (2.07)	10.8 (2.01)	11.9 (1.77)	11.6 (1.86)
Height (cm)	141.8 (13.03)	135.0 (13.36)	144.6 (10.00)	139.9 (10.76)

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Weight (kg)	33.3 (8.25)	29.3 (8.76)	37.9 (11.23)	33.8 (9.85)
Body mass index (kg/m^2)	16.3 (2.46)	15.2 (1.57)	17.9 (4.18)	17.0 (3.35)
Waist circumference (cm)	61.2 (6.20)	58.8 (8.37)	65.2 (10.23)	60.6 (8.93)
Hip circumference (cm)	71.0 (7.10)	67.7 (8.56)	75.3 (11.90)	72.2 (8.44)
Waist hip ratio	0.86 (0.05)	0.87 (0.05)	0.87 (0.07)	0.84 (0.06)
Waist to height ratio (WHtR)	0.43 (0.04)	0.44 (0.04)	0.45 (0.06)	0.43 (0.06)
Weight of schoolbag (kg)	3.9 (0.96)	3.5 (1.21)	4.2 (1.29)	3.8 (1.27)
Weight carriage as % of BW	12.6 (4.68)	12.9 (5.73)	11.6 (4.26)	12.0 (4.39)
Percentage of children carried weight <10% of BW (%)	27.5	30	40	27.5
Percentage of children carried weight 10-15% of BW (%)	50	32.5	47.5	50
Percentage of children carried weight >15% of BW (%)	22.5	37.5	12.5	22.5
Percentage of children above the cut-off limits (50 th percentile) for WHtR	40	42.5	45	30

SES- Socioeconomicstatus

Height, weight, BMI, hip circumference were significantly higher among rural male children compared to urban children (Table 2). Height, weight, WC and WHR were significantly higher among rural female children compared to urban children. Absolute weight of schoolbag was significantly higher among rural male children compared to urban children.

Table 2: Significant difference between parameters of different groups

Parameters of different group showing significant difference between them	p value
Height, weight, body mass index, hip circumference between rural and urban male children **	$p < 0.05$
Height, weight, waist circumference and Waist to hip ratio between rural and urban female children **	$p < 0.05$
Absolute weight of schoolbag between rural and urban male children **	$p < 0.05$

**= significantly higher (first group)

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The percentages of children suffering from pain in different parts of the body are shown in Table 3. The majority of rural and urban children were susceptible to musculoskeletal pain in neck, shoulder, back and leg region. Percentage of urban male and female children exposed to pain in these segments was higher compared to rural children.

Table 3: Percentages of children suffering from pain in different parts of the body

Group	Neck	Shoulder	Upper arm	Lower arm	Back	Thigh	Legs
Rural male children	35%	37.5%	12.5%	-------	32.5%	------	30%
Urban male children	37.5%	67.5%	20%	7.5%	65%	40%	55%
Rural female children	45%	42.5%	17.5%	2.5%	17.5%	5%	25%
Urban female children	52.5%	62.5%	27.5%	5%	55%	10%	52.5%

Table 4 shows mean (SD) values of fat % and lean % in rural and urban male and female children. Significant negative correlation was observed between fat % and neck pain among rural male children (Table 5). Significant positive correlation was observed between body fat % and pain in neck and back region among rural female children

Table 4: Mean (SD) values of fat % and lean % in different groups

Group	Fat %	Lean %
Rural male children	13.0 (8.73)	87 (8.73)
Urban male children	11.1 (7.71)	88.9 (7.71)
Rural female children	15.7 (6.29)	84.3 (6.29)

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Urban female children	14.6 (5.32)	85.4 (5.32)

Table 5: Correlation between body fat % with perception of pain.

Perception of pain	r value	p value	
Neck pain of rural male children	-0.35	<0.05	p< 0.05
Neck pain of rural female children	0.42	<0.05	p< 0.05
Beck pain of rural female children	0.41	<0.05	p< 0.05

DISCUSSION

This study focused on the development of pain among rural male and female children due to school bag carriage and association of pain with the body composition of the children. Literature suggests that abdominal obesity is highly prevalent among South Asians and prevalence rate is higher among urban population compared to rural population. Interestingly abdominal obesity is a major health concern for underprivileged population in terms of their SES. In India Coronary Heart Disease (CHD), Type II Diabetes Mellitus and insulin resistance (syndrome X) are now becoming epidemic (Bhave, Bavdekar & Otiv, 2004). Thus evaluation of abdominal obesity, body fat % and their association with perceived pain among children is of significant importance.

This study showed that mean school bag weight among both rural and urban children of low SES were beyond the recommended safe load limit i.e., 10% load of their BW. Literature showed that change in the habitat from urban to rural resulted in a 3.86% decrease in the % of bag weight compared to body weight of the children (Mwaka, Munabi, Bukkiriza & Ochieng, 2014). Previous study showed that among urban children of high and low SES, lower the SES, higher

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the perception of pain (Basu et al, 2017) This study revealed that absolute weight of school bag was higher among both rural male and female children compared to their urban counterpart but there was a reduction in % of bag weight carriage as per % of BW among rural children. This could be due to the mean body weight of the urban children was lower compared to rural children. This is in contrast to the report that undernourishment is predominant in rural areas (NFHS, 2012). Both rural and urban school going children are susceptible to musculoskeletal symptoms in different body parts due to schoolbag carriage.

Studies have explored that heavy backpack carriage can be a risk factor for back pain among children and adolescent and this musculoskeletal symptoms may prevail in adulthood (Hazel, 2009 & Milanese & Grimmer, 2010). This study revealed that majority of rural and urban children experienced pain in neck, shoulder, back and leg region. Percentage of urban male and female children exposed to pain in these segments was higher compared to rural children. More studies are required to determine the prevalence of abdominal obesity and school bag carriage related perceived pain among rural children. Recent report of Health care Committee of Associated Chambers of Commerce and Industry of India (ASSOCHAM) revealed that majority of children carry heavy backpacks and they are suffering from mild back pain which can be developed into chronic pain. Along with many other cities in India, this survey was conducted in Kolkata also. One study showed that rural children carried heavier bags (Siddalingappa et al, 2015) and another study revealed that urban children carried significantly heavier school bags (Mwaka et al, 2014). This study showed that percentage of urban children exposed to pain was much higher compared to rural children. Nutritional status in terms of weight, height and BMI might be key contributory factor for occurrences of pain among the urban children. Literature suggests that undernourishment is predominant in rural areas but obesity rate is higher among urban children (NFHS, 2012). This study revealed that as per WHtR, urban male children were more exposed to central obesity compared to rural male children. Taking the same parameter into consideration, rural female children were more vulnerable to abdominal obesity. Percentage of urban male children exceeded the cut off value for WHtR was higher compared to rural male children (Kuriyan et al, 2011). In contrast percentage of rural female children beyond the limit for WHtR was higher compared to urban female children.

Heavy weight of the school bag and excess accumulation of body fat can exert increasing

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pressure on joints and ligament and this in turn lead to spinal damage of the growing children (De Paula et al, 2012). This study showed the correlation between body fat % and occurrence of pain. In this study attempt was made to find out the correlation between WHtR and occurrence of pain. No correlation was observed between the parameters. But body composition parameter such as body fat%, was significantly correlated with perceived pain in different parts of the body. Significant negative correlation was observed between fat % and neck pain among rural male children i.e., lower the fat %, higher the perception of neck pain ($p<0.05$). From this finding it can be stated that body fat acts as mechanical buffer in case of males. But in case of rural females, significant positive correlation was observed between body fat % and pain in neck and back region i.e., higher the body fat %, higher the perceived pain. Thus for females body fat% acts as an 'added load'.

This study is a preliminary attempt which concludes that schoolbag carriage limit should be optimized based on SES, nutritional status and habitat. This study revealed that body composition parameters are vital contributory factors for occurrences of pain in different parts of the body. Rural and urban male and female children of low SES are exposed to abdominal obesity and musculoskeletal symptoms such as pain and discomfort in various part of the body due to heavy school bag carriage. Assessment of abdominal obesity pattern and subjective quantification of pain among children are essential to recommend remedial measures. Ergonomic intervention and nutritional improvement can effectively reduce the musculoskeletal disorders, obesity and can assure better health. It is important to consider the role of SES and its influence on the effect of load carriage in the school children. A comparative analysis of perceived pain based on socioeconomic status and habitat is essentialfor implementation of ergonomic interventions. Therefore, this study revealed the necessity of SES and habitat specific load limit optimization among school children.

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Conflict of interest: None

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References

Aggarwal, O.P., Bhasin, S.K., Sharma, A.K., Chhabra, P., Aggarwal, K and Rajoura, O.P. (2005): A new instrument (scale) for measuring the socioeconomic status of a family: Preliminary study, I.J.C.M. 30: 111-114.

Basu, B., Dutta, K., Mukherjee, R., Barman, R and Sen, D. (2017): Quantification of weight and duration of schoolbag carriage based on socioeconomic status and its correlation with occurrence of pain among urban children, I.J.P.H.R.D. 8: 324-327.

Bhave, S., Bavdekar, A and Otiv, M. (2004): IAP national task force for childhood prevention of adult diseases: Childhood obesity, Indian. Pediatr. 41: 559-575.

Das, D and Das, A. (2005): Statistics in biology and psychology. Academic publishers, India, pp 109.

De, P.A.J.F., Silva, J.C.P., Paschoarelli, L.C and Fujii, J.B. (2012): Backpacks and school children's obesity: challenges for public health and ergonomics, Work. 41: 900-906.

Hazel, D.L. (2009): The backpack problem is evident but the solution is less obvious. Work. 32: 329–338.

http://www.newindianexpress.com/nation/2016/sep/06/Thanks-to-heavy-school-bags-68-percent-of-children-in-indian-run-risk-of-backeches-and-hunch backs-1516556.html. Accessed on 6 th September, 2016.

http://www.nfhsindia.org/nfhs3.html. Accessed on 6 th March, 2012.

Key, A., Fidanza, F., Karvonen, M.J., Kimura, N and Taylor, H.L. (2014): Indices of relative weight and obesity, Int. J. Epidemiol. 43: 655-665.

Kuriyan, R., Thomas, T., Lokesh, D.P., Sheth, N.R., Mahendra, A., Joy, R., Sumithra, S., Bhat, S and Kurpad, A.V. (2011): Waist circumference and waist for height percentiles in urban South Indian children aged 3-16 years, Indian. Pediatr. 48: 765-771.

Linda, B & Houtkooper, J. (1992): Bioelectrical impedance estimation of fat free body mass in children and youth: a cross validation study, Appl. Physiol. 72: 366-373.

Milanese, S & Grimmer, K. (2010): What is adolescent low back pain? Current defnitions used to defne the adolescent with low back pain, J. Pain. Res. 3: 57–66.

Mwaka, E.S., Munabi, I.G., Bukkiriza, J and Ochieng, J. (2014): Musculoskeletal pain and

Volume 28 June 2022
Indian Journal of Biological Sciences
(A Peer Reviewed Journal)
ISSN 0972-8503
http://dx.doi.org/10.62424/ IJBS.2022.28.01.04

school bag use: a cross-sectional study among ugandan pupils. BMC. Res. Notes. 7: 1-7.

Negrini, S and Carabalona, R. (2002): Backpacks on! Schoolchildren's perceptions of load, associations with back pain and factors determining the load, Spine. 27:187-195.

NFHS (National Family Health Surveys 2, 1998-99 and 3, 2005-06). https://rchiips.org/nfhs/nfhs3.shtml.

Sarva Shiksha Abhiyan. (2005): All India survey of out-of-school children in the 6-13 years age group, Department of elementary education and literacy, MHRD, India. https://www.education.gov.in/hi/sites/upload_files/mhrd/files/upload_document/SSA-Frame-work.pdf.

Siddalingappa, H., Murthy, N., Kulkarni, P., Shrinivasa, B.M., Sunilkumar, D and Renuka, M. (2015): Burden of heavy schoolbag among high school students and its relation with their physical growth in mysore and camarajanagar district. I.J.H.S.R.5: 8-14.

The children school bags (limitation on weight) bill, 2006. Bill no. Lxxxvi. 2006. https://www.vijaydarda.in/wp-content/uploads/2021/01/The-Children-School-Bags-Limitation-On-Weight-Bill-2006.pdf?utm_medium=email&utm_source=transaction

Wilson, J.R & Corlette, E.N. (1985): Evaluation of human work- a practical Ergonomic methodology. Taylor and Francis, London, pp 890.

World Health Organization (2003). Diet, Nutrition and Prevention of chronic diseases, WHO technical report series, Report of a joint WHO/FAO expert consultation, Geneva.https://www.who.int/publications/i/item/924120