



Energy Expenditure and Its Relationship with Body Mass Index among North Indian School Children's

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Abstract

Background: Growing burden of overweight and obesity along with its serious health complications including non-communicable diseases is increasing in children because of low levels of energy expenditure in the form of physical inactivity.

Objective: This study aimed at assessing levels of energy expenditure and its relationship with body mass index among children of Jammu region.

Methods: A cross sectional study was carried out in school children of Jammu region. Energy expenditure levels were assessed using modified global physical activity questionnaire (version 2) and expressed in metabolic equivalents (MET-minutes per week) in different domains and classified into vigorous, moderate and low physical activity as per WHO recommendations for physical activity for the age group of 5-17 years. Anthropometric assessments and BMI percentiles obtained from WHO age and gender specific BMI charts.

Results: Of 230 children studied higher body mass index in the category of overweight and obesity was observed to be about 8%. About 10% of study participants reported low levels of energy expenditure in different domains (at school, during travel and recreational activities). This was observed more in females. 33% of those with higher body mass index were engaged in low levels of energy expenditure and were six times at higher risk ($\text{Chi-Square}(1)=12.58, p\text{-value}<0.001$).

Conclusion: Low levels of energy expenditure and sedentary behaviour contribute significantly to obesity in childhood. Therefore it is need of hour to create environment for adoption of healthy lifestyles including physical activity which should be promoted at all levels.

Keywords: Energy expenditure, Body Mass Index, Childhood.

Introduction

Physical activity is a key determinant of energy expenditure and is basic to energy balance and weight control. As per WHO recommendations

for age group of 5-17 years there should be at least 60 minutes of moderate to vigorous intensity physical activity daily¹. The global school based student health survey in India reported overall

23% of sedentary behaviour in school children². WHO commission on ending childhood obesity reported an increasing number of infants and young children aged 0 to 5 years with higher body mass index where vast majority of these children are living in developing countries³.

Higher body mass index in childhood is associated with significant reductions in quality of life,⁴ and wide range of serious health complications including cardiovascular diseases, cancers, respiratory diseases including asthma and chronic obstructive pulmonary disease and diabetes which are responsible for 82% of deaths due to non-communicable diseases⁵. It is primarily due to changes in social and physical environment over the past three decades which have adversely influenced child's eating and activity behaviour including attitudes and behaviour of their parents. Due to pressure for academic performance, less time is devoted to physical education in schools. The advent of television, computers and mobile phones has resulted in more opportunities of sedentary activities.

WHO Global Strategy on Diet, Physical Activity and Health,⁶ promotes and protects health by guiding the development of environment for sustainable actions at individual, community, national and global levels that will lead to reduced disease and death rates related to unhealthy lifestyle. This study aimed at assessing levels of energy expenditure and its relationship with body mass index among children of Jammu region.

Materials and Methods

The present cross-sectional study was conducted for a period of one year to assess energy expenditure levels in different domains and its relationship with body mass index among children of both sex aged 6-14 years in rural and urban areas of Jammu. Study was conducted in Zone Miran Sahib which is a rural field practice area of Department of Community Medicine GMC Jammu and Zone Jammu (representing urban unit of study).

Data collection was started after institutional ethical committee approval. Six high schools each from rural as well as urban areas were selected randomly using simple random sampling procedure. Heads of selected Institutions were contacted, their support solicited and a day convenient to the school authorities was selected. Class wise list of all students aged 6-14 years enrolled in a particular school was prepared and five of them were requested for interview on a particular day. After explaining the purpose of study, students were interviewed by the investigator using standardized tools. Parents were contacted telephonically wherever needed for their consent and any further information.

Students were first assessed for their levels of energy expenditure using modified Global Physical Activity Questionnaire (Version 2)⁷ developed by WHO. Information regarding participation in physical activity was obtained in three settings: Activity at school, travel to and from school, recreational activities, as well as sedentary behaviour. The questionnaire items collected recent physical activity history by recall over past seven days. Weekly minutes of physical activity of varying intensity were calculated separately by multiplying the number of days per week by the duration of activity on an average day. Reported minutes per week in each category were weighted by a metabolic equivalent (MET) as per modified Global Physical Activity Questionnaire (Version 2)⁷ resulting in a physical activity estimate expressed in MET-minutes per week (computed by multiplying METs by minutes per week). Total MET-minutes per week was estimated by adding the MET-minutes per week of each category.

Total physical activity was then classified into vigorous, moderate and low physical activity as per WHO recommendations for physical activity for the age group of 5-17 years.¹ Physical activity was defined as vigorous if the student had at least seven days of any combination of activities accumulating at least 3360 MET-minutes per week; as moderate if the student had at least seven

days of any combination of activities between 1680-3359 MET-minutes per week and low if the student did not meet the conditions for high and moderate physical activity.

After physical activity assessment students were subjected to anthropometric measurements. Instruments for anthropometric measurements were standardised and calibrated. Height was measured using a standard tape with bare foot and in upright posture, back against wall and heels together (to the nearest 0.1cm) and weight was measured using a standard balance to the nearest 0.5kg. Thereafter Body Mass Index was calculated by using formula; $BMI = \text{Weight (kg)}/\text{Height (m)}^2$, and BMI percentiles were obtained from WHO age and gender specific BMI charts.⁸ Overweight was defined as $BMI \geq 85^{\text{th}}$ and $<95^{\text{th}}$ percentile for children of same age & sex and obesity was defined as $BMI \geq 95^{\text{th}}$ percentile for children of same age & sex. Statistical significance was set at $p \leq 0.05$. Results were analysed by using CDC Epi Info (version:7.2.2.6).

Results

A total of 230 participants in the age group of 6-14 years were surveyed for assessing levels of energy expenditure and its relationship with body mass index. The maximum number of children studied were in the age group of 12-14 yrs with slight preponderance in males i.e., 47% versus 38% females. Higher proportion of sample comprised of children from rural areas (46.3% versus 39.2% urban).

Table I summarize energy expenditure in MET-min per week in different domains. It is seen that an average child regardless of age was engaged in physical activity for 4596.2 MET-min per week (4305 MET-min per week in urban and 4861.5 MET-min per week in rural). No differences were discernible between males and females (Males 4573.1 MET-min per week while females spent 4609.5 MET-min per week in physical activity). The mean time spent in physical activity at school was 1561 MET-min per week and was higher for

rural (1848 MET-min per week) than for urban children (1290.8 MET-min per week). The mean time spent in travel to and from school was also similar i.e., 620.2 MET-min per week for urban and 560.7 MET-min per week for rural children, 594.3 MET-min per week for males and 585.9 MET-min per week for females. The mean time spent in recreational activities was equal sex wise and according to residence.

Table I also classifies physical activity into three categories of vigorous, moderate and low intensity as per WHO recommendations for the age group of 5-17 years.¹ Total physical activity of children has been classified on the basis of duration and intensity of physical activity. Nearly two third children 62.1% overall (54.5% urban and 69.8% rural) reported vigorous physical activity. Low physical activity was reported by 9.6% of all (13.7% urban and 5.6% rural areas). The percentage of children in high level of physical activity was slightly more in the age group of 6-8 years (68.6%).

Table II depicts relationship of physical activity and sedentary behaviour with overweight and obesity. It is evident from above table that about one third of those among overweight and obese were engaged in low physical activity. Those engaged in low physical activity were 6 times at higher risk. The association of overweight and obesity with low physical activity came to be highly significant ($\text{Chi-Square}_{(1)}=12.58$, $p\text{-value}<0.001$). It is also clear from above table that more than 90% among overweight and obese children were having sedentary behaviour and were 2.2 times at higher risk. However, the association of overweight and obesity with sedentary behaviour was not significant statistically. ($\text{Chi-Square}_{(1)}=0.59$, $p\text{-value}=0.22$).

Out of 230 children surveyed in the age group of 6-14 years, more females than males were having higher body mass index (overweight and obese). Rural urban differences revealed a higher proportion of urban males (7.4%) overweight and obese as compared to rural males (3%). Similarly more urban females (16.9%) were overweight and

obese as compared to rural females (6.6%). Under nutrition was also observed among children of both areas. About half of males of rural areas and

20.3% of urban areas were under nourished (<5th percentile) as compared to females (11.3% urban and 8.3% rural).

Table I: Energy expenditure expressed in mean met-minutes per week in different domains and its classification as vigorous, moderate and low as per who recommendations along with sedentary behaviour on an average day

ENERGY EXPENDITURE IN MEAN MET-MIN PER WEEK	MALES		FEMALES	
	URBAN	RURAL	URBAN	RURAL
(6-8yrs)				
AT SCHOOL	1363.2	1931.3	1402.7	1852.3
DURING TRAVEL	582.3	566.0	576.0	557.1
RECREATION	2514.1	2523.6	2473.6	2459.8
(9-11yrs)				
AT SCHOOL	1275.1	1930.6	1370.2	1782.2
DURING TRAVEL	639.1	560.0	588.3	565.4
RECREATION	2343.0	2437.5	2587.7	2391.3
(12-14yrs)				
AT SCHOOL	1219.1	1889.6	1222.4	1905.0
DURING TRAVEL	640.0	566.1	641.0	561.1
RECREATION	2402.6	2480.5	2406.8	2494.2
WHO CLASSIFICATION OF PHYSICAL ACTIVITY* n(%)				
(6-8yrs)				
VIGIROUS**	10(76.9)	10(83.3)	5(33.3)	13(81.2)
MODERATE**	2(15.3)	1(8.3)	5(33.3)	3(18.7)
LOW**	1(7.6)	1(8.3)	5(33.3)	0(0.0)
(9-11yrs)				
VIGIROUS**	11(64.7)	15(78.9)	11(55.0)	10(52.6)
MODERATE**	4(23.5)	4(21.0)	5(25.0)	7(36.8)
LOW**	2(11.7)	0(0.0)	4(20.0)	2(10.5)
(12-14yrs)				
VIGOROUS**	14(58.3)	24(75.0)	7(38.8)	12(48.0)
MODERATE**	9(37.5)	7(21.8)	10(55.5)	10(40.0)
LOW**	1(4.1)	1(3.1)	1(5.5)	3(12.0)
SEDENTARY BEHAVIOUR n(%)				
NO	16(29.6)	25(39.6)	8(15.1)	23(38.3)
YES***	38(70.3)	38(60.3)	45(84.9)	37(61.6)
TOTAL	54(100)	63(100)	53 (100)	60(100)

*WHO Recommendations of Physical Activity for age group 5-17 years.

**Physical activity defined as Vigorous: If the student had at least seven days of any combination of activities accumulating at least 3360 MET-minutes per week;

**Moderate if the student had at least seven days of any combination of activities between 1680-3359 MET-minutes per week;

**Low if the student did not met the conditions for high and moderate physical activity.

***More than 5 hours per day

Table II: Relationship of body mass index (category overweight and obesity) with physical activity and sedentary behaviour

	Overweight and Obese n(%)	Not Overweight and Obese n(%)	ODDS RATIO (95% CI)
PHYSICAL ACTIVITY			
LOW	6(31.6)	15(7.1)	6 (2.0-18.13)
MOD-VIGOROUS	13(68.4)	196(92.9)	REFERENCE
Chi-square ₍₁₎ =12.58, p-value <0.001(highly significant)			
SEDENTARY BEHAVIOUR			
PRESENT	18(94.7)	188(89.1)	2.2(0.28-17.27)
ABSENT	1(5.3)	23(10.9)	REFERENCE
Chi-square ₍₁₎ =0.59, p-value=0.22(not significant)			

Discussion

Measurement of energy expenditure is a complex process and requires its measurement in multiple domains. Low levels of energy expenditure in the form of physical inactivity has been reported as a significant risk factor for higher values of body mass index by many investigators.^{9,10,11,12,13} Sedentary lifestyle and cultural changes associated with globalization has further aggravated the problem among children and adolescents.^{14,15} The present study observed females engaged to a lesser extent in moderate to vigorous physical activity as compared to males, a finding shared by Swaminathan S et al,¹⁶ and Nyawornota VK et al¹⁷ as well. This might well explain higher prevalence of obesity among females. The findings from Central Board of Secondary Examination- Global School Health Survey in India 2007 also reported low levels of physical activity in adolescents which was more among females than their male counterparts.²

Television viewing, use of computers and mobile phones, availability and affordability of varied public transport has led to decreased energy expenditure. Due to unsafe roads children are not encouraged to walk or use bicycle to reach school. Instead motorized vehicles are popular and considered to be safe and quick means of transport. Lack of open spaces for recreational activities and parental time to supervise their children add to increasing unhealthy lifestyles. Rosiek A et al¹⁸ reviewed effect of television on obesity. Watching television takes away from the time children spent in physical activity. Product advertisements encourage children to make unhealthy food choices, as an overt food theme is always present on television. Eating while watching television is a common practice among families. In addition to decreasing energy expenditure, watching television while eating increases risk of obesity and overweight as it increases motivated responding for food and energy intake in children.¹⁹ On an average, references to food on television are made ten times an hour. It is seen that an average child

watches television for four hours a day and every additional hour per week increases the risk of developing obesity in children by three percent.¹⁸ Sedentary habits thus have both short as well as long term effects on health and efforts to reduce them from an early life is critical.²⁰

Physical education at school is an important determinant of physical activity as a child spends one third of a day at school. Most investigators including us have reported that school authorities at most places have ensured that children must attain recommended levels of physical activity while being in schools by making explicit provisions in their curricular structure. National policy on education²¹ and NCERT position paper on health and physical education²² emphasize the integration of sports education in school curriculum. Similar sentiments have been expressed by experts from WHO which support policies and programmes for adoption of healthy lifestyle through changes in environment, behaviour and education.²³

In conclusion there-off low levels of energy expenditure and sedentary behaviour including television watching, playing of indoor games on computers, use of mobile phones contribute significantly to obesity in children. Therefore physical activity in children should be promoted both at household and in schools which will burn calories and exercise muscles.

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