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Association between body mass index percentile and motor skills in 5 to 12 years old Indian children

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Abstract
Obesity and overweight during childhood is a matter of growing concern. Overweight in children has become a matter of growing concern. In developed societies, several studies have shown increasing numbers of overweight children [1]. The global prevalence of childhood overweight for 2010 is estimated at 46 %. The purpose of this study was to investigate gross & fine motor skill in overweight and obese children compared with normal weight peers. According to International cut off points for body mass index from CDC, Center for Chronic Disease Prevention and Health Promotion (2000), all 150 participants (5-12 years) were classified as being normal weight (n=52), overweight(n=51), and obese(n=48) in accordance with percentiles for boys & girls. Level of motor skills were assessed using the Movement Assessment Battery for Children (MABC).Score for balance and Ball skills ($p<.05$) were significantly better in normal weight & overweight children as compare with their obese counterparts. A similar trend was found for manual dexterity ($p<.10$). This study demonstrates that general motor skill level is lower in obese children than in normal weight & overweight peers.

Keywords: obesity, body mass index (BMI), gross and fine motor skill, movement assessment battery for children, overweight

Introduction
Obesity has become a growing epidemic in the India with no cessation in sight. With the prevalence of obesity in today's society, many researchers have earnestly investigated this issue. According to Flegal, (1999), "Obesity is often studied as a characteristic of an individual and discussed in relation to individual dietary patterns, physical activity levels, or genetic constitution". The Center for Disease Control and Prevention (CDC) defined “obesity as at or above the 95th percentile of BMI for age and sex” [1, 4]. Childhood obesity with all its adverse health consequences is growing at a fast rate in developing countries due to changing life style as a result of rapid urbanization and mechanization [1, 3].

Flegal focused not on individuals, rather on populations in the world, by reporting the prevalence of overweight and obese individuals [8]. By using data from the National Health and Nutrition Examination Survey (NHANES), Troiano and Flegal (1998) report that since the 1960s a series of national surveys that include the height and weight of both adults and children have been collected. An individual's health can often be taken for granted regardless of age, gender, and or ethnicity. Obesity has been linked to fatal and nonfatal diseases, including insulin resistance, glucose intolerance, diabetes mellitus, hypertension, dyslipidemia, sleep apnea, arthritis, hyperuricemia, gallbladder disease, back pain, renal disease, surgical complications, and certain types of cancer. Neglect, such as poor eating habits and lack of physical activity, is a common theme for some Americans (National Institute of Health and National Heart, 1998). A lifestyle that fosters improper nutrition habits and/or sedentary behavior is a recipe for obesity. Obesity has been and is continually a topic of great concern for many individuals in the United States (Chen, Fox, Hasse, & Wang, 2006; Davison, Ford, Cogswell, & Dietz, 2002; Schonfeld-Warden, 1997). Prevalence of obesity is on rise in Indian children, highlighting the possible role of change in the dietary pattern and physical activities with increase in income levels. An estimated 42 million of school children aged less than 5 years are overweight and close to 35 millions of these are living in developing countries. About 10% of school children aged between 5 to 17 years around the globe are overweight out of which 70% grow up to become obese adults [8]. Combination of our genetic propensity to store fat, the ready availability of calorie dense foods and sedentary lifestyle promotes overweight [10]. The Child’s food environment combined with parental obesity is the strong determinants of obesity. Motor competence can be defined as a person’s movement coordination quality when performing different motor skills, ranging on a continuum from gross to fine motor skills [8]. Majority of available studies on motor skill competence in overweight and obese children focuses exclusively on gross motor skills, like balance and gait. Marshall and Steele (2004) found body composition to be negatively related to locomotor skill proficiency (running, jumping) but did not reveal differences in motor skill level of relatively stationary object control tasks (e.g. striking, throwing, catching etc). Till date there is no research in literature which has evaluated the relation between motor competence and BMI in Indian obese children age 5-12 years. The purpose of the present study was to find the association between both gross and fine motor skills and BMI in children (overweight, obese and normal).

Methodology

A total of 150 children between the age group of 5 to 12 years (52- normal weight, 51-overweight, 48-obese, both boys and girls) participated in the study. Dehradun Public School, Panchsheel Prime Rose Society and Residential Welfare Association Ghaziabad contributed to this study. Parents of the children were informed about the study, the relevant consent form was filled, and they were asked to report their educational level as well as the stature and the other relevant information regarding family and child birth history. Inclusion of the study was both boys and girls with age between 5 to 12 years. Subjects having any neurological condition, any metabolic disorder, Juvenile arthritis/ diabetes or any associated illness were excluded.

Procedure

BMI: The height and the weight of the children were measured. The height was measured barefoot by using an inch tape. The participants were asked to stand with back, buttocks, heel against the wall, with their feet together and flat on the floor and their head straightened in a neutral position. Body mass was measured in minimal clothing using the weighing scale. From the height and the weight measurement of the children, BMI was calculated for each child. From the BMI, the BMI percentile was calculated using the BMI age growth chart for both boys and the girls.

BMI	Recommended Classification
< 5th Percentile	Underweight
5th – 84th Percentile	Healthy Weight
85th – 95th Percentile	Overweight
> 95th – 99th Percentile	Obesity
> 99th Percentile	Severe Obesity

Fig 1

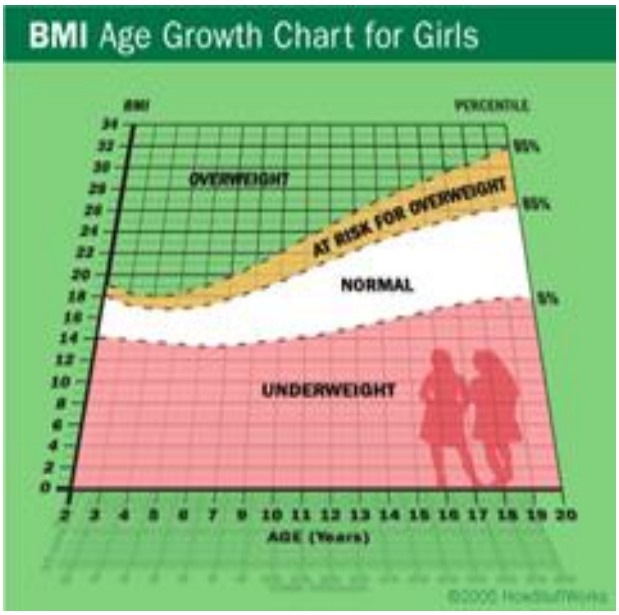

Fig 2

Motor skills: Motor skills were assessed by means of movement assessment battery for children (MABC; Handerson and Sugden, 1992). The MABC consists of eight age-specific test items, brought together in three clusters

(manual dexterity, ball skills, and static and dynamic balance). A stop watch is used to measure the time taken by children in each manual dexterity task. The score and the grades was given to the children according to the time they have taken to complete the task.

	Age Band 1 3-6 years	Age Band 2 7-10 years	Age Band 3 11-16 years
Manual Dexterity1	Posting coins	Placing Pegs	Turning pegs
Manual Dexterity 2	Threading beads	Threading Lace	*Triangle with nuts and bolts*
Manual Dexterity 3	*Bicycle Trail I*	*Bicycle Trail II*	*Bicycle Trail III*
A&C: Catching	Catching bean bag	Two-hand catch	One-hand catch
A&C: Aiming	*Throwing bean bag into box*	*Throwing bean bag into mat*	Throwing at wall target
Static Balance	One-leg balance	One-board balance	Two-board balance
Dynamic Balance 1	Jumping in squares	Hopping in squares	*Zig-zag hopping*
Dynamic Balance 2	Walking heels raised	Heel-to-toe walking	Walking backwards

Fig 3: Children performing various activities according to MABC TEST

Data analysis

The mean and standard deviation of all the variables were analysed. Data analysis was done with the help of SPSS for windows version 20.0 in order to verify the investigations of the study. Pearson correlation coefficient and repeated ANOVA measures was used to analyze within group difference for all the dependent variables. The significance level set for this study was 95% ($p<0.05$).

Result

Descriptive variables: Demographic details of all the three groups are reported in Table 1. There was no significant difference between the groups on demographic information and the groups were found to be comparable. 150 children were screened out of which 146 participated in the study.

Table 1: Demographic characteristics of the subjects of Group A (Normal weight) and Group B (Overweight) and Group C (Obese) at baseline

Measures	Group A Normal Weight n=52	Group B Overweight n = 51	Group C Obese n = 48
	MEAN± SD	MEAN± SD	MEAN± SD
Age (Years)	8.4±2.3	8.4±2.18	8.5±2.3

Table 2 indicates correlation between BMI and MABC SCORES of three groups i.e. between Group A (Normal), Group B (Overweight) and Group C (Obese). The result shows negative correlation between the variables that is MABC and BMI.

Table 2: Correlation between BMI and Movement Assessment battery score of three groups

Measures	BMI	MABC Score	r value
	MEAN±SD	MEAN±SD	
Normal weight(NW)	17.44±2.05	18.51 ± 2.99	-.22
Overweight(OW)	19.8 ± 1.8	27.3 ± 2.9	-.25
Obese(OB)	23.6 ± 3.1	29.05 ± 2.9	-.33*

Significance level p< .05

Table 3: Mean, standard deviations and BMI- Group main effects for MABC scores

Measures	Group A Normal Weight n=52	Group B Overweight n = 51	Group C Obese n = 48	F value	p value
Manual Dexterity	6.83± .96	8.6 ± 1.63	9.63±1.54	1.41	.05*
Ball skills	4.58±1.53	8.01± 1.57	8.77±1.37	1.62	.01**
Static and dynamic balance	7.08±1.63	10.69±1.48	10.64±1.43	1.65	.01**
Total	18.51±2.99	27.3±2.91	29.05± 2.9	1.92	.001***

Table 4: Correlation between BMI and Movement Assessment battery score

Measures	Mean ± SD	BMI Score r	p value
Manual Dexterity	8.36 ± 1.80	.40**	0.000
Ball skills	7.12±2.36	.33**	0.000
Static and dynamic balance	9.4±2.27	.44**	0.000
Total	24.9±5.5	.43**	0.000

Discussion

The result of the study indicates that there was a week negative correlation between the BMI and Motor skills both fine and gross but there was significant difference found in obese group as compared to overweight and normal weight peers. ($p<.05$). Results demonstrated that childhood obesity is associated with lower total MABC scores. So next to their already extensively documented lower physical fitness, obese children also display poorer general motor skill performance. The inverse relationship between motor skill competence and body weight is often explained from a mechanical point of view, because obesity influences body geometry and increases the mass of different body segments. Hence, noncontributory mass could lead to biomechanical movement inefficiency and could be detrimental for motor proficiency. Nevertheless, it is believed that the reported negative relationship between motor skill and BMI is mediated by several alternative, and possibly complementary, mechanisms[6]. Scores of the obese group differed most from both other BMI-groups for the static and dynamic balance cluster (gross motor skill). Childhood overweight in itself did not seem to be related to inferior functional levels of static and dynamic balance when compared with normal-weight peers. These findings are thus in accordance with earlier studies demonstrating that obese boys and girls have poorer outputs on balance and postural sway (Goulding *et al.*, 2003; McGraw *et al.*, 2000)[9]. The same significant differences between BMI-groups were found for the ball skills cluster that combines fine motor control and balance control in an upright position. This may be due to the use of evaluation of outcomes which in current study is based on objective product scores (e.g time in seconds, number of successful repetitions). Berrigan, Simoneau and Teasdale (2006) actually demonstrated that obesity imposes constraints on goal-directed movements, given its disadvantageous effect on the control of balance. For the manual dexterity cluster, a tendency toward weaker performances of obese children compared with normal-weight and overweight counterparts was observed. The absence of an actual significant difference between BMI-groups may be because temporal and spatial constraints of the tasks are controlled by the child itself. In contrast, in the ball skills cluster of the MABC, most tasks are externally paced. D'Hondt *et al.* in 2008 demonstrated that poorer motor competence in overweight and obese children is believed to be the mechanical consequence of greater inertial load on the system, caused by the excess mass of body segments participating in the action[9]. This could be related to the result of the current study too. The present findings are important because a lower level of motor skill may hamper participation in regular physical activities, which is an important factor in both prevention and treatment of childhood obesity. It is concluded from the present study that both gross and fine motor skills are associated with increase body mass index i.e. skill performances decreases as BMI increases. Therefore BMI is significantly negatively correlated to motor skill performances

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