Original Article

BODY MASS ABDOMINAL INDEX: A NEW INDEX FOR ADIPOSITY AMONG PRE-SCHOOL CHILDREN

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Abstract

The new index Body Mass Abdominal Index (BMAI) has been derived by combining two separate indices – weight for height and waist for height ratios. Our study investigated the relationship of common indicators of abdominal adiposity – waist circumference (WC), waist-hip ratio (WHR), waist-height ratio (WHTR), conicity index (CI) and newly proposed body mass abdominal index (BMAI) with body mass index (BMI) among 347 pre-school children of Purulia District, India. Results showed that significant correlations were observed for all adiposity measures except WHR. A noteworthy point was that the correlations were strongest ($p < 0.01$) with BMAI (boys: $r = 0.863$, girls: $r = 0.863$). The correlations of BMAI with BMI were similar in both sexes. In conclusion, our results indicate that the new index BMAI has a distinct advantage as it relates much strongly with overall adiposity (BMI) than the other commonly used indicators of adiposity.

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Key Words: Pre-school children, body mass index, body mass abdominal index, India.

Introduction

Childhood obesity is one of the most serious public health challenges of the 21st century. Overweight and obesity are defined as "abnormal or excessive fat accumulation that presents a risk to health". The problem is global and is steadily affecting many low- and middle-income countries, particularly in urban settings. The prevalence has increased at an alarming rate. Globally, in 2010 the number of overweight children under the age of five is estimated to be over 42 million. Close to 35 million of these are living in developing countries. It is difficult to develop one simple index for the measurement of overweight and obesity in children and adolescents because their bodies undergo a number of physiological changes as they grow.[1]

Due to the rising prevalence of obesity in children and its many adverse health effects it is being recognized as a serious public health concern.[2] The term overweight rather than obese is often used in children as it is less stigmatizing.[3] Obesity during adolescence has been found to increase mortality rates during adulthood.[4] A 2008 study has found that children who are obese have carotid arteries which have prematurely aged by as much as thirty years and abnormal levels of cholesterol.[5] The adiposity in preschool children is measured by using weight for length, waist-to-height index and body mass index. While BMI is the recommended method for population based screening of children for obesity it was a poor predictor of body fat for individual children. The new index Body Mass Adiposity Index (BMAI) has been derived by combining two separate indices - weight for height and waist for height ratios. The BMAI is mostly influenced by waist circumference which will mostly include fat component. Overweight and obese children are likely to stay obese into adulthood and more likely to develop non-communicable diseases like diabetes and cardiovascular diseases at a younger age. Overweight and obesity, as well as their related diseases, are largely preventable. Prevention of childhood obesity therefore needs high priority.[1]

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Furthermore, obesity in children is a cause for concern because it may predict adult obesity and increased risk of coronary heart disease in adult life.[6] The adiposity in preschool children is measured by using weight for length, waist-to-height index and body mass index.[2] Currently increase in weight gain and obesity in preschool children are measured independently either by weight for length index,[7] waist – to - hip ratio,[8] or BMI for age.[7] There is another index, Conicity index, which is a function of weight, height and waist circumference, but it has been shown in one of the studies that BMI is better than conicity index in predicting coronary artery disease.[9] Therefore, all these ratios have mathematical complexity. Recent evidence indicates a disturbing trend of increasing adiposity in developed and developing countries including India.[10-12] It would be of interest to determine if a similar trend is observable at an earlier age and that too from a developing country like India, which is currently undergoing a nutritional transition.[13]

Materials and Methods

Data on 347 pre-school children (185 boys and 162 girls), aged 2-6 years were taken. All children were of Scheduled caste (SC) from nine villages of Purulia District, West Bengal, India. Purulia District is situated approximately 250 km from Kolkata, the capital of West Bengal. The area is remote and mostly inhabited by Scheduled castes. All subjects were measured by one observer (SD) using standard techniques.[3] Information on age and ethnicity were obtained from official records as answers to specific questions in questionnaires. A hypothetical index for better measuring adiposity – "Body Mass Abdominal Index" (BMAI) was proposed in a recent article.[2] The BMAI has been derived by combining two indices – weight for height and waist – to – height ratios. The article has suggested that since these are two independent ratios, so the product of these ratios will be more accurate for measuring adiposity.[2] Mathematically,

$$\begin{aligned} \text{BMAI} &= \text{Weight / Height X Waist Circumference / Height} \\ &= \text{Weight / (Height)}^2 \text{ X Waist Circumference} \\ &= \text{BMI X Waist Circumference} \end{aligned}$$

Where Weight is in kg and Waist Circumference and Height are in meters.

The author[2] has clearly demonstrated that two children having similar BMI may have very different values of BMAI depending on their waist circumference measurements. The BMI includes lean mass and fat components of the body. He has further stated that although BMI values of two children may be very close their lean mass and fat components may be totally different. The BMAI is mostly influenced by waist circumference which will mostly include fat component. He has suggested that the measurement of adiposity is better reflected in BMAI rather than BMI or waist/ height ratio alone. Moreover, it has been suggested that BMAI is a very simple index to use and all the three main body measurements – weight, height and waist circumference are included. It has been proposed that BMAI will be useful in measuring adiposity in preschool children.

The objective of our paper is to study the relationship of four common indicators of abdominal adiposity, namely waist circumference (WC), waist-hip ratio (WHR), waist-height ratio (WHTR), conicity index (CI) and BMAI with overall adiposity as measured by BMI.

Results

Among boys, the mean (sd) values of BMI, WC, WHR, WHTR, CI and BMAI were 14.15 kg/m^2 (2.22), 46.83 cm (4.52), 0.97 (0.07), 0.49(0.06), 1.17 (0.10) and 6.63 kg/m (1.27) respectively. The corresponding values among girls were 13.42 kg/m^2 (1.48), 46.37 cm (3.61), 0.96 (0.05), 0.48 (0.05), 1.18 (0.06) and 6.24 kg/m (0.92). The overall (sex-combined) values were 13.81 kg/m^2 (1.94), 46.61 cm (4.11), 0.96 (0.06), 0.48 (0.05), 1.18 (0.0) and 6.56 kg/m (1.13), respectively. The correlation coefficients (r) of the adiposity measures with BMI are presented in Table 1. From the table, it

Table-1: *Pearson Correlation Coefficients (r) of WC, WHR, WHTR, CI and BMAI with BMI among the subjects*

Adiposity Measure	Boys (n=185)	Girls (n=162)	Sex Combined (n=347)
WC	0.060	0.265**	0.133
WHR	-0.001	-0.168*	0.014
WHTR	0.583**	0.643**	0.597**
CI	-0.309**	-0.243**	-0.303**
BMAI	0.863**	0.863**	0.867**

$* p < 0.05$; $** p < 0.01$.

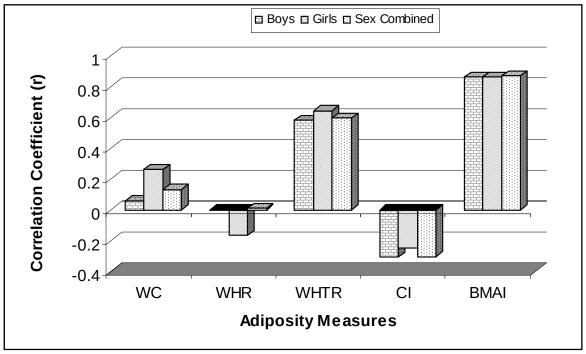

Fig-1. *Correlation of BMI with WC, WHR, WHTR, CI and BMAI*

can be seen that although significant correlations were observed for all adiposity measures except WHR, and negative in case of CI. A noteworthy point was that the correlations were strongest ($p < 0.01$) with BMAI (boys: $r = 0.863$, girls: $r = 0.863$, sex-combined: $r = 0.867$). The correlations of BMAI with BMI were similar in both sexes.

Discussion

The correlation coefficients (r) of the adiposity measures with BMI are shown in Figure 1. Ideally, any acceptable and good adiposity measure must have a strong positive relationship with BMI which is an indicator of overall adiposity. This should be equally true for both sexes. On the other hand, an adiposity measure at any particular site which does not have a strong relationship with BMI may accurately reflect regional adiposity, but it fails to relate adequately with overall adiposity (BMI). Hence, it may be of limited use in epidemiological studies, particularly those dealing with the anthropometric evaluation of nutritional status.

Conclusion

In conclusion, our results clearly indicate that the new index BMAI has a distinct advantage in that it relates very strongly with overall adiposity (BMI) than the other commonly used indicators of adiposity. Its use may be advantageous in studies dealing with the evaluation of nutritional status of preschool children. However, it is very well established that there exits significant ethnic differences in the relationship between regional adiposity and overall adiposity. Thus, we suggest that similar studies, utilizing this new index, be undertaken among other ethnic groups. These would provide us with valuable results as to whether the findings obtained by us holds true across ethnic groups. This is particularly important for a country like India which is ethnically heterogeneous. Moreover, it would be of much interest to investigate whether this utility of BMAI holds its validity among individuals of higher age groups also. Finally, it must be mentioned here that the advantage of using BMAI over other anthropometric measures of adiposity should be validated with other direct measures of adiposity like bio-electrical impedance analysis (BIA), magnetic resonance imaging (MRI) and DEXA (dual X-ray absorptiometry).

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