Short Communication

The Utility of a New Index for Adiposity among Pre-school Children

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ABSTRACT

Obesity in children is a cause for concern because it may predict adult obesity and increased risk of coronary heart disease in adult life. Adiposity in pre-school children is measured by different conventional indices. The aim of the present study was to measure the indicators of abdominal adiposity – waist circumference (WC), waist-hip ratio (WHR), waist-height ratio (WHTR), conicity index (CI) and a newly proposed body mass abdominal index (BMAI), and to assess the relationship of these with overall adiposity as measured by body mass index (BMI). The study was conducted on 2,016 rural pre-school children (930 boys and 1,086 girls), aged 3-5 years from randomly selected 66 Integrated Child Development Services (ICDS) centres in the Nadia District of West Bengal, India. Results showed significant correlations for all adiposity measures with BMI in both sexes. A noteworthy point was that the correlations were strongest ($p < 0.01$) with BMAI (boys: r = 0.856, girls: r = 0.868, sex-combined: r = 0.863). Results of linear regression of adiposity measures with BMI revealed that BMAI had the strongest significant impact (t = 76.729) on BMI. Moreover, this new index accounted for 74.5% of variations in BMI. In conclusion, our results provide evidence for the use of body mass abdominal index (BMAI) as a good indicator of overall adiposity (BMI). More studies should be undertaken including its validation with other direct measures of adiposity.

Keywords: Adiposity, body mass abdominal index, pre-school children

INTRODUCTION

Obese children are more prone to become overweight adults as the tendency of obesity in such children persists throughout life (Kaur Sangha, Kaur Pandhar & Kochar, 2006). Obesity is the most rapidly growing form of malnutrition in the developed as well as developing countries experiencing an economic transition (Chopra, Galbirth & Darnton-Hill 2002; Madanat, Trontman & Al-Madi, 2008). 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 (Must & Strauss, 1999).

While body mass index (BMI) is the recommended method for population-based screening of children for obesity, it is a poor predictor of body fat for individual children (Ellis, Abrams & Wong, 1999). Kumar (2009) has proposed a new index of adiposity, namely the body mass abdominal index (BMAI), which was shown to differ in

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children having a similar BMI value, depending on their waist circumference measurements. The BMI includes lean mass and fat components of the body, which may differ in children with similar BMI.

The objective of our study was to assess 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 determined by BMI.

METHODOLOGY

This cross-sectional study was undertaken at Chapra Block, Nadia District, West Bengal, India, during December 2003 to November 2004. The area is remote and mostly inhabited by Bengalee Muslims. The study included 2,016 pre-school children (930 boys and 1,086 girls), aged 3-5 years from randomly selected 66 Integrated Child Development Services (ICDS) centres. The ICDS are allocated 80 paise (approximately 2 US cents) per head (child) per day by the Government of India to provide supple-mentary nutrition to the children. This financial assistance ensures that each child is given a porridge consisting of 41 g of rice and 17 g of lentils per day.

Height (cm) weight (kg) waist circum-ference (cm) and hip circumference (cm) were taken by first author (SB) on each subject following the standard techniques (Lohman, Roche &Martorell, 1988). Technical errors of measurements (TEM) were found to be within reference values (Ulijaszek & Kerr, 1999) and thus not incorporated in statistical analyses. Height (cm) and all circum-ferences were taken to nearest 0.1 cm and weight (kg) was taken to nearest 0.5 kg accuracy. Body mass index (BMI), conicity index (CI), waist hip ratio (WHR) and waist height ratio (WHTR) were calculated using internationally accepted formulae.

Body mass abdominal index was calculated in the following way:

BMAI = weight / height x waist circumference / height

= weight / (height)^2 x waist circumference

= BMI X waist circumference

where weight is in kg and waist circumference and height is in metres (Kumar, 2009).

Student t-tests were performed to test for significant sex differences of these variables. Pearson correlation coefficient (r) and linear regression were performed to test for association and relationship of BMI with other adiposity measures. In regression analyses, BMI was used as a dependent variable.

RESULTS AND DISCUSSION

Among boys, the mean (sd) values of BMI, WC, WHR, WHTR, CI and BMAI were 14.48 kg/m^2 (1.14), 45.73 cm (2.58), 0.95 (0.03), 0.47(0.02), 1.12 (0.04) and 6.63 kg/m (0.71) respectively. The corresponding values among girls were 14.18 kg/m^2 (1.14), 45.82 cm (2.66), 0.96 (0.02), 0.48(0.03), 1.14 (0.04) and 6.51 kg/m (0.74). Significant sex differences were observed in means of BMI (t = 5.835, p< 0.001), WHTR (t = -3.924, p < 0.001), CI (t = -9.572, p<0.001) and BMAI (t = 9.739, p <0.001). The overall (sex-combined) values were 14.32 kg/m^2 (1.15), 45.78 cm (2.62), 0.95 (0.02), 0.48(0.03), 1.13 (0.04) and 6.56 (0.73) kg/m (0.74), respectively.

The correlation coefficients (r) of the adiposity measures with BMI are presented in Table 1. Significant correlations were observed for all adiposity measures, with negative correlation in the case of WHR and CI. The correlations were similar in both sexes. A noteworthy point is that the correlation is strongest (p < 0.01) with BMAI (boys: r = 0.856, girls: r = 0.868, sex-combined: r = 0.863). Results of linear regression of adiposity measurers with BMI revealed that BMAI had the strongest significant impact (t = 76.729) on BMI. Moreover, this new index accounted for 74.5% of variations in BMI (Table 2).

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

Adiposity Measure	Boys (n = 930)	Girls (n = 1086)	Sex combined (n = 2016)
WC	0.231**	0.295**	0.261**
WHR	-0.077*	-0.085*	-0.084**
WHTR	0.665**	0.682**	0.665**
CI	-0.408**	-0.350**	-0.392**
BMAI	**0.856****	**0.868****	**0.863****

* $p < 0.05$
** $p < 0.01$

Table 2. Linear regression of adiposity measures with BMI.

Adiposity measurers	B	SeB	Beta	Adjusted R^2	t	p
Waist Circumference (WC)	0.114	0.009	0.261	0.068	12.155	0.001
Waist Hip Ratio (WHR)	-3.899	1.030	-0.084	0.007	-3.787	0.001
Waist Height Ratio(WHTR)	29.658	0.763	0.655	0.428	30.714	0.001
Conicity Index (CI)	-10.476	0.548	-0.392	0.153	-19.128	0.001
Body Mass Abdominal Index (BMAI)	1.362	0.018	0.863	0.745	76.729	0.001

BMI = dependent variable

Assessing adiposity in children is fraught with challenges. Hitherto, adiposity in pre-school children was most commonly determined by weight for height, and body mass indices. Ideally, any acceptable and good adiposity measure should have a strong 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 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.

In conclusion, our results indicate that the body mass abdominal index (BMAI) has a distinct advantage in that it relates much better with overall adiposity (BMI) than the other commonly used indicators of adiposity. However, it is well established that there exists significant ethnic differences in the relationship between regional adiposity and overall adiposity. Thus, we suggest that similar studies, utilising BMAI be undertaken among other ethnic groups. Such investigations would provide us with important results as to whether our findings hold across ethnic groups. This particularly important for a country like India which has a vast ethnic heterogeneity.

Lastly, 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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REFERENCES

Chopra M, Galbirth S & Darnton-Hill (2002). A global response to a global problem: the epidemic of over-nutrition. *Bull World Health Organ* 80 (12): 925–958.

Ellis KJ, Abrams SA and Wong WW (1999). Monitoring childhood obesity: assessment of the weight / height² index. *Am J Epidemiol* 150 : 939–946.

Kaur Sangha J, Kaur Pandhar A & Kochhar A (2006). Anthropometric profile and adiposity in obese Punjabi children and their parents. *J Hum Ecol* 19 (3): 159–162.

Kumar PA (2009). Hypothetical index for adiposity 'Body Mass Abdominal Index'- that will predict cardiovascular disease risk factors in children. *The Internet J Pediatr and Neonatol* 11(1): Letter to the Editor.

Lohman TG, Roche AF & Martorell R (1988). Anthropometric Standardization Reference Manual. Chicago: Human Kinetics Books.

Madanat HN, Trontman KP & Al-Madi B (2008). The nutrition transition in Jordon: the political, economic and food consumption contexts. *Promot Educat* 15: 6–10.

Must A & Strauss RS (1999). Risks and consequences of childhood and adolescent obesity. *Int J Obes Relat Metab Disord* 23 : S 2–11.

Ulijaszek SJ & Kerr DA (1999). Anthropometric measurement error and the assessment of nutritional status. *Br J Nutr* 82: 165–177.