Is body mass index a good indicator of obesity?

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Published online: 7 June 2016

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The obesity epidemic has become the most blatantly visible public health problem globally. Industrialization, urbanization, and globalizations have resulted in the adoption of pro-obesity lifestyle. The incidence of non-communicable diseases (NCDs) is increasing at alarming rates globally. As of 2014, more than 1.9 billion adults 18 years and older were classified as overweight and more than 600 million as obese. Combined overweight and obesity account for more deaths worldwide than underweight [1–3].

Obesity and its associated twin diabetes together comprise a major public health problem. The term diabetes is being used frequently to better describe the current twin epidemic [4].

Body mass is the simplest and the most widely used parameter for measuring obesity. Body mass index (BMI) is calculated by dividing body weight in kilograms by height in meters squared ($\text{BMI} = \text{kg}/\text{m}^2$). It is the epidemiological and clinical parameter used to define obesity in most of the studies. According to the World Health Organization (WHO), a BMI of greater than or equal to 25 is classified as overweight and a BMI of greater than or equal to 30 is classified as obese. This is the most useful population-level measure of overweight and obesity. It does not measure the body fat directly and hence is an indirect measure of obesity [3]. Hence, it has several drawbacks. A person's body fat composition changes

with age and increases as the person gets older. This is not necessarily reflected by the person's weight and height. Furthermore, the correspondence between BMI and body differs for both men and women. For example, a man and woman of the same height and weight may have the same BMI but women have higher body fat composition compared to men. Taking the debate one step further, several long-term studies have shown that individuals classified as overweight with respect to their BMI, by and large, had the same or in some instances better health profile outcomes as compared to those who had a normal BMI. These and other such studies have opened a new avenue for the researchers to look into the intrinsic limitations of BMI in differentiating adipose tissue from lean body mass [5, 6].

It is a well-accepted fact that central or abdominal fat is far more likely to be associated with chronic metabolic disorders rather than the overall excess weight reflected by BMI; several studies have reported a higher incidence of metabolic abnormalities in Indian population. The same studies have further gone on to document a higher incidence of cardio-metabolic abnormalities in Indians for any given level of BMI [7, 8]. Considering these observations, the WHO had lowered BMI cutoffs for overweight and obesity in Asians to 23 and 27 kg/m^2 , respectively, mainly for public health action [9].

However, evidence used to establish this classification was obtained from only limited numbers of prevalence studies, not from more conclusive incidence or mortality data. This has generated debate about the appropriateness of ethnic-specific cutoff points for defining obesity.

A pertinent question which arises then is “does BMI above the cutoffs currently defined for overweight and obesity result in detrimental health consequences?”

The answer is not a simple yes as the literature is replete with contradictions. A pooled analysis showed a reasonably strong association of higher BMI with diabetes and atherosclerotic

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cardiovascular disease (ASCVD) [10]. Analysis of data from two national surveys showed a higher prevalence of diabetes, hypertension, and dyslipidemia with increasing BMI. However, what was also observed was the prevalence of all the aforementioned conditions across all BMIs. Another prospective analysis showed a J-shaped association between BMI and all-cause mortality after adjusting for confounders. This J-shaped association has also been demonstrated in patients with type 2 diabetes mellitus [11]; interestingly, a prospective analysis showed decreased mortality with increasing BMI in individuals with diabetes where the reverse was true for those without. This association of lower all-cause mortality has also been demonstrated in individuals who are overweight [12].

Now, where the adult data is fraught with such basic contradictions, the pediatric literature on obesity is even more controversial. Classifying children into underweight, normal, overweight, or obese is itself met with many problems. There are too many regional, national, and international classifications giving different age- and sex-based percentile charts. There are issues regarding how the study population is selected for deriving these BMI charts—the WHO recommended selecting samples representing children growing in an optimum environment for that country in which the initial group must be from the modern elite group [13]. There are critical comments against selecting the so-called economically privileged group since there are many studies to prove that too much is not too good and the term “optimum” is not clearly defined [14]. Using standards derived from such studies for finding a prevalence of childhood obesity (even if done on large samples) tends to underestimate obesity and overestimate underweight in developing countries like India [14]. Recently, the Indian Academy of Pediatrics has devised a growth chart taking samples of children from upper and middle socioeconomic class and excluding children who are more than 2 standard deviations (SD) score for weight and height to avoid the phenomenon of “normalizing” obese children [15].

In this background, there are many studies which strongly associate childhood obesity to be a risk factor for metabolic syndrome and type 2 diabetes in adulthood [16–18]. A recent study from 2.3 million Israeli adolescents followed up over 40 years showed similar result wherein overweight and obesity during adolescence was strongly associated with an increased cardiovascular and all-cause mortality [19]. On the contrary, a systematic review shows little evidence that childhood obesity is an independent risk factor for adult blood lipid status, insulin levels, metabolic syndrome, or type 2 diabetes without adjusting for adult BMI [20]. More prospective studies that track the BMI, as well as the body fatness index of children to adulthood and the incident health outcomes, are required.

To further complicate the issue, epidemiologists question the basic idea of BMI as a causal agent which according to them is just an arithmetic derivative. They propose an argument that weight and perhaps height which are the causes for BMI as well as mortality are confounding factors in the association between BMI and mortality [21].

In summary, clinicians should be aware of the limitations of BMI as a measure of obesity and the controversies surrounding the statistically derived cutoffs from large population studies. While extrapolating these on individual patients in the clinic setup, it is best to approach holistically taking into consideration other clinical and investigational parameters in health risk stratification of that patient.

References

1. Zimmet PZ, Alberti KG. Introduction: globalization and the non-communicable disease epidemic. *Obesity*. 2006;14:1–3.
2. Nishida C, Uauy R, Kumanyika S, Shetty P. Joint WHO/FAO expert consultation on diet, nutrition and the prevention of chronic diseases: process, product and policy implications. *Public Health Nutr*. 2004;7:245–50.
3. World Health Organization (WHO). Obesity and overweight factsheet from the WHO. 2011 Available from: <http://www.thehealthwell.info/node/82914> [Accessed: 12th May 2016].
4. McNaughton D. “Diabesity” down under: overweight and obesity as cultural signifiers for type 2 diabetes mellitus. *Crit Publ Health*. 2013;23:274–88.
5. McAllister EJ, Dhurandhar NV, Keith SW. Ten putative contributors to the obesity epidemic. *Crit Rev Food Sci Nutr*. 2009;49:868–913.
6. Rothman KJ. BMI-related errors in the measurement of obesity. *Int J Obes*. 2008;32:556–9.
7. Banerji MA, Faridi N, Atluri R, Lebovitz HE, Chaiken RL. Body composition, visceral fat, leptin and insulin resistance in Asian Indian men. *J Clin Endocrinol Metab*. 1999;84:137–44.
8. Chandalia M, Abate N, Garg A, Stray-Gundersen J, Grundy SM. Relationship between generalized and upper body obesity to insulin resistance in Asian Indian men. *J Clin Endocrinol Metab*. 1999;84:2329–35.
9. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*. 2004;363:157–63.
10. Jackson CL, Yeh HC, Szklo M, Hu FB, Wang NY, Dray-Spira R, et al. Body-mass index and all-cause mortality in us adults with and without diabetes. *J Gen Intern Med*. 2014;29:25–33.
11. Tobias DK, Pan A, Jackson CL, O'Reilly EJ, Ding EL, Willett WC, et al. Body-mass index and mortality among adults with incident type 2 diabetes. *N Engl J Med*. 2014;370:233–44.
12. Flegal KM, Kit BK, Orpana H, Graubard BI. Association of all-cause mortality with overweight and obesity using standard body mass index categories. A systematic review and meta-analysis. *JAMA*. 2013;309:71–82.
13. International Union of Nutrition Sciences. The creation of growth standards: a committee report of meeting in Tunis. *Am J Clin Nutr*. 1971;25:218–20.
14. Goldstein H, Tanner JM. Ecological considerations in the creation and the use of child growth standards. *Lancet*. 1980;1:582–5.
15. Kumaravel V, Shriram V, Anitharani M, Mahadevan S, Balamurugan AN, Sathiyasekaran B. Are the current Indian growth charts really

- representative? Analysis of anthropometric assessment of school children in a South Indian district. *Indian J Endocr Metab.* 2014;18:56–62.
16. Khadilkar V, Yadav S, Agrawal KK, Tamboli S, Banerjee M, Cherian A, et al. Revised IAP growth charts for height, weight and body mass index for 5- to 18-year-old Indian children. *Indian Pediatr.* 2015;52:47–55.
 17. Vanhala M, Vanhala P, Kumpusalo E, Halonen P, Takala J. Relation between obesity from childhood to adulthood and the metabolic syndrome: population based study. *BMJ.* 1998;317:319.
 18. Srinivasan SR, Myers L, Berenson GS. Changes in metabolic syndrome variables since childhood in prehypertensive and hypertensive subjects: the Bogalusa Heart Study. *Hypertension.* 2006;48:33–9.
 19. Sinaiko AR, Donahue RP, Jacobs Jr DR, Prineas RJ. Relation of weight and rate of increase in weight during childhood and adolescence to body size, blood pressure, fasting insulin, and lipids in young adults. *Minneapolis Children's Blood Press Stud.* 1999;99:1471–6.
 20. Twig G, Yaniv G, Levine H, Leiba A, Goldberger N, Derazne E. Body-mass index in 2.3 million adolescents and cardiovascular death in adulthood. *N Engl J Med.* 2016. doi:[10.1056/NEJMoa1503840](https://doi.org/10.1056/NEJMoa1503840).
 21. Lloyd LJ, Langley-Evans SC, McMullen S. Childhood obesity and risk of the adult metabolic syndrome: a systematic review. *Int J Obes.* 2012;36:1–11.