

Body Mass Index-Is it Reliable Indicator of Obesity?

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Abstract

Body mass index (BMI) is a universally accepted anthropometric method to classify overweight and obesity. The term was coined by Ancel Keys, also known as the Quetelet index; it is a value of body mass derived by dividing weight in kilograms by height in squared meters. BMI is easy to calculate, reproducible and least expensive way to categorize weight but limited by number of factors. Gender, ethnicity, body composition are few important factors that affects the credibility of BMI. Yet it is used as gold standard to diagnose, categorize and treat overweight/obesity. After critical analysis and detailed discussion of the limiting factors this review article concludes that BMI should not be used as the only criteria and that, it should be used along with waist circumference, skin fold thickness measurement and body composition analysis to diagnose obesity/overweight with greater accuracy.

Keywords: Body mass index; Weight; Obesity; Body composition analysis

Introduction

Body mass index (BMI) is weight in kilograms divided by height squared in meters. It is widely used and universally accepted anthropometric method to classify overweight and obesity. It is calculated at every office visit, by every electronic health record (EHR) and even considered as an important quality measure by HMOs. The BMI has been used by WHO, CDC and NIH as a standard to statistically record obesity as well as to classify it (Figure 1) [1].

The term "Body Mass Index" was coined by Ancel Keys et al in an article published in journal of chronic diseases (currently known as Journal of Epidemiology) in July 1972. The article titled "Indices of relative weight and obesity" states that the body mass index is slightly better than the simple ratio of weight to height [2]. The body mass index seems preferable over the other indices of relative weight as well as on the simplicity of the calculation and, in contrast to other percentage of average weight, the applicability to all populations at all times as per the article's inference.

Methodology

BMI is easy to calculate, reproducible and is a least expensive way to categorize weight. There are so many BMI calculators and charts that are easily available to the physicians and public. This review article is a critical analysis of those limiting factors affecting the credibility of the BMI. Based on the systematic study of various research publications on BMI along with clinical experience, the author puts together the reason for not taking BMI alone as the only criteria for diagnosing/categorizing obesity.

Discussion

BMI is limited by various factors like gender, ethnicity and body composition.

Gender: BMI does not take into consideration the gender of the patient. The BMI chart is same for both the genders. While Joe and Jane may have the same BMI, Jane is mostly likely to have a higher fat mass than Joe. "Mechanisms behind gender differences in circulating leptin levels" published in Journal of Internal Medicine, 2000 by L. Hellstrom et al. explains why women have higher fat percentage at the same BMI than men [3]. "Leptin, secreted from adipose tissue, appears to play a major role in regulating the body fat mass in animal models. Women have much higher leptin concentrations than men at all levels of body mass index (BMI). It is possible that gender variations in circulating leptin levels explain why most women have a higher body fat content than do men" (Figure 2).

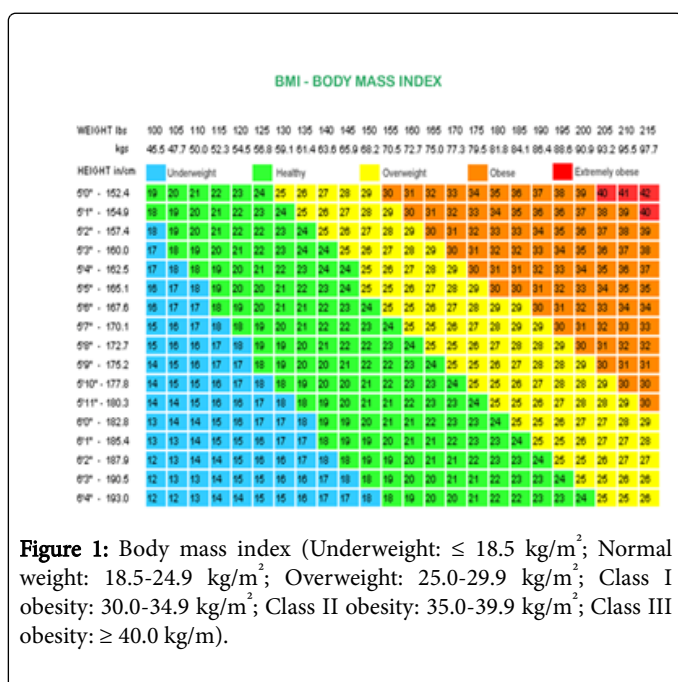
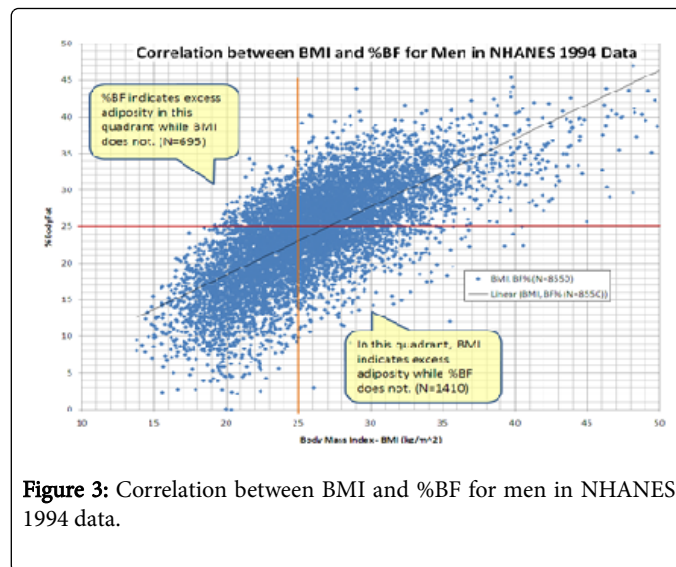
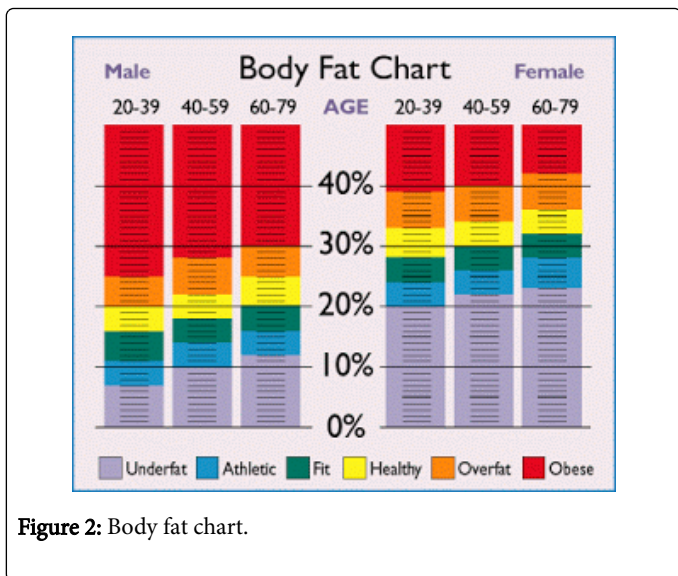


Figure 1: Body mass index (Underweight: ≤ 18.5 kg/m²; Normal weight: 18.5-24.9 kg/m²; Overweight: 25.0-29.9 kg/m²; Class I obesity: 30.0-34.9 kg/m²; Class II obesity: 35.0-39.9 kg/m²; Class III obesity: ≥ 40.0 kg/m).



Ethnicity: BMI and its association with morbidity/mortality are different in various ethnic populations across the globe. Asians tend to have higher fat mass than whites and blacks for the same BMI. According to an article in The Lancet published in Jan 2004 [4], the proportion of Asian people with a high risk of type 2 diabetes and cardiovascular disease is substantial at BMIs lower than the existing WHO cut-off point for overweight ($\geq 25 \text{ kg/m}^2$). Hence Asian countries like Singapore, Japan have their own BMI chart with lower cut off for the diagnosis of obesity/overweight (Table 1).

Category	BMI
Normal	18.5 to 25
Obese level 1	25 to 30
Obese level 2	30 to 35
Obese level 3	35 to 40
Obese level 4	49

Table 1: Japan society study of obesity (2000).

Body composition: BMI does not reflect the true body composition. An Olympic athlete with BMI of 30 might have a fat mass less than 15% and still be labeled obese! Hence BMI is an inaccurate marker of adiposity since it does not calculate body fat directly. This brings us to the another interesting term "TOFI"(thin-outside-fat-inside) which is used to describe thin people with disproportionately high percentage of visceral fat putting them at high risk for developing insulin resistance and type 2 Diabetes. "The metabolically-obese, normal weight individuals" journal article in American Journal of Clinical Nutrition, August 1981 [5] observed that such individuals might be characterized by hyperinsulinism and possibly an increase in fat cell size compared to patients of similar age, height, and weight or to themselves at an earlier time. So, Body Mass Index is not a true representation of a body composition. We are classifying obesity based on the BMI which does not measure body fat and there is no standard method to classify obesity based on the body fat as it should be (Figure 3).

Other tools: In order to get an accurate measure of the body composition analysis there are more sophisticated measuring tools like DEXA scan, Bio-electrical impedance, air-displacement plethysmography etc. Bio-electric impedance analysis (BIA) technology is used in office-based body composition analysis scales. It is relatively simpler to use compared to other diagnostic tools for evaluation of body fat which are mostly used in research laboratories or in large epidemiological studies. The concept behind Bio-electrical impedance analysis is that electric current flows at different rates at different parts of the body depending on its density. Hence it is able to differentiate fat mass from lean body mass. Body composition analysis scales using BIA technology can calculate the fat percentage, muscle and water mass along with resting metabolism with great accuracy.

A system review and meta-analysis study published in International Journal of Obesity in 2010 [6] concluded that the commonly used BMI cutoff values to diagnose obesity have high specificity, but low sensitivity to identify adiposity, as they fail to identify half of the people with excess BF%. This means that we are under diagnosing adiposity in patient with normal weight using the current BMI cut-off values. "Despite the good correlation between BMI and BF%, BMI failed to discriminate between BF% and lean mass. The diagnostic accuracy of BMI in detecting obesity is limited, particularly for individuals in the intermediate BMI ranges, in men and in the elderly" International Journal of Obesity, 2008 [7].

Conclusion

BMI should not be the gold standard for diagnosis of obesity when it does not reflect the true fat mass of an individual. The definition of obesity is "accumulation of excess body fat that it negatively impacts health". Here we are diagnosing and treating obesity based on a parameter that does not measure the body fat. Given the wide variation in BMI with different subset of individuals, clinicians should think twice before giving a clean bill of health to a person with BMI of 21, as we should before alarming a person with BMI of 30. BMI must be used along with waist circumference, skin fold thickness measurement and body composition analysis to diagnose obesity with greater accuracy. BMI is a simple measure but an outdated one. Our fixation with total body weight and BMI should be erased as it is not

reflective of "fatness". Hence BMI should be one of the criteria for diagnosis of overweight/obesity and should not be the only one!

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