



Body Mass Index and its Adequacy in Capturing Body Fat

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ABSTRACT Many different types of studies such as metabolic, nutritional and others have extensively used body mass index (BMI) as an indicator of body fat content in human subjects. BMI is also made use to classify different grades of obesity. Its ability to predict fatness as an independent risk factor in cardiovascular disorders is seriously questioned in one of the recent reports. Therefore, a literature survey was conducted with the main objective to identify the points in favor or against the use of BMI as an indicator of body fat. Several studies illustrated in this article have recognized that BMI can give misleading information on changes in body fat in a variety of conditions. Similarly, a number of reports of early days are in favor of using BMI as an index of body fat content. However, considering the universal applicability of BMI as a measure of body fat in various situations, it has been advocated that a better way is to directly measure the body fat using a standard, universally acceptable method rather than depending on some surrogate measures such as the body mass index.

Key words: Body mass index, Body fat.

What is it all about?

Science grows with changes. It is particularly so in the field of medicine. Changes occur as new information would become available through research and clinical experience. This will broaden the knowledge and enable better perception and understanding. The case in question is body mass index (BMI); one of the most frequently used parameters in certain types of studies especially involving cardiovascular risks, because the current practice with BMI as a measure of obesity or body fatness is considered obsolete. Undoubtedly BMI has been shown to correlate closely with body fat, irrespective of age, sex and ethnicity¹. Not only that, it has also been claimed that changes in BMI is reflected in development of lean body tissue between 6 and 20 years of age and loss of

lean tissue after 65 years of life in both sexes². However, the disagreement between BMI and its usefulness in predicting body fat may have important consequences in some specialized areas such as risks of coronary heart diseases, diabetes, weight loss program, population health surveys, epidemiological studies of diet and health, sports and fitness training, clinical care and so on. A recent large scale study on different measures of body composition and risk of myocardial infarction from 52 countries across the world that included subjects of different age groups and ethnic origins has sounded very strongly against BMI as an independent cardiovascular risk factor³.

Let us go a little backward:

BMI, previously known as Quetelet index, was proposed by Lambert Adolphe Jacques Quetelet (1796-1874), a social scientist from Belgium, well remembered for his probability theory of social phenomena⁴. He proposed this index in an attempt to describe the relationship between body weights in proportion to height in humans to determine the 'best body weight' for the

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height. Subsequently, BMI was employed as a popular measure of nutritional status or indicator of health status/physical standards around the globe to recruit people for national services. However, at a later stage it was suggested by Garrow and Webster and a few others that BMI could be used as an indicator of body fat content⁵. Thereafter, BMI has become one of the most common parameters often used in nutritional, metabolic and cardiovascular studies.

WHO defines obesity as an excessive accumulation of body fat over the normal amounts affecting the health and well being of an individual. As mentioned earlier, BMI is used extensively as an indirect measure of body fatness in spite of its original intentions to determine the best body weights for height. Despite knowing this fully well, a compromise or a tolerant attitude was shown in favor of BMI to be used as a surrogate measure of body fat content and also in the classification of obesity. The reason for this is that BMI is easy to calculate. It is a non-invasive, indirect and simple method that can be used in clinics and on a large number of subjects in population studies. This is in contrast to the actual or direct measurements of body fat or body composition that require more time, better facilities, well-trained staff, tedious methodology and of course more money. Therefore, the advantages might have outweighed the disadvantages in favor of BMI as a simple measure of body fat.

However, there were always questions raised from time to time regarding the universal applicability of BMI in reflecting body fat mass under different conditions related to age, physical activity, ethnicity and so on⁶⁻¹⁵. Such challenges to BMI have become more evident recently, particularly in studies related to cardiovascular risks. This group of researchers support waist circumference and waist/hip ratio as better measures of cardiovascular risks³. Rather than just the disagreement, there were also suggestions from certain quarters to even abandon the use of BMI as an indicator of body fat content⁽¹⁶⁾.

Points in favor to discard BMI:

A few illustrations given below from innumerable studies will clearly demonstrate the case against BMI.

1. Cohn¹⁷, in one of his classical studies on a large number of male subjects has pointed out that ageing is very closely associated with progressive increase in the ratio between fat and lean body mass. Such changes are

observed even in individuals who maintain a constant BMI as they age; thereby driving home the point that BMI fails to detect conversion of lean tissue to fat mass that accrues during normal ageing¹⁷. According to him, individuals can increase their body fat up to 30 percent particularly, after middle age and during menopause in women in the process of ageing.

2. Certain ethnic groups display a very different relationship between BMI and body fat. Many Asian races have been shown to carry higher body fat mass for a given BMI than Caucasians^{8,13,18,19}. In another study, the Asian-Indian men who were non-obese by BMI standards had 33 ± 7 percent body fat when measured directly, a much higher value than would be predicted from BMI using Caucasian based formula¹⁴. The reverse is also true for most black people or Polynesians who have low body fat for a given BMI. In this context, it is worth noting the reports on BMI and body fatness from Deurenberg and his group which are highly relevant to the Malay, Chinese and Indian ethnic groups in Malaysia, Singapore, and Indonesia^{13,18,20-23}. The authors have elegantly pointed out the influence of physical activity, body build/body frame, body length and its relation to BMI and body fat content. They strongly suggest that for comparison of obesity prevalence between different ethnic groups even amongst the Asians, the present universal cut off points of BMI are not appropriate. Ko and his co-workers have expressed similar views for Hong Kong Chinese population¹⁹. Similarly, poor predictability of body fat from BMI in undernourished individuals is also reported in one of the recent studies by Swethadri, Kotian and Muralidhara from India²⁴. Of course, there are some studies that do not claim any differences in BMI/BF% relationships across certain ethnic groups such as the Caucasians, Chinese and the Afro-Americans^{25,26}.

3. BMI poorly reflects body fat in athletes. It is also true in sports persons, military personnel and others who are involved in long term physical activity and therefore, would have a well developed musculature. The same may be the case with individuals who would have genetically inherited a naturally good muscular build²⁷.

4. In another interesting case, the famous American football player, Jermaine Mayberry who weighs 148 kg and stands 6 feet 4 inches tall has a BMI of 39.6 kg/m². Accordingly, he is close in the category of class III obesity. The fact is, his lean body mass is about 120 kg

and the body fat content is about 19 percent. But, using the surrogate measures for body fat content for his BMI, body fat calculated will be about 40 percent²⁸.

5. BMI also serves as a scale in weight control (reduction) programs through physical activity and/or diet based manipulations. Actual measurements of body fat in such cases can provide better interpretation than BMI or weight alone. There are studies related to exercise and weight loss that demonstrate the differences in weight loss due to fat mass and lean tissue mass changes. For example, the data from a study in one group of obese subjects who were put on an exercise and diet control regimen lost 11.8 kg weight as compared to similar obese, diet controlled but non-exercising subjects who lost only 9.2 kg. In the former group, the fat loss was 11.2 kg with almost no loss of lean tissue while in the latter group, fat loss was 5.2 kg with a loss of 4 kg of lean tissue²⁹. This means that the weight loss does not mean loss of fat alone.

6. It is also worth taking note of a year 2001 review article by EAH Sims³⁰ on a very special group of obese subjects who are metabolically normal. Such a concept of normal, healthy obese individuals is recorded in literature even from the times as early as 1940's. In the opinion of Sims, attempts by such obese individuals who are otherwise normal and healthy in metabolic terms to lose weight may be counterproductive. This may demonstrate the point that there are some poorly understood or entirely unknown benefits of mild to moderate obesity in certain groups of "healthy obese" individuals³⁰. One should exercise extra care and caution in identifying this healthy sub group of obese individuals to i) avoid inappropriate treatment, ii) include in research studies to avoid invalid statistical analysis and iii) include in medical education to stress the need for better characterization of patients.

7. A similar situation may also be seen in certain clinical conditions such as endocrine disorders, changes in tissue hydration and septic conditions where the relationship between lean tissue and fat tissue is altered and the BMI can give misleading impressions of body composition changes.

What is the solution?

It has become clear that BMI and its cut off values

are quite inappropriate for many ethnic groups as there is a different relationship between BMI and body fat content. A committee has been formed by the WHO to address the issue of proposing a new set of BMI cut off values for different races/ethnic groups. The other way to overcome the problem is to actually measure the body fat directly and have appropriate data from large scale studies. Though, several techniques are available to measure body composition, unfortunately, no one single method is ideal that could be used universally for all age groups under different physiological and disease conditions. Therefore, it is important to develop an industry standard technique that is applied widely to achieve the goal of developing body fat standards. In this context, it may be worth mentioning that Gallagher and his associates¹¹ have suggested a new approach for developing healthy percentage of body fat ranges by establishing the average levels of body fat equivalent to BMI criteria that is already available. However, according to some experts in the field, this approach to solve the problem may not have greater validity.

Conclusion:

1. The observations made above do not mean to belittle in any way the excellent contribution of BMI so far, as it formed the corner stone in the progress of obesity classification and a valuable tool in the assessment of obesity. It is important to remember that the conflicting findings on BMI/BF% relationship may also be partly a result of methodological differences and inherent errors in the methods.

2. Despite the disadvantages being pointed out as above, it seems that BMI may remain a standard approach for a considerable period of time in the future because, a) any proposals/ suggestions made by the committees set up to remedy the ills of BMI will take several years to develop the necessary database in different populations all over the world and b) BMI can still serve some basic applications.

3. Considering the limitations of BMI as illustrated above, it appears that there is a need to gradually evolve beyond BMI towards standards based on actual measurements of body fat mass.

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