Body Mass Index

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History and Purpose of the Body Mass Index

The body mass index (BMI) is a simple, safe, non-invasive, and cheap way of estimating body fat percentage and assessing a person's health and nutritional status. The BMI is one of many anthropometric indices, but it is by far the most popular. Indeed, it is an internationally accepted index for defining obesity (Jequier, 1987). The concept of the BMI dates back to the Belgian Adolphe Quatelet, who, in 1832, observed that an individual's weight is approximately proportional to the square of their height (kg/m2) (Eknoyan, 2007). However, it was only in the 1970's, when the American scientist Ancel Keys published several papers showing that the BMI is both highly correlated with adiposity and largely uncorrelated with height, that the Index began to gain popularity for assessing the level of obesity, optimal weight, and overall nutritional health (Keys et al., 1972).

The History and Concept of an "Ideal Weight"

Since an individual's weight increases as a function of the square of their height, the BMI provides a rough guideline for evaluating when an individual deviates from the mean. The Index on its own, however, does not provide one with a guideline for appropriate cut-off values associated with an "ideal weight". Modern attempts to establish "ideal weight" standards, defined as the weight associated with the lowest mortality, date back to Louis Dublin, a statistician and vice-president of the Metropolitan Life Insurance Company (Met Life) (Jarrett, 1986). Met Life first issued height-for-weight tables based on longevity statistics in the early 1940's, and then again in 1959, compiling information from 4.9 million policies issued to adults between the ages of 25-59 by 26 life insurance companies in the United States and Canada (Jarrett, 1986).

The Met Life tables were reproduced and appraised in a report on obesity by the Royal College of Physicians (RCP), and in 1973, the Fogarty Center conference also used the Met Life tables to establish guidelines for body weight (Jarrett, 1986). The conference recommended "ideal" BMI ranges of 20.1-25 for men, and 18.7-23.8, for women. Later, the NIH utilized the Met Life tables in its recommendation of "ideal weight", although the values were higher than those recommended by the RCP and Fogarty Center. In 1995, the World Health Organization also adopted it as a tool to evaluate obesity (WHO, 1995).

"Ideal Weight": Biases in evaluating weight-associated mortality

Given that the Met Life data played a key role in establishing the current BMI cut-off points, it is important to consider the biases and limitations of the results. The data is biased and likely not wholly representative of the population for many reasons: (1) insurance policies do not necessarily reflect individual people (one may have several), (2) policies may be terminated for reasons other than death (skewing mortality data) and (3) non-random sampling, which involves collecting data only from those wealthy enough to have life insurance. Methods of data collection were also inconsistent. Approximately 20% of the weights were self-reported, while the others were weighed in indoor clothing with shoes on (to correct for this, 7lbs and 4lbs were subtracted from the men and women, respectively) (Shah et al, 2006). Individuals with coronary heart diseases were excluded from subsequent analyses, and important covariates such as smoking (which can lead to reduced weight) were not considered (Jarrett, 1986).

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To make matters more complex, frame build was arbitrarily assigned based on Dublin's observation that there was a large distribution in weight for a given height, which led him to divide the distribution into thirds, for "small", "medium" and "heavy" frames. He defined the "ideal" weights to be the average weight for each third. In the subsequent table, issued in 1983, body frame was determined more precisely by measuring elbow breadth. This was based on the assumption that the measure was independent of body fat mass, but even this assumption has not been supported by evidence (Himes and Bouchard, 1985). Perhaps most importantly, the WHO's BMI recommendation cut-offs are the same for both genders and all ethnic backgrounds, but Met Life data was collected from a largely Caucasian sample, and thus, may be inappropriate for for non-Caucasians.

Limitations of the BMI

In recent years, the BMI has become a tool for evaluating health and disease risk on an individual basis, despite the fact that according to Keys, it was meant to assess populations in epidemiological studies only (Eknoyan, 2008). The BMI, which assumes that the average person is relatively sedentary and of "average" body composition, is also not appropriate for athletes or extremely sedentary but slim individuals. In addition, the BMI can be misleading when evaluating the elderly, as many age-related diseases result in weight loss, and tends to miscategorise very short or tall individuals into the obese category (Freeman et al, 1995). Nonetheless, the BMI still serves as a proxy for body adiposity, which is associated with an increased risk of many diseases, such as type 2 diabetes, cardiovascular diseases, and several cancers. However, in recent years, it has become apparent that the BMI is often not the best tool for predicting the risk of many of these diseases (Huxley et al, 2010). This is because the BMI does not take into account fat distribution, which is known to be an important predictor in cardiovascular diseases (Jarrett, 1986; WHO, 2000).

There is also increasing evidence that even when it has predictive value, the cut-off points for evaluating clinically significant risk vary for different ethnic populations (WHO, 2000). In particular, studies have shown that the proportion of the Asian population with type 2 diabetes and cardiovascular diseases is substantial in the "normal" range, and that for a particular BMI, body fat mass can vary substantially among Asians, when compared to a Caucasian population (Huxley et al, 2010; WHO, 2000). For this reason, the WHO has recommended that for these populations, cut-off for the normal range be changed to 22, which is associated with the lowest mortality risk in these groups (WHO, 2000).

Beyond the BMI

It is well-established that increased adiposity correlates with an increased risk for the development of certain diseases and mortality, but the exact cut-off points at which this risk becomes significant is often not clear. Indeed, it is likely to depend on age, ethnic background, fat distribution, level of activity, diet, frame size, disease and family history and other behaviours (such as smoking). And while the BMI is a useful tool for epidemiological research and as a rough estimate for body fat, when it comes to predicting disease risk, many alternatives fare much better (Jarrett, 1986; Huxley et al, 2010; WHO, 2000). Hydrodensitrometry (underwater weighing) and DXA (dual-energy x-ray absortiometry) are the most accurate measures of adiposity, but they are not readily available for clinical or epidemiological studies. Thus, better alternatives to the BMI include the waist-to-hip ratio, waist circumference and waist-to height ratio, all of which are more reflective measures of central or visceral adiposity (Jarrett, 1986; Huxley et al, 2010).

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BMI Values

Underweight (less than 18.5)

Normal weight (between 18.5 and 24.9)

Overweight (between 25 and 29.9)

Obese (30 and over)

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