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EDITORIALS

Is BMI the best measure of obesity?

It works for most people most of the time

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Obesity, defined as abnormal accumulation of fat such that health is impaired,[1] is most commonly assessed using the body mass index (BMI). But some people have questioned whether BMI is the best diagnostic measure.

To answer this, we need to consider the objectives of measurement (clinical assessment, surveillance, evaluating response to interventions), the definition of "abnormal" fat accumulation, and the characteristics of a good measurement tool (accuracy and acceptability). Accurate diagnosis of obesity is important, not only for the individual, when misdiagnosis could lead to undertreatment or potential stigma, but also at the population and policy levels. Inaccurate measurements could mislead our interpretation of the epidemiology of obesity or planning of services.

The most accurate direct measures of the amount and distribution of adipose tissue include dual energy x ray absorptiometry (DEXA) and imaging techniques. Increasing total body fat, measured by DEXA, is associated with higher mortality risk.[2] However, imaging techniques have shown that fat distribution (specifically visceral fat) is a more important predictor than total fat levels.[3] Despite their accuracy, these techniques are cumbersome and expensive, less acceptable for routine use, and have no standardised thresholds to define high risk. Indirect, anthropometric measures of adiposity are therefore more commonly used.

Measuring adults

BMI (weight in kg divided by the square of height in m) is a relatively simple and low cost indirect measure for assessing obesity with reasonable height standardisation. BMI cut-offs to define obesity are based on well established risks for cardiometabolic morbidity and premature mortality.[4] However, although BMI is strongly correlated with gold standard body fat measures, it cannot distinguish between lean and fat mass and provides no indication of body fat distribution. Compared with direct measures, BMI has high specificity (0.90) but low sensitivity (0.50) for assessing obesity.[5] The relations between BMI, total body fatness, and cardiometabolic outcomes (particularly type 2 diabetes) differ by ethnic group, leading to different recommendations for obesity thresholds by ethnicity.[6] The loss of muscle mass in elderly people means that BMI is also a less accurate predictor of body fat in this group.[7]

Several studies have suggested that compared with BMI, central obesity measures— including waist circumference, waist:hip ratio, and waist:height ratio—are better at predicting visceral adiposity, cardiometabolic disease, and mortality.[8] However, others have shown that these measures are highly correlated with BMI and have a similar strength of association with risk of cardiovascular disease, and so add little further information.[9] Nevertheless, measures of central obesity are associated with morbidity and mortality independently of BMI and recommended for clinical assessment, particularly in people with low BMI,[10] and are potentially more important in women.[11] Among the central obesity measures, waist:hip and waist:height ratios are probably better predictors than waist circumference, though more complex to determine. They also lack standardised measurement protocols, reference data, and accuracy in people with severe obesity (BMI>35).[12]

Other measurements include skinfold thickness—with subscapular/abdominal:biceps/triceps ratio a potential marker of central-to-peripheral fat distribution that is associated with cardiovascular morbidity[13]—and bioelectrical impedance, which is highly correlated with direct measures of body fat but requires adjustment for environmental, medical, ethnicity, and other factors.[14] The limited available evidence does not suggest these have better or additional predictive ability for disease risk in comparison with BMI, waist circumference, or waist:hip ratio.

Measuring children

In children, BMI measurements are standardised for age and sex to account for growth patterns. Obesity is defined using thresholds derived from one of several reference populations, each with advantages in different situations.[15] Conventional statistical approaches are mostly used to define obesity, with separate thresholds applied to the reference population for clinical and epidemiological purposes (95th and 98th centiles

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respectively using the UK1990 reference curves in UK. It is also important to consider ethnicity[16] and pubertal stage. Compared with direct measures, the use of BMI to diagnose obesity in children has high specificity and reasonable sensitivity (0.73).[17]

Measures of central obesity and skinfold thickness have also been used to measure obesity in children. All are correlated with direct measures and with cardiovascular risk factors.[18] A systematic review of the diagnostic accuracy of these measures compared with reference body fat measures showed that all were able to discriminate obese from non-obese children reasonably well, but they were less good at assessing the degree of adiposity.[19]Among measures of central obesity, waist:height ratio was more accurate than waist circumference or waist:hip ratio. None performed better than BMI in direct comparisons, although sum of skinfold thickness (usually biceps, triceps, supra-iliac, and subscapular) was a useful supplementary measure.[19] Bioelectric impendence is also promising but highly dependent on the device and prediction equation used.[20] Overall, BMI is the most familiar and acceptable measure among children, parents, and healthcare staff. Measurement of waist circumference tends to lead to more embarrassment.[19]

BMI remains the most commonly used, widely accepted, and practical measure of obesity in both children and adults, particularly for surveillance. However, interpretation should be ethnically sensitive, given the poorer diagnostic performance in some minority groups (including those of South Asian or African or Caribbean heritage). At the individual level, alternative approaches are needed for older adults, and measures of central adiposity in addition to BMI are valuable for assessing disease risk.

Competing interests: We have read and understood BMJ policy on declaration of interests and declare that PA and MJP are conducting a trial on prevention of childhood obesity in Chinese schools that has received a donation from Yong Ning Pharmaceuticals in China.

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