

Body Mass Index

Joseph P. Iser

What is BMI?

- ▶ BMI is a person's weight in kilograms divided by the square of height in meters.
- ▶ BMI does not measure body fat directly, but research has shown that BMI is moderately correlated with more direct measures of body fat^{1,2,3}.
- ▶ BMI appears to be as strongly correlated with various metabolic and disease outcome as are these more direct measures of body fatness^{4,5,6,7,8,9}.
- ▶ In general, BMI is an inexpensive and easy-to-perform method of screening for weight category, for example underweight, normal or healthy weight, overweight, and obesity.

How is BMI used?

- ▶ A high BMI can be an indicator of high body fatness. BMI can be used as a screening tool but is not diagnostic of the body fatness or health of an individual.
- ▶ To determine if a high BMI is a health risk *for individuals*, a healthcare provider would need to perform further assessments. These assessments might include skinfold thickness measurements, evaluations of diet, physical activity, family history, and other appropriate health screenings¹⁰.

What are the BMI trends for adults in the United States?

- ▶ The prevalence of adult BMI greater than or equal to 30 kg/m² (obese status) has greatly increased since the 1970s. Recently, however, this trend has leveled off, except for older women. Obesity has continued to increase in adult women who are age 60 years and older.
- ▶ To learn more about the trends of adult obesity, visit [Adult Obesity Facts](http://www.cdc.gov/obesity/data/adult.html)(<http://www.cdc.gov/obesity/data/adult.html>).

Why is BMI used to measure overweight and obesity?

- ▶ BMI can be used for population assessment of overweight and obesity. Because calculation requires only height and weight, it is inexpensive and easy to use for clinicians and for the general public.
- ▶ BMI can be used as a screening tool for body fatness *but is not diagnostic*.

What are some other ways to assess excess body fatness besides BMI?

- ▶ Other methods to measure body fatness include skinfold thickness measurements (with calipers), underwater weighing, bioelectrical impedance, dual-energy x-ray absorptiometry (DXA), and isotope dilution^{1,2,3}.
- ▶ However, these methods are not always readily available, and they are either expensive or need to be conducted by highly trained personnel.
- ▶ Many of these methods can be difficult to standardize across observers or machines, complicating comparisons across studies and time periods.

How is BMI calculated?

- ▶ BMI is calculated the same way for both adults and children. The calculation is based on the following formula using US measurements:
 - Formula: $\text{weight (lb)} / [\text{height (in)}]^2 \times 703$
 - Calculate BMI by dividing weight in pounds (lbs) by height in inches (in) squared and multiplying by a conversion factor of 703.
 - Example: Weight = 150 lbs, Height = 5'5" (65")
Calculation: $[150 \div (65)^2] \times 703 = 24.96$

How is BMI interpreted for adults?

BMI	Weight Status
Below 18.5	Underweight
18.5 – 24.9	Normal or Healthy Weight
25.0 – 29.9	Overweight
30.0 and Above	Obese

Is BMI interpreted the same way for children and teens as it is for adults?

- ▶ BMI is interpreted differently for children and teens, even though it is calculated using the same formula as adult BMI.
- ▶ BMI needs to be age and sex-specific because the amount of body fat changes with age, and the amount of body fat differs between girls and boys. The CDC BMI-for-age growth charts take into account these differences and visually show BMI as a percentile ranking.
- ▶ These percentiles were determined using representative data of the U.S. population of 2- to 19-year-olds that were collected in various surveys from 1963-65 to 1988-94¹¹.

Obesity in Children

- ▶ Obesity among 2- to 19-year-olds is defined as a BMI at or above the 95th percentile of children of the same age and sex in this 1963 to 1994 reference population.
- ▶ For example, a 10-year-old boy of average height (56 inches) who weighs 102 pounds would have a BMI of 22.9. This would place the boy in the 95th percentile for BMI – meaning that his BMI is greater than that of 95% of similarly aged boys in this reference population – and he would be considered to have obesity.
- ▶ For more information and to access the [CDC Growth Charts](http://www.cdc.gov/growthcharts/clinical_charts.htm)(http://www.cdc.gov/growthcharts/clinical_charts.htm)
- ▶ For adults, the interpretation of BMI does not depend on sex or age. Read more about [interpreting adult BMI](http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html#InterpretedAdults)(http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html#InterpretedAdults).

How good is BMI as an indicator of body fatness?

- ▶ The correlation between the BMI and body fatness is fairly strong^{1,2,3,7}, but even if 2 people have the same BMI, their level of body fatness could easily differ¹².
- ▶ In general,
 - At the same BMI, women tend to have more body fat than men.
 - At the same BMI, Blacks have less body fat than do Whites^{13,14}, and Asians have more body fat than do Whites¹⁵.
 - At the same BMI, older people, on average, tend to have more body fat than younger adults.
 - At the same BMI, athletes have less body fat than do non-athletes.

Accuracy

- ▶ The accuracy of BMI as an indicator of body fatness also appears to be higher in persons with higher levels of BMI and body fatness¹⁶.
- ▶ While a person with a very high BMI (e.g., 35 kg/m²) is very likely to have high body fat, a relatively high BMI can be the result of either high body fat or high lean body mass (muscle and bone).
- ▶ A healthcare provider should perform appropriate health assessments in order to evaluate an individual's health status and risks.

What are the health consequences of obesity for adults?

- ▶ People who are obese are at increased risk for many diseases and health conditions, including the following: ^{10, 17, 18}
 - All-causes of death (mortality)
 - High blood pressure (Hypertension)
 - High LDL cholesterol, low HDL cholesterol, or high levels of triglycerides (Dyslipidemia)
 - Type 2 diabetes
 - Coronary heart disease
 - Stroke

What are the health consequences of obesity for adults?

- ▶ People who are obese are at increased risk for many diseases and health conditions, including the following: ^{10, 17, 18}
 - Gallbladder disease
 - Osteoarthritis (a breakdown of cartilage and bone within a joint)
 - Sleep apnea and breathing problems
 - Chronic inflammation and increased oxidative stress^{19,20}
 - Some cancers (endometrial, breast, colon, kidney, gallbladder, and liver)
 - Low quality of life
 - Mental illness such as clinical depression, anxiety, and other mental disorders^{21,22}

References

- ▶ ¹Garrow, J.S. & Webster, J., 1985. Quetelet's index (W/H²) as a measure of fatness. *Int. J. Obes.*, 9(2), pp.147-153.
- ▶ ²Freedman, D.S., Horlick, M. & Berenson, G.S., 2013. A comparison of the Slaughter skinfold-thickness equations and BMI in predicting body fatness and cardiovascular disease risk factor levels in children. *Am. J. Clin. Nutr.*, 98(6), pp.1417-24.
- ▶ ³Wohlfahrt-Veje, C. et al., 2014. Body fat throughout childhood in 2647 healthy Danish children: agreement of BMI, waist circumference, skinfolds with dual X-ray absorptiometry. *Eur. J. Clin. Nutr.*, 68(6), pp.664-70.
- ▶ ⁴Steinberger, J. et al., 2005. Comparison of body fatness measurements by BMI and skinfolds vs dual energy X-ray absorptiometry and their relation to cardiovascular risk factors in adolescents. *Int. J. Obes.*, 29(11), pp.1346-1352.
- ▶ ⁵Sun, Q. et al., 2010. Comparison of dual-energy x-ray absorptiometric and anthropometric measures of adiposity in relation to adiposity-related biologic factors. *Am. J. Epidemiol.*, 172(12), pp.1442-1454.
- ▶ ⁶Lawlor, D.A. et al., 2010. Association between general and central adiposity in childhood, and change in these, with cardiovascular risk factors in adolescence: prospective cohort study. *BMJ*, 341, p.c6224.

- ▶ ⁷Flegal, K.M. & Graubard, B.I., 2009. Estimates of excess deaths associated with body mass index and other anthropometric variables. *Am. J. Clin. Nutr.*, 89(4), pp.1213–1219.
- ▶ ⁸Freedman, D.S. et al., 2009. Relation of body mass index and skinfold thicknesses to cardiovascular disease risk factors in children: the Bogalusa Heart Study. *Am. J. Clin. Nutr.*, 90(1), pp.210–216.
- ▶ ⁹Willett, K. et al., 2006. Comparison of bioelectrical impedance and BMI in predicting obesity-related medical conditions. *Obes. (Silver Spring)*, 14(3), pp.480–490.
- ▶ ¹⁰NHLBI. 2013. [Managing Overweight and Obesity in Adults: Systematic Evidence Review from the Obesity Expert Panel](#)[PDF – 5.98MB]
- ▶ ¹¹Kuczumarski, R.J. et al., 2002. 2000 CDC Growth Charts for the United States: methods and development. *Vital Health Stat.* 11., 11(246), pp.1–190.
- ▶ ¹²Prentice, A.M. & Jebb, S.A., 2001. Beyond body mass index. *Obes. Rev.*, 2(3), pp.141–7.

- ▶ ¹³Wagner, D.R. & Heyward, V.H., 2000. Measures of body composition in blacks and whites: a comparative review. *Am. J. Clin. Nutr.*, 71(6), pp.1392-1402.
- ▶ ¹⁴Flegal, K.M. et al., 2010. High adiposity and high body mass index-for-age in US children and adolescents overall and by race-ethnic group. *Am. J. Clin. Nutr.*, 91(4), pp.1020-6.
- ▶ ¹⁵Barba, C. et al., 2004. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*, 363(9403), pp.157-163.
- ▶ ¹⁶Bray, G.A. et al., 2001. Evaluation of body fat in fatter and leaner 10-y-old African American and white children: the Baton Rouge Children's Study. *Am. J. Clin. Nutr.*, 73(4), pp.687-702.
- ▶ ¹⁷[Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults\[PDF - 1.25MB\]](#).
- ▶ ¹⁸Bhaskaran K, Douglas I, Forbes H, dos-Santos-Silva I, Leon DA, Smeeth L. Body-mass index and risk of 22 specific cancers: a population-based cohort study of 5·24 million UK adults. *Lancet*. 2014 Aug 30;384(9945):755-65. doi: 10.1016/S0140-6736(14)60892-8. Epub 2014 Aug 13.

- ▶ ¹⁹Engstrom G, Hedblad B, Stavenow L, Lind P, Janzon L and Lingarde F. Inflammation– sensitive plasma proteins are associated with future weight gain. *Diabetes*. Aug 2003; 52(08): 2097–101.
- ▶ ²⁰Marseglia L, Manti S, D’Angelo G, Nicotera A, Parisi E, DiRosa G, Gitto E, Arrigo T. Oxidative stress in obesity: a critical component in human diseases. *International Journal of Molecular Sciences*. Dec 2014; 16(1):378–400.
- ▶ ²¹Kasen, Stephanie, et al. "Obesity and psychopathology in women: a three decade prospective study." *International Journal of Obesity* 32.3 (2008): 558–566.
- ▶ ²²Luppino, Floriana S., et al. "Overweight, obesity, and depression: a systematic review and meta–analysis of longitudinal studies." *Archives of general psychiatry* 67.3 (2010): 220–229.
- ▶ ²³Han, T. S., et al. "Quality of life in relation to overweight and body fat distribution." *American Journal of Public Health* 88.12 (1998): 1814–1820.