Obesity and Body Mass Index

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1 Definition of Obesity

Obesity is a complex health issue that results from a combination of causes and contributing factors that include behavior (dietary patterns, inactivity, medication use), environment (food and physical activity environment, education and skills, food marketing and promotion) and genetics (family history, variants of genes responsible for hunger and satiety). The intricate intertwining of these factors plays a major role in the existence of obesity and health at the individual and community level.

According to the Centre of Disease Control, in the year 2015–2016, obesity affected 93.3 million adults in the USA, making up 39.8% of the total population. This number has been showing a steady significant increase in the past decade, tripling since 1975, and demonstrating no sign of slowing down. This trend has been seen all over the world, with the estimated percentage of individuals aged 18 and above with a body mass index (BMI) of 30 and above in each of the Gulf countries as of 2014 proving to be 42.3% in Qatar, 39.7% in Kuwait, 37.2% in United Arab Emirates (UAE), 35.1% in Bahrain, 34.7 in Saudi Arabia, and 30.9% in Oman. When looking at he western counterparts, the USA showed 33.7%, New Zealand 29.2%, Australia 28.6%, the UK 28.1%, Mexico 28.1% and Canada showing obesity rates of 28% Obesity was also shown to affect people in the middle-aged group (40–59 years old) more than those considered to be in the young adult group (20–39 years old) with 42.8% of the former population proving to be defined as obese, versus 35.7% in the latter [1]. Due to the multiple comorbidities that have

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been shown to be associated with obesity, alongside the burden of the disease itself, the estimated annual medical cost in the USA was shown to be $147 billion in 2008 alone. This corresponded to a medical cost of $1,429 higher for people with obesity than those of normal weight [2]. Furthermore, it was shown that Hispanics (47%) and non-Hispanic blacks (46.8%) had the highest age-adjusted prevalence of obesity compared to other race populations (Figs. 1, 2, 3) [1]. So how do we define this debilitating condition that has affected such a large population of the world, and what can be done about it?

2 Obesity and BMI

Obesity/overweight is defined as a weight that is higher than what is considered a healthy weight for a given height, causing an abnormal or excess fat accumulation that may impair health [3]. Currently, the most widely used tool to assess the degree of obesity is the body mass index (BMI), which divides a person's body weight in kilograms (kg) by their height in meters squared (m^2).

$$\text{BMI} = \text{weight (kg)}/\text{Height (m)} * \text{Height (m)} = \text{kg}/\text{m}^2$$

The results of this calculation places people in specific weight categories as follows:

- If the BMI is lower than 18.5, it falls in the underweight range.
- If the BMI is between 18.5 and < 25, it is considered to be in the normal range.
- If the BMI is between 25.0 and < 30, it is in the overweight range.
- If the BMI is 30.0 and higher, it falls within the obese range.

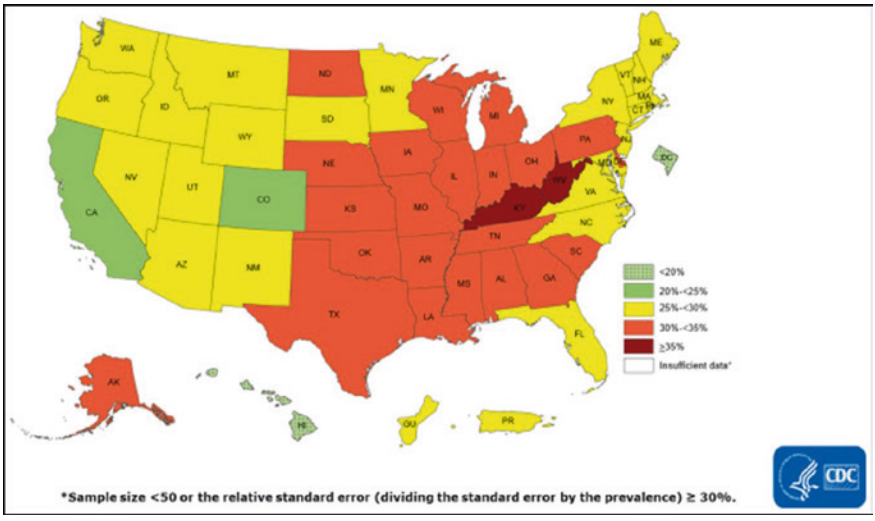

Fig. 1 Prevalence of self-reported obesity among non-hispanic white adults, by State and Territory, BRFSS, 2016–2018

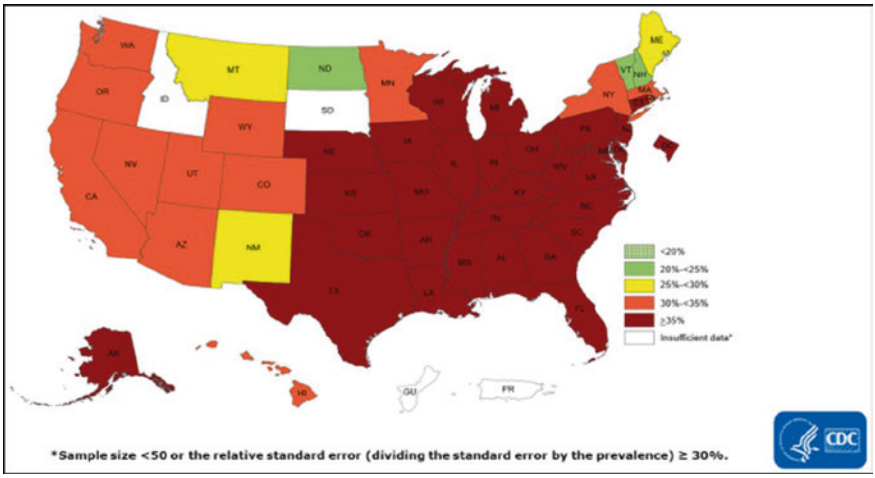

Fig. 2 Prevalence of self-reported obesity among non-hispanic black adults, by State and Territory, BRFSS, 2016–2018

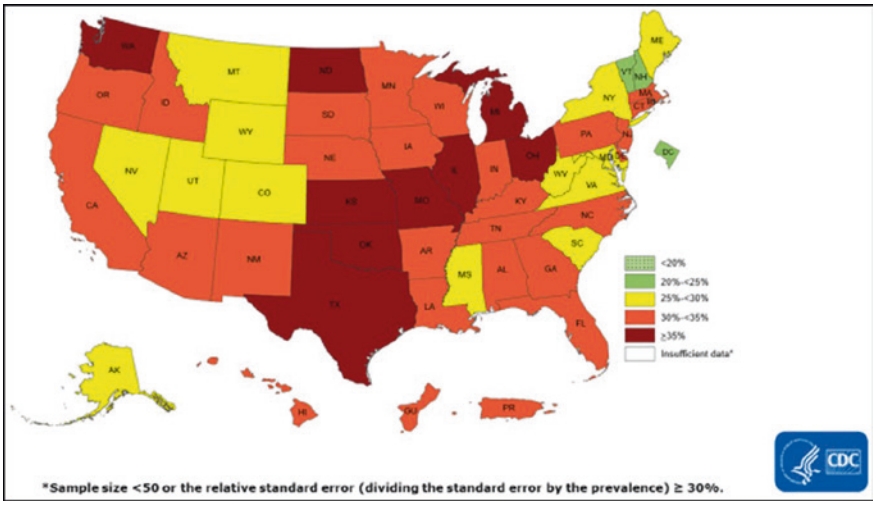

Fig. 3 Prevalence of self-reported obesity among hispanic adults, by State and Territory, BRFSS, 2016–2018

Obesity is also further subdivided into three class categories as follows:

- Class 1 obesity is defined as a BMI ranging between 30 to < 35
- Class 2 obesity is defined as a BMI ranging between 35 to < 40
- Class 3 obesity is defined as a BMI of 40 or higher, and is considered "severe" obesity.

BMI provides the most useful population-level measure of overweight and obesity as it is the same for both sexes and for all ages of adults. However, at an individual level, BMI is not diagnostic of body fatness or the health of the individual, but can be thought of as more of a useful screening tool. Research has shown that BMI is only moderately correlated with more direct measures of body fat obtained from skinfold thickness measurements, bioelectrical impedance, underwater weighing, dual energy x-ray absorptiometry (DXA) and other methods [4–6]. Furthermore, even though change in BMI can be used to assess weight loss and gain, other measures that employ the use of BMI have proven to provide more accurate depictions of weight change with time.

3 Percent Excess Weight Loss (%EWL)

Weight loss has been reported in many ways and by various methods according to the entity reporting it (for example dieticians vs bariatric surgeons); however, the best method should allow for the most accurate comparisons between the broadest ranges of patients' weight and population characteristics. One of the most widely used tools in the surgical community currently can be considered to be %EWL.

This is calculated using the following formula:

$$(\text{weight loss} \,/\, \text{baseline excess weight}) \times 100$$

where weight loss = preoperative weight − current weight;
baseline excess weight = preoperative weight − ideal weight,
and where ideal weight = weight corresponding to a BMI of 25 kg/m^2.

An advantage of %EWL is that it expresses weight loss that has been achieved relative to a defined goal. This goal is usually determined according to a BMI of 25 kg/m^2. However, a major concern when employing this method is that the definition of preoperative weight and ideal body weight can be ambiguous and vary between different studies and papers. Furthermore, the %EWL calculation can vary considerably if pre-operative weight is defined as the weight of the first visit, or the highest weight between first visit and the day of surgery. Ideal body weight (usually captured through the Metropolitan Life Tables) also varies depending upon which size body frame is used. As the Metropolitan Life Tables were originally created in the 1940s and have not been updated since 1983, many feel this method is outdated.

4 Percent Excess BMI loss (%EBMIL)

Due to the possible discrepancies previously discussed, experts from both the medical and surgical communities have proposed alternatives to %EWL. Percent excess BMI loss (%EBMIL) is one measure that is frequently used outside the United States and is favored by some experts.

This is calculated using the following formula:

$$\%\text{EBMIL} = [\Delta\text{BMI}/(\text{Initial BMI} - 25)]100$$

BMI is thought to be the easiest index of "fatness" when compared with hydrodensitometry studies [7, 8]. The accuracy of BMI continues to be challenged, however, particularly as it relates to individuals with normal weight obesity (defined as a combination of normal BMI and high body fat content) and muscular body types. Furthermore, when compared to dual-energy x-ray absorptiometry (DXA), a recent paper revealed that BMI misclassified 25% of men and 48% of women [9]. It is for this reason that many experts feel that the accuracy of BMI in diagnosing obesity is extremely limited.

5 Percent of Total Weight Loss (%TWL)

One of the key issues in this debate is determining what constitutes successful weight loss. Currently, the medical community prefers the calculation of percent total weight loss (%TWL).

The following formula can be used to calculate this:

$$\%\text{TWL} = \big[(\text{Initial Weight}) - (\text{Postop Weight})\big]/\big[(\text{Initial Weight})\big]100$$

Percent TWL is more accurate than kilograms of weight lost because it takes into account the fact that those with a high starting weight tend to lose more weight. Percent TWL can also be helpful to characterize reversal or prevention of obesity-related comorbidities. For example, in one diabetes prevention program, a seven-percent total weight loss prevented diabetes in 50% of the patients [10]. Also, a 10% total weight loss has been proven to produce improvements in a majority of metabolic and cardiac risk factors. One of the disadvantages of %TWL is that it does not take into account a therapeutic goal, nor does it express a patient's desire of how much weight he or she might wish to lose [11].

References

1. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of Obesity Among Adults and Youth: United States, 2015–2016. NCHS Data Brief. 2017;288:1–8.
2. Finkelstein EA, Trogdon JG, Cohen JW, Dietz W. Annual medical spending attributable to obesity: payer-and service-specific estimates. Health Aff (Millwood). 2009;28(5):w822–31.
3. Organization WH. Obesity 2014 [Available from: https://www.who.int/topics/obesity/en/.
4. Freedman DS, Horlick M, Berenson GS. 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. 2013;98(6):1417–24.
5. Garrow JS, Webster J. Quetelet's index (W/H2) as a measure of fatness. Int J Obes. 1985;9(2):147–53.
6. Wohlfahrt-Veje C, Tinggaard J, Winther K, Mouritsen A, Hagen CP, Mieritz MG, et al. Body fat throughout childhood in 2647 healthy Danish children: agreement of BMI, waist circumference, skinfolds with dual X-ray absorptiometry. Eur J Clin Nutr. 2014;68(6):664–70.

7. Deitel M. Comment on: reported excess weight loss after bariatric surgery could vary significantly depending on calculation method: a plea for standardization. Surg Obes Relat Dis. 2011;7(4):534–5.
8. Keys A, Fidanza F, Karvonen MJ, Kimura N, Taylor HL. Indices of relative weight and obesity. J Chronic Dis. 1972;25(6):329–43.
9. Shah NR, Braverman ER. Measuring adiposity in patients: the utility of body mass index (BMI), percent body fat, and leptin. PLoS ONE. 2012;7(4):e33308.
10. Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med. 2002;346(6):393–403.
11. Bray GA, Bouchard C, Church TS, Cefalu WT, Greenway FL, Gupta AK, et al. Is it time to change the way we report and discuss weight loss? Obesity (Silver Spring). 2009;17(4):619–21.