12.3: Indicators of Health: Body Mass Index, Body Composition, and Fat Distribution

Skills to Develop

• Be able to calculate body mass index (BMI) given a particular weight and height.
• Name the factors that affect body composition and distribution.

What weight should you weigh? This has been a difficult question to answer because humans come in so many different sizes and shapes. We do know that carrying too much fat is not good for one’s health. Ideal body weight (IBW) has been used to determine one’s desirable weight. Usually, IBW is determined by reference weight-for-height charts and the most commonly used chart is the Metropolitan Life Insurance Tables which include data for men and women by height and frame size. Hamwi is another method which does not require reading a table. Instead, it is a calculation:

• Males: 106 lbs for 5’ in height plus 6 lbs for every inch over
• Females: 100 lbs for 5’ in height plus 5 lbs for every inch over

If the individual has a large from then the number is increased 10% and if that person's frame is small, then 10% is subtracted from the number. Once you have calculated their suggested weight, the following interpretative guidelines can be applied. If the person's weight is a certain percent over then they would be considered:

• Overweight if greater than 10% over IBW
• Mild obesity if greater than 20% over IBW
• Moderate obesity if greater than 40% over IBW
• Severe obesity if greater than 100% over IBW

There are limitations to both methods. Neither method is based on a representative population or all populations. The
Metropolitan Life Insurance tables are based on mortality risk, not just obesity. Finally, there are many examples of people who are defined as overweight but don't have excess fat stores, for example, body builders and weight lifters.

![Weight Categories]

*Figure 1*: Obesity and BMI. Image used with permission (CC BY-SA 4.0; BruceBlaus).

Although the terms "overweight" and "obese" are often used interchangeably and considered as gradations of the same thing, they can denote different things. You weigh what you weigh because of your: water weight, lean muscle weight, bone weight, and weight from body fat (adipose). "Overweight" refers to having more weight than is typical for a particular height. That weight may be the result of water weight, muscle weight, or fat mass. "Obese" refers specifically to having excess body fat. In most cases, people who are overweight also have excessive body fat and therefore body weight is an indicator of obesity in much of the population.

The "ideal" healthy body weight for a particular person is dependent on many things, such as frame size, sex (hormone profile), muscle mass, bone density, age, and height. The perception of the "ideal" body weight can be additionally dependent on cultural factors and the mainstream societal advertisement of beauty.

In this author's opinion, the concept of "ideal body weight" is concerning. I feel that each of us should be eating healthfully (not just saying it but doing it), exercising healthfully and then allowing our body weight to go where it wants to go. However, medical doctors, public health officials, and others needed to find a simple tool to look at patterns of weight gain in the U.S.A. and elsewhere. The easy tool that was developed is called the Body Mass Index (BMI). BMI is a tool meant to tell an individual if they weigh too much, too little or just right. BMI uses the information that we already have readily available from every doctor's visit: weight and height. The general idea is if you are very tall and have a low weight you are probably underweight. If you are very short and you weigh a lot you are probably overweight. It is a crude tool but one that can quickly, inexpensively give estimates of overweight and/or underweight.

**The Body Mass Index (BMI) and Its Limitations**

Body mass index (BMI) is calculated using **height** and **weight** measurements and is more predictive of a health risk.
than using weight alone. BMI measurements are used to indicate whether an individual may be underweight (with a BMI less than 18.5), overweight (with a BMI over 25), or obese (with a BMI over 30). Very high AND very low BMI's appear to increase a person's risk of dying. If you look at a graph of BMI (Figure 6.7.1) as it relates to your risk of dying, it has a "J-shaped Curve" or a "U-shaped Curve" because being too low and/or too high both raise your risk of mortality. Instead, you'd like to be in the middle range of the BMI which is what they use for "Normal weight". You will notice that, even though you will be categorized as "overweight" at a BMI of 25 and "obese" at a BMI of 30, the risk of dying goes up gradually. Like a teacher assigning a letter grade, the decision of exactly where to draw the lines for underweight, normal weight, overweight and obese are somewhat arbitrary.

To calculate your BMI, multiply your weight in pounds by 703 (conversion factor for converting to metric units) and then divide the product by your height in inches, squared.

\[ \text{BMI} = \frac{\text{weight (lb)}}{(\text{height (in)}^2)} \tag{11.2.1a} \]

or

\[ \text{BMI} = \frac{\text{weight (kg)}}{(\text{height (m)}^2)} \tag{11.2.1b} \]

Automatic BMI Calculators

The National Heart, Lung, and Blood Institute and the CDC have automatic BMI calculators on their websites:

- http://www.nhlbisupport.com/bmi/

To see how your BMI indicates the weight category you are in, see Table \( \text{Table} \{1\} \) or use a chart of weight and

![Mortality risk vs. BMI](https://med.libretexts.org/Courses/American_Public_University/APU%3A_Basic_Foundation_of_Nutrition_for_Sports_Perform…)

**Figure \( \text{Figure} \{2\} \): Mortality risk vs. BMI.**
height to figure out your BMI.

Table 1: BMI Categories

<table>
<thead>
<tr>
<th>Categories</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.5</td>
</tr>
<tr>
<td>Normal weight</td>
<td>18.5–24.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>25–29.9</td>
</tr>
<tr>
<td>Obese</td>
<td>&gt; 30.0</td>
</tr>
</tbody>
</table>


BMI Limitations

A BMI is a fairly simple measurement and does not take into account fat mass or fat distribution in the body, both of which are additional predictors of disease risk. Body fat weighs less than muscle mass. Therefore, BMI can sometimes underestimate the amount of body fat in overweight or obese people and overestimate it in more muscular people. For instance, a muscular athlete will have more muscle mass (which is heavier than fat mass) than a couch potato of the same height. Based on their BMIs the muscular athlete would be less "ideal" and may be categorized as more overweight or obese than the couch potato; however, this is an infrequent problem with BMI calculation. Additionally, an older person with osteoporosis (decreased bone mass) will have a lower BMI than an older person of the same height without osteoporosis, even though the person with osteoporosis may have more fat mass. A BMI is a useful inexpensive tool to categorize people and is highly correlative with disease risk, but other measurements are needed to diagnose obesity and more accurately assess disease risk.

BMI is not a good measure for children and adolescents because they are growing. A new BMI for these ages was recently introduced in which the weight in kg is divided by the height in meters cubed. Its use is not well-established yet.

BMI does not consider where the fat is located. Individuals with abdominal fat or android shape have a greater risk of obesity associated diseases than individuals who carry their fat in the hips (gynoid or "pear shape"). Men tend to be "apple-shaped" while women tend to be "pear shaped." Gynoid shape tends to be associated with fewer health risks. For this reason, a ratio of body waist circumference to hip circumference may be measured and the ratio calculated. If you are male and your ratio is greater than 0.95, then you have excessive abdominal fat. If you are female and your ratio is greater than 0.86, then you have excessive abdominal fat.

Measuring Body Fat Content

Water, organs, bone tissue, fat, and muscle tissue make up a person’s weight. Having more fat mass may be indicative of disease risk, but fat mass also varies with sex, age, and physical activity level. Females have more fat mass, which is needed for reproduction and, in part, is a consequence of different levels of hormones. The optimal fat content of a
female is between 20 and 30 percent of her total weight and for a male is between 12 and 20 percent. Fat mass can be measured in a variety of ways. The simplest and lowest-cost way is the skin-fold test. A health professional uses a caliper to measure the thickness of skin on the back, arm, and other parts of the body and compares it to standards to assess body fatness. It is a noninvasive and fairly accurate method of measuring fat mass, but similar to BMI, is compared to standards of mostly young to middle-aged adults. Other methods of measuring fat mass are more expensive and more technically challenging. They include:

- **Underwater Weighing (Hydrostatic).** This technique requires a chamber full of water big enough for the whole body can fit in. First, a person is weighed outside the chamber and then weighed again while immersed in water. Bone and muscle weigh more than water, but fat does not—therefore a person with a higher muscle and bone mass will weigh more when in water than a person with less bone and muscle mass. This method is considered the gold standard but requires special facilities and not many places offer underwater weighing even for highly trained athletes. Also, this method is not easy or useful with children, the elderly or those afraid of water.

- **Bioelectric Impedance Analysis (BIA).** This device is based on the fact that fat slows down the passage of electricity through the body. When a small amount of electricity is passed through the body, the rate at which it travels is used to determine body composition. The percent of body fat is proportional to the body's resistance to the flow of current. A limitation of the method is BIA measures total body water which only estimates muscle and fat. Since water conducts the current, it is imperative that the individual is fully hydrated. These devices are also sold for home use and commonly called body composition scales.

- **Dual-energy x-ray absorptiometry.** This technique can be used to measure bone density. It also can determine fat content via the same method, which directs two low-dose x-ray beams through the body and determines the amount of the energy absorbed from the beams. The amount of energy absorbed is dependent on the body's content of bone, lean tissue mass, and fat mass. Using standard mathematical formulas, fat content can be accurately estimated.

- **Skinfold measurements.** This technique picks up the skin and measures the thickness. Calipers are used to measure the thickness of the fold which is bigger if there are abundant fat stores. A number of body sites are measured and the selection of sites depends on gender and which method is going to be used to estimate body fat percent. This method has several limitations and its accuracy is dependent on the training of the person completing the measurements. Several body sites must be measured and there is wide variation in the numbers obtained among different technicians.

- **BOD POD (Air Displacement).** This machine measures how much air your body displaces within its chamber. Percent body fat is calculated based on the relationship between body weight, density, and volume. This machine requires a special facility and is not easy or useful for children and the elderly.

### Measuring Fat Distribution

Total body fat mass is one predictor of health; another is how the fat is distributed in the body. You may have heard that fat on the hips is better than fat in the belly—this is true. Fat can be found in different areas in the body and it does not all act the same, meaning it differs physiologically based on location. Fat deposited in the abdominal cavity is called visceral fat and it is a better predictor of disease risk than total fat mass. Visceral fat releases hormones and inflammatory factors that contribute to disease risk. The only tool required for measuring visceral fat is a measuring tape. The measurement (of waist circumference) is taken just above the belly button. Men with a waist circumference greater than 40 inches and women with a waist circumference greater than 35 inches are predicted to face greater health risks.

The waist-to-hip ratio is often considered a better measurement than waist circumference alone in predicting disease risk. To calculate your waist-to-hip ratio, use a measuring tape to measure your waist circumference and then measure
your hip circumference at its widest part. Next, divide the waist circumference by the hip circumference to arrive at the waist-to-hip ratio. Observational studies have demonstrated that people with “apple-shaped” bodies, (who carry more weight around the waist) have greater risks for chronic disease than those with “pear-shaped” bodies, (who carry more weight around the hips). A study published in the November 2005 issue of *Lancet* with more than twenty-seven thousand participants from fifty-two countries concluded that the waist-to-hip ratio is highly correlated with heart attack risk worldwide and is a better predictor of heart attacks than BMI. Yusuf, S. et al. “Obesity and the Risk of Myocardial Infarction in 27,000 Participants from 52 Countries: A Case-Control Study.” *Lancet* 366, no. 9497 (2005): 1640–9. Accessed October 5, 2011. [http://www.ncbi.nlm.nih.gov/pubmed/16271645?dopt=AbstractPlus](http://www.ncbi.nlm.nih.gov/pubmed/16271645?dopt=AbstractPlus). Abdominal obesity is defined by the World Health Organization (WHO) as having a waist-to-hip ratio above 0.95 for males and above 0.85 for females.

### Key Takeaways

Most people who are overweight also have excessive body fat and therefore body weight is an indicator of obesity in much of the population. To standardize the “ideal” body weight and relate it to health, scientists have devised some computational measurements to better define a healthy ideal weight. Body weight in relation to height is called BMI and is correlated with disease risk. Total body fat mass is another predictor of disease risk; another is where the fat is distributed. Fat deposits in different areas in the body and do not all act the same, meaning it differs physiologically based on location. Visceral fat contributes more to disease risk, for example.

### Discussion Starters

2. Based on what you learned, why would an individual with a high BMI have a decreased risk of osteoporosis?