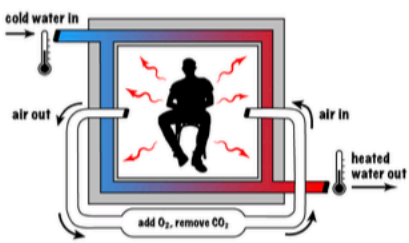
of a person's BMR are their gender, height, weight and age (Harris & Benedict, 1919). The BMR can be significantly affected by certain medical diagnoses, for example, hypothyroidism tends to depress BMR (Marcus, 2013). Many diseases increase BMR, including acromegaly (rare condition in which the body produces too much growth hormone), cancer, congestive heart failure (CHF), polycythemia (increased number of red blood cells), Paget's disease (excessive breakdown and regrowth of bone), and hyperthyroidism (Marcus, 2013). Pregnancy and lactation also increase BMR: exclusive breastfeeding requires ~500 kcal-/day, partial breastfeeding ~250 kcal/day, first-term pregnancy ~ 50 kcal /day, second-term pregnancy ~340 kcal /day, third-term pregnancy ~450 kcals/day, and third-term pregnancy with twins ~700 kcal/day (Sally et al, 2013). Other conditions, known as **stress factors**, can also increase BMR; these include infection, fever, recent surgery, trauma or a burn. For example, a minor wound or infection can increase BMR by ~20%; a moderate wound, burn, or trauma by ~50%; and a severe burn or massive trauma by ~60-100% (Falcão & Tannuri, 2002). Research has also shown that low-calorie dieting, including 'yo-yo' dieting, eventually suppresses BMR, but to what degree and for how long varies upon the severity and duration of caloric restriction as well as other factors such as the intensity and duration of any exercise program engaged in during the period of low-calorie dieting (e.g., Martin et al, 2007).

MEASUREMENT OF BMR

Direct calorimetry is the most accurate way to assess BMR, but it is very costly and time intensive. Direct calorimetry requires the person be placed in an isocaloric chamber, which measures the amount of heat her body 'gives off.' For a simple visual, refer to **Figure 6-2.4. Direct Calorimetry.**

Figure 6-2.4. Direct Calorimetry

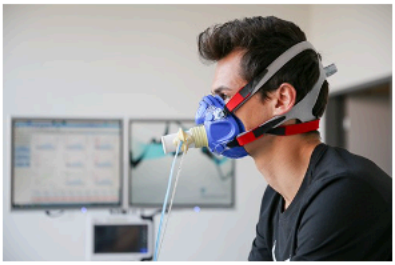


Although not as accurate as direct calorimetry, BMR can also be measured through **indirect calorimetry**, the equipment for which is significantly less expensive than the equipment required for direct method, uses spirometry to capture gases released from respiration at rest. The concentration of the gases is measured and correlated to estimate a patient's BMR. For a visual, refer to **Figure 6-2.5. Indirect Calorimetry.**

Figure 6-2.5. Indirect Calorimetry

New on the market is a **portable indirect calorimetry** device and even a '**one-time personal use**' calorimetry device. For a visual a 'one-time personal use' device, refer to **Figure 6-2.6. Portable Indirect Calorimetry.** For a comparison of direct and indirect calorimetry, watch the brief video provided in the **Textbook Supplement** at WellnessSociety.org.

Figure 6-2.6. Portable Indirect Calorimetry



The simplest and free method to estimate BMR is with the use of the **Harris-Benedict equation** (Harris& Benedict, 1919). This formula, developed in 1919, takes into account four primary factors that influence a person's BMR: gender, age, height, and weight. **Gender** is a factor because the 'reference man' has significantly more muscle mass then the 'reference women,' and, even at rest, skeletal muscle is significantly more metabolically active than fat tissue. **Height** and **weight** are factors because they determine total body mass, which, as it increases, requires more energy to sustain it. Other factors being equal, the BMR of a younger adult is higher than that of an elderly person because, for example, the density of muscle mass decreases with advanced age (McArdle et al, 2015). Periods of growth, such as during adolescence, also elevate the BMR. The males and female equations are provided in **Figure 6-2.7. Harris-Benedict Equation.** An online calculator is provided in the **Textbook Supplement** at WellnessSociety.org. Because of its simplicity, the Harris-Benedict formula is less accurate if a patient has an atypical body composition. For an illustration, refer to **Figure 6-2.8. Michael** and **Figure 6-4.9. Ralph.** Each man is 28 years-old, 6'0" in height, and 240lbs in weight. The Harris-Benedict equation estimates each of the BMR to be 2,293 kcals/day. However, because skeletal muscle mass is more metabolically active than fat mass, Michael's BMR would actually be significantly higher than Ralph's. As a practice exercise, utilize the Harris-Benedict equation and calculate the estimated BMR in each of the five patients listed and described in **Figure 6-2.10. BMR?** (Suggestion: For ease, use the online calculator in the **Textbook Supplement** at WellnessSociety.org.)

Figure 6-2.7. Harris-Benedict Equation

Men:	BMR = (10 × weight in kg) + (6.25 × height in cm) - (5 × age in years) + 5
Women:	BMR = (10 × weight in kg) + (6.25 × height in cm) - (5 × age in years) – 161

Figure 6-2.8. Michael

Figure 6-2.9. Ralph

Figure 6-2.10. BMR?

1. Carol: A 42-yr-old woman who is 5'2" height and 145 lbs. weight who has a mild viral infection.
2. Henry: A 78-yr-old man who is 5'9" height and 167 lbs. weight who is post-op and is currently in an ICU (acute setting) on bed rest with bed side physical therapy ordered.
3. Rachel: A 68-yr-old woman who is 5'7" height and 120 lbs. weight who has suffered a long-bone fracture trauma and is attending outpatient physical therapy.
4. Sonya: A 30-yr-old woman who is 5'10" height and 165 lbs. weight.
5. George: A 50-yr-old man who is 5'11" height and 175 lbs. weight who has end-stage cancer, is essentially on bed-rest and is receiving three visits of physical therapy through hospice for family and caregiver education.
6. Rain: A 22-yr-old transgender who is 5'8" height and 140 lbs. weight who has no 'stress factors' and is attending a yoga class offered by an outpatient physical therapy clinic as part of their 'community wellness' program.

SPECIAL TOPIC: OBESITY AND COVID-19

Obesity is unfavorably linked to the COVID-19 pandemic. According to a review of the literature, obese individuals (compared to lean individuals) are more vulnerable to COVID-19; more likely to require hospitalization, ICU, and mechanical ventilation; require longer ICU and ventilation durations; are more contagious; and are more likely to die as a direct result of the illness (Abdalazim & Albashir, 2020). This research fueled the vaccine vs healthy weight debate.

left, the women depicted is 5'6." The first image is her at her baseline weight of 170lbs; the second image depicts her body following a 4-month reduced-calorie whole foot plant-based diet and exercise regime at her new weight of 130lbs. Her baseline BMI is 27.4 (overweight) and her post-intervention BMI is 21 (normal). At face value, the pre- and post-BMI values are valid. In contrast, both of the men in the second image are 6'0" tall, 200lbs, with a BMI of 25.7 (overweight). At face value, the BMI of the leaner man is not valid, that is, the BMI of 25.7 implies he is overfat. These cases illustrate the validity the BMI equation. In addition, the problem that very high and very low amount of muscle causes, the BMI does not consider gender or age. What would be the benefit of adding a correction factor for each gender and age?

Figure 6-4.9. BMI Validity

CHAPTER 6 – SECTION 5:
BODY COMPOSITION PARAMETERS AND MEASUREMENT

My abs are normal - McAmerican.
Brian Spellman (1966-)

OBSERVATION OF BODY COMPOSITION

When you meet a patient for the first time – before you begin your 'formal' examination, you will observe demographic information such as perhaps gender, race and ethnicity, age group, and so forth. You will also observe their approximate height, weight, skeletal frame, and 'face value' body composition, (e.g., athletic, toned, average overfat, obese, or morbidly obese). While it is not mandatory to formally examine the body composition of a every patient, it provides a snapshot of the patient's lifestyle. Also, follow-up body composition measurements can provide positive reinforcement if the patient is working diligently to lose fat. When overfat adults begin to regularly exercise and rely upon the scale for feedback, improvements in body composition can go undetected in one-third of those who gain weight and in almost one-third of those whose weight does not change (Cruz et al, 2011).