The 101 of Resting Energy Expenditure

What is Resting Energy Expenditure (REE)?

REE represents the number of calories used to sustain basic life processes including respiration, heartbeat, kidney function, and blood circulation. REE is a measurement of your metabolism rate and represents the minimum number of calories needed for vital physiological functions. Vital organs use more calories than muscle and fat tissues in a resting state. REE is thought to account for 60-70% of daily total energy expenditure.[1]

How is your REE/BMR determined and what is RER/RQ?

The most accurate measurement to determine REE is called indirect calorimetry (IC). IC measures inspired oxygen (O_2) and expired carbon dioxide (CO_2) and results in a ratio called the respiratory exchange ratio (RER), or respiratory quotient (RQ) = VCO_2/VO_2. Examining the RER/RQ provides valuable information for total energy expenditure and the substrate (carbohydrate or fat) being used for energy.[1] The RER/RQ value falls within the range of 0.70-1.20 under normal, steady-state conditions, where the contribution of protein for energy is minimal; thus, protein is ignored in determining a non-protein RQ value.[1,2] Once the volumes of O_2 and CO_2 have been determined, the REE can be calculated.[1]

Standard values of RQ include [1]:

- Fat = 0.70
- Protein = 0.80
- 40% carbohydrate + 60% fat = 0.82
- Mixed energy = 0.85
- Carbohydrate = 1.00

What is Metabolic Flexibility?

Metabolic flexibility is the ability of an organism to shift the fuel type used for energy (carbohydrate or fat) based on changes in fuel availability; i.e. a metabolically flexible person should use energy from primarily fat in a fasted state (RQ closer to 0.70), use energy from fat after eating a high fat meal, and use energy from carbohydrate after eating a high carbohydrate meal. Metabolic flexibility is primarily influenced by activity frequency and intensity. A sedentary lifestyle, i.e. little to no intentional exercise, may lead to metabolic inflexibility. Metabolic inflexibility is when the body utilizes primarily carbohydrate for energy in a fasted state (RQ closer to 1.00), or when the body does not shift to the nutrient available after eating a high fat or high carbohydrate meal, thus leading to elevated blood glucose and/or the synthesis of fatty acids that are stored in body fat. Increasing intentional exercise is the best therapy to improve metabolic flexibility.[3,4]

What makes up the total calories you burn, aka Total Daily Energy Expenditure?

Total daily energy expenditure (TDEE) is comprised primarily of 1. REE, 2. thermic effect of food (TEF), and 3. energy expenditure of physical activity or exercise (EEPA). REE is thought to account for 65-80%

of our total daily burned calories; on average, digesting and absorbing food accounts for approximately 10% of our total daily burned calories; intentional exercise and activity may account for 20-40% of our total daily burned calories, though it may be considerably less in a truly sedentary person or significantly greater in a very physically active person. Factors that influence the calories you burn during and after exercise include the type, the intensity, the duration, and the frequency of the exercise is performed.[1] The calories burned from eating food is minimal and is often not included in the calculation for our total daily burned calories. Thus, our total daily burned calories is typically determined by measuring or calculating REE and multiplying it by an activity factor.

What Is the Impact of Exercise on TDEE?

Exercise is the most easily altered variable in the number of daily calories burned.[1] Some sedentary people expend just a little bit above their REE in a given day, while others can more than double it. The following table defines various activity levels and equates them to activity factors.[5,6] The activity factor is multiplied by your predicted or measured REE to calculate how many calories you burn daily.

Activity Level	Physical Activity Factor (PAL)	Definition
Sedentary	**1.0 to <1.4**	A person with a sedentary occupation who spends the entire day sitting
Low-active	**1.4 to <1.6**	An office worker who sits most of the day other than the walking necessary to perform tasks of daily living, equivalent to a 154 lb person walking about 2 miles per day*
Active	**1.6 to <1.9**	A 154 lb person who exercises approximately 1 hour/day, or has an active vocation equivalent to walking 6-8 miles/day*
Very Active	**1.9 to <2.5**	A 154 lb person who engages in several hours of daily exercise, equivalent to walking 16-17 miles/day*

*Note: These distances will vary with changes in body weight and may be significantly reduced by walking faster or performing other activities of various intensities.[5,6]

What Variables Affect REE?

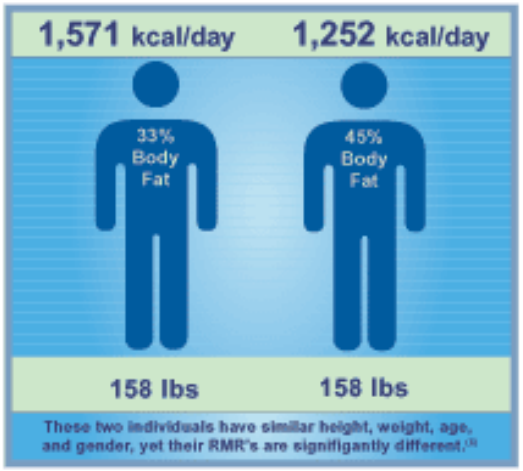
Some variables are independent of our influence and lifestyle behaviors, these include:

1. **Genetics.** Some people are born with faster metabolisms, while others naturally have slower metabolisms. This is likely related to body composition of fat-free lean mass and body fat percentage.[6]
2. **Gender.** Men typically have a greater fat-free lean mass and a lower body fat percentage compared to women, therefore they generally have a greater REE.[2]
3. **Age.** REE begins to naturally decline after age 20. REE is estimated to decrease by 2% per decade in healthy adult women and approximately 3% per decade in healthy adult men.[6]
4. **External temperature.** Changes in the environmental temperature, especially below the comfort zone, can temporarily increase the rate of metabolism to restore the body temperature to normal.[1]

Other variables are dependent on our lifestyle behaviors and choices, thus they can be changed. These include:

1. **Body Size (primarily weight).** Larger people will have a higher REE compared to smaller people , mostly due to greater fat-free lean tissue and organ mass.[6]

2. **Fat-free lean mass (FFM).** A number of studies have shown that FFM most closely correlates with REE, independent of age, BMI, and other metabolic variables. Thus, FFM is more metabolically active compared to body fat.[2] For example, two people who weigh the same but have different body composition will have different REE values.[8] The person with greater FFM will have a higher REE (see image to the right).



3. **Diet.** Very low calorie diets (<800 calories per day) will cause the metabolism to slow down in order to preserve enough energy for vital organs to function. Therefore, underfeeding may cause a decrease in REE.[1]

4. **Exercise.** Energy expenditure is elevated for a period of time following exercise, with more calories burned during the recovery period immediately following a higher-intensity exercise.[6]

Additional variables may be independently and dependently influenced, i.e. many health conditions are genetic; however, many develop from lifestyle choices. These variables include:

1. **Health Conditions.** Various health conditions may increase or decrease REE, including hyperthyroidism, hypothyroidism, obesity-related hormones, cancer, respiratory diseases, recent injury/infection, and eating disorders. [7]

2. **Medications and Drugs (including caffeine and nicotine).** Medications and drugs that alter physiological processes occurring in the central nervous system, neuromuscular, respiratory, or cardiovascular systems may alter metabolism rate.[7]

How does your body adapt to endurance (cardio) training compared to resistance (strength) training?
Cardio and strength training exercises produce beneficial, though different, physiological adaptations.[8] Some adaptations can be seen, while others can be felt. Additionally, there is a relationship between the intensity and duration of the exercise to the energy expended during the activity and afterwards during recovery. As the intensity and/or the duration of exercise increases, so does energy expenditure.[6] In other words, you will burn more calories completing a high-intensity and/or longer duration exercise compared to a lower intensity and/or shorter duration exercise. Thus, high-intensity interval training is believed to be a superior form of exercise. Endurance training has been shown to delay the onset of fatigue by improving the use of fat for energy and increasing a person's ability to use and delivery oxygen. The adaptations occur through increasing the number of capillaries (oxygen delivery system) and increasing the number of mitochondria (the powerhouse that creates energy in every cell in the body).[8] Resistance training results in hypertrophy (enlargement) of muscle and increases strength.[8] In summary, endurance exercise will help prevent fatigue, improve the body's ability to use oxygen, and improve metabolic flexibility; resistance exercise will increase muscle size, improve strength, and improve metabolic flexibility; and high-intensity exercise (in the form of either endurance or resistance) will increase energy expenditure occurring hours after the activity.[6,8] A combination of different exercises will lead to improved body composition (decrease in body fat and increase in lean muscle mass) and may decrease the risk of health issues. Current physical activity guidelines include:

1. At least 150 minutes per week of moderate-intensity (30 minutes on 5 days), or 75 minutes per week of vigorous-intensity aerobic (endurance) activity, or a combination of aerobic intensities.

a. Aerobic bouts can be divided into 10-minute increments, i.e. three 10-minute walks per day = 30 minutes of daily activity.[9]
b. For additional and more extensive health benefits, especially helpful for weight management, adults should increase their aerobic activity to 300 minutes per week of moderate-intensity, or 150 minutes per week of vigorous-intensity aerobic activity, or a combination of aerobic intensities.[9]

2. At least 2 days per week of moderate- or high-intensity muscle-strengthening activity that involves all major muscle groups.[9]

How is REE used in the One 2 One weight management program?

A health professional will review the REE data collected using indirect calorimetry, where specific recommendations will be developed based on your REE results and health goals. The REE value is multiplied by a participant-chosen activity factor (reference the table above). The calculation provides a value for the total number of calories burn in 24 hours. To maintain weight, a person would eat the same amount of calories as they expend, i.e. calories in = calories out. Calorie adjustments will be made by the health professional to facilitate changes in body composition and weight loss. Furthermore, the health professional will discuss optimal energy balance for weight management based on changes in activity level and will develop lifestyle recommendations based on the RQ value.

Reference List

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