Total Energy (Caloric) Expenditure

What is it?

Total energy expenditure is amount of energy required to sustain and move the body each day and is the sum of three components: resting energy expenditure, dietary thermogenesis (the energy expenditure of digestion), and activity thermogenesis (the energy expenditure of activity). Each of these components is highly variable based on intrinsic and extrinsic factors, resulting in a wide range of energy expenditure values amongst individuals.

Resting energy expenditure (synonymous with resting metabolic rate), represents the minimal energy required for the body's vital functions and maintenance, and contributes to 60-80% of daily energy expenditure for most sedentary individuals and nearly 50% for those who are physically active. Dietary thermogenesis is the increase in energy expenditure associated with digestion, absorption and storage of food, and accounts for approximately 10% of the total daily energy expenditure. Activity thermogenesis is the energy that accompanies physical activities and, therefore, can be divided into exercise and non-exercise activity thermogenesis (NEAT). Exercise related energy expenditure generally accounts for about 10% of total daily expenditure for physically active individuals, but may be as low as 0% in the sedentary population. NEAT encompasses the combined energy costs of the physical activities of daily living, fidgeting, spontaneous muscle contraction, and maintaining posture, and accounts for the remainder of the total daily energy expenditure for most individuals.

Why is it important?

The determination of energy expenditure is necessary because balancing energy intake (diet) with expenditure has important health implications. Indeed, a total energy expenditure assessment can provide information around which a wellness program, whether it is diet, exercise, or both, can be designed to improve body composition, enhance performance, and forestay the premature morbidity and mortality that is so prevalent in today's society.

How is it assessed?

It was recognized over 2,000 years ago that biological life processes give off heat as a by-product. This set the stage for the measurement of heat production (calorimetry) as a way to quantify biological energy expenditure. Measuring the heat loss of humans, a process known as direct calorimetry, has been and continues to be the gold standard in the interpretation of energy expenditure. However, this process is an expensive, labor intensive endeavor requiring individual confinement for 24 hours or more. Fortunately tremendous advances have been made in devices that measure gas exchange, called indirect calorimetry.

Estimating energy expenditure and substrate (the body's various energy sources) utilization through indirect calorimetry using gas exchange (i.e., breath-by-breath system) is based on the amount of oxygen required to combust gram equivalents of carbohydrate, fat, and protein. Glucose and fat metabolism depends on oxygen availability and produces CO2 and water as by-products. The amount of O2 and CO2 exchanged in the lungs normally equals that used and released by body tissues, thus measurement of expired gasses provides an accurate estimate of metabolic activity in body. Indirect calorimetry yields results comparable to those from direct measurements (less than 1% error) with the benefit of being simpler, cheaper and more portable. Alternatively, there are a number of non-calorimetric techniques to predict energy expenditure by extrapolation from physiological measurements (e.g., accelerometry, heart rate, etc.), observations (e.g., questionnaires and visual) and use of prediction equations based on anthropometric measures, gender, and age. Although, these may be woefully inadequate due to limitations and measurement error; for example, even the best prediction equations are within 10% of measures results.

Your assessment will include the following:

1. **Resting energy expenditure:** A breath-by-breath indirect calorimetric system will measure airflow continuously and simultaneously determine instantaneous expired O2 and CO2 concentrations which will be converted to energy equivalents (calories).

2. **Activity Thermogenesis:** In addition to the above lab assessment, you will don a wearable physiological status monitor at home for 24 hours to measure physiological markers of physical activity and activities-of-daily living exertion and movement via heart rate and triaxial accelerometry. Estimations of your caloric expenditure beyond that of the resting energy expenditure will be subsequently computed.

What to expect during the assessment:

1. You will be resting in a comfortable, semi-reclined position (10 degree vertical tilt) in a thermo-neutral (72- 74 F), semi-dimmed room.
2. You will be fitted with a face mask that envelops both nose and mouth while laying for 15 min of rest followed by a 5 minute steady-state measurement period
3. You will be instructed to remain awake yet motionless, quiet, and minimize any other potentially stimulating distractions during the test.

Participant preparation:

Test validity and data accuracy are greatly improved by adhering to the following guidelines prior to your assessment. Your test(s) will be given on the assumption that you have followed these recommendations:

1. Refrain from ingesting heavy meals, alcohol, caffeine and tobacco products within 12 hours of testing
2. You should be well rested for the test: avoid significant exertion or exercise 24 hours prior to testing and get a good night's sleep
3. Drink amble fluids over the 24-hour period preceding the assessment to ensure normal hydration
4. No consuming nutritional supplements or medications that contain stimulants (such as Ma Haung and ephedrine) the day of the test.