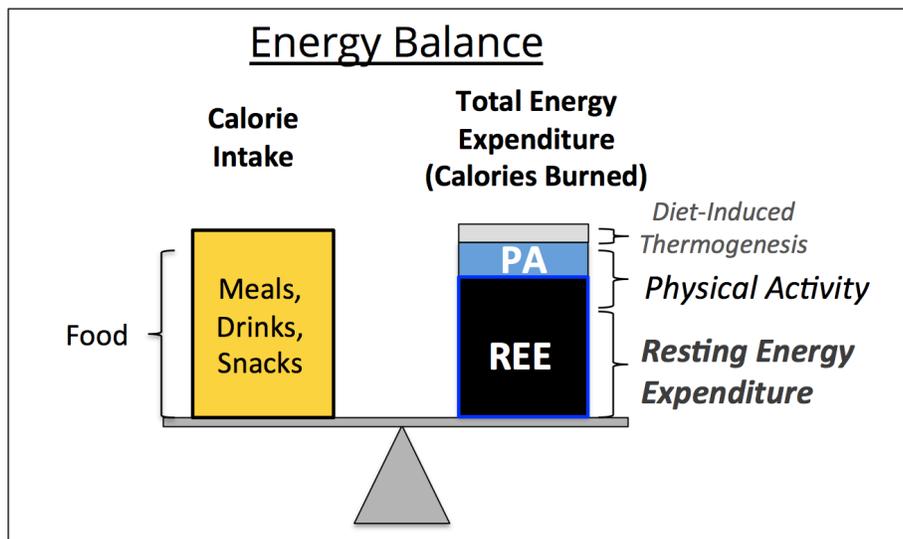


## Energy Balance: Importance of Resting Metabolism

Physiologically, the key to weight management lies in energy balance, commonly referred to as “calories in = calories out”.

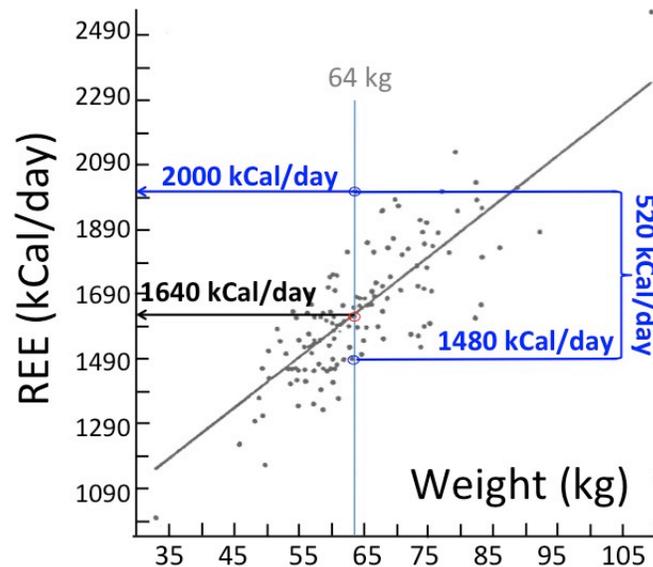
Understanding energy balance can enable individuals to better manage changes in weight, by monitoring the energy difference (calorie gap) between calorie intake (“calories in”) and energy expenditure (“calories out”). To accurately monitor this energy difference, knowing both calorie intake and Total Energy Expenditure (TEE) is important (**Fig. 1**).



**Figure 1.** Energy is balanced when calorie intake equals total energy expenditure (TEE). TEE includes Resting Energy Expenditure (REE), Physical Activity Energy Expenditure (PA), and Diet-induced Thermogenesis (DIT). REE, PA, and DIT respectively constitute between 60 to 85 %, 15 to 30%, and ~10% of TEE, depending on the activity level of the individual (e.g., highly active vs. sedentary).

TEE comprises of resting energy expenditure (resting metabolic rate), diet-induced thermogenesis, and physical activity. Resting Energy Expenditure (REE) is the energy needed to maintain basic body functions, such as breathing, cellular repair and growth, blood circulation, and brain activity. REE values are determined by an individual’s metabolism, and can account for as much as 85% of total calories burned (see more details in Application Note No. 103). Knowing REE is therefore essential to monitoring energy balance for weight management.

While indirect calorimetry is the gold standard method of measuring REE, the traditional measurement process has been viewed as costly, time-consuming, and cumbersome. For that reason, REE is commonly estimated from standard equations such as the Harris-Benedict Equation to provide calorie intake recommendations. However, these calculated REE values can be significantly higher or lower than measured REE values. **Fig. 2** highlights the difference between calculated REE estimates and measured REE values for a male sample of the population [1, 2].



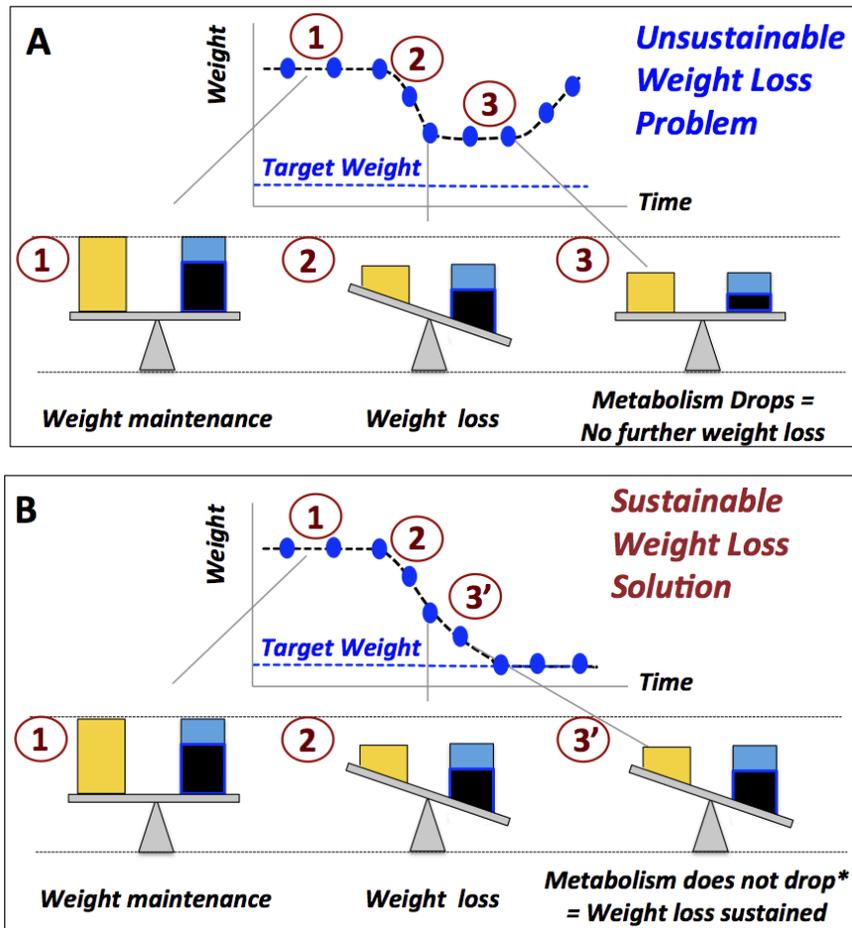
**Figure 2.** Results from Harris-Benedict's equation (extracted from original work [1]) and differences between actual REE value and calculated REE value for males of 64 kg, in the same age and height group. Differences between actual (measured) and calculated REE values can impede weight loss efforts (e.g., and individual with calculated REE of 1640 kCal/day and actual REE of 1480 kCal/day).

As depicted in the graph above, REE calculations are an average of the sample group's measurement values; therefore, calculated REE estimates (shown by the black line) do not represent each individual's actual REE (shown by the scattered points). Individual differences between calculated and actual (measured) REE values can be as high as 520 calories per day. REE (metabolic rate) is based on each person's unique physiology, which can vary greatly among individuals - even those with the same age, height, weight, and gender. An equation-based estimate of REE can lead to inaccurate recommendations for caloric intake and physical activity, impeding weight loss/gain/maintenance efforts. Thus, the *Academy of Nutritionists and Dietetics (formerly American Dietetic Association)* strongly recommends REE measurement in establishing an effective weight management plan [3].

For the professional who aids others in achieving their weight goals, research demonstrates greater success in achieving target weight when the individual's plan is based on his/her REE measurement. A study conducted by Dr. Leoluca Criscione [4] has shown successful weight loss in 97% of 207 subjects. His study demonstrates weight loss of ~1.5, ~5.0, and ~8.0 kg at 1, 6, and 12 months, respectively.

Moreover, to maintain energy balance and sustain weight loss in the long term, consistent tracking of REE measurements is needed. Over time, REE changes. This reflects body composition changes (which may include fat loss), lifestyle changes, and adaptations to changes in diet. If, for example, calorie intake is suddenly reduced, REE will also tend to drop [5-8], offsetting the initial calorie difference and making weight loss efforts unsustainable. **Fig. 3A** illustrates a decrease in REE (the black bar) following the reduction in calorie intake (yellow bar).

In **Fig. 3B**, weight loss is sustained due to a higher REE, as the calorie difference between calorie intake and TEE is maintained.



**Figure 3.** (A) Unsustainable weight loss: Reduction of calorie intake (yellow bar) may induce a drop in REE (black bar), which often results in weight plateau and weight re-gain. (B) Sustainable weight loss: monitoring and \*raising/maintaining REE (e.g. by increasing muscle mass).

Until now, lack of access to metabolic testing equipment has been a barrier to accurate REE measurement and tracking. Breezing™ Metabolism Tracker is the only indirect calorimeter that pairs with a mobile app to easily measure and track metabolism (REE), and provides accurate information for diet, activity, and weight planning based on the energy balance equation.

*Note: Breezing Tracker's advisory plan uses recommendations by the Academy of Nutritionists and Dietetics [3] for weight management.*

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