New consensus on energy balance and body weight regulation

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Experts in weight management, energy metabolism, physical activity and behaviour, from the USA and the UK, have published a new consensus statement on energy balance and body weight regulation. This statement is the result of a consensus conference entitled "The role of energy balance in health and wellness".

Changes in body weight over time are associated with an imbalance between energy intake (calories consumed) and energy expenditure (calories burned). Understanding this relation, including the different components of the energy balance, could prove useful in the development of interventions that target weight loss. The consensus statement provides insights into the following related topics:

Energy (im)balance in the biological system

Energy balance, in the context of weight management, refers to the equation in which on one side are all food and drinks that are consumed (energy in, E_I), and on the other side all energy expended (energy out, E_O) by the body to maintain life and perform physical activity. When E_I exceeds E_O, the surplus of energy is stored (E_S) in the human body, mostly as fat in adipose tissue, but also as glycogen (from carbohydrates) in liver and muscle. Obesity, by necessity, develops when there is a long-term energy surplus that leads to excessive body fat accumulation. If on the other hand E_O is greater than E_I for prolonged periods of time, the body will tap into its energy reserves and lose weight.

The net energy from food, i.e. the fraction available for the body to use, is called metabolizable energy (referred to as E_I). It is corrected for a loss of energy through faeces (2-10% of energy) and urine. E_O can be subdivided into resting energy expenditure (REE), thermic effect of food (TEF), and activity energy expenditure (AEE). The REE, which approximately accounts for two-thirds of E_O, varies between and within individuals by body size, body composition (lean body tissue uses more energy than fat tissue) and recent imbalance. TEF is associated with the digestion and metabolic processing of food, and AEE consists of exercise energy expenditure (e.g. sports) and non-exercise activity thermogenesis (e.g. working, playing, and fidgeting).

Interaction and regulation of E_I, E_O and E_S

The mechanism underlying energy balance is not well understood. Intake and expenditure may vary largely, over a 1-day period, but also on a day-to-day basis, and it is only over a longer term period that they are balancing out (in case of weight maintenance). This particular point has been explicitly stressed by the expert panel. A second point emphasized, is the fact that all components of energy balance (E_I, E_O and E_S) interact with each other and should therefore all be considered in intervention research on obesity.

Two different control systems to explain the energy balance concept are discussed; a "set point", based on a feedback control mechanism to maintain body weight, and a “settling point”, a system without active feedback control on E_I and E_O. These systems however overlap. Factors that affect E_I are for instance satiation, the feeling that makes you stop eating, and satiety, which determines the time between a meal and the next moment that appetite comes up again. However, liking and wanting a food can overcome those feelings and intake might still occur. A positive energy balance is passively compensated by increases in REE (due to increased lean body tissue), AEE (due to increased body mass) and TEF (due to increased E_I), but there is little evidence for active stimulation of physical activity when caloric intake is increased.

Whether a negative energy balance, due to increased exercise, is compensated by eating more is not clear; exercise interventions show a large variability in body weight response, which is affected by the adherence to the intervention as well as the extent of compensatory behaviour, i.e. responding to hunger after exercise.

A popular idea is that besides the use of energy used during exercise, there is also an after-exercise component accounting for 6-15% of the energy expended during an exercise session. However, the believed increase in REE because of regular exercise and subsequent changes in body composition is negligible. Another important factor is that physical activity does not always lead to an increase in E_O because of compensatory behaviour, i.e. more sedentary pursuits in the hours following the exercise. In other words, to estimate more accurately the daily E_O, all activities need to be taken into consideration, bearing in mind that lots of little activities may add up to significant energy expenditure.

Veracity of popular beliefs

A) The reduction in weight loss that people might encounter being on a weight-loss diet for 6-8 months is more likely due to failure in compliance with the intervention, rather than a slowed metabolism; adherence to a specific diet regime is extremely difficult because of the intrinsic drives to eat.

B) Reduced energy expenditure (low metabolism) does not cause established obesity to persist, but its role in developing obesity in the first place remains unclear. Previous reports about lower REE in individuals with obesity compared to lean individuals erroneously considered energy expenditure per kilogram body weight. As the authors put it, the “balance is not struck between total food intake per individual and expenditure per kilogram but rather between energy intake per individual and energy expenditure per individual.”

C) The 3500-kcal-per-pound rule, which postulates that a reduction of 3500 kcal over an unspecified timeframe leads to a reduction of 1 pound of body weight, should not be used as an intervention approach. It wrongly assumes a linear change in body weight whereas even under perfect adherence, without active compensation, weight change slows down because of a passive reduction in E_O. The authors propose a “new rule of thumb" in a mathematical model. This model takes the passive compensation into account and thereby gives a more realistic reflection of the weight loss that can be expected for a certain reduction in energy intake, and also an indication of the time needed to achieve this.

D) It is important to have reasonable weight loss expectations when making changes in either energy intake or expenditure. The increasingly promoted small lifestyle changes should not be overestimated as the body might counteract by passive behaviour changes.

Limitations in the study of energy balance

Precise measurement of the energy balance components is extremely difficult, especially when it concerns small changes and long-term periods in free-living individuals. New technologies may be more accurate, but laboratory studies with inpatients will not represent free-living conditions.

Guidance for future research

The energy balance system is interactive and complex. To close key knowledge gaps the panel identified the following needs: 1) long-term longitudinal studies on the relations between the components of energy balance and their effect of body weight and composition, 2) studies of a more integrative nature rather than isolating single components of the energy balance, 3) more detailed knowledge on physical activity and how the different doses and types affect daily E_O, but also E_I, food preferences and body weight, 4) identification of underlying mechanisms of active compensatory behaviour in weight maintenance, for instance in the period subsequent to weight loss, and 5) improvements in the tools to measure energy in- and output, as well as methods to better monitor free-living subjects.

For further information, see

Hall KD, Heymsfield SB, Kemnitz JW, Klein S, Schoeller DA, Speakman JR. (2012) Energy balance and its components: implications for body weight regulation. American Journal of Clinical Nutrition, Apr; 95(4): 989-94.