Calorie restriction versus exercise: which produces the best health outcomes?

L.K. Heilbronn,[1] D. Samocha-Bonet,[2] E. Larsen-Meyer,[3] L. Redman,[3] A. Civitarese,[3] S. Smith[3] and E. Ravussin,[3]
[1]Level 6 Eleanor Harrald Building, Discipline of Medicine, The University of Adelaide, Adelaide, SA 5005, Australia, [2]Garvan Institute, Darlinghurst, NSW 2010, Australia and [3]Pennington Biomedical Research Centre, Baton Rouge, LA 70808-4124, USA. (Introduced by Matt Watt)

The prevalence of obesity is rapidly escalating worldwide and obesity is closely linked to the development of insulin resistance, metabolic syndrome and type 2 diabetes. Negative energy balance is key in reversing the metabolic defects associated with obesity and produces an array of health benefits that cannot be matched by any one drug that is currently on the market. These include improved lipid profiles and insulin sensitivity, reduced ectopic lipid deposition, blood pressure and reduced inflammatory cytokine production. However, the optimal method to achieve negative energy balance is debated. Here I compare studies of reduced energy intake to increased energy expenditure, and in particular focus on the differential effects of these interventions on lean mass preservation, energy metabolism and insulin action.

In free living studies, moderate calorie restriction (CR) nearly always produces greater weight loss, but there is evidence to suggest that aerobic exercise may provide equal or greater health benefits and is better to maintain weight loss following CR. Here, I report findings from the CALERIE studies, where we compared 25% CR versus 12.5% CR plus 12.5% increase in energy expenditure by aerobic exercise training under stringent laboratory conditions for 6-months in healthy overweight individuals. In this study, energy requirements were carefully assessed, all foods were provided for 3.5 months whilst individuals attended weekly training sessions to learn how to accurately count calories, and all of the exercise sessions were conducted under supervision. Under these conditions, CR and CR+EX produced equal energy deficits; and thus equal losses in body weight, subcutaneous fat cell size and subcutaneous, visceral and liver fat stores by MRI. No changes were observed in intramyocellular lipid, but CR+EX led to slightly greater preservation of lean body mass at 3-months, and greater improvements in fitness and insulin sensitivity at 3- and 6-months. Similar results were produced from the CALERIE study conducted at Washington University where participants were randomised to either 20% CR or a 20% increase in physical activity alone.

We also observed that energy expenditure in the 24-hour chamber was reduced more than predicted based on the loss of mass in both CR and CR+EX indicating metabolic adaptation, but there was no change in spontaneous physical activity. Total daily energy expenditure was reduced only in CR, and was greater than was accounted for based on the decrease in sedentary energy expenditure. This suggests that the CR group also reduced daily activity. This result is found following prolonged CR in monkeys, although CR rodents that are given access to a running wheel exercise more than *ad-libitum* fed animals. We also observed that CR and CR+EX produced similar increases in mitochondrial biogenesis and SIRT1 expression in muscle and equivalent reductions in DNA damage, although functional changes in mitochondria were not observed. Interestingly, a recently completed study that we have conducted of high fat overfeeding also produced an increase in mitochondrial biogenesis, despite induction of insulin resistance, lending support to the growing body of evidence that suggests that mitochondrial dysfunction may be a consequence rather than a cause of insulin resistance.

So, should we promote dieting or exercise? This probably depends on whether the goal is weight loss or maximal improvement in health. Without close dietary and exercise support, exercise alone is unlikely to produce much weight loss. However, dieting alone reduces sedentary energy expenditure and physical activity which will promote weight regain over time. We have shown that the combination of CR+EX prevents reductions in total energy expenditure, and may also provide slightly greater health benefits than dieting alone.