See corresponding articles on pages 542, 583 and 593.

Exercise for weight loss

Klaas R Westerterp

NUTRIM, Maastricht University Medical Centre, Maastricht, Netherlands

Negative energy balance and subsequent weight loss can be achieved by either reducing energy intake (1) or increasing energy expenditure, the latter usually by exercise. Exercise-induced weight loss, however, is usually small, and smaller than expected from an exercise-induced increase in energy expenditure (2). In this issue of the Journal, Martin et al. (3) try to identify mechanisms for the phenomenon termed "weight compensation" in response to exercise in overweight and obese participants.

Nearly 200 women and men were randomly assigned to receive 3 treatments over 24 wk: no-exercise control, 8 kcal · kg body weight^{-1} · wk^{-1} supervised exercise (8 KKW), or 20 kcal · kg body weight^{-1} · wk^{-1} supervised exercise (20 KKW). Outcome measures, as assessed at baseline and week 24, included energy expenditure, energy intake, and body composition. Energy expenditure increased in the exercise groups as expected, without compensatory metabolic or activity changes. However, weight loss was only 36.2% and 40.8% of predicted values in the 8- and 20-KKW groups, respectively, indicating that compensation was noted at both exercise levels. (Indeed, 42.4% of the subjects in the 8-KKW group and 23.5% in the 20-KKW group did not lose weight or even gained weight.) Participants compensated by increasing energy intake (an average of 90.7 kcal/d in the 8-KKW group and 123.6 kcal/d in the 20-KKW group).

This elegant study by Martin et al. (3) was well designed and had sufficient power. All exercise sessions were monitored and supervised. The session length established the energy expenditure goal for each participant. The 24-wk duration was relatively long for a supervised exercise intervention. The dropout rate was only 10%, with 178 participants completing follow-up testing; only 7 participants in the exercise groups did not meet the 75% cutoff for adherence. Energy intake was derived from the best available method in free-living conditions, namely total energy expenditure as measured with doubly labeled water.

The objective of the study was to refine weight-loss guidelines for clinicians counseling patients on how to lose weight with exercise. This suggests overweight and obesity are associated with inactivity. Doubly labeled water measurements of free-living energy expenditure showed, however, that total energy expenditure (TEE) steadily increases with an increasing body mass index (4). Basal metabolic rate (BMR) as well as activity-induced energy expenditure, the 2 largest components of TEE, are higher in larger subjects. Physical activity level (PAL), derived from energy expenditure as TEE/BMR, remains quite constant with increasing weight and body mass index (4, 5). Overweight and obesity implicate a larger energy requirement for maintenance and, on average, activity-induced energy expenditure is similarly higher as well. Overweight and obesity are not associated with reduced activity-induced energy expenditure (4, 5).

Overweight and obesity limit the pattern and intensity of body movement, as shown in a comparative study with normal-weight and obese participants, both with the same activity-induced energy expenditure (6). Accelerometer-assessed body movement was >30% lower in the obese group with 40 kg more body weight and the same doubly labeled water–assessed activity-induced energy expenditure. The difference in body movement is explained by the increased cost of moving a larger body mass, resulting in slower and less frequent body movement. In the current study, exercise load was adjusted to individual differences in body mass, mainly as body fat. Consequently, participants with more body fat exercised more than those with less body fat. Another approach would be to adjust exercise load to activity level as measured at baseline.

Activity level at baseline might be a determinant of the observed difference between actual weight change and predicted weight loss from the energy balance model as depicted by Martin et al. (3). The analysis allows further identification of mechanisms for weight compensation in response to exercise. A lower activity level at baseline might allow an exercise-induced increase in energy expenditure with less intake compensation. Alternatively, a lower activity level at baseline indicates a limitation for an exercise-induced increase in energy expenditure without intake compensation.

The results of the exercise intervention by Martin et al. (3) are in line with a recent review of 23 exercise training studies, varying in duration from 2 to 64 wk, among normal-weight, overweight, or obese sedentary participants (7). An exercise-induced energy imbalance was lower than expected and showed an exponential decline to nearly 0 after ∼1 y. The suggested explanation for a

Address correspondence to KRW (e-mail: k.westerterp@maastrichtuniversity.nl).

The author declares no conflicts of interest.

First published online June 7, 2019; doi: https://doi.org/10.1093/ajcn/nqz070.

return to energy balance was a compensatory increase in energy intake. The current study confirms this supposition.

The results of the study as presented suggest that the focus of a weight-loss intervention should be on reducing energy intake rather than solely on exercise-induced energy expenditure. Weight loss induced by energy restriction will allow increasing body movement afterwards. Exercise has been shown to prevent regain after weight loss (8). Further research is needed to determine what interventions are most effective at reducing the compensatory increase in energy intake in response to an exercise-induced increase in energy expenditure.

The sole author was responsible for all aspects of this manuscript. The author declares no conflicts of interest.

References

1. Velthuis-te Wierik EJ, Westerterp KR, Van den Berg H. Effect of a moderately energy-restricted diet on energy metabolism and body composition in non-obese men. Int J Obes Relat Metab Disord 1995;19:318–24.
2. Thomas DM, Bouchard C, Church T, Slentz C, Kraus WE, Redman LM, Martin CK, Silva AM, Vossen M, Westerterp K, et al. Why do individuals not lose more weight from an exercise intervention at a defined dose? An energy balance analysis. Obes Rev 2012;13:835–47.
3. Martin CK, Johnson WD, Myers CA, Apolzan JW, Earnest CP, Thomas DM, Rood JC, Johannsen NM, Tudor-Locke C, Harris M, et al. Effect of different doses of supervised exercise on food intake, metabolism, and non-exercise physical activity: the E_MECHANIC randomized controlled trial. Am J Clin Nutr 2019;110:583–92.
4. Prentice AM, Black AE, Coward WA, Cole TJ. Energy expenditure in overweight and obese adults in affluent societies: an analysis of 319 doubly-labelled water measurements. Eur J Clin Nutr 1996;50: 93–7.
5. Westerterp KR. Physical activity as determined by age, body mass and energy balance. Eur J Appl Physiol 2015;115:1177–84.
6. Ekelund U, Aman J, Yngve A, Renman C, Westerterp K, Sjöström M. Physical activity but not energy expenditure is reduced in obese adolescents: a case-control study. Am J Clin Nutr 2002;76:935–41.
7. Westerterp KR. Exercise, energy balance and body composition. Eur J Clin Nutr 2018;72:1246–50.
8. Weinsier RL, Hunter GR, Desmond RA, Byrne NM, Zuckerman PA, Darnell BE. Free-living activity energy expenditure in women successful and unsuccessful in maintaining a normal body weight. Am J Clin Nutr 2002;75:499–504.