HOT TOPICS

bridging the gap between science and application™

The Role of EPOC in Weight Loss Programs

Ed McNeely, MS

Strength and Conditioning Coach Rowing Canada

This paper was presented as part of the NSCA Hot Topic Series.

Join the discussion online.

NSCA™ National Strength and Conditioning Association

Bridging the gap between science and application™ • www.nsca-lift.org

Is EPOC Large Enough to Cause Weight Loss?

Metabolic rate is not static; it varies throughout the day based on food intake, time of day, and physical activity. Changes in metabolic rate during the post-exercise recovery period following an exercise session have received much attention in both popular and scientific literature. The recovery period is typically biphasic with an initial recovery period lasting 10 seconds up to several minutes, and a second slow phase that may last up to several hours (13). During this time, oxygen consumption is elevated due to increased catecholamine release, increased cardiac and pulmonary function, lactate and H^+ removal, and to help restore metabolic processes to baseline levels (3). This increased oxygen consumption has been termed excess post-exercise oxygen consumption (EPOC). EPOC, and the added calories used that accompanies the post-exercise increase in metabolism, has been proposed as a potentially important factor in weight loss (14).

Factors Affecting EPOC

Program design and the manipulation of variables such as intensity and duration can have a significant effect on the outcome of a training program. Aerobic exercise intensity has long been known to have an effect on EPOC (11,12). EPOC value, which are measured in L/min of oxygen consumption or Kcal/min, have been seen to more than double when increasing intensity from 55 to 95% of $\dot{V}O_2$ max for two-minute intervals (20). Even when controlled for total energy expenditure during the exercise session, increasing exercise intensity from 50 to 75% $\dot{V}O_2$ max results in an almost doubling of EPOC (16,19). While exercise intensity is the most important contributor to EPOC, accounting for 45.5% of the systematic variance in EPOC at exercise intensities above 50% of $\dot{V}O_2$ max, there is a linear relationship between the duration of EPOC and the duration of the exercise session (2,5,6). This relationship holds true for both submaximal and supramaximal exercise.

EPOC and Supramaximal Work

The magnitude of EPOC increases with increased exercise intensity for both submaximal and supramaximal exercises (exercise at an intensity greater than $\dot{V}O_2$ max) (5). As such, it has been speculated that the increased metabolic rate associated with EPOC is one of the primary contributing factors to the success of high intensity interval training (HIIT) programs for weight loss (3,7,18,22). Compared to continuous, lower intensity activity, sprint intervals create a significantly greater increase in EPOC. Laforgia, Withers, Ship, and Gore compared 30 min of continuous running at 70% $\dot{V}O_2$ max with 20 x 1-min intervals at 105% $\dot{V}O_2$ max with a 2-min rest period (14). They found nine-hour EPOC values of 6.9 ± 3.8 and 15.0 ± 3.3 liters of O_2 for the submaximal and supramaximal treatments, respectively. Even though the interval session produced a higher EPOC, the authors suggest that since this is the equivalent in kJ of about 75 mL of orange juice and that the EPOC was of little physiological significance to the subjects' energy balance, the major contribution to weight loss would be through the energy expended during the actual exercise session (14). Even when the duration or volume of intervals are manipulated the increase in EPOC, although statistically significant, are probably not enough to play a major role in weight loss.

Tanaka, Shibuya, and Ogaki examined the EPOC of 7 x 30-s intervals with 15-s rest periods at 150% of $\dot{V}O_2$ max (21). They found that the three-hour EPOC value was 10.5 ± 2.4 L of oxygen, which amounts to approximately 50 kcal over the period of three hours or 16 kcal per hour (21). Bahr, Gronnerod, and Sejersted examined the effects of sprint volume on EPOC, having subjects perform 1, 2, or 3 x 120-s sprints at 108% of $\dot{V}O_2$ max (1). They found that higher volumes of sprint training elicit a higher EPOC, but that even at the 3 x 120-s sprint, the four-hour EPOC total was 16.3 ± 3.01 L of oxygen, or about 80 kcal of extra energy expenditure (1).

Similar results have been seen in resistance training studies. Kelleher et al. examined the differences between traditional and superset resistance exercise on post-exercise energy expenditure (9). They found that while supersetting produced a 33% greater EPOC, the energy expenditure during the 60-min recovery period amounted to only 18.96 ± 1.79 kcal. The superset exercise session required 241.23 ± 17.06 kcal (9).

While HIIT programs have gained in popularity as a tool for promoting fat or weight loss, the benefits of these programs are likely due to factors such as energy expended during training, changes in insulin sensitivity, or decreased appetite rather than EPOC, as the EPOC values are quite modest, accounting for less than 15% of total exercise and recovery energy expenditure (3,13).

Long-Term Effects of EPOC

An increased metabolic rate after exercise can occur for up to 24 hr with appropriate combinations of duration and intensity (13). Even though the amount of energy expenditure post-exercise is small, it could be argued that small increases over an extended period of time can amount to significant calories burned. In a metabolic chamber study of 24-hr energy expenditure, the authors found that EPOC amounted to 35 ± 78 kcal on a day that involved periods of slow walking, brisk walking, and jogging at 65% $\dot{V}O_2$ max, an amount that was not statistically significant (8). A more recent study found an increase of 190 kcal in metabolic rate over a 14.2-hr period following an exercise session, which is only 13.4 kcal per hour, or the equivalent of about two almonds (10). The exercise session resulted in an expenditure of 519 kcal.

There is also no difference in the 24-hr rate of fat use following exercise, regardless of intensity (15,17,23). Warren, Howden, Williams, Fell, and Johnson found after their comparisons of long and short duration exercise, high versus low intensity exercise and continuous versus interval exercise, concluded that even though there was an increase in fat oxidation during the recovery period following long duration and high-intensity interventions, the amount of fat oxidized after exercise may be inconsequential compared with what was oxidized during the exercise bout (24). This suggests that EPOC is not a primary contributor to the energy cost of exercise and that it does not alter substrate use enough to be of consequence in a weight loss program.

Conclusion

Long-term adherence to exercise or physical activity is key for weight loss and maintenance of weight loss. The duration or intensity of activity required to elicit a prolonged EPOC are probably not well tolerated by obese or overweight untrained people (13). This is particularly true of higher intensity exercise, where even modest increases in intensity over a comfortable self-selected pace greatly diminish exercise enjoyment and adherence (4). Many popular infomercials and programs base their weight loss and fat burning claims on increased EPOC, yet EPOC values are modest compared to the actual energy expenditure from the exercise session itself, accounting for only 6 – 15% of the total energy cost (13). There is no evidence that EPOC alone can significantly contribute to weight loss.

References

1. Bahr, R., Grønnerød, O, and Sejersted, O. Effect of supramaximal exercise on excess post-exercise oxygen consumption. *Medicine and Science in Sports and Exercise,* 24: 66–71, 1992.

2. Bahr, R, Ingnes, O, Vaage, O, Sejersted, O, and Newsholme, E. Effect of duration of exercise on excess post-exercise O_2 consumption. *J Appl Physiol* 62: 485–490, 1987.

3. Boutcher, S. High-intensity intermittent exercise and fat loss. *Journal of Obesity* 2011: 1–10, 2011.

4. Ekkekakis, P, Parfitt, G, and Petruzzello, S. The pleasure and displeasure people feel when they exercise at different intensities decennial update and progress towards a tripartite rationale for exercise intensity prescription. *Sports Med* 41 (8): 641–671, 2011.

5. Gore, C, and Withers, R. Effect of exercise intensity and duration on post-exercise metabolism *J Appl Physiol* 68: 2362–2368, 1990.

6. Gore, C, and Withers, R. Effect of exercise intensity and duration on the oxygen deficit and post-exercise oxygen consumption. *Eur J Appl Physiol* 60: 169–174, 1990.

7. Irving, B, Davis, C, Brock, D, Weltman, J, Barrett, E, Gaesser, G, and Weltman, A. Effect of exercise training intensity on abdominal visceral fat and body composition. *Medicine and Science in Sports and Exercise* 40(11): 1863–1872, 2008.

8. Kazunori, O, Tanaka, S, Ishikawa-Takata, K, and Tabata, I. Twenty-four hour analysis of elevated energy expenditure after physical activity in a metabolic chamber: Models of daily total energy expenditure. *American Journal of Clinical Nutrition* 87: 1268–1276, 2008.

9. Kelleher, A, Hackney, K, Fairchild, T, Keslacy, S, and Ploutz-Snyder, L. The metabolic costs of reciprocal supersets vs. traditional resistance exercise in young recreationally active adults. *J Strength Cond Res* 24(4): 1043–1051, 2010.

10. Knab, A, Shanely, R, Corbin, K, Jin Sha, W, and Nieman, D. A 45-min vigorous exercise bout increases metabolic rate for 14 hours. *Medicine and Science in Sports and Exercise* 43(9): 1643–1648, 2011.

11. Knuttgen, H. Oxygen debt, lactate, pyruvate, and excess lactate after muscular work. *Journal of Applied Physiology* 17: 639 – 644, 1962.

12. Knuttgen, H. Oxygen debt after submaximal physical exercise. *Journal of Applied Physiology* 29: 651 – 657, 1970.

13. Laforgia, J, Withers, R, and Gore, C. Effects of exercise intensity and duration on the excess post-exercise oxygen consumption. *Journal of Sports Sciences* 24(12): 1247–1264, 2006.

14. Laforgia, J, Withers, R, Shipp, N, and Gore, C. Comparison of energy expenditure elevations after submaximal and supramaximal running. *J Appl Physiol* 82(2): 661–666, 1997.

15. Melanson, E, Sharp, T, Seagle, H, Horton, T, Donahoo, W, Grunwald, G, Hamilton, J, and Hill, J. Effect exercise intensity on 24-hr energy expenditure and nutrient oxidation. *J Appl Physiol* 92: 1045–1052, 2002.

16. Phelain, J, Reinke, E, Harris, M, and Melby, C. Post-exercise energy expenditure and substrate oxidation in young women resulting from exercise bouts of different intensity. *Journal of the American College of Nutrition* 16: 140–146, 1997.

17. Saris, W, and Schrauwen, P. Substrate oxidation differences between high- and low-intensity exercise are compensated over 24 hours in obese men. *International Journal of Obesity* 28: 759–765, 2004.

18. Schoenfeld, B, and Dawes, J. High-intensity interval training: Applications for general fitness training. *Strength and Conditioning Journal* 31(6): 44–46, 2008.

19. Sedlock, D, Fissinger, J, and Melby, C. Effect of exercise intensity and duration on post-exercise energy expenditure. *Medicine and Science in Sports and Exercise* 21: 662–666, 1989.

20. Segal, S, and Brooks, G. Effects of glycogen depletion and work load on post-exercise oxygen consumption and blood lactate. *Journal of Applied Physiology* 47: 514–521, 1979.

21. Tanaka, J, Shibuya, K, and Ogaki, T. The comparison of post-exercise oxygen consumption between two difference supramaximal exercises. *Japanese Journal of Physical Fitness and Sports Medicine* 54(2): 133–142, 2005.

22. Tremblay, A, Simoneau, J, and Bouchard, C. Impact of exercise intensity on body fatness and skeletal muscle metabolism. *Metabolism* 43(7): 814–818, 1994.

23. Treuth, M, Hunter, G, and Williams, M. Effects of exercise intensity on 24-hr energy expenditure and substrate oxidation. *Medicine and Science in Sports and Exercise* 28(9): 1138–1143, 1996.

24. Warren, A, Howden, E, Williams, A, Fell, J, and Johnson, N. Post-exercise fat oxidation: Effect of exercise duration, intensity, and modality. *Int J Sport Nutr Exer Metab* 19(6):607–623, 2009.