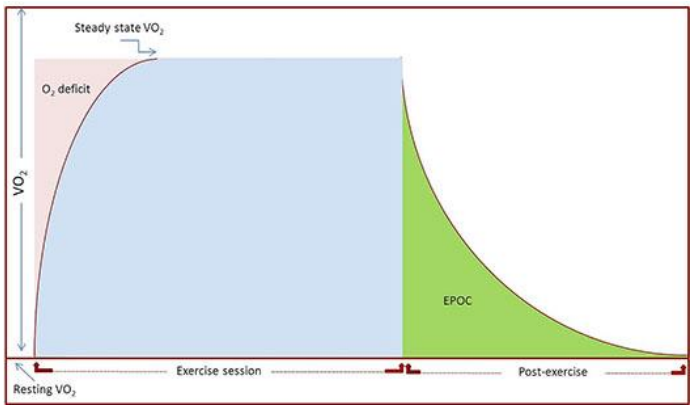
Myth: *Morning workouts increase metabolism better than workouts performed later in the day.*

This myth has two components: (1) that exercise performed in the morning increases metabolism (a phenomenon known as excess post-exercise oxygen consumption or EPOC) that persists throughout the day and will subsequently result in more burned fat and ultimately lead to weight loss. And (2) that exercising on an empty stomach burns more fat compared to exercising after breakfast. Therefore, working out before breakfast will increase weight loss.

When a person stops exercising, their oxygen consumption (VO_2) returns to baseline levels, first demonstrating an initial, fast or rapid component followed by a slow component (see Figure 2). In 1923, Hill and Lupton proposed that the elevated VO_2 post-exercise was an oxygen debt. This interpretation was based on the understanding that there would be an oxygen cost involved with replenishing creatine phosphate and the oxidation of lactate produced from glycolysis during the oxygen deficit. More recently, it has been acknowledged that additional factors beyond those recognized by Hill and Lupton contribute to this elevated post-exercise metabolism. EPOC is believed to be the product of widespread homeostatic changes, and repayment of the oxygen deficit contributes only fractionally to this event. Accordingly, in 1984 the term EPOC was coined (Gaesser and Brooks, 1984) to better represent the multiple factors that contribute to elevated post-exercise metabolism.

Figure 2. Conceptual Schematic of Oxygen Deficit and Excess Post-exercise Oxygen Consumption (EPOC)



EPOC has two phases: rapid and slow. The duration of the rapid phase generally lasts two to three minutes, but may extend out toward 30 to 60 minutes, and primarily involves:

- Removal and reconversion (oxidation) of lactate

The slow phase may last 24 hours or longer, depending on the magnitude of tissue stimulation (repair and adaptation) and the amount of recovery needed, and includes:

- Continued thermoregulation
- Increased heart rate and ventilatory demand for anabolic processes
- Increased metabolism due to tissue repair and synthesis, and glycogen synthesis
- Residual effects of circulating sympathetic hormones (e.g., catecholamines)
- Removing an accumulated carbon dioxide remaining within body tissues

Exercise intensity and exercise duration contribute most notably to the magnitude of EPOC. Overall, it has been concluded that exercise intensity has a greater role in EPOC variability (~46% vs. ~9%) compared to exercise duration. Preliminary research findings increased interest in the possibility that EPOC could play an important role in weight loss.

Does excess post-exercise oxygen consumption (EPOC) play a significant role in weight loss?

Early researchers whose work focused on EPOC seemed to think this scenario might be a real possibility. However, more recent research since the seminal studies of the early twentieth century has cast some doubt on this likelihood. LaForgia and colleagues (2006) recently reviewed much of the research done on the topic of EPOC and concluded that the earlier optimism concerning a critical role for EPOC in weight loss is largely unsubstantiated.

The studies that have tended to elicit a substantial EPOC (e.g., >100 kcal) generally have consisted of regimens that are either high in intensity, long in duration, or both, raising concerns that there would be any effect in non-athletic populations. This particular issue can be underscored in a recent study by Knab and colleagues (2011), which required 10 male participants to complete two separate 24-hour visits (one exercise and one rest day) in a metabolic chamber. Careful energy balance was maintained for each visit. On the exercise day, participants cycled for 45 minutes at an intensity of 73% of maximal oxygen uptake (VO_2max). The exercise bout itself resulted in an energy expenditure of 519 kcal. Energy expenditure remained elevated above resting levels for 14 hours postexercise, with the total EPOC reported to be an impressive 190 kcal. The authors concluded that the magnitude and duration of EPOC may have important implications for weight loss and management. However, it must be noted that the intensity of exercise performed by participants in this study was *vigorous*. For example, an exercise intensity of 70 to 75% VO_2max generally corresponds to the lactate threshold level of an endurance-trained individual. Accordingly, it follows that individuals exercising to lose weight are probably unlikely to be capable of regularly performing the types of exercise workouts that research has found to be required for stimulating a meaningful EPOC.

In conclusion, it has been purported that the EPOC generates approximately 7% of the total energy expenditure of exercise. While the EPOC may be limited in the contribution it can make to most individuals in their weight-loss efforts, there may be a role for it in terms of energy balance (i.e., weight maintenance). It has been suggested that the cumulative effect of the EPOC over a one-year period may be the energy expenditure equivalent of 3 pounds of adipose tissue.

Does exercise before breakfast result in greater fat burning and weight loss?

A quick Google search reveals claims that exercise in the morning before breakfast will increase fat oxidation (i.e., fat burning) by threefold, compared to the magnitude of fat oxidation with exercise in the morning following a breakfast meal. While this would be ideal for those individuals with weight-loss or weight-management exercise goals, the scientific evidence clearly shows much more is needed to facilitate weight loss than simply exercising first thing in the morning before breakfast. It has been well-known for quite some time that the proportion of fat burned during an exercise session is higher when performed prior to eating (vs. after a meal). For example, Horowitz et al. (1997) demonstrated that during a one-hour session of moderate-intensity exercise, 40% of energy expenditure was from fat oxidation if the exerciser was in a fasting state. Exercising after consuming a carbohydrate breakfast resulted in just 20% of energy expenditure from fat oxidation. However, regardless of the sequence of exercise and meal (i.e., breakfast-exercise or exercise-breakfast) the overall energy expenditure from the exercise session was the same.

Research has clearly shown that total energy expenditure is equivalent across different meal and exercise orders (Farah and Gill, 2012; Horowitz et al., 1997); as such, any long-term weight loss attained would be comparable. Therefore, the decision to eat or not eat before exercise in the morning should be driven by personal preference rather than any false hopes that greater weight loss will be achieved by exercising before breakfast. Instead, consider urging clients who want to lose weight to simply extend their exercise sessions by 10 to 15 minutes each day to expend more calories.

The Bottom Line: *Under ordinary circumstances, EPOC contributes minimally to overall energy expenditure. EPOC does not play a significant role in weight loss, nor is overall energy expenditure affected by exercising on an empty stomach.*