FEEL THE AFTERBURN

Professor David Cameron-Smith

Understanding how high-intensity exercise affects your body's metabolism will help you maximize the effects during AND after your workout.

Feeling hot and sweaty hours after a hard session in the gym? Feeling energized and alert? You can thank "excess post-exercise oxygen consumption" (EPOC) for boosting your metabolic rate and burning more calories for hours afterwards.

Ever wondered exactly why this works?

There are many ways to maximize your "burn" in a given time period. Elite athletes can finely tune their minds and bodies to go to the point of almost complete exhaustion in the last few minutes of a race or event. But this takes years of training and practice. For the rest of us, there are exercise strategies such as high-intensity interval training (HIIT). By repeating short bursts of intense exercise with a short recovery you can push yourself to your own personal limits.

Like all exercise, HIIT uses muscles, lots of muscles. Muscles contracting provide the power for each and every movement of the body. But each contraction needs energy, lots of energy. The more resistance (weights), the higher the number of reps (muscle contractions), and the time spent exercising, all vary the total amount of energy needed to sustain physical movement.

So first of all, it helps to know what your muscles are doing when you hit the gym.

Stage 1: To get muscles started, there is a short-term explosive energy source know as creatine phosphate. This is found in your muscles in very limited supplies, so only lasts for a few short seconds.

Stage 2: After that you need a more sustained energy source. Most of this comes from the breakdown of glycogen, the major store of carbohydrate energy in the muscles. Glycogen starts by liberating some energy without oxygen, producing lactic acid. Again this can only fuel your muscles for a few minutes.

Stage 3: Longer term energy needs oxygen. A small drop in blood oxygen levels triggers a complex set of responses that has you breathing hard and your heart pumping faster. The new oxygen in your blood passes into the muscles within the first few minutes of exercise and allows you to start generating energy by a process known as aerobic metabolism. The major fuel is still glycogen, but now you are able to use the oxygen to generate water and carbon dioxide (CO_2). This allows you to keep exercising, without making more lactic acid.

As your heart rate increases, fat is slowly released from the body's fat stores. Within 10 to 15 minutes the release of fat reaches its peak. This fat circulates in the blood and is taken up by the muscles. Inside the muscles, both glycogen and fat are used as the fuel mix to sustain the energy need to keep the muscles contracting.

Explosive and high-intensity exercise causes a rapid rise in lactic acid. At the same time, muscles begin to "burn" and fatigue. Lactic acid is produced from glycogen (and glucose) when there is not enough oxygen available. It's a small molecule released from the muscles and eventually converted back into glucose, then glycogen, by the liver. Surprisingly, and contrary to a long-held belief, it seems lactic acid is not the cause of the muscular burning sensation of intense exercise. Studies have even shown lactic acid may be beneficial in helping muscles continue to contract. The chemical cause of the burning sensation remains unknown, but sports scientists continue to search for it.

Metabolism boost in recovery

Once you stop exercising, the process of recovery starts immediately. You might notice you often sweat, and keep sweating, sometimes for hours after you finish exercising. Sweating is necessary to keep you cool as your muscles, liver, heart and immune system begin the complex and energy-demanding process of recovering.

This persistent increase in metabolism is where excess post-exercise oxygen consumption (EPOC) comes into play.

The extra energy is used in many recovery processes. One major requirement is to remove most of the lactic acid (as a chemical by-product, it needs to be cleared and converted into a useful energy source). The synthesis pathway to turn lactic acid back to glucose (then glycogen) costs energy and is an important function of the liver.

At the same time, muscles need to repair and adapt. This requires protein breakdown and synthesis. Again, this requires energy. Nerves need to make fresh neurotransmitters, and hormones used during exercise need to be freshly synthesised. It's an energetically expensive process.

There is a direct relationship between the amount of energy used during an exercise session and the amount of EPOC. Going hard in a HIIT workout will require more EPOC than taking it easy. By working your whole body (legs, arms and core), you can cycle through many of the major muscle groups, leaving each one in need of recovery and EPOC.

EPOC can generally be measured for up to three hours. The actual amount of calories used to recover, as a percentage of the total energy used during an exercise session, has been the subject of intense study. Somewhere between six and 15 percent seems to be the mainstream consensus, although it may be higher for elite athletes performing extreme physical activity.

It's unlikely EPOC is the only beneficial after-effect of exercise, and the benefits of HIIT metabolically are still poorly understood. The question of why HIIT seems to burn more fat than other forms of exercise definitely warrants more study. Also, EPOC varies between different people and scientists cannot yet pinpoint the reasons for this variation (although it seems not to be influenced by fitness, fatness or gender).

Make your EPOC epic

Like the workout itself, good recovery technique can improve performance and boost the benefits of training. Good recovery starts with hydration and nutrition. Ensuring you are adequately hydrated is vital to speed the removal of lactic acid and allow glycogen stores to be regenerated. High-quality carbohydrates and proteins should feature on all recovery menus. This should all be followed up with sleep. A long restful night does wonders to help muscles recover for another high energy day.

If you're suffering from muscle soreness post workout, there are some simple tips to get your through, but whatever you do, don't follow in the footsteps of some pro athletes – ice baths are a no go!

And remember, EPOC is one part of the important processes of recovery, so be realistic. It offers a nice bonus, but it does not mean your midriff will magically sprout abs, or that you can enjoy a completely guilt-free chocolate bar.

Professor David Cameron-Smith is a regular contributor to Fit Planet. A transplanted Australian, he obtained a PhD in nutritional biochemistry from Deakin University, and undertook postdoctoral training at the Royal Prince Alfred Hospital, Sydney. His research interests include the importance of nutrition in the maintenance of optimal health in an ageing population, and the impact of nutrition in regulating the function of muscles.

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