Demystifying VO2 max

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“His VO2 is 75, man, what a beast!”

In the world of endurance sports, one of the most common buzzwords is VO2max, often referred to simply as “VO2”. VO2max serves as a physiological benchmark that many endurance athletes- from amateur to pro- hold in high regard. It's a measure commonly used to determine training zones, and stands as a bragging point among competitive friends. Perhaps most often, it is used as a piece of impressive-sounding jargon we pull out when hoping to sound “legit.”

Measuring VO2max can be a powerful training tool and performance predictor. But do we really understand what it is? Or how we can influence it? Or perhaps most importantly, how knowing our own VO2max, or not, can help us make gains in our training and performance?

Okay, first a quick breakdown of what the term means. V stands for Volume, O2 for Oxygen. Said textbook-style, VO2max refers to the maximum volume of oxygen a body can consume. This is not the same as the amount of oxygen you can breathe in. The cardiovascular system works together to produce aerobic energy, which powers most of our daily activities, including almost all of our endurance pursuits. When our energy demands are such that oxygen is being delivered through our body and used to produce energy at 100% capacity, we have reached our VO2max.

More oxygen being used to create more energy? Yes, please! If I keep training, and train harder, and do more intervals, will I increase my VO2max? The answer is, of course, yes, but the limitations may be greater than you expect.

For untrained, inactive individuals beginning an aerobic training plan with appropriate amounts of high-intensity training, the estimated amount your VO2max may increase ranges from 5-20%. That could be huge! But what about for folks who are already highly trained athletes?

Consensus has not been reached in the exercise science community regarding the extent to which genetics determines the upper limit of one’s VO2max. But there is reason to believe that for long-term endurance athletes who incorporate high-intensity training, continuing gains in VO2max are limited.

Okay, okay, so does VO2max matter, if we all might have a genetic cap anyway? It is true that a high VO2max often corresponds to high-level performances for endurance athletes. But is it the end-all, be-all? Thankfully, no. Once we have reached the point where our VO2max is no longer increasing or increasing only very minimally, we have a couple options.

One of the benefits of continuing to train at or near VO2max is that we can increase the amount of time we can stay at VO2max. An untrained individual may only be able to exercise at VO2max exertion for 4-5 minutes. A trained athlete can double that! It's also worth noting that the genetic cap on VO2max may decrease by approximately 1% per year for inactive folks over the age of 25 years. That's fitness potential you can't get back, so better not to lose it in the first place!

Beyond that, there is still much we can do to improve our endurance performance, and for that, we need to add two new buzzwords to our vocabulary: economy and lactate threshold.

Economy refers to the efficiency of energy usage, which is influenced by everything from body structure to technique to muscle fiber composition. Two skiers with the same VO2max skiing at the same speed will sustain that pace for different amounts of time if their economy differs. This is the vehicle-fuel-efficiency equivalent for athletes.

Lactate threshold refers to the point at which the body can no longer clear blood lactate as fast as the lactate is being produced. As athletes, we want this point to be at the highest possible percentage of our VO2max or max heart rate. Said simply, the higher the lactate threshold, the harder we can go, for longer, with less blood lactate accumulation. This is especially critical for any sub-maximal, high intensity effort, meaning any high-intensity effort at which we are utilizing less than 100% of our VO2max. This means just about any race 5k or longer, for xc skiers and runners.

Knowing your VO2max or lactate threshold can come in useful, as you can set training zones that correspond to it, based on the heart rate that corresponds to these points. Unfortunately, the lab testing required to learn our exact VO2max, lactate threshold, or even heart rate are expensive, and not readily available to many recreationally competitive athletes. Luckily, there are other ways to effectively gauge your training effort.

Have you ever tried to run a short race, 3k or so, or attempted 8-10 minute intervals on the bike or on skis, and felt great for about three-quarters of the interval before hitting the wall and crawling the rest of the way? You just exceeded your VO2max, and this is a critical experiment.

To zero in on your VO2max, hit the track for a 2-3k running time trial, and pace so that you are nearing collapse at the end of the TT, but not before. This effort should put you at your VO2max. You won't get a specific measure of the volume of oxygen you are consuming, but you'll be able to measure the heart rate that corresponds. To find lactate threshold, do the same, but for a 30-60 minute time trial, not a 3k. You average heart rate over the final 20 minutes roughly corresponds to your lactate threshold.

With practice, you will come to recognize these paces and exertions when performed off the track, in other sports, and for varying duration.

We've concluded that VO2max does matter, but that there are other factors just as important to our fitness and potential for endurance success. The last big question is, what should we be doing in training to maximize these components?

Improvements in economy result mainly from improvements in technique. Sport-specific exercises targeting strength, balance and proprioception are key in making your movements more energy-efficient and teaching your body over time to recruit fewer muscle fibers or a wider variety of muscle fibers to get the same job done. Repeating these motions during aerobic training reinforces the neural pathways that will make efficient technique more natural. Consult your coach for the best exercises related to your target sport. It's these seemingly small details that fill in the gaps and allow athletes to reach higher levels than they can attain from focusing on aerobic training alone.

And by all means, the next time your friend and Strava competitor asks you what your VO2max is, show off your newly acquired expertise, and forward them this article.

Click here for a deeper dive on how to use lactate threshold and VO2max to set training zones, and here for live and recorded classes to improve your sport-specific economy.