

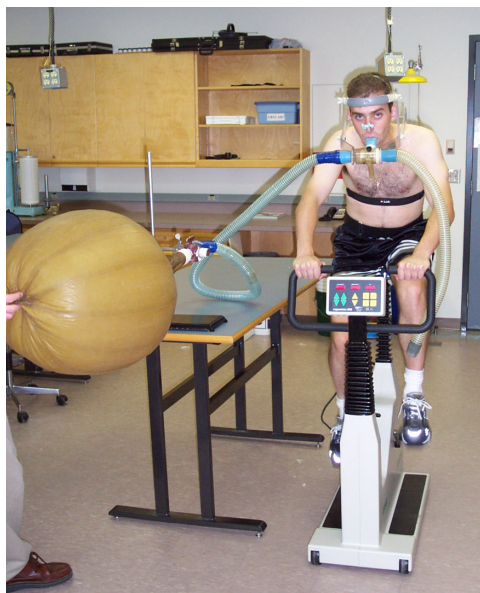
the **CrossFit** JOURNAL ARTICLES

VO₂ max: Not the gold standard?

Tony Leyland

In my article on exercise science in last month's *CFJ*, I highlighted the difficulty of scientifically determining optimal training methods. Most often, it is coaches working hands-on using a trial-and-error methodology that actually push the science ahead. Eventually, scientists notice that most coaches are doing a particular thing with success and then design a study to determine why it is effective.

However, coaches' practical, field-tested insights and clinical experience don't necessarily translate into the realm of scientific testing and study design. I was recently contacted by a coach working with the Canadian National wrestling team. One of the wrestlers was competing in the 62 kg class, but the coaches thought that if he could drop down a weight class he would be able to medal at the Olympics. They wanted him to drop from 62 to 55 kg, but realized that he was, understandably, concerned about how he would perform after dropping over 11 percent of his body weight. So they wanted him to get a few weight-cutting practice trials in before he actually had to do it in competition. He was to act like it was a wrestling meet and cut down for weigh-in at 6 p.m., rehydrate overnight, and then go through some physiological fitness tests in the morning. They wanted to see how his body handled the cut-down and hopefully



give him confidence that he could maintain fitness and perform normally while dropping that much weight. That is where I come in: they wanted me to conduct the morning fitness tests at my university.

The tests they wanted to use were a VO₂ max test (aerobic capacity measured while working to exhaustion on a treadmill or stationary bike) and a Wingate test (a bike test designed to assess both anaerobic pathways). Not a good idea in my book, as those tests do not mirror the performance required by the wrestler in his sport. They would not very effectively test the

wrestler's ability to perform at the tasks required for his event—which was the whole point of the experiment.

So why did they suggest tests that are clearly not the best to assess the athlete's performance? I think it is because we all have a tendency to work with standards that are universally accepted. (Maybe this is why CrossFit is viewed with suspicion by some: it doesn't put much stock in the standard tests for evaluating fitness. How can people compare CrossFit's methods and results with others? How can they evaluate and quantify the fitness it produces? Nobody else uses tests called "Fran," "Linda," etc., to measure progress. The unfamiliar is always suspect.)

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The VO₂ max test on a treadmill or stationary bike measuring gas exchange is considered the “gold standard” of laboratory tests to assess VO₂ max (the conventional measure of aerobic fitness), which is why the wrestling coaches wanted to use it for their athlete. But does it transfer to a wrestling match? Olympic freestyle wrestling bouts consist of three rounds of two minutes each. Wrestling is an exceptionally demanding sport using multiple lines of action (pushes, pulls, and static grips with both the arms and legs) and demanding both cardiovascular endurance and muscular stamina, so why not assess all these abilities in one test? You could do three two-minute rounds of one minute of thrusters and then one minute of pull-ups (like a Fran), or maybe three sets of two minutes of clean and jerks (like a Grace). This would tax the cardiovascular system as well as muscular strength, power, and endurance, and the athlete’s scores for each would measure changes in his fitness. You could also develop a continuous six-minute test similar to Fight Gone Bad that would cover many of these aspects and be indicative of the wrestler’s VO₂ max. To break the testing into a VO₂ max test (which would quantify how well he pumps blood to his leg muscles and the stamina of those muscles) and a Wingate test (which is a 30-second maximal-output bike test to assess phosphagen and glycolytic energy pathways) doesn’t adequately test the demands of the sport.

If you wanted to assess other energy systems separately, you could test the phosphagen system with a maximal sprint (say, 60 meters) or, if you wanted a very short-duration power test, you could use a vertical jump or clean and jerk. As for the glycolytic system...well, I think any self-respecting CrossFitter could think of something extremely intense using multiple muscle groups that you could sustain for only 90 seconds before collapsing in a heap on the floor.

When I discussed these issues with the wrestling coach, I got a very positive response. It made a lot of sense to him (as did the thought that he wouldn’t have to pay for expensive tests). Also he now has complete control on the timing of the test and he can repeat it more frequently than relying on my university to conduct the test.

Athletes are competitive by nature and love to challenge themselves, so I frequently get calls asking me to measure VO₂ max and body fat percentages. As with the wrestling coach, I usually tell people to save their

money. There is no need for expensive tests to measure these variables and there is good science to prove you shouldn’t. I’ll talk about percent body fat at another time but this month I want to focus on VO₂ max.

VO₂ max is a measure of your body’s ability to take up and utilize oxygen. VO₂ max is measured by determining the amount of oxygen in the inspired air and the expired air. The difference is the amount of oxygen used by the body. This is usually done by analyzing inspired and expired gases while having the subject run on a treadmill with ever-increasing speed and/or incline until exhaustion.

At sea level, the most important physiological factors that determine VO₂ max in a given person are:

1. the ability of the heart to pump blood
2. the oxygen-carrying capacity of the blood (hemoglobin content)
3. the ability of the working muscles to accept a large blood supply (amount of capillarization within a muscle)
4. the ability of the muscle cells to extract oxygen from the capillary blood and use it to produce energy (number of mitochondria and aerobic enzymes)

Delivery of oxygen to the blood via the lungs is important, but at sea level it is not a limiting factor. Most people can get adequate amounts of air into the lungs. The last two points in the list above are really why I thought that a running or biking VO₂ max test for the wrestler wasn’t a good idea. A runner may have a large stroke volume (amount of blood pumped by the heart per beat, #1 above) but if you put him on a bike, his VO₂ max measurement will come out lower than when he is tested on a treadmill. Similarly, a cyclist will not do as well on a treadmill. This is because of the difference between systemic adaptations to the training impulse and peripheral adaptations. Both runner and cyclist have large stroke volumes but the runner’s quads cannot accept as large a volume of blood and extract oxygen as efficiently as the cyclist’s quads. Likewise, the hamstrings and especially the ankle extensors (gastrocnemius and soleus) of the runner are able to receive larger amounts of blood and extract oxygen more effectively than those of the cyclist. So VO₂ max is specific to what you are doing. In truth, there is no single, movement-agnostic

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VO₂ max. There is a “running VO₂ max,” a “cycling VO₂ max,” a “thruster VO₂ max,” etc.

The highest VO₂ maximums recorded are for cross-country skiers, as they utilize the most muscle tissue in their event. I wonder what the VO₂ max of an elite CrossFit athlete would be while doing thrusters. You could have a series of barbells set up with different weights and increase the weight being thrusted every three minutes until the athlete couldn't sustain that power output (similar to increasing the speed and/or inclination of the treadmill). Not an easy test to administer, but it is interesting to consider. The VO₂ max recorded would undoubtedly be a very high value.

Another important point to keep in mind about measuring athletic performance is that there is daily variation in our physiological parameters. If you measure your heart rate upon waking each morning, it will vary from day to day. So will the maximum heart rate you can achieve on any given day. It has been reported that there can be up to an 8% variation in the VO₂ max due to this natural daily variation (we are not robots responding to stimuli exactly the same way every time). So why pay for one VO₂ max test when you are trying to determine change? You need at least two measures. But even two tests aren't ideal, as the difference is likely to be affected by daily variation and other factors such as hydration, nutrition, and environmental temperature, rather than changed VO₂ max per se.

So the best thing is to have simple tests such as a 5k run that you can easily repeat six or seven or more times a year. If your time improves consistently, you know your running VO₂ max has improved. Over the year and multiple tests, variation due to factors other than improved running VO₂ will cancel out. This is why it is so easy to test yourself while following CrossFit: the benchmark workouts become the standardized tests.

You might not hit a PR every time, but you will see which direction you are heading in and how steep the trend curve is.

If you actually want a specific numeric measure of your VO₂ max (in ml of oxygen utilized per kg of body weight per minute), you can run a 1.5-mile test (6 laps of a standard 400-meter track) or run for as far as you can on the track in 12 minutes. The links below will take you to calculators that will estimate your VO₂ max based on your results:

- <http://www.exrx.net/Calculators/OneAndHalf.html>
- <http://www.exrx.net/Calculators/MinuteRun.html>

Sure, there are errors in these predictions compared to a test that actually measures the O₂ content in your inspired and expired breath (the gold standard of testing, remember), but they are free and repeatable whenever you can find a 400-meter track and a stopwatch.

Not a runner? Test yourself at 150 wall-ball shots for time. If over the year your time decreases, your VO₂ max for wall ball has improved. And that is good to know. However, you must be able to sustain any movement you want to use to test VO₂ max continuously for about 6 minutes or more. If wall ball with a 20-pound ball overloads your arms so that you have to break sets and rest, it wouldn't be the best choice for evaluating VO₂ max. Using a lighter ball (and maybe even adding to the number of shots) so that you can work continuously for 6 minutes or more would make it work as a test of your wall-ball VO₂ max. So for anyone thinking of getting an expensive fitness test done, don't bother. Spend your money on useful things, like the *CrossFit Journal* or another medicine ball or another set of rings so your friends can join you in actually improving your fitness rather than worrying about how to quantify it.



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