

Level 4: Interval Training

By Jack Daniels, Ph.D.

Of all workout types, interval training takes on the greatest number of possible meanings, and it wouldn't be appropriate for me to try to accommodate them all, so I have chosen to define exactly what I mean by interval (**I**) training, or " $\dot{V}O_2\text{max I}$ training," as I often refer to it. I use the latter term because optimizing the upper limit of aerobic energy production ($\dot{V}O_2\text{max}$) is, in my view, the greatest benefit of **I** training, at least when performed as described in this chapter, where I will identify and explain my reasoning behind 1) the ideal intensity for **I** training; 2) the optimal duration of individual workouts and recovery periods in between; and 3) how much total **I** pace running (the "quality portion") is desirable per workout.

The purpose of an interval session is to accumulate a significant amount of time running at $\dot{V}O_2\text{max}$, but note that a little less than 100 percent of maximum can still produce substantial conditioning benefits, so I have identified the "**I** zone" as 95 to 100 percent of $\dot{V}O_2\text{max}$ (98-100% maximum heart rate). When running at proper **I** pace – sometimes referred to as $v\dot{V}O_2\text{max}$ – your body takes about 2 minutes to reach the point where it's operating at maximum oxygen consumption, so if you do four 5-minute intervals at this pace, and it takes 2 minutes to reach max in each run, then of your 20 minutes hard running you've accumulated 12 minutes at $\dot{V}O_2\text{max}$. In fact, you're virtually guaranteed 12 minutes at max even if you recover completely between each 5-minute workout.

On the other hand, if you do seven 3-minute runs at interval pace, and it takes 2 minutes to reach max for each run, then you accumulate only 7 minutes at $\dot{V}O_2\text{max}$ for the 21 minutes you've spent running hard. Going a step further, if you do twenty 1-minute runs at the same pace and recover fully between each of them, you would accumulate zero time at $\dot{V}O_2\text{max}$. Again, it takes 2 minutes to reach max, and running hard for only one minute at a time won't allow that, therefore, in order to accumulate any time at max, you must reduce the time between workouts so that you don't fully recover, and $\dot{V}O_2$ uptake is at a higher starting level for the next run. After several intervals you might reach $\dot{V}O_2\text{max}$ in a matter of only 30 seconds or so, and accumulate ~10 minutes at $\dot{V}O_2\text{max}$ over the course of twenty 1-minute runs. It becomes clear why short workouts must be accompanied by even shorter recovery intervals in order to work at $\dot{V}O_2\text{max}$, and why the longer (3-5 minute) workouts are the ideal for stressing $\dot{V}O_2\text{max}$.

So the duration of workouts and the recovery periods that follow is important, but intensity is critical during interval training (in fact, it's the key when stressing any physiological system), since you attain $\dot{V}O_2\text{max}$ only when running within a fairly narrow range, with the ideal being the least stressful intensity that makes the cardiovascular system work as hard as it can. The problem with running faster than the slowest pace that elicits $\dot{V}O_2\text{max}$ is that you can't work any harder aerobically, which means you're doing the extra work at the expense of anaerobic metabolism, and lactic acidosis begins to limit you as the workout progresses. The higher intensity, however, doesn't improve the targeted physiological systems any more than the lowest intensity that elicits $\dot{V}O_2\text{max}$. As a result, the workout becomes more stressful, but the benefits are no greater – in fact, they may be lessened. If, for example, going too hard in early workouts results in subsequent intervals actually being slower than required to elicit $\dot{V}O_2\text{max}$, then the latter bouts won't be intense enough to be effective. Nothing is more frustrating than to work really hard in a training session and not get the desired (and deserved) benefits.

It would be easy to say simply that all workouts in an **I** session should be “hard,” and let it go at that. Certainly, if some surges within a fartlek session are meant to elicit $\dot{V}O_{2max}$, then they should be hard, but when it’s possible to monitor and regulate training pace, there’s no need to run any faster than the minimum pace that produces $\dot{V}O_{2max}$.

It should be noted that, under some conditions, the speed (or pace) of running does not always reflect intensity with perfect consistency. As an example, if a speed of 300 meters per minute (5:20 mile pace) is associated with a runner’s $\dot{V}O_{2max}$, they certainly wouldn’t need to go that fast to reach $\dot{V}O_{2max}$ when running uphill, into a wind, or at altitude, so under such conditions, some adjustment of pace becomes necessary (see the “Facing the Wind” sidebar article below).

Similar caution should be observed when heart rate (HR) is used to gauge intensity during **I** workouts, as it sometimes is, since maximum heart rate is associated with $\dot{V}O_{2max}$. For instance, if $\dot{V}O_{2max}$ corresponds to a pace of 5:00 per mile, what HR will be associated with a 4:50 mile pace (or anything faster than 5:00, for that matter)? Maximum, of course, so it’s quite common to run faster than necessary if you’re looking at HRmax as an indicator of $\dot{V}O_{2max}$.

Interval Duration

Interval intensity is demanding for anyone, so workouts in an **I** session are typically no more than five minutes each, and experience (as well as research) tells me three to five minutes is optimal. Longer than that causes too much lactic acid accumulation, possibly causing you to cut the workout short or run the last few intervals too slowly (which doesn’t accomplish the purpose of the workout).

That said, it is possible to use intervals as short as 30 seconds (as discussed below), which is considered the lower boundary of workout duration for $\dot{V}O_{2max}$ **I** workouts, but you must also shorten recovery time in order to reach $\dot{V}O_{2max}$ within each workout. Varying workout duration can add interest to and help minimize the mental stress of interval training; just as with all other types of training, a balance must be struck between accomplishing the physiological and biomechanical goals of the workout and optimizing the psychological factors.

With a 5-minute limit for the recommended maximum duration of individual workouts, you shouldn’t use 1,600-meter workouts if your VDOT is less than 66, since proper **I** pace would require more than five minutes to complete a mile (see pp. 52-55). For people who fall into this category, workouts of 1,200 meters or less are the longest distances that should be used, and typically, I prescribe 1,200-1,600 meter intervals for men, while a distance of 1,000-1,200 meters works best for women. Stay under the 5-minute limit whenever possible.

Another option is to run strictly for time, and 5-minute runs actually work quite well for an interval session, regardless of how much distance you cover in this time. I used to call this type of interval training “nonstructured,” since you rely on feeling the degree of stress rather than going a set distance in a predetermined time, even though you’re timing the duration of each quality run. You can do the same type of thing with 1-, 2-, 3-, or 4-minute runs. Now I prefer to use the original Swedish term “fartlek” for these types of sessions.

Recovery Time

Again, since the purpose of interval training is to stress your $\dot{V}O_2\text{max}$, you must spend time running at $\dot{V}O_2\text{max}$. As shown in figure 8.1, a 5-minute workout does this well; the first two minutes are needed to reach $\dot{V}O_2\text{max}$, but the remaining three are spent at max – a good return on your investment.

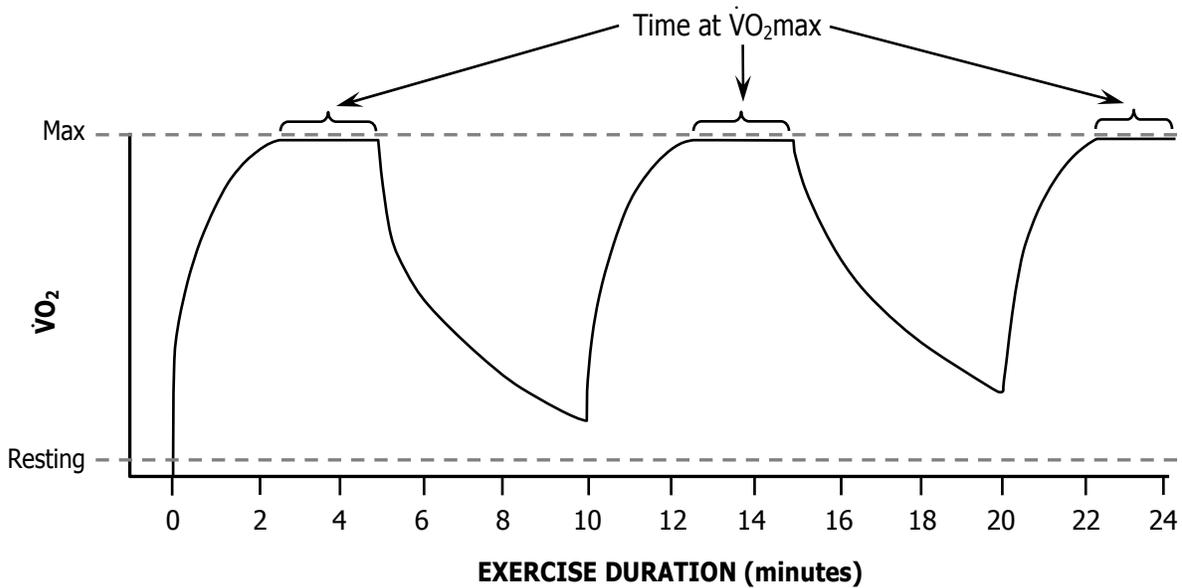


Figure 8.1 Interval running allows you to train at maximum aerobic capacity ($\dot{V}O_2\text{max}$) for a good portion of the workout while still getting necessary rest periods.

Adapted with permission from J. Karlsson, et al. *Energikraven vid Löpning* (Stockholm: Trygg, 1970), p. 39.

The length of recovery time between workouts should be equal to or a little less than the duration of the workout itself, so for example, if you're doing 1,600-meter runs of five minutes each, you should take up to five minutes recovery time before the next 1,600 meters, while 40-second intervals require recoveries of no more than 40 seconds each. Generally, the longer the workouts, the less you need to concern yourself with recovery time being too brief.

In contrast to 5-minute runs, Figure 8.2 shows what happens when 400-meter runs at 80 seconds each are used during an interval workout. Each individual workout doesn't last long enough to allow you to reach $\dot{V}O_2\text{max}$, so short recoveries are needed to achieve $\dot{V}O_2\text{max}$ more quickly in subsequent workouts, since they don't permit full recovery back to resting $\dot{V}O_2$. With each new workout, $\dot{V}O_2\text{max}$ is reached more quickly than in earlier bouts or with longer recoveries, and by repeating the short intervals and short recoveries over and over, you can accumulate a fair amount of time at $\dot{V}O_2\text{max}$.

A way to handle interval 400s is to start one every 2 minutes, which means that 80-second 400s allow for 40-second recoveries, but this doesn't work too well for runners who do interval 400s in 90 seconds or longer because they get so little recovery time that they have trouble running a full lap at the proper speed. Interval 200s on a 1-minute send-off (starting a 200 every minute) are also good for variety.

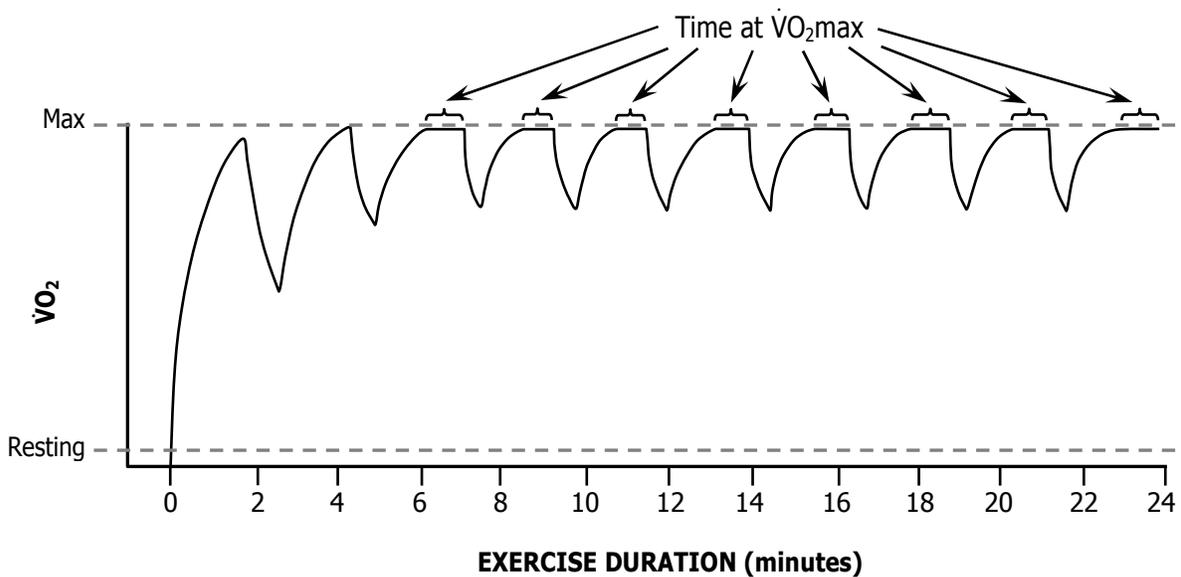


Figure 8.2 To reap the benefits of short interval training, the recovery periods must be kept even shorter.

Adapted with permission from J. Karlsson, et al. *Energikraven vid Löpning* (Stockholm: Trygg, 1970), p. 41.

Runners often ask, “What should I do during the recovery?” Active recovery (easy running or jogging) is best because low-intensity activity helps to clear waste metabolites from the working musculature and bring you to the next workout at a slightly elevated $\dot{V}O_2$, making the attainment of $\dot{V}O_{2max}$ a little quicker. Jogging during recoveries also keeps muscles loose and flexible for the demanding runs yet to come.

FACING THE WIND

Of the many adverse weather conditions, perhaps the only one that every runner is confronted with at one time or another is wind – and if there's anything that does more to disrupt training and racing, I have yet to encounter it. I consider myself fortunate to have coached for four years in Oklahoma, where you really come to respect the wind, since it's as much a part of running there as heat is in Florida or Arizona. You learn to work with the wind, avoiding it when you can by running early in the morning or in the evening. Here are some facts about wind that are important to runners:

Wind generally moves heat away from the body, which enhances cooling. The exception is when you're running with a steady tailwind that's equal in velocity to your running speed, in which case removal of air surrounding the body is inhibited. The result is a loss of heat dissipation and an increase in body temperature. This can be disastrous on a warm day but advantageous under cold conditions. Although headwinds can slow you down significantly, a tailwind of equal velocity won't speed you up to the same extent. Figure 8.3 shows the effect of wind on the aerobic demands of running.

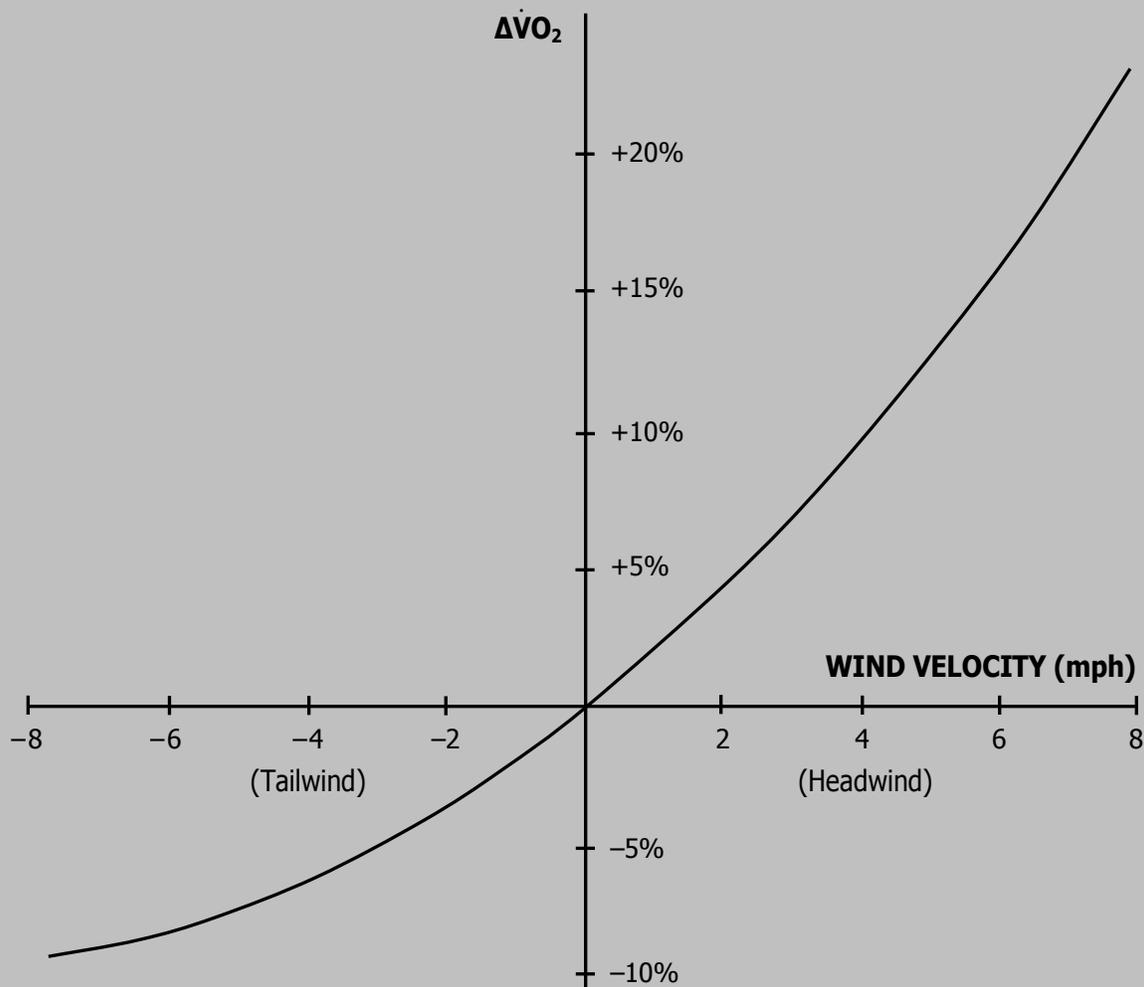


Figure 8.3 Change in oxygen demand ($\Delta\dot{V}O_2$) as a result of a headwind or tailwind, relative to calm air.

- ▶ Running behind another runner (drafting) is increasingly beneficial as wind velocity picks up, and sometimes it's good to work with a competitor under windy conditions, sharing the duties of breaking the wind. This is especially appropriate when both runners are trying for a particular time.
- ▶ Be careful in setting up workouts under different temperature conditions when you're not going around a track. On cold days, do your harder and faster running against the wind, and your slower running with it. This way the cooling effect is kept short and is related to harder work, whereas recovery (slower running) can take advantage of the tailwind. On warm days, do the opposite – run fast or hard with the wind, and run slowly against it, to enhance its cooling effect. This might not sound enjoyable, but it's better to spend more time being warm on a cold day and cool on a warm day than the other way around.
- ▶ The above strategy for dealing with the cooling and warming effects of wind also applies to out-and-back steady runs. Start out against the wind on a cold day so that the trip home will be warmer. Running with a tailwind first on a cold day can lead to some really chilly conditions on the return run, particularly if you get sweaty on the way out. The opposite applies to runs in warm weather – go with the tailwind first and return against the cooling wind to negate the tendency to overheat later in the run.

Workout Intensity

Be sure to evenly maintain the correct pace during each workout of the **I** session, regardless of the duration. Many runners are surprised to learn that you shouldn't run shorter intervals any faster than interval miles, and they try for a faster pace when doing 400s for instance, but it's better to save your speed for repetition workouts (as described in chapter 9). The basic purpose of the **I** workout is to boost your $\dot{V}O_2\text{max}$, not to convert you into a workout fanatic.

Again, running faster than $v\dot{V}O_2\text{max}$ can't produce a greater aerobic involvement than running at $v\dot{V}O_2\text{max}$; the stress of shorter workouts in **I** pace sessions comes from shortening the recoveries, not running faster. If you feel that interval 400s at **I** pace are too easy, then shorten your recoveries, or use 1,000-meter instead of 400-meter workouts, but don't play with intensity; you can bring some variety to interval workouts by adjusting distances and recoveries (see following section), just don't introduce higher intensities unless you're certain you've moved up in fitness. If you want to train faster, prove you're fit enough by racing faster first.

When improved race performances do indicate an increase in intensity (or, if there's no race by which to judge improvement, after four to six weeks of consistent training), don't go over a one-unit VDOT increase, unless your races show that a larger increase is acceptable. If you're in a nonracing mode, use the same rule of thumb as with threshold training – increase VDOT by one unit no more often than every fourth week of consistent training.

Determining I Workout Quality Portion From Weekly Volume

The total workout distance/duration in an interval session should be up to 8 percent of weekly mileage, with a 6-mile/10-kilometer maximum, or a 30-minute/30-point limit, as described in chapter 2. Even if you're logging 120-mile (200-kilometer) weeks, you shouldn't exceed the suggested cap, because $\dot{V}O_2\text{max}$ intervals are without a doubt the most demanding workout you can do. This is another reason you shouldn't go faster than prescribed during a workout – the excess speed might prevent you from recovering sufficiently and thus compromise another quality workout later in the week.

The idea of holding interval mileage to a percentage of current weekly mileage is to prevent athletes with lower training loads from overdoing it when they work out with higher-mileage runners. You should never ask a 20-mile-per-week runner to go through a 6-mile interval session with a 75-mile-per-week runner, even if they have the same **I** pace. They can run their workout together up to the point where the lower-mileage runner should drop out because of quality-training limits imposed by their lower total weekly training load. Six miles of running at **I** pace, plus warm-up, recovery, and cool-down running could easily add up to half of the lower-mileage runner's weekly total. That's just too much.

Varying I Pace Workout Structure

One of the nice things about interval training – and it's good to find something nice about it – is the varied makeup of training sessions that can be used to accomplish the same purpose of stressing $\dot{V}O_2\text{max}$. Not only can you change the composition from one workout to the next, you can also vary the workouts within a single training session. For example, if your **I** pace is 268 meters per minute (6-minute mile pace or 90-second 400-meter pace) and you want to accumulate 24 minutes (four miles) of quality running in a workout, you could do six 2-minute runs with 1-minute recoveries, followed by eight 1-minute runs with 30-second recoveries, then finish up by doing eight 30-second runs with 15-second recoveries. All runs should be at 90-second 400-meter pace, so that $\dot{V}O_2\text{max}$ is stressed properly, and the recovery times should

be equal to or less than the corresponding workouts. The total session would last 36 minutes, with 24 minutes of **I** pace running and 12 minutes of easy recovery running. In this particular workout, the feeling of stress should remain pretty constant as the workout progresses because the individual workouts get shorter as the total amount of quality running accumulates.

Thus, you can make up almost any type of interval workout as long as you stick to the rules of interval training set forth in this chapter and summarized here:

- ▶ Stick to **I** pace for all aspects of quality running.
- ▶ Run between 30 seconds and 5 minutes per workout, with 3 to 5 minutes being ideal.
- ▶ Jog easily during recovery periods, keeping them equal to or shorter than the workouts they follow.
- ▶ Let the quality portion of an interval session total up to 8 percent of your current weekly mileage (or weekly time spent running) with a nonnegotiable upper limit of 10 kilometers, or 30 minutes of running at **I** pace.

Perform each interval session with some thought about what the workout is going to accomplish for you in the long run. Intervals are challenging, but don't look at **I** pace as something you have to surpass. Consistent training is the key to success, and trying to set a record in an interval workout is not the best way to achieve consistency. Use the interval workout to meet your long-term goals with as little effort as possible; don't overtrain (too intensely or too long).