

Interval Training for the Cyclist: What, Why and How

Mike Niederpruem, M.S., CSCS

Interval training is perhaps one of the more common training methods used to improve physical performance, but at the same time, because of the almost infinite combinations of variables utilized in creating an interval training program, it is one of the least understood by athletes and coaches alike. Simply put, interval training can be defined as alternating efforts of high intensity activity with efforts of low intensity (active recovery).

Why Do Intervals?

The rationale for interval training is that an athlete can perform more work (i.e., go faster or produce more power) during short periods of time than he would be able to for a longer, continuous period of time.

For example, a cyclist might be able to ride a fixed-distance time trial, at a maximum sustainable effort, for 30 minutes continuously at an average speed of about 25 miles per hour (depending on his level of physical development, training experience, and other factors). However, if this same cyclist performed an interval workout, it might look like this:

<i>Sets</i>	<i># of Repetitions (Reps.)</i>	<i>Duration of each Rep.</i>	<i>Recovery betw. Efforts</i>	<i>Recovery betw. Sets</i>	<i>MPH</i>
2	5 per set	3 minutes	3 minutes	10 minutes	28

As you can see from this example, the cyclist was able to ride significantly faster during each of the 3-minute intervals than he could by riding the entire 30 minutes continuously.

Exercise Physiology 101

Before we can begin discussing all the variables involved in creating specific interval training programs, we need to briefly review some basic physiology of exercise. There are three energy systems in the human body that can be optimized or enhanced through the use of interval training:

1. **ATP-PCr System**—This energy system refers to high-energy phosphates (ATP - adenosine triphosphate, and PCr - phosphocreatine) that are stored inside the muscles, and are an immediate source of energy for short duration (5 - 20 seconds), high intensity exercise. Practical examples include race starts, sprints, etc.
2. **Lactic Acid System**—As the ATP-PCr system becomes depleted, anaerobic glycolysis begins resynthesizing the high energy phosphates by using muscle glycogen (the storage form of glucose—the final product of carbohydrate digestion and the main form of carbohydrate within the blood) as a source of energy. As a result of this process, lactate is produced, and high levels of lactate accumulate in the blood between 1 and 3 minutes of continued high-intensity exercise. Practical examples include 500 meter and 1 kilometer time trials, break-aways or attacks lasting up to 3 minutes, etc.
3. **Aerobic System**—If the effort continues, lactate continues to accumulate, and you will no longer be able to maintain a high intensity level. If you continue to ride at a lower intensity level, a third energy system, the Aerobic system, is activated. The aerobic system is, by far, the most efficient energy system for sustained endurance activity and provides the

greatest amount of energy as well. As the duration of the activity exceeds three minutes and beyond, more and more of the energy is derived from this energy system. Generally, long-duration efforts relying almost exclusively on the aerobic system are referred to as submaximal exercise.

The good news is that all three energy systems can be trained, either individually or in combination, and by incorporating appropriate interval progressions into your training plan, you will see measurable improvements, not only in your physical ability, but your racing performance as well.

Learning the Vocabulary

In our first example, we used a number of different terms in defining and quantifying an interval workout. Familiarity and understanding with these terms and the others listed below will help facilitate your efforts at designing effective interval training programs:

Intensity—how hard you are supposed to go, so to speak, for the duration of each effort.

Intensity can be prescribed by heart rate (in beats per minute), speed (miles or kilometers per hour), ratings of perceived exertion (a subjective rating for how hard you feel you are working), or in more advanced situations, by power (Watts) or by blood lactate levels.

Duration—the length of time for each work interval; can be in seconds for the ATP-PCr energy system, up to minutes for the Lactic Acid and Aerobic energy system.

Repetitions—the total number of efforts performed; can be prescribed in sets. For example, one set of 10 efforts, or 2 sets of 5 efforts each.

Recovery—most, if not all, recovery will be active recovery. This means that in between the intervals, you will be riding along slowly. Another type of recovery is passive recovery, where you may actually get off the bike and sit for the time of recovery. Recovery can differ

between efforts as opposed to sets. Usually, recovery between sets is 2 or 3 times longer than recovery between intervals. For example, if the recovery between intervals is 3 minutes, then the recovery between sets might be between 6 - 10 minutes.

Additionally, recovery times in between efforts are usually expressed as a ratio of time of effort to time of recovery, sometimes referred to as “work : rest.” For the ATP-PCr energy system, this can range from 1:3 to 1:10; for the Lactic Acid System, 1:2 to 1:3; for the Aerobic System, 1:1 to 1:1.5.

How to Perform Intervals—Getting Started

What follows are numerous examples of interval training programs for the various energy systems. As mentioned previously, these can be performed individually or in combination. First, regardless of your level of physical development or experience, it is important that you have a sufficient “base” or foundation. This means that a majority, if not all, of your recent training (the last 4 - 8 weeks) has been low intensity, long-duration activity. Performing interval training prematurely or too often can increase the risk for injury, overtraining, or both.

Second, determine your current level of physical development by comparing yourself to the chart below. These are general guidelines, and you may not fit into one specific category. If in doubt, choose the lower level. If, after a week or two, it feels too easy, then it is easy to move up to the next level. It has been my experience in the last 15 years of coaching that most people over-estimate their ability, and thus, are chronically training too hard, too often.

	NOVICE	INTERMEDIATE	ADVANCED
Years of Experience with Structured Training	New to the sport, or up to one year	1 to 3 years	3+ years
Time Available for Training	Less than 8 hours/week	8 - 12 hours/week	12 - 18+ hours/week

Training the ATP-PCr Energy System

NOVICE

Sets	Reps	Duration (seconds)	Recovery betw. Efforts	Recovery betw. Sets	Intensity	Frequency
1	5	5 - 10	15 - 30 s minimum; 1 - 5 minutes maximum	Not Applicable (NA)	Max	1x/week
2	4	5 - 15	Same as above	5 minutes	Max	1x/week
2	3	10 - 20	Same as above	5 minutes	Max	2x/week

INTERMEDIATE

Sets	Reps	Duration (seconds)	Recovery betw. Efforts	Recovery betw. Sets	Intensity	Frequency
1	5	5 - 10	15 - 30 s minimum; 1 - 5 minutes maximum	NA	Max	1x/week
2	4	5 - 15	Same as above	5 minutes	Max	2x/week
3	3	10 - 20	Same as above	5 minutes	Max	2x/week

ADVANCED

Sets	Reps	Duration (seconds)	Recovery betw. Efforts	Recovery betw. Sets	Intensity	Frequency
1	5	5 - 10	15 - 30 s minimum; 1 - 5 minutes maximum	NA	Max	1x/week
2	4	5 - 15	Same as above	5 minutes	Max	2x/week
3	3	10 - 20	Same as above	5 minutes	Max	2 - 3x/week

Notes:

1. Because these efforts are so short, there is insufficient time for the heart to respond. Therefore, using HR as a means for prescribing intensity is not appropriate. Nonetheless, these efforts need to be performed at maximum sustainable intensity on the part of the cyclist.
2. There is a wide range of time allowed for recovery between these types of efforts. Allow longer periods of recovery when you are just beginning these types of intervals, and as you improve, shorten the recovery time. Also, if you find that you are unable to complete subsequent efforts, then you probably aren't allowing enough time between efforts for recovery.

Training the Lactic Acid Energy System

NOVICE

Sets	Reps	Duration (minutes)	Recovery betw. Efforts	Recovery betw. Sets	Intensity (Max HR)	Frequency
2	3	2	2 minutes	6 minutes	92 - 94%	1x/week
2	4	2	2 minutes	6 minutes	92 - 94%	1x/week
2	3	3	3 minutes	10 minutes	92 - 94%	2x/week

INTERMEDIATE

Sets	Reps	Duration (minutes)	Recovery betw. Efforts	Recovery betw. Sets	Intensity (Max HR)	Frequency
2	4	3	3 minutes	10 minutes	92 - 95%	2x/week
2	4	4	4 minutes	12 minutes	92 - 95%	2x/week
1	8	4	4 minutes	NA	92 - 95%	2x/week

ADVANCED

Sets	Reps	Duration (minutes)	Recovery betw. Efforts	Recovery betw. Sets	Intensity (Max HR)	Frequency
2	5	3	3 minutes	10 minutes	95%+	2x/week
2	5	4	4 minutes	10 minutes	95%+	2x/week
1	10	4	4 minutes	NA	95%+	3x/week

Note:

1. Using percentage of maximum heart rate is only one possible method for determining intensity. These ranges are only general recommendations. For further clarification in determining the ideal training intensities, please contact a licensed coach, certified personal trainer, exercise physiologist, or other trained fitness professional.

Training the Aerobic Energy System

NOVICE

Sets	Reps	Duration (minutes)	Recovery betw. Efforts	Recovery betw. Sets	Intensity (Max HR)	Frequency
1	3	6	6 - 9 minutes	NA	82 - 90%	1x/week
1	4	6	6 - 9 minutes	NA	82 - 90%	1x/week
1	4	8	6 - 9 minutes	NA	82 - 90%	2x/week

INTERMEDIATE

Sets	Reps	Duration (minutes)	Recovery betw. Efforts	Recovery betw. Sets	Intensity (Max HR)	Frequency
1	3	8	8 - 12 minutes	NA	82 - 90%	1x/week
1	4	8	8 - 12 minutes	NA	82 - 90%	2x/week
1	4	10	10 - 15 minutes	NA	82 - 90%	2x/week

ADVANCED

Sets	Reps	Duration (minutes)	Recovery betw. Efforts	Recovery betw. Sets	Intensity (Max HR)	Frequency
1	4	10	10 - 15 minutes	NA	82 - 92%	2x/week
1	4	12	12 - 16 minutes	NA	82 - 92%	2 - 3x/week
1	5	12+	12 - 16+ minutes	NA	82 - 92%	2 - 3x/week

Note:

1. Using percentage of maximum heart rate is only one possible method for determining intensity. These ranges are only general recommendations. For further clarification in determining the ideal training intensities, please contact a licensed coach, certified personal trainer, exercise physiologist, or other trained fitness professional.

Considerations

Combining Types

You can combine interval types. Usually, you should only focus on two different types at one time. For example, one day a week dedicated to the ATP-PCr energy system, and the other dedicated to the Lactic Acid energy system. Remember, interval training is both physically and psychologically challenging, and more is not always better. Even the most highly trained cyclists will limit their interval training to three times a week, with the very rare exception of one or two weeks perhaps of four sessions per week.

Progression

It's usually a good idea to perform the same session of intervals at least twice before making adjustments to make the interval session more difficult. This way, any improvements are observable.

Discipline specificity

By making adjustments to the cadence at which you perform intervals, they can be made more specific to a particular cycling discipline. Road cycling usually occurs in the range of 80 - 110 rpm's; mountain biking in the range of 75 - 100 rpm's; track racing in the range of 85 - 150+ rpm's.

The strategic use of intervals (and their subsequent progression) as part of a structured training plan can have a positive and powerful impact on a cyclist's development physically, as well as improving their race results.

Suggested Reading

British Cycling Federation Coaching Education Course Resources.
British Cycling: Manchester, England; coaching@british-cycling.org.uk

Carmichael Training Systems Member Training Manual, vol. 1.
Carmichael Training Systems: Colorado Springs, CO; proshop@trainright.com

McArdle, Katch and Katch. *Exercise Physiology: Energy, Nutrition and Human Performance.* Lippincott, Williams and Wilkins: ISBN 0-7817-2544-5; 2001

USA Cycling Club, Expert and Elite Coaching Manuals. USA Cycling: Colorado Springs, CO; coaches@usacycling.org

About the Author

Mike Niederpruem, M.S., CSCS, is currently the Director of Coaching Development at Carmichael Training Systems. Mike received both his undergraduate and graduate degrees from Indiana University. Previously, Mike was responsible for creating the coaching education curriculum at USA Cycling, and he also recently served as the National Coaching Director for the British Cycling Federation.