Resistance Training for Cyclists

Gregg Fuhrman, M.P.T., CSCS

Cycling is primarily an endurance sport with the major energy contribution coming from aerobic energy production. Resistance training, or weight lifting, is primarily an anaerobic activity characterized by short bursts of high intensity work. At first glance it would appear that these two activities are at the opposite ends of the fitness spectrum. In fact, Chris Carmichael, personal coach to Lance Armstrong, has compared the relationship of weight training and cycling to that of "oil and water."

While Carmichael acknowledges the dichotomy of weight lifting and cycling, he feels that the time spent in the gym lifting in the early season is essential to build the cyclist's strength for the demands of the competitive season. But what about the recreational or amateur cyclist; why should they be concerned with weight lifting?

Why lift weights for cycling?

In the book *Science of Cycling*, edited by Dr. Edmund R. Burke, Harvey Newton outlines several benefits of resistance training.

1 First and foremost is obviously increasing strength. The ultimate goal of increasing your cycling performance is to ride faster. In order to ride faster, the cyclist has three choices: exert more force into the pedals, pedal faster or both. Resistance training builds strength in musculature needed to exert more force into the pedals.

2 Second, resistance training improves local muscular endurance. If the primary muscle groups involved in turning the pedals have increased endurance, the rider will be able to sustain a faster speed for a longer time, hence a better performance.

3 Third, resistance training plays an important role in injury prevention. Cycling is inherently a highly repetitive activity. Consider a cyclist out for a two-hour training ride. With a cadence of 94 revolutions per minute (rpm), he or she will perform 11,280 repetitions! If the musculoskeletal system is not prepared to handle this quantity of repetition, overuse injuries can easily result. Resistance training strengthens connective tissue found in muscle, tendon, and at their attachment sites onto bones. The benefit of this "pre-hab" is important for the athlete who wants to stay on the road.

4 Finally, resistance training is an important component of a post-injury rehabilitation program to get the athlete back on the bike.

Cycling Biomechanics

In the power phase, as one leg pushes down on the pedal from a starting point at the 12 o'clock position, the following actions are occurring. The hip flexors contract to flex the hip to prepare for the push phase. Knee extensors (muscles that straighten the knee) contract as the rider pushes down, coordinating with the powerful hip extensors contracting to straighten the hip. Plantar flexors (muscles that point the foot down) contract to further assist with the push on the pedals. As the pedal stroke continues, the antagonist (opposing) muscle groups to those mentioned, contract to prepare the leg for the upcoming pedal revolution.

Anecdotally, it was thought that the use of toe clips, and more recently clipless pedal systems that fix the rider's foot to the pedal, allow the rider to pull up on the pedal opposite to the side that is pushing down. However, laboratory research has more accurately shown that the non-pushing leg is really being prepared to get out of the way and to unload resistance off the pushing side pedal. A skilled cyclist is more efficient at both phases: applying more force to the pushing side pedal, while concurrently unloading the opposite side pedal.

A final point on muscle function—riding a bike is a concentric muscle activation activity. Concentric muscle activation is defined as a muscle generating force through shortening. Eccentric muscle activation is defined as a muscle generating force as it is elongating. Activities that include both eccentric and concentric activation patterns include walking, running, jumping, throwing, and catching. The bicycle as a machine is unique in that it allows the rider to activate the necessary muscle groups concentrically.

Table 1: Sample Periodization Scheme for Cyclists

Based on a competitive season from May through August

Phase	Timing/ Duration	Sets	Reps	Intensity (% 1RM*)	Training Days/week	Recovery Time
Transitional	6 weeks: Oct. to mid-Nov.	1 - 3/exercise	12 - 15/set	low: 30 - 50% for each exercise	2 - 3 on alternate days	60 - 90 seconds between sets
Hypertrophy	6 weeks: mid-Nov. to end Dec.	3/upper body exercise; 5/lower body exercise	8 - 12/set	Moderate to high: 70 - 85% for each exercise	3 on alternate days	60 - 120 seconds between sets
Basic Strength	4 weeks: Jan. to Feb.	5/exercise	4 - 6/set	High: 80 - 100% for each exercise	2 (with 1 on-bike workout)	60 - 120 seconds between sets
Power	4 weeks: Feb. to March	4 - 6/exercise	8 - 15/set	Moderate to high: 70 - 100% for each exercise	2 - 3 on alternate days	60 - 120 seconds between sets
Muscular Endurance	4 weeks: March to April	4 - 6/exercise	20 - 30/set	Low to moderate: 50 - 80% for each exercise	2 days	30 - 60 seconds between sets

**1 RM: 1 repetition maximum. Maximum amount of weight the athlete can lift 1 time with proper form.*
Adapted from Stone, O'Brien, Garhammer, McMullan, and Rozenek.

It's not just legs . . .

Cycling is primarily a sagittal plane sport. Anatomically, the sagittal plane cuts the body into right and left halves with the axis of rotation oriented at 90° from the plane or from medial to lateral. Simplifying things further, in the sagittal plane, joints predominantly flex (bend) and extend (straighten). From a strength perspective, a cyclist will want to target those muscle groups mentioned previously that work at the hip, knee, and ankle to flex and extend, but what about the rest of the body?

The two other anatomical planes that exist are the frontal plane, which divides the body into front and back halves, and the transverse plane, which divides the body into top and bottom halves. Muscles of the trunk, spine, and upper extremity that function in these two planes have the chief role of stabilizing movements of the hips, legs, and arms. This stabilization allows the rider to impart more force into the pedals because the hips, legs, and arms now have a stable base to push and pull against while pedaling.

The plan: Keep first things first

The goal of resistance training for the cyclist is to enhance cycling performance. Resistance training must be viewed as an adjunct to riding; a means to a better end. A comprehensive resistance training program for a cyclist must be specific, dynamic, and adaptable. In order to meet these criteria, the concept of periodization should be used when creating a training plan.

Periodization as a framework for structuring a weight training program for cyclists was outlined by Stone, O'Brien, Garhammer, McMullan and Rozenek in a 1982 article published in the *National Strength and Conditioning Association Journal*. (Table 1 is adapted from this article.) The basic premise of a periodization training scheme is that the training should be cyclical and progressive in nature, allow for rest and regeneration, and manipulate training variables to better prepare the athlete for competition.

Weight room exercises

Cycling-specific movement patterns involve the major muscle groups used while riding a bicycle. The goal of these exercises is to train cycling movement patterns and not merely muscle groups in isolation. For this reason, emphasis is placed on the use of free weights to further challenge and train your balance reactions. The final, very important point is that every exercise can be used to train the trunk or core musculature. Core musculature includes the abdominals, obliques, tranversus abdominus and intrinsic and extrinsic spinal stabilizers. Training cycling-specific movement patterns inherently calls for activation of these stabilizing muscle groups for functional, efficient and safe exercise performance.

Split squat

Using a barbell held in the traditional squat position, stand with one foot slightly in front of the other with a hip-width stance. Maintain a neutral lumbar spine/pelvis relationship during the entire exercise performance. (In the neutral lumbar spine posture, the low back is held in a mid/neutral position via strong contraction of the core musculature. A neutral lumbar spine is achieved by actively “bracing” the trunk musculature, or drawing the belly button in towards the spine to make a rigid wall through the entire trunk.)

Place 75 - 90% of your weight on the front foot and then squat down to approximately a 90° angle at the lead knee. The lead knee should not move in front of the toes on the lead leg. As you ascend to an upright posture, the lead leg provides the majority of propulsion on the ascent, and the back leg stays on the ground to provide balance and stabilization. The exercise is completed with each leg performing sets in the lead position. (photos 1, 2)

Photo 1 (above): Split squat mid point
Photo 2 (right): Split squat start and end position

Single leg squat

The single leg squat is performed in a similar position to the split squat, however place the back leg on a bench or stability ball behind you. The same guidelines apply for the positioning and depth of bend for the lead leg. The nature of this exercise places more demands on your balance and trunk stability for proper exercise performance (photo 8). You can use dumbbells or a barbell for resistance with this exercise. The barbell is more challenging because the weight is moved further away from the your center of gravity.

Photo 3: Single leg squat

High step-ups

Using a barbell or dumbbells, perform a step-up onto a flat weight bench. Most gym weight benches are 14 - 17 inches high. The key to proper performance of this exercise is to make sure you use the lead leg to propel the ascent and lower yourself under control on the descent. Don't use the back leg to assist in the push phase on the ascent of the step-up. Again, balance is maintained with a strong contraction and "bracing" of the core musculature throughout the performance of the exercise. (Photos 4, 5)

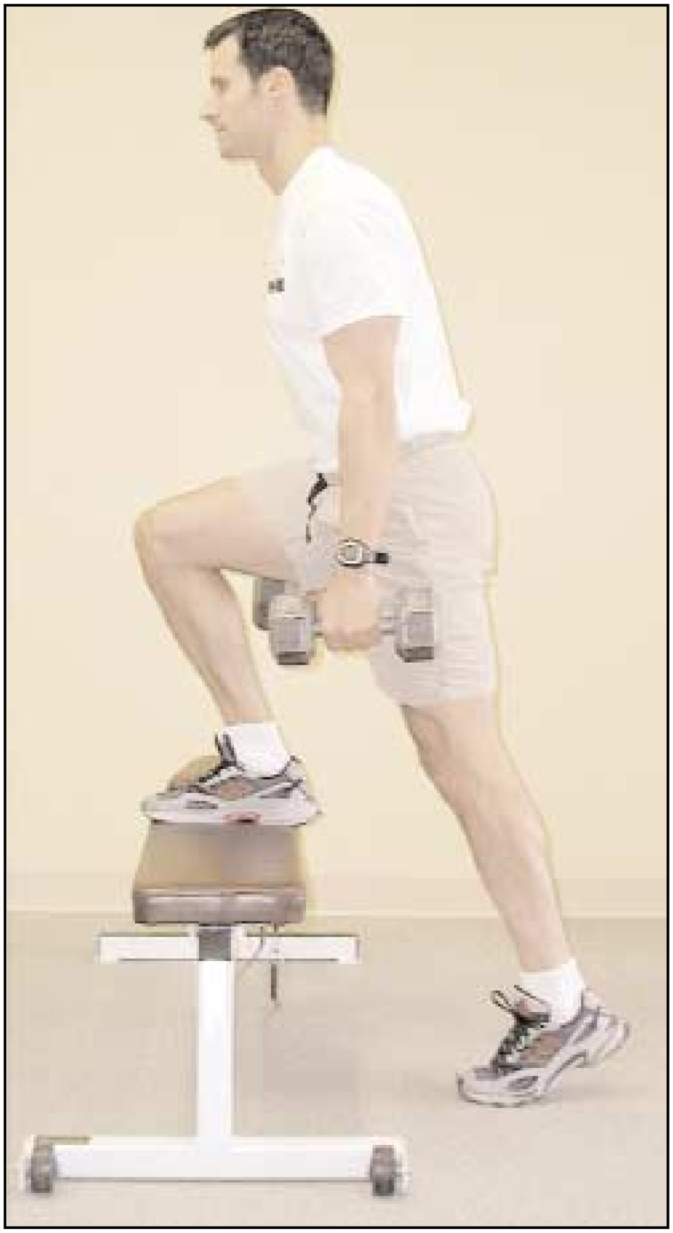

Photo 4 (above): High step-up, starting position

Photo 5 (right): High step-up, descending position

Single arm rowing

While holding a dumbbell in the right hand only and with the feet positioned in a stride stance slightly wider than the split squat, lower the dumbbell to the height of the left shin as you squat down onto the left leg. Maintain a neutral lumbar spine and ensure that the hip and knee of the lead leg are flexing evenly to allow the low back to be protected. Ninety percent of your weight is now on the lead leg and the ball of the lead foot (photo 6). As the you begin the ascent from the squat position, concurrently pull (or row) the dumbbell to the lower border of right rib cage to complete the exercise (photo 7). Sets are completed alternating feet in the lead position and switching the dumbbell to the opposite hand. This movement simulates pulling on the handlebars while riding uphill or sprinting on the bike.

Photo 6 (below): Single arm rowing, descending postion

Photo 7 (left): Single arm rowing, ascending position

On-the-bike strength and skill exercises

The following drills allow you to effectively transfer the strength gains made in the gym to specific, on-the-bike application.

Single leg pedaling

After a thorough warm-up, alternate pedaling with one foot for bouts of 30 seconds. Pedal against a light to moderate resistance with one leg while the other leg is held off the pedal and to your side. Pedal cadence will drop but the pedal stroke should be made as smooth as possible as your skill level increases. Complete 30 seconds of single leg pedaling followed by 2 - 4 minutes of regular pedaling at a faster cadence (95 - 110 rpm). Alternate legs with each set. Progress to single leg pedaling intervals up to 1 minute.

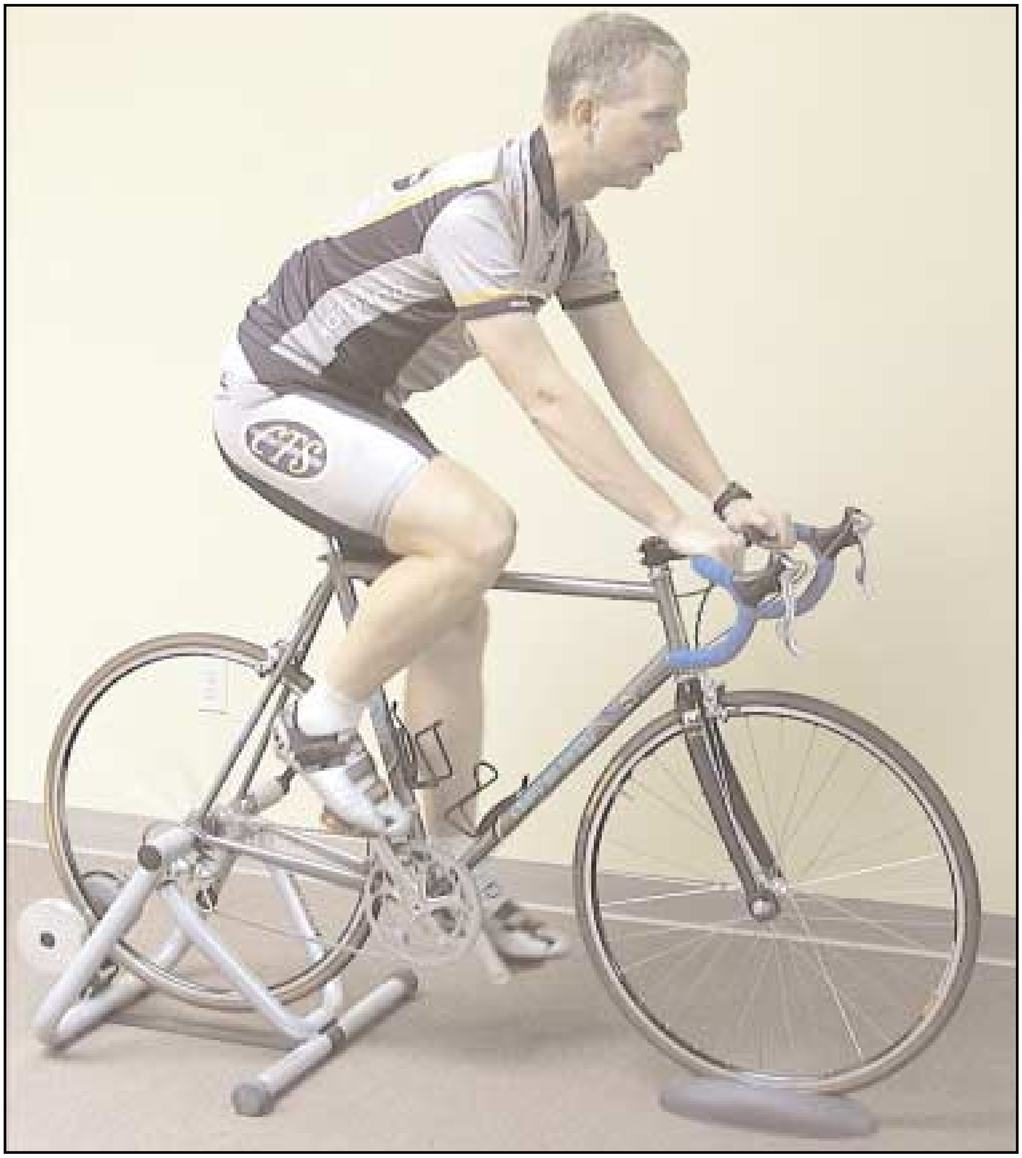

Photo 8: High resistance pedaling—seated (described on next page)

High resistance pedaling seated and standing

After a thorough warm-up, set a high amount of resistance using the gearing on the bicycle and resistance settings on the stationary trainer. Pedal cadence with this drill will be slower; 70 - 80 rpm when seated, and 60 - 70 rpm when standing. When performing this drill seated, your hands should be placed on the top, flat section of the handlebars and you should concentrate on a smooth pedal stroke with the upper body remaining very stable (photo 8, previous page). Rocking of the pelvis or shoulders should be controlled by bracing the core musculature to maintain a solid base for the legs to push against when pedaling under load. In the standing position, you will typically grasp the brake levers on the handlebars (photo 9). Spend 2 minutes initially pedaling against higher resistance. With training and practice, these intervals can progress up to 10 minutes.

CAUTION: This drill places a higher compressive load on the knees. Do not attempt this drill until you have completed the Basic Strength Phase of weight training outlined in Table 1. Athletes with known knee injuries or chronic knee pain should not perform this drill.

A comprehensive training program that includes both endurance and resistance training will maximize cycling performance.

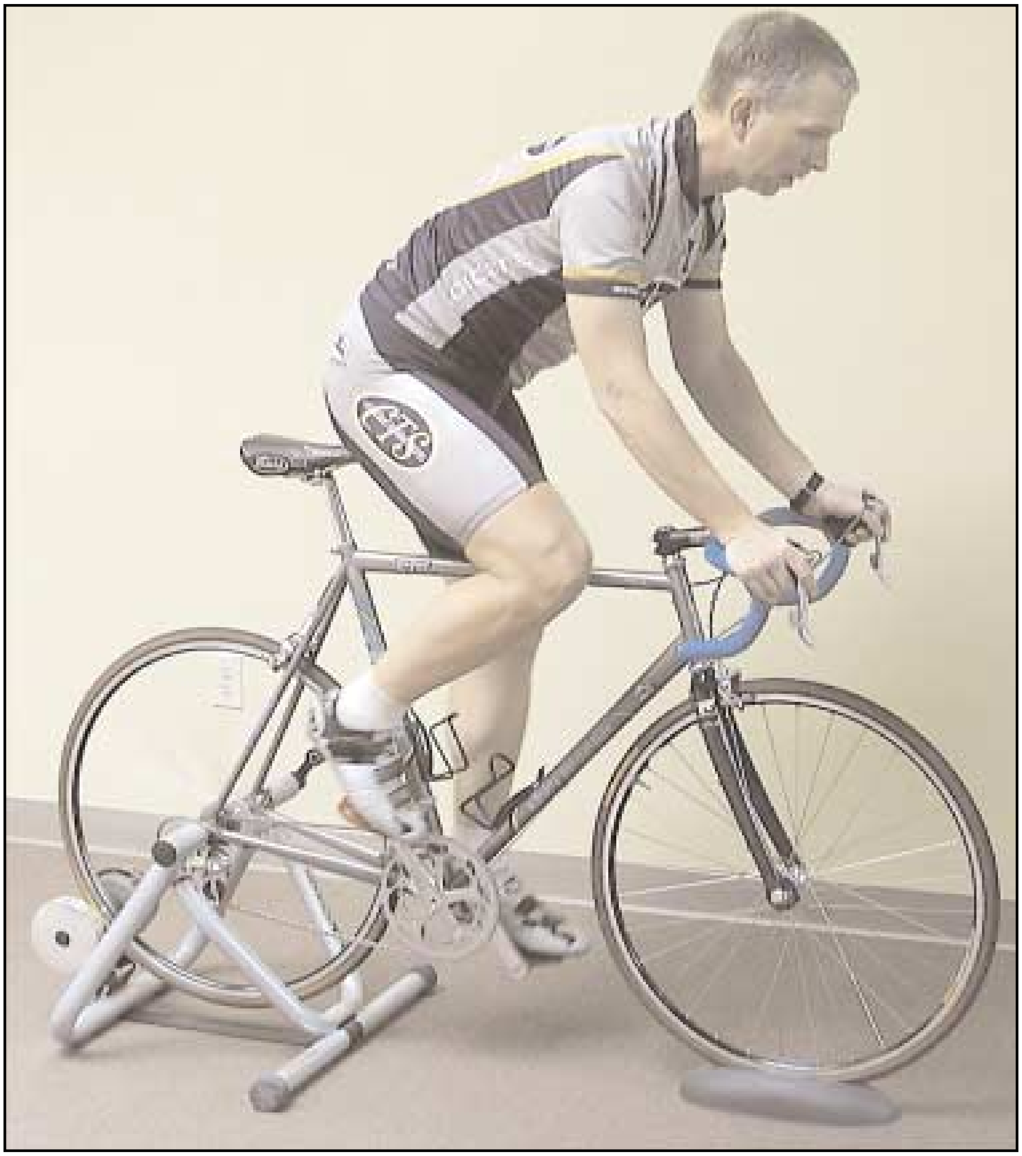

Photo 9: High resistance pedaling—standing

References

1. Burke, E.R. *Science of Cyclin*g, Human Kinetics Publishers, Inc. Champaign, Il; 1986.
2. Timmer, C.A.W. Cycling Biomechanics: A Literature Review. *Journal of Orthopaedic and Sport Physical Therapy* (14) 3: 106 - 114; September 1991.

About the Author

Gregg Fuhrman, M.P.T., CSCS received his Masters of Physical Therapy degree at Marquette University. He holds a Bachelors degree in Allied Health/Exercise Physiology from the University of Wisconsin-Milwaukee. Gregg is employed full-time as a physical therapist at Body Mechanics in downtown Milwaukee. He specializes in outpatient physical therapy with an emphasis on manual therapy and functional training. Gregg has been a Certified Strength and Conditioning Specialist (CSCS) with the National Strength and Conditioning Association since 1991. He teaches in the Program in Physical Therapy at Marquette University, and is a Certified Cycling Coach with Carmichael Training Systems.