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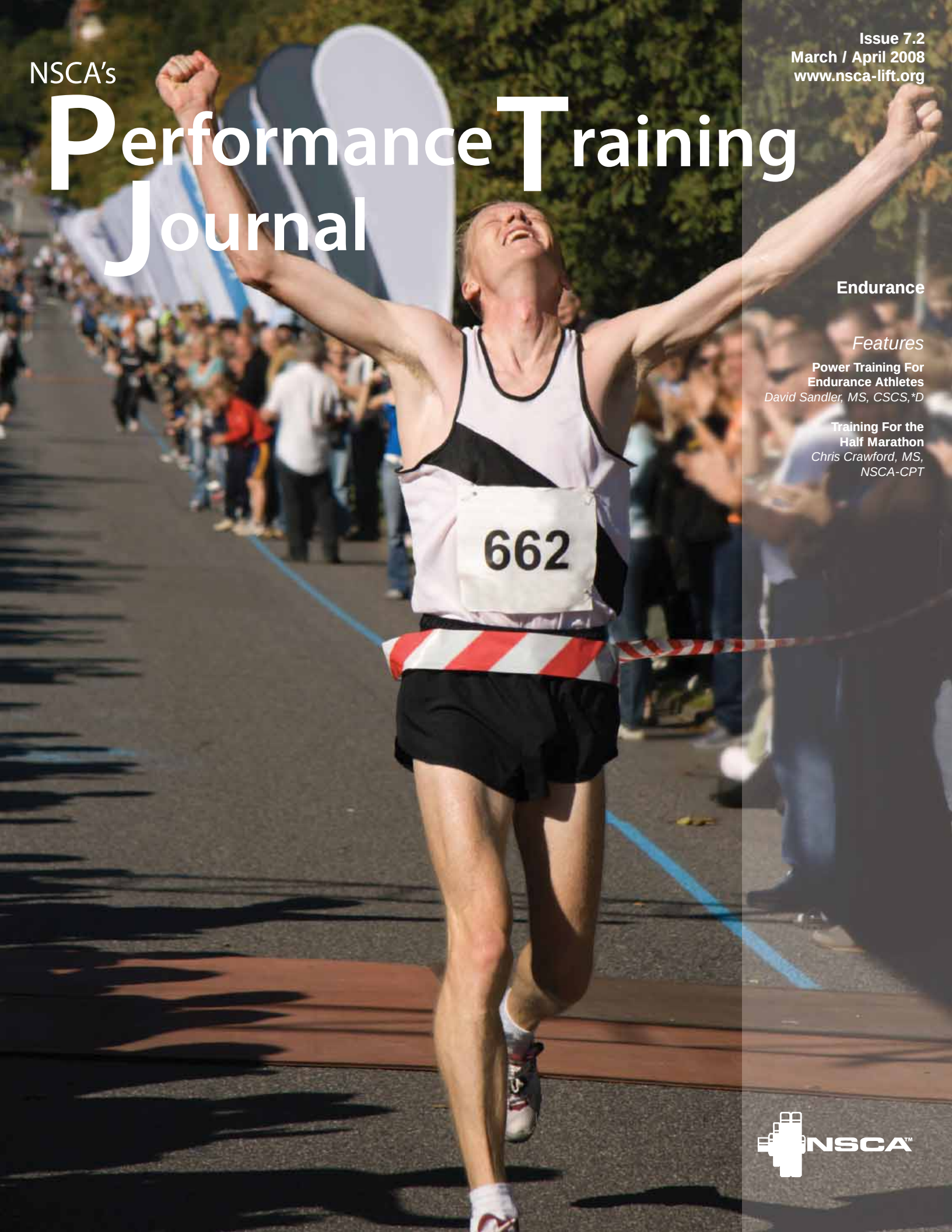

Endurance

Features

NSCA™

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NSCA's
Performance Training Journal

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Kyle Brown, CSCS

Periodization & Specificity: Resistance Training and Endurance Athletes

about the AUTHOR

Kyle Brown is a health and fitness expert whose portfolio includes everything from leading workshops for Fortune 500 companies and publishing nutrition articles in top-ranked fitness journals, to training celebrity clientele—from pro athletes to CEOs to multi-platinum recording artists. Kyle's unique approach to health and fitness emphasizes nutrition and supplementation as the foundation for optimal wellness. After playing water polo for Indiana University, as well as in London, Kyle became involved in bodybuilding and fitness for sport-specific training. Kyle is the creator and Chief Operating Officer for FIT 365—Complete Nutritional Shake (www.fit365.com).

Many endurance athletes frown upon lifting weights because they fear it will make them too bulky and slow them down. Still others believe it's acceptable as long as it involves low weight and high repetitions. The truth is neither of these statements is correct. Whether or not resistance training is beneficial for endurance athletes is more about periodization and specificity than anything else.

During an endurance activity, you are contracting your muscles at a low to moderate force repeatedly for a long duration. Resistance training, especially strength and power training, involves just the opposite: high intensity and high force output for a short duration. On paper, it would seem that intermingling the two types of training would be of no benefit, or are even counterproductive. Yet modern science has proven that implementing resistance training programs into endurance athlete training protocols can be highly effective as long as periodization and specificity are taken into consideration (1).

Specificity refers to ensuring your program is customized to your unique needs. Many people think performing 2 sets of 15 to 20 repetitions using light to moderate weights is best for endurance athletes. However, this type of training does not necessarily condition the neuromuscular system for long distance events (1). Conversely, strength training should be the foundation for any endurance athlete's program. This makes sense because the greater an athlete's maximal strength, the greater their potential for strength endurance by improving the amount of force they are able to apply for a prolonged period of time (1). Distance athletes need to have adequate strength-endurance to avoid the deterioration of their form as they begin to fatigue (4).

Heavy strength training has also been shown to improve exercise economy in endurance athletes (2). The term "exercise economy" is used to express the oxygen consumption required to perform a given exercise workload, whether it be spinning, running, or any other endurance activity (2). Moreover, strength imbalances and lack of flexibility are two reasons why endurance athletes get injured(3). Training to improve overall strength—and increase flexibility—is fundamental to any endurance athlete's resistance training program.

Timing is everything when it comes to incorporating resistance training programs for endurance athletes. Periodization is an organized approach to training that involves progressive cycling of various aspects of a training program during a specific period of time (3). The best time to begin a resistance training program is in the off-season. This is because in the short-term, incorporating resistance training may decrease performance in one's sport. This can come from muscle soreness as well as having to adapt neuromuscular control due to rapid increases in strength (3). However, honing your endurance sport skills as you adapt to your newfound strength will limit this potential side effect (4). Periodization is also important to decrease the likelihood of overtraining. Endurance athletes need to find a balance between high volume training and required rest and recovery.

Tips for incorporating resistance training into the endurance athletes training program:

1. Taper off (reduce) your resistance training immediately before your endurance event
2. Don't start a new resistance training program while "in-season"
3. Perform your resistance training before your endurance training, so technique is not significantly compromised due to fatigue.
4. Perform your resistance training on your lighter, lower intensity days
5. Incorporate full body workouts performing bilateral movements that create symmetry, enhance flexibility, and improve your overall strength
6. Make sure you continue to focus on honing your endurance-sport skills while incorporating a resistance training program ■

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Jason Brumitt, MSPT, SCS, ATC, CSCS,*D

Training Tips to Help Triathletes Reduce Overuse Injuries

about the **AUTHOR**

Jason Brumitt is a board-certified sports physical therapist, certified athletic trainer, and a Certified Strength and Conditioning Specialist. He is an instructor of physical therapy for Pacific University in Hillsboro, Oregon. To contact the author email him at jbrumitt72@hotmail.com.

The triathlon is arguably the most physically demanding endurance sport. Competitive triathletes report training up to 20 hours per week when preparing for a competition (3, 7). The repetitive motions experienced during training increases the triathlete's risk of sustaining an overuse injury. Almost 50% of triathletes will experience a sport-related injury that will affect their ability to train or will require them to seek medical attention (1).

Overuse Injuries Experienced by the Triathlete

The joints most vulnerable to injury when training for a triathlon include the knee, the shoulder, and the ankle (1). The onset of a sport-related overuse injury may be due in part to poor or deficient strength. For example, sports medicine professionals have identified that weakness in the hips may contribute to hip injuries or other lower extremity injuries (2, 6). Niemuth et al (6) found that injured runners were significantly weaker in their hips when compared with non-injured runners. The repetitive overhead shoulder motion of the freestyle stroke, combined with scapular and rotator cuff muscular weakness, may increase the triathlete's risk of developing shoulder pain (9).

Training Habits of the Triathlete

The majority of the triathlete's conditioning program is devoted to training for each event. For example, a sample training program for a competitive triathlete will include swimming 3 days a week (1,500 to 4,000 meters each session), cycling 3 days a week (30 to 100 kilometers each session), and running 5 days a week (8 to 25 km each session) (8). Weight training may help to reduce the athletes' risk of sustaining certain overuse injuries. It appears that the typical triathlete has very little time to devote to weight training. It has been reported that the typical triathlete weight training program lasts 30 minutes and is performed only 2 days a week (8).

The Training Program

The program presented in this article utilizes several exercises that combine 2 or more muscle groups (see page 8). Adopting this program (or at least some of the exercises) will allow the triathlete to train several muscles or muscle groups in a short training session.

The "abdominal brace" contraction should be performed with each plank exercise. The abdominal brace is a contraction of the abdominal wall musculature with no inward or outward movement of the abdominal wall (4).

Scaption

The "scaption" exercise (figure 1) targets the deltoid and the supraspinatus muscles (10). The exercise is performed with arms relaxed at the side and palms facing forward. Begin by raising both arms from the side of the body to shoulder height. The arms should not be raised directly to the side; rather the arms should be elevated in the plane of the scapula.

Side Plank with Shoulder External Rotation

The side plank is an effective core exercise for training the obliques and the transversus abdominis (4). In the side plank pose, position the shoulder and upper arm along the side of the body with the elbow flexed to a 90 degree angle. Raise the hand upwards (rotating the shoulder away from the body) to train the portions of the rotator cuff (figure 2).

Three Point Plank with Upper Extremity Movements

Start in a 3-point plank position with one upper extremity free for movement. Horizontally abducting (move away from the body) the arm with the shoulder in external rotation (figure 3) trains the external rotators, the supraspinatus, the middle trapezius, and the rhomboids (5, 10). Extending the shoulder (figure 4) trains the middle trapezius and the posterior deltoid (5, 10). The shoulder row (figure 5) is effective for strengthening the trapezius, the rhomboids, and the posterior deltoid (5, 10).

Prone Plank with Lower Extremity Extension

This exercise is effective for training the core musculature and the gluteus maximus. Assume the prone plank position on your forearm and feet (figure 6). The exercise is performed by lifting (extending) the lower extremity 3 to 5 inches off the ground (figure 7).

Side Plank with Hip Abduction

This exercise is effective for training the core and the gluteus medius. Once the side plank position is assumed, lift (abduct) the leg off the lower leg (figure 8).

Lunges

The lunge (figure 9) is an excellent exercise for training the muscles of the hips and the quadriceps. Dumbbells may be held in each hand to add resistance.

Including these exercises into a comprehensive training program may help to reduce the risk of sustaining an overuse injury. A triathlete may also benefit from consulting or training with a certified strength and conditioning specialist (CSCS). ■

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Triathlete Injury Prevention Training Program

2 – 3 sets of 15 repetitions

Utilize dumbbells with exercises 1 – 3 and 6, increasing weights as able.

Figure 1. Scaption

Figure 2. Side plank with shoulder external rotation

Figure 3. Three-point plank with shoulder horizontal abduction

Figure 4. Three-point plank with shoulder extension

Figure 5. Three-point plank with shoulder row

Triathlete Injury Prevention Training Program

2 – 3 sets of 15 repetitions

Utilize dumbbells with exercises 1 – 3 and 6, increasing weights as able.

Figure 6. Prone plank

Figure 7. Prone plank with hip extension

Figure 8. Side plank with hip abduction

Figure 9. Lunges

G. Gregory Haff, PhD, CSCS, FNSCA

about the **AUTHOR**

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High Intensity Intervals Improve Aerobic Power More Than Moderate Aerobic Training

Recently research from Norway explored the effects of different methods of training that were matched for total work and frequency on markers of aerobic endurance. Forty healthy subjects were assigned to one of four training interventions: 1) long slow distance (LSD) performed for 45 minutes at 70% of maximal heart rate, 2) lactate threshold running (LTR) performed at 85% of maximal heart rate for 24.25 minutes, 3) 15/15 interval training (15INT) in which 47 sets of 15 second intervals performed at 90 – 95% of maximum heart rate interspersed with 15 seconds of active recovery performed at 70% of maximum heart rate were performed (total time ~23 minutes), and 4) 4 x 4 interval running (4INT) in which four intervals of 4 minutes at 90 – 95% of max heart rate interspersed with 3 minutes active recovery at 70% maximum heart rate were performed (~28 min). All training was performed 3 days per week for 8 total weeks. Training adaptations such as changes in stroke volume, blood volume, maximal aerobic power (VO2max), and running economy were determined in response to the training period. The highest percent change in aerobic power and stroke volume was noted for the 4INT (VO2max = +7.2%) and the 15INT (VO2max = +5.5%) training groups. The least change in aerobic power was noted in the LSD group. No training induced differences in blood or hematological responses were noted between the 4 training groups. Additionally, no changes in running economy or lactate threshold were noted between training groups. All groups improved the velocity of running at the lactate threshold (+9.6%). Based upon these results it appears that interval training has a greater potential to improve aerobic power. While the 15INT group produced significant improvements the authors suggested that the implementation of the 4INT protocol which uses longer intervals is warranted when attempting to improve aerobic power. This recommendation was made based upon the higher increases noted with the 4INT intervention and the ease at which this protocol could be administered. Of particular importance is to note that the 4INT training duration was -17 minutes shorter than the LSD training sessions. Thus when clients or athletes are attempting to maximize training in shorter durations of time the use of high intensity intervals may be warranted.

Helgerud, J, K Hoydal, E Wang, T Karlsen, P Berg, M Bjerkaas, T Simonsen, C Helgesen, N Hjorth, R Bach, and J Hoff. Aerobic high-intensity intervals improve VO2max more than moderate training. *Med Sci Sports Exerc* 39:665 – 671. 2007.

Can Daily Heart Rate Variability be used to Guide Endurance Training?

The present study was designed to examine the usefulness of daily heart rate variability (HRV) in the individualization of endurance training prescriptions. Theoretically, HRV can be used to guide training. For example when HRV decreases the training stimulus can be decreased, or maintain training intensity when HRV increased or remained the same. Thirty health subjects were divided into three treatment groups: 1) a training group (TRA) performed a 6 minute warm-up and cool down at 65% of maximal heart rate and a 30 minute bout of running at 85% of max heart rate 6 days per week for 4 weeks, 2) the heart rate variability group (HRV) performed either a low training bout (65% of max heart rate), a high training bout (85% of max heart rate), or rested depending upon the daily changes in heart rate variability, and 3) a control group that performed no training. Heart rate variability was measured at changes in the high-frequency R-R interval (Polar S819i) and heart rate (Polar s625x) as measured each morning. The interesting aspect of this investigation was that the daily manipulation of training based upon HRV appeared to result in significant improvements in endurance performance. The HRV resulted in a significantly greater improvement in both maximal aerobic power (VO2peak) and maximal running velocity, while the TRA group only improved their maximal running velocity. However, no significant differences were noted between treatment groups. Based upon these data the authors concluded that HRV may be a useful tool for guiding training loads in endurance athletes.

Kiviniemi, AM, AJ Hautala, H Kinnunen, and MP Tulppo. Endurance training guided individually by daily heart rate variability measurements. *Eur J Appl Physio*l 101:743 – 751. 2007.

What is the Prevalence of the Female Athlete Triad in Female Triathletes?

The female athlete triad is a multifactorial condition which includes disordered eating, amenorrhea (cessation of menstruation), and osteoporosis. Recently, researchers from the Medical College of Wisconsin examined the prevalence of the female athlete triad in a club triathlon team. Fifteen women participated in this investigation. Disordered eating and menstrual cycle status were evaluated with the use of questionnaires, while occurrence of osteoporosis was evaluated with the use of dual-energy x-ray absorptiometry (DEXA). The results of the investigation revealed that 65% of the athletes were training under a significant calorie deficit. Fifty three percent of the athletes had a deficit in carbohydrate intake, 47% of the athletes had insufficient fat intake, and 40% of the athletes were deficient in protein intake. Additionally, it was determined that 33% of the athletes did not consume enough calcium in their diet. Forty five percent of the athletes demonstrated signs of amenorrhea. However, the athletes bone mineral density was normal at the lumbar spine and left hip. Based upon these results it appears that female club triathletes are at risk for some of the components of the female athlete triad. When the athletes were questioned about the female athlete triad over half of the athletes were unaware of what the female athlete triad is. The researchers concluded that it is important for female triathletes to be educated about the female athlete triad and appropriate interventions must be taken in order to reduce the prevalence of the disorder.

Hoch, AZ, JE Stavrakos, and JE Schimke. Prevalence of female athlete triad characteristics in a club triathlon team. *Arch Phys Med Rehabil* 88:681 – 682. 2007.

Upper Body Explosive Strength and Power are Related to Cross Country Skiing Sprint Performance

Recently researchers from Austria examined the relationship between upper body power, strength, and sprint performance over 50 and 1000-m. The first part of the project was to develop a sport specific strength and power based testing protocol. The second part of the study was designed to evaluate skiing performance and relate performance to the strength and power based tests developed by the researchers. Double poling was simulated with a rollerboard device (weighing 7.5kg) which allowed the athlete to kneel while poling. In this exercise the athlete pulls themselves towards the elevated end of the machine. The first test performed of the rollerboard was a 4 repetition maximum test which required the athletes to move as fast as possible. After a 3 minute recovery period the athlete performed a 40 repetition test at maximum speeds. Skiing performance was then determined with the use of treadmill and field tests using roller skiis. The first treadmill test was a double poling exercise performed at maximal speed. All subjects started at 4 m/s performed for 30s then speed was increased to 7 m/s. Speed was then increased by 0.3 m/s every 5 seconds until a maximal speed was achieved. The second test was 1000-m double poling test which required the subjects to complete 1000 m as quickly as possible. The final test was a 50-m poling testing where the subject was to complete 50-m as fast as they could. Results of this study suggested that 40 repetition test was highly reliable and explained 84% of the variance in 50-m double poling and 61% of the variance seen in the 1000-m double poling test. Specifically there was a significant relationship between maximal upper body power output during the 40 repetition test and 50 and 1000-m sprint performance thus suggesting that utilizing methods to improve upper body strength and power are warranted for cross country skiers. Based upon this data the authors concluded that explosive strength and maximal power are key components to successful sprinting in cross country skiing.

Stoggl, T, S Lindinger, and E Muller. Evaluation of an upper-body strength test for the cross-country skiing sprint. *Med Sci Sports Exerc* 39:1160 – 1169. 2007. ■

about the AUTHOR

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Power Training for Endurance Athletes

David Sandler, MS, CSCS,*D

Power is the ultimate combination of the two most fundamental human factors of survival: speed and strength. From the true warrior to the finest athlete to young children, power is quintessential to success. Power by its very definition suggests you cannot go with out, yet it deceives many and is generally considered necessary for contact sport or weightlifting athletes. However, many forget about the positive impact that power has on endurance performance.

Power Defined

Physics defines power as the rate at which work is performed. Human physiology defines power as the ability to generate enough energy to accomplish a specific feat or task in the least amount of time possible. Simply put, if you want to perform better in a specific sport or in daily activities, you should incorporate some form of power training into your workouts. For the endurance athlete this is no exception. In fact, power training may considerably improve running times by enhancing both physiological and mental functions.

The very nature of the word endurance suggests that power is not a significant part of the equation. For power to truly exist, the duration of an activity must be quick in nature, but with endurance, the opposite is true. Since the endurance athlete focuses on many aspects of improving performance through cardiovascular adaptation and improving metabolic efficiency, the idea of being explosive eludes many of these athletes. Being more explosive gives the endurance athlete another tool they can utilize during training and competition, such as speed to burst at the end of a race, power to climb a hill, and confidence knowing that you have more in "the tank" if needed.

Why Power Training?

The obvious connection of explosive training to power sports makes its training for endurance sports seem counter intuitive. The endurance athlete typically spends time doing Long Slow Duration (LSD) training mixed with interval training. Why do intervals? By comparison, it is relatively new to training since people have been running distances for centuries. They are performed in order to improve anaerobic threshold parameters as well as maximal aerobic power. Power training is also beneficial to the endurance athlete for the same reason but for a different application. Power training can improve an endurance athlete's submaximal strength as well as maximal power. This translates to an easier time running hills, applying quick bursts or improving maximal speed.

When Do We Add Power Training?

Since intervals have become common-place in the endurance athletes training program, it may seem wise to add explosive exercises to your daily routine as well. However, power training comes at a cost. High intensity exercise places greater stress on the soft tissue network (such as muscles, tendons, and ligaments) as well as a significantly higher neurological demand on the central nervous system (1). To combat these stresses, power training should be done in cycles, allowing the athlete plenty of recovery time to focus on other aspects of endurance sports. When adding explosive exercises to your program, they should be done first after a good warm-up, last no more then about 20 minutes, incorporated no more then twice per week, and cycled off after 3 – 4 weeks of training. More importantly, explosive exercises should not be done right before a big event, rather, your power training should end 2 weeks before your major competition. For those who compete year round, power exercises should be included in the training program when training for less important events.

What Type of Explosive Exercises Should I Do?

If you have rarely lifted weights in the past, you should stick to the basics, but for those who are more experienced with weight training, power cleans and snatches, provided form is correct, are safe and effective. In general though, you do not want to lose focus of your ultimate goal, which is moving your body on the field or the course, so this author's recommendation is to focus on bodyweight plyometric applications, lighter medicine ball exercises, and faster pace rep schemes for your general exercises.

Upper Body Day			
Exercise	Sets	Reps	Rest
Speed/Power/Plyometrics			
Medicine Ball Chest Pass	4	6	1 min
Medicine Ball Power Drop	4	6	1 min
Plyo Push Up	2	6	1 min
Basic Strength/Hypertrophy			
Flat Bench Press	3	12	90 sec
Incline Dumbbell Press	2	10	90 sec
Seated Row	3	12	90 sec
Lat Pulldown	2	10	90 sec
Overhead Press	3	10	90 sec

Lower Body Day			
Exercise	Sets	Reps	Rest
Speed/Power/Plyometrics			
Box Jump	4	6	1 min
Split Jump	4	6	1 min
Lateral Hurdle Hops	3*	6	1 min
Leg Press (timed for speed)	3	10	90 sec
Leg Extension (timed for speed)	3	12	90 sec
Basic Strength/Hypertrophy			
Leg Curl	3	12	
Romanian Deadlift	4	8	
Standing Calf Raise	3	15	

*** performed to each side**

Table 1

The following set of workouts are for combining your power and strength exercises into one workout. Each day could be done once or twice per week. If you are looking for a 3 day program, use the workout above, then the following two below.

What are Plyometrics and Do I Need To Do Them?

Plyometrics, often called "Plyos", are a method of training which enhances muscle's natural ability to contract more forcefully and rapidly. By decreasing the time and increasing the magnitude of the eccentric to concentric action of muscle (known as the Stretch Shorten Cycle), the athlete improves his or her ability to produce greater force more rapidly, thus improving the overall power of the movement. Plyometric activity utilizes muscle's inherent stretch-contract mechanism and over time, improves the rate at which force is developed. So, yes, even an endurance athlete should perform plyometrics.

Power Training and Workout Pace

First and foremost, before you begin to train power you should make sure you have developed an adequate amount of strength to perform this type of training. While certain strength measures are not feasible, you should be able to perform deep barbell squats, bench presses, and basic pulling exercises. If you have never done these exercises before, power training is not rec ommended until after at least 8 – 12 weeks of solid strength training. For those who have established a base level of strength, workout pace will be a key. Although the idea of shorter rest, fast pace workouts are opposite to power training recommendations, for the endurance athlete, ultimate 1 time power is not requested. Power training for the endurance athlete should emphasize more Power-Endurance, rather than maxing power. Endurance athletes will still perform short rep sets of no more then 8 reps, however, rest time should be 60 seconds to no more then 90 seconds between sets (as opposed to the recommendation of 3 – 5 minutes for power athletes).

Table 2: Training Circuit

Exercise for Beginner	Time/Reps	Rest	Modified Exercise for Moderate to Advanced
Seated Row	15s/ 8	10s	Bench Pull
Leg Press	15s/ 6	30s	Speed Squats w/ Bar
Bench Press	15s/ 6	15s	Bench Press
Leg Curl	15s/ 6	10s	Glute Ham Raise or RDL
Arm Curl	15s/10	10s	Arm Curl
Calf Raise	15s/15	10s	Calf Jumps for Speed
Overhead Press	15s/ 6	15s	Push Press or Push Jerk
Back Extension	15s/ 6	15s	Straight Leg Deadlift
Triceps Press	15s/ 10	10s	Dips or Triceps Press
Rest for 2 minutes then perform the above workout for 2 more circuits			

The above resistance workout should be performed twice per week for 3 – 4 weeks provided that a good strength base already exists. To keep time in the gym to a minimum, alternate exercises between upper and lower body after plyometrics. Resistance sets are timed so that all lifts become "explosive" in nature. Rather then using a controlled slow rep speed, you should look to complete your reps in the time allotted.

Plyometrics and power training in general is beneficial to everyone, not just power athletes. Improving strength and speed, while maybe less important for the endurance athlete focusing on cardiovascular fitness, will improve overall performance. More importantly, the athlete will feel stronger and be more secure in his or her pacing knowing that they have the burst speed and strength when needed. Be careful not to over-do-it, but also make sure to push yourself hard for more profound results. ■

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Training For the Half-Marathon

Chris Crawford, MS, NSCA-CPT

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Many recreational runners would like to push themselves beyond the more common 5K to 10K race distance but may not be ready to commit to running a full marathon (26.2 miles). For this reason the half-marathon (13.1 mile) race has become increasingly popular. Some enjoy competing at this distance because the training time required and the physical stress placed on the body is significantly less than when training for the full-marathon. Whether your goal is to simply finish this 13.1 mile run, or you are striving to set a personal best, it is important to have a properly designed training program to help you meet these goals systematically and safely. It is also important to have a basic understanding of your training program and the factors that influence performance. The following section will discuss these factors in greater detail.

Performance Factors

Maximal Aerobic Power (V02 max)

The major factors that influence a runner's ability to improve their performance are maximal aerobic power (V02 max), lactate threshold, and running economy.

V02 max is the maximal amount of oxygen that can be taken in and utilized by the working muscles. There is a high correlation between V02 max and performance (2), therefore; the higher the V02 max a runner has, the greater the potential for success. Many believe that one of the most effective ways to increase this factor for experienced runners is to run at an intensity or pace close to or equal to VO2 max (6).

There are numerous ways to determine VO2 max, however most of them require specialized equipment or must be done in a laboratory setting. For this reason, a more cost effective alternative is to perform the 1.5 mile Run Test and estimate your predicted VO2 max. In order to perform this test you need a stopwatch and a standard ¼ mile track (to ensure the accurate distance is used). To conduct this test simply record the amount of time it takes you to run or run/walk 1.5 miles. Once completed convert the elapsed time to a decimal form by dividing any seconds by 60, for example if your time was 10 minutes and 25 seconds, you would divide 25/60, and the elapsed time would be 10.42 minutes. Once you have determined the elapsed time, divide 2413.5 by the elapsed time (2413.5/10.42= 231.62) and multiply by 0.2. (231.62x0.2= 46.32). Finally, add 3.5 (49.82) and you will get your estimated VO2 for this test (6)

Lactate Threshold

Although V02 max is an important factor in running performance, lactate threshold may be even more significant (2).Lactate is a byproduct of glycolysis, or the "short term" energy system. Distance running primarily uses the aerobic energy system to provide the body with energy, however, when intensity is increased, the glycolic energy system is called upon, and lactic acid is produced as a byproduct. Lactic acid is broken down into lactate, which is further used by the body as energy, and hydrogen ions; which build up on muscular contraction sites leading to fatigue and decreased performance (8). Lactate threshold is the term used to describe the intensity at which the hydrogen ions begin to accumulate to a level that the body is not able to use efficiently or clear. This leads to muscle fatigue and decreased performance. A major goal of a training program that is focused on improving running performance should be to increase lactate threshold to a higher percentage of V02 max. Lactate threshold has a significant influence on running pace. A higher lactate threshold allows the runner to sustain a faster pace without becoming reliant on the glycolic energy system. Similar to V02max, one of the most effective ways to increase lactate threshold is to train at an intensity or pace close to this level. For distance runners, this typically ranges from 75 to 90% of V02 max, depending on their current level of fitness (3).

Running Economy

Running economy is the final physiological factor discussed that can influence a runner's performance. This term is used to describe the energy cost of running. For

example, those with good running economy expend less energy, or require less oxygen for a given running pace than those with poor economy. When training to improve V02 max or lactate threshold there is a given intensity or pace that serves as a reference point. Improving running economy is a more abstract approach. The idea is that by improving several factors, such as biomechanics (running form/posture), cardiovascular efficiency (the ability of the heart and lungs to transport oxygen to muscles), muscular strength, endurance, and power, the runner will become more efficient, therefore expending less energy.

Types of Training

Long Runs

Long runs are used to build endurance in the cardiovascular and muscular systems, and progressively train the body to become more efficient at utilizing oxygen. These positive changes improve running economy and increases V02 max in the less experienced runner (6).

Both running programs (beginner and advanced) contain one long run each week on Saturday. These runs should be at a slow, comfortable pace allowing you to carry on a conversation. For those wearing a heart rate monitor this is typically 65 – 80% of maximal heart rate. The distance of these runs progresses from 5 to 12 miles in the beginner program and 5 to 14 miles in the advanced program.

Easy Runs

Easy runs make up the majority of the training in the beginner program. These runs are done at a low intensity, which allows the aerobic (oxidative) energy system to supply a steady amount of energy to the working muscles. Easy runs are also used to recover from the more strenuous workouts in the advanced program. The intensity of an easy run should be done at a conversation pace.

Tempo Runs

Tempo paced running is a method of increasing lactate threshold; which will allow you to increase your race pace and run for a longer duration of time. The intensity of a tempo run should be equal to or slightly lower than lactate threshold, but faster than the pace of the easy and long runs, and sustainable for at least 20 minutes.

The duration of the tempo runs will range from 30 to 45 minutes. These should begin at easy run pace for 5 minutes before increasing to 10K pace and end with 5 minutes of easy run pace. The duration listed in the program includes this warm-up and cool-down period.

Interval Runs

Interval training is often necessary to increase V02 max in more experienced runners (5). This type of training allows you to run at a faster pace for a greater amount of time than would be possible if running continuously. Interval runs are included in the advanced program. In order to prepare for an interval begin with an easy run of 800 meters to a mile, followed by a few 100 meter runs at tempo pace. The advanced program involves 800 meter runs separated by rest periods of walking. The rest periods should be at least half the distance covered in the interval (6).

Cross Training

Implementing another type of training activity into your program is referred to as cross training. Cross training may reduce the likelihood of overuse injuries because it shifts the stress of training to different muscle groups, or stresses the same muscles used during running in a slightly different way (2). Aerobic cross training allows you to decrease your weekly mileage by replacing it with conditioning that helps maintain fitness level while enhancing recovery (3). Low impact cross training can encourage faster recovery than sedentary behavior (4). Any activity other than running that elevates your body above the resting levels for an extended period of time could be considered cross training. Examples include swimming, biking, water jogging, rowing, or strength training.

While cross training it is important to remember that the purpose of this activity is to promote recovery and not push your limits, thus a low- intensity and duration should be maintained.

Hill Running

The addition of hill training during half-marathon preparation is important for several reasons. From a practical standpoint, during a race you will inevitably encounter hills so in order to be adequately prepared you must spend time training on them. Running hills also improves functional strength (4). If performed properly, hill training can also help improve running economy. Any area with moderate sized hills will usually be sufficient for this method of training. However, if the race you are training for contains more significant hills, you may want to implement similar terrain in some of your training.

When Hill training, make certain you do not make the mistake of sprinting downhill as this increases the likelihood of experiencing delayed onset muscle soreness due to the forceful elongation of muscle fibers in the lower extremities. Conversely, it is also important to avoid "putting on the breaks" when running downhill, as this will cause a significant "jarring" effect on foot strike, also accentuating the amount of stress the body must endure.

Rest

Although recovery takes place with low intensity activity having a day of complete rest that does not involve any type of structured activity is suggested. Both programs include a rest day immediately prior to the long run.

Putting it All Together

The beginner program is designed for individuals with the goal of completing the run regardless of pace or time. Before attempting this program it is suggested that you have some experience running and have a current training base of at least 10 – 15 miles per week.

The advanced program is intended for those wanting to improve their performance based on previous competitions. To participate in this program it is recommended that the runner currently have a base of at least 10 – 15 miles per week and be able to accurately judge their 5k and 10k pace in order to get the most out of tempo and interval runs.

The following are examples of 16-week training plans for the half-marathon, however, it is impor-

Wk	Sun	Mon	Tues	Wed	Thurs	Fri	Sat
1	Walk/ER - 30 min	2m	CT - 30 min	2m	2m	Rest	5m
2	Walk/ER - 30 min	2m	CT - 30 min	2m	2m	Rest	5.5m
3	Walk/ER - 30 min	3m	CT - 30 min	3m	3m	Rest	6m
4	Walk/ER - 30 min	3.5m	CT - 30 min	3m	3m	Rest	6.5m
5	Walk/ER - 30 min	3.5m	CT - 30 min	3m	3m	Rest	7m
6	Walk/ER - 30 min	3.5m	CT - 30 min	Hill Run -20min	3m	Rest	7.5m
7	Walk/ER - 30 min	4m	CT - 30 min	Hill Run -20min	3m	Rest	8m
8	Walk/ER - 30 min	4m	CT - 30 min	3m	3m	Rest	8.5m
9	Walk/ER - 30 min	4m	CT - 30 min	Hill Run - 20min	3m	Rest	9m
10	Walk/ER - 30 min	4.5m	CT - 30 min	Hill Run - 20min	3m	Rest	9.5m
11	Walk/ER - 30 min	4.5m	CT - 30 min	3m	3m	Rest	10m
12	Walk/ER - 30 min	4.5m	CT - 30 min	Hill Run - 30min	3m	Rest	10.5m
13	Walk/ER - 30 min	5m	CT - 30 min	Hill Run - 30min	3m	Rest	11m
14	Walk/ER - 30 min	5m	CT - 30 min	3m	3m	Rest	11.5m
15	Walk/ER - 30 min	5m	CT - 30 min	Hill Run - 30min	3m	Rest	12m
16	Walk/ER - 30 min	3m	CT - 30 min	3m	2m	Rest	Rest
17	**RACE DAY**						

Table 1

Beginners

ER = Easy Run
CT = Cross Train
m = Mile

tant to listen to your body. If you start to notice significant reductions in performance or seem to have more difficulty recovering from your training runs than normal, occasionally adding an easy run or rest day to the training program may help reduce injury risk and the signs and symptoms of overtraining rather than trying to simply "push" through the fatigue. ■

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Wk	Sun	Mon	Tues	Wed	Thurs	Fri	Sat
1	Walk/ER - 30 min	TR - 30 min	CT - 30 min	3m	3m - ER	Rest	5m
2	Walk/ER - 30 min	TR - 30 min	CT - 30 min	IR - 4/800 meters	3m - ER	Rest	5.5m
3	Walk/ER - 30 min	TR - 30 min	CT - 30 min	IR - 4/800 meters	3m - ER	Rest	6m
4	Walk/ER - 30 min	TR - 30 min	CT - 30 min	6m - ER	3m - ER	Rest	6.5m
5	Walk/ER - 30 min	TR - 30 min	CT - 30 min	Hill Run - 20min	3m - ER	Rest	7m
6	Walk/ER - 30 min	TR - 30 min	CT - 30 min	Hill Run - 20min	3m - ER	Rest	7.5m
7	Walk/ER - 30 min	TR - 45 min	CT - 30 min	IR - 6/800 meters	3m - ER	Rest	8m
8	Walk/ER - 30 min	TR - 45 min	CT - 30 min	IR - 6/800 meters	3m - ER	Rest	9m
9	Walk/ER - 30 min	TR - 45 min	CT - 30 min	6m - ER	3m - ER	Rest	10m
10	Walk/ER - 30 min	TR - 45 min	CT - 30 min	Hill Run - 30min	3m - ER	Rest	11m
11	Walk/ER - 30 min	TR - 45 min	CT - 30 min	Hill Run - 30min	3m - ER	Rest	12m
12	Walk/ER - 30 min	TR - 45 min	CT - 30 min	IR - 8/800 meters	3m - ER	Rest	13m
13	Walk/ER - 30 min	TR - 45 min	CT - 30 min	IR - 8/800 meters	3m - ER	Rest	14m
14	Walk/ER - 30 min	TR - 45 min	CT - 30 min	6m - ER	3m - ER	Rest	12m
15	Walk/ER - 30 min	TR - 45 min	CT - 30 min	Hill Run - 30min	3m - ER	Rest	10m
16	Walk/ER - 30 min	TR - 30 min	CT - 30 min	3m	3m - ER	Rest	Rest
17	**RACE DAY**						

Table 2

Advanced

ER = Easy Run
TR = Tempo Run
CT = Cross Train
IR = Interval Run
m = Mile

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Avoid Sport Beverage Blunders: Which One is Right For You?

about the AUTHOR

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Sports drinks are a concentration of water, carbohydrates and electrolytes that are designed to replenish athletes' energy and fluid balance. They are recommended to hydrate athletes involved in sustained, intense exercise lasting longer than one-hour to mainly add carbohydrates for energy (1). Sports drinks add fuel to the muscles for extended exercise or recovery of muscle glycogen after exercise (3).

The goal of drinking during exercise is to prevent dehydration, considered >2% fluid loss in body weight (1), which ultimately hinders performance. Electrolytes, such as sodium and potassium, are commonly added to sports drinks to replace losses from sweating. Sodium is the main electrolyte lost in sweat and replacement is necessary for athletes participating in prolonged exercise of three hours or more (marathons, triathlons, etc.) for prevention of hyponatremia or water intoxication(5). Hyponatremia occurs when too much water is consumed, dangerously lowering sodium and potassium levels. The replacement of electrolytes lost during exercise of less than 3 hours can be met through meals consumed post exercise, not necessarily through a sports drink (3).

People that workout less than one hour should drink plain water for hydration (1). If plain water does not suit you, enhanced water or water with added flavors are good substitutes. Try mixing water with a few ounces of juice for flavor. Sodium in these drinks could provide benefit because it stimulates thirst, resulting in rehydration (5).

The carbohydrate recommendation for sports drinks is to provide 30 – 60 grams of carbohydrate per hour (1). Drinks that contain 60 – 80 calories per 8 ounces supply the needed carbohydrates required for continuous performance to prevent muscle fatigue. Ideally, the best way to refuel carbohydrates is with a combination of sugars (ex: glucose, sucrose, fructose, maltodextrine) and the concentration should be 6 – 8% carbohydrate (or 14.2 – 18.9 grams per 8 oz.), as highly concentrated carbohydrate beverages are shown to reduce gastric emptying and can even produce stomach upset (3). Furthermore, fructose should not be the main carbohydrate source during exercise because it is converted too slowly into an energy source and can cause gastrointestinal distress (1).

Many sports drinks now contain added protein. These drinks provide a 4:1 carbohydrate to protein ratio designed to increase endurance and sports performance. A 2006 study published by *Medicine & Science in Sports & Exercise* found that adding 2% protein to a 6% carbohydrate drink provided no additional performance benefit during sports activity in which athletes normally compete (2). The additional protein provides greater caloric intake during exercise and recovery which may account for any improvements seen in performance (4). However, at this time more research is needed on this subject.

Enhanced water is a general term for water that contains additions of flavor, color or vitamins and minerals. Enhanced waters (e.g., Gatorade's Propel, Glaceau's Vitamin Water, Sobe's Life Water, etc.) have less calories and electrolytes than sports drinks and are intended for everyday consumers as well as athletes not participating in intense activity. Are these beverages necessary? No. On the other hand, research shows that children (and adults) will drink more and stay hydrated better if the water is enhanced with flavor (6).

Although one serving can provide between 10 – 100% of the DRI for some vitamins, (Table 2), it is possible that these beverages, along with a multivitamin and the nutrients naturally found in foods could bring a person's intake to levels close to or exceeding the upper level recommendations for that nutrient.

Drinking enhanced water does help meet fluid needs but the vitamins supplied do not substitute for a meal and these drinks do have added calories that are not present in regular water. So if weight loss is the primary goal, drinks like Sobe Life and Vitamin Water which provide 120 – 150 calories per bottle, will add unnecessary calories.

Enhanced waters made with artificial sweeteners, such as Propel, provide minimal carbohydrates. Although Propel is more suited for hydrating people trying to lose or

Tables 1 and 2

Sports Drink (8 oz serving)	Calories	CHO (g)	CHO source	Protein (g)	Sodium (mg)	Artificial Sweetener
Gatorade	50	14	Sucrose, glucose-fructose solution	0	110	No
Powerade	70	19	High fructose corn syrup, maltodextrin	0	55	No
AllSport	65	16	Sucrose	0	54	No
Accelerade	80	15	Sucrose	4	120	No

Enhanced Water (8 oz)	Calories	CHO source	CHO (g)	Protein (g)	Sodium (mg)	Vitamins	Artificial Sweetener
Propel	10	Sucrose	3	0	35	Vitamin C: 10%; Vitamin E: 10%; Niacin: 25%; Vitamin B6: 25%; Vitamin B12: 4%; Pantothenic acid: 25%	Sucralose
Vitamin Water	50	Fructose	13	0	0	Vitamin B3:10%, Vitamin B5:10%, Vitamin B6:10%, Vitamin B12:10%, Vitamin C: 60%	No
Sobe Life Water	40	Sucrose	10	0	35	Vitamin C: 100%; Vitamin E: 20%; Niacin: 10%; Vitamin B6: 10%; Vitamin B12: 10%; Pantothenic acid: 10%	No

maintain weight, they are not suited for athletes engaging in long, intense exercise routines.

In summary, athletes that exercise intensely for 1 hour or more need additional carbohydrates and fluid replacement than simply water alone. Athletes participating in prolonged exercise for 3 hours or more need fluid, carbohydrate and electrolyte replacement. Enhanced waters provide hydration, but also calories that can contribute to weight gain if not used in moderation. ■

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Strive For Quality

about the AUTHOR

Suzie Tuffey Riewald received her degrees in Sport Psychology/ Exercise Science from the University of North Carolina —Greensboro. She has worked for USA Swimming as the Sport Psychology and Sport Science Director, and most recently as the Associate Director of Coaching with the USOC where she worked with various sport national governing bodies (NGBs) to develop and enhance coaching education and training. Suzie currently works as a sport psychology consultant to several NGBs.

In this column, learn strategies to help you consistently make training a physical, technical and mental endeavor and prepare yourself for competition. We have touched on this subject before in this column but it bears repeating—over and over again, if necessary. This fact struck me as I was talking with an athlete this past week. He's an elite level athlete with a realistic opportunity to represent his country in the Olympics, which would be the fulfillment of a lifelong dream. With this goal within his reach, you would think he would have every reason to be motivated, focused and purposeful about his daily training. Yet, he admittedly struggles with these things, almost on a daily basis. This got me thinking about athletes in general—what keeps you going and how can you stay focused and motivated given that this is even a challenge for some of the best athletes in the world.

In this column, we are going to take a look at why the notion of purposeful, quality training is so important and identify specific things you can do to enhance your daily training. We'll discuss strategies to help you consistently make training a physical, technical and mental endeavor by bringing intensity, effort, purposefulness and quality into the practice arena—qualities that are needed to prepare yourself optimally for when it comes time to compete. And, for the next issue of the PTJ, I'm going to call on you to provide further strategies that you have found effective.

You may be asking yourself, "Why all the fuss, I'm training every day. Isn't that enough?" A simple answer to this question is "No." So much more can be achieved when you train with purpose and intensity (when you integrate the mental with the physical) versus just training (when it is strictly a physical and technical endeavor).

For one, intensity and purposefulness in your training today is going to enhance your training today. Quality training will lead to quality performances. To illustrate this, compare two tennis players who both take a hopper of balls out to the court to work on serves. One player pounds out her serves one after the other and gets through the basket of balls as quickly as possible. The second player takes a different approach to the same task. She performs her pre-serve routine prior to every serve and really works on getting full extension as she drives up to the ball, something she has been struggling with recently. Pretty easy to identify the player who is achieving more, isn't it? While they hit the same number of serves, the quality and focus of the practice is drastically different.

Additionally, intensity and purposefulness in your training will help develop the mental skills important for competition and, thus, enhance your competitive performance. To perform well in competition, one needs to be mentally prepared such as being focused, composed and confident. Just as you train the physical and technical skills that are necessary for performance, you need to train and develop mental skills—effective concentration doesn't just happen, it needs to be learned and developed. Mental skills needs to be trained in training to "have them" for competition.

Let's look at ways to bring intensity and purposefulness to training. We'll start a list of strategies then continue this in the next Mind Games column.

- **Set a Training Goal.** Before each training session, identify one thing that you want to accomplish to bring purpose to your training session.
- **Use Cues** to emphasize important points during practice. "Rotate," "torpedo off the wall," "explode," "run like a gazelle." Performance cues can help you focus on the process without getting overwhelmed with "every little thing" you need to do. It is these same performance cues that you bring to competition.
- **Integrate Imagery.** Prior to a drill or a repeat, visualize correct execution. This offers you an additional form of practice and "imprints" success.
- **Be an Athlete.** Prior to a training session, make a conscious effort to place stress, worries, thoughts unrelated to your sport aside and commit to being an athlete for the next 1 – 2 hours. These distracters have a way of creeping into training sessions and taking mental energy away from the task at hand.
- **Strive for Perfection.** In talking with a coach, he noted that athletes sometimes fall in the trap of accepting "sloppy" technique in training yet turning around and demanding perfection in competition.

Don't allow this to happen to you. Every day, remind yourself that how you train is how you will compete.

- **Remind Yourself** of your competition goals. Sometimes a reminder about "why" you are training hard every day can enhance daily motivation. Tell yourself that your effort today will pay off at the end of the season.
- **Take a Mental Break**. Just as you need rest and recovery days built into a training program, you need a mental break as well. Identify days in your training program where you can allow yourself to rest mentally (i.e., slow, easy days, cross training days). This will keep you mentally fresh.

Call to Action

The suggested strategies for enhancing training (and, thus, competition performances) offer a great start. But, now, it is your turn. Many of you have been training and competing for years and years, even decades. What do you do to bring focus, intensity and quality to your training? How do you structure your training so it is more than just "going through the motions or putting in the time?" You have undoubtedly figured out some effective strategies to integrate the mental piece into your training and to bring quality and purposefulness to what you do. I ask you to share these with me so I can share them with others in our next column. Please email me your practical ideas at suzriewald@aol.com. I look forward to hearing from you. ■