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NSCA's

Performance Training Journal

Running

NSCA™

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Contents

Feature: Running

Departments

NSCA's Performance Training Journal

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Mission

As the worldwide authority on strength and conditioning, we support and disseminate research-based knowledge and its practical application to improve athletic performance and fitness.

AskTheExperts

Question

"I plan on competing in a marathon, and some friends have recommended I carbo-load for it. What is it, and how do I do it?"

Answer

Carbohydrate loading works by depleting the glycogen stores in your muscles, then consuming more than the usual amount of carbohydrates. This results in a super compensation of stored glycogen, providing extra energy during endurance activities.

The most commonly-used protocol today for carbohydrate loading is performed by training at 85% of your heart rate max for 1.5 hours on day one. Gradually exercise duration is reduced on successive days. Diet for the first three days should be composed of 50% carbohydrates. The final three days, carbohydrates should represent 70% of total calories.

Because of the large amount water that is needed to store muscle glycogen, some athletes feel much heavier, and uncomfortable when they carbohydrate load. This is one of the reasons why carbohydrate loading can have a negative affect on your performance. It is best to try it out during your training, and log all training sessions to see if there is any detriment in your performance. If your performance has decreased, then you probably do not want to carbohydrate load.

Keith E. Cinea, MA, CSCS

Keith E. Cinea, MA, CSCS, earned his B.A. and M.A. from the University of Northern Colorado. He is currently the Educational Programs and Products Coordinator for the NSCA. Before taking this position, he was the Strength Training Coordinator for the Central Denver YMCA, and worked as an adjunct faculty member at Front Range Community College in Westminster, Colorado.

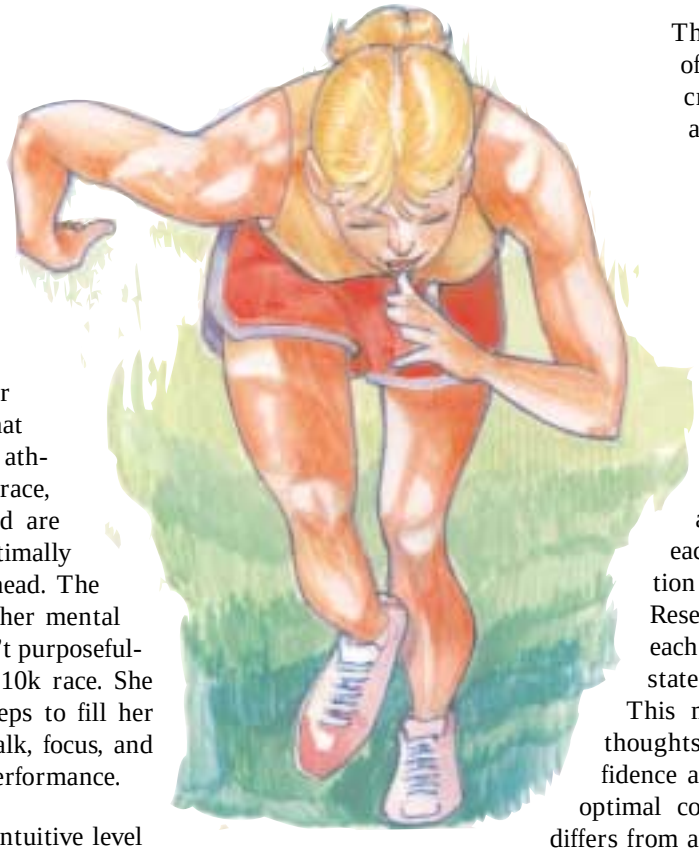
TalkToUs

We will choose one question each issue for the "Ask the Experts" column. The December 2002 issue will focus on periodization, so send your periodization questions to *Performance Training* Editor, NSCA, 1955 North Union Blvd., Colorado Springs, CO 80909 or by email to webmaster@nsca-lift.org.

By Suzie Tuffey Riewald, PhD, NSCA-CPT

Bring Your Mind to the Line

Haley has done an easy warm up jog, stretched, and put on her racing flats ... and there are still 30 minutes until the gun goes off for the 10k road race. She feels like she has done all she can to get herself ready for the race so now has time to kill. What do you think? Is she optimally prepared to race and to race fast?



It seems that Haley has done a great job of getting her body ready to race, but what about her mind? Anytime an athlete steps up to the line to race, both her body and her mind are with her—both need to be optimally prepared for the challenge ahead. The element Haley is missing is her mental preparation. That is, she hasn't purposefully directed her mind to the 10k race. She could benefit from taking steps to fill her mind with the images, self-talk, focus, and goals that will enhance her performance.

While it makes sense on an intuitive level to suggest that an athlete needs to be mentally prepared in addition to being physically prepared, I want to provide you with two pieces of compelling information to convince you of the value and importance of mental preparation.

- Psychological profiles of elite athletes reveal that "having a well developed mental routine" is a critical characteristic related to success.
- Research on 1996 and 1998 Olympians found "developing and adhering to physical and mental preparation plans" was a characteristic that distinguished more versus less successful Olympians.

These findings suggest that use of a mental preparation plan is critical to athletic performance—for Olympians and for you. So, now that I have your attention, let's take a look at the basics of mental preparation so you can begin developing your own mental preparation routine.

- **Mental preparation is highly individualized.** There is no "best" mental preparation routine that applies to every athlete. Rather, each athlete has a mental preparation plan that works best for him. Research supports the notion that each athlete has a zone or mental state at which he performs best. This mental state encompasses the thoughts, the focus, goals, attitude, confidence and anxiety of an athlete. The optimal combination of these variables differs from athlete to athlete, from sport to sport. One thing remains consistent, however. Prior to a competition, when an athlete is in his optimal mental state, he will tend to have better performances.

- **Identify YOUR optimal mental state.** An effective way to figure out how you tend to perform best is to assess your past performances. Think back to a great racing performance and try to recall what you were thinking, how nervous you were, how you were focused, your confidence level, and how you were feeling physically and mentally. Write it down. Now, do the same assessment for a poor performance—a race where you didn't perform as you know you are capable. Compare your mental state prior to the great and poor performance. There are a lot of differences, aren't there? Use this information as a starting point in helping you determine the precompetition mental state at which you performance best.
- **Develop a routine to attain this precompetition mental state.** You've identified how you need to think and feel prior to a race to facilitate a good performance. The next challenge is to determine how to get into this mental state on a consistent basis. Your precompetition mental routine will incorporate various mental skills and strategies that you use to purposefully get you into your optimal mental state. Let me give you a few examples to bring this to life:

Connor has realized that he tends to race the 5k best when he is focused on himself (not the other runners), is confident, and has very little nervousness. After much practice, he learned that for him to keep his nervousness low, it was best for him NOT to think about the race and NOT to worry about the other runners. (This is a tough feat to accomplish.) He decides that he needs to distract himself from the race environment so he opts to listen to his Walkman, off by himself and away from the hubbub of the race, until 10 minutes before the start. During this time, he mentally rehearses the race two times, seeing and feeling himself achieve his goals. His purposeful self-talk focuses on cues about what he needs to do—relax the first mile, work your arms and pick up the pace on mile 2, then bring it home. Connor uses this mental routine prior to every race, whether it is the local 5k or State Championships.

After learning about mental preparation, Haley approaches competition a little differently. Instead of "killing time" prior to the race, Haley is using the time wisely. She has learned she races best when confident, so to build her confidence she reminds herself of all the awesome workouts she has run and the consistent high quality of her training. She uses positive self-talk and tells herself "you can do it, you're trained and ready" and "manage your pace through the 5k then slowly pick it up." The image in her head is of a gazelle running through a field. She imagines herself running like a gazelle—effortlessly.

Each of these athletes takes a different, but equally effective, approach to preparing for his or her race. Instead of just "seeing what happens," they take the time before a competition to focus their thoughts and to get mentally prepared. You can do the same thing. It is important for you first to determine the mental state at which you race best and then piece together mental skills and preparation strategies to help you attain this state. Developing a routine does not happen overnight, but you can start the process today and soon you can be running "out of your mind."

About the Author

Suzie Tuffey Riewald received her Master's and PhD 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 now is Associate Director of Coaching with the USOC where she works with various sport national governing bodies (NGBs) to develop and enhance coaching education and training. Additionally, Suzie is an NSCA-Certified Personal Trainer.

Lee E. Brown, EdD, EPC, CSCS,*D

Fractal Periodization

Periodization is the regulation of resistance training program variables, over time, which results in the prevention of overtraining. It was developed in Russia in the 1960's, was modeled after Selye's General Adaptation Syndrome[4] and was popularized in this country in the early 1980's by Stone[5]. A fractal object is one that is self-similar at increasing levels of magnification[2]. This means that as you look closer and closer at the object it still looks the same as it did in full view (figure 1). Fractal objects occur throughout the span of our environment such as clouds, coastlines and snowflakes[3] as well as human physiology in heartbeats, brain waves and strength expression[2]. They are discernible as fractal because they contain high levels of complexity and are born out of chaos theory[3]. Chaos theory merely states that future performance will be very difficult to predict from models containing significant levels of complexity.

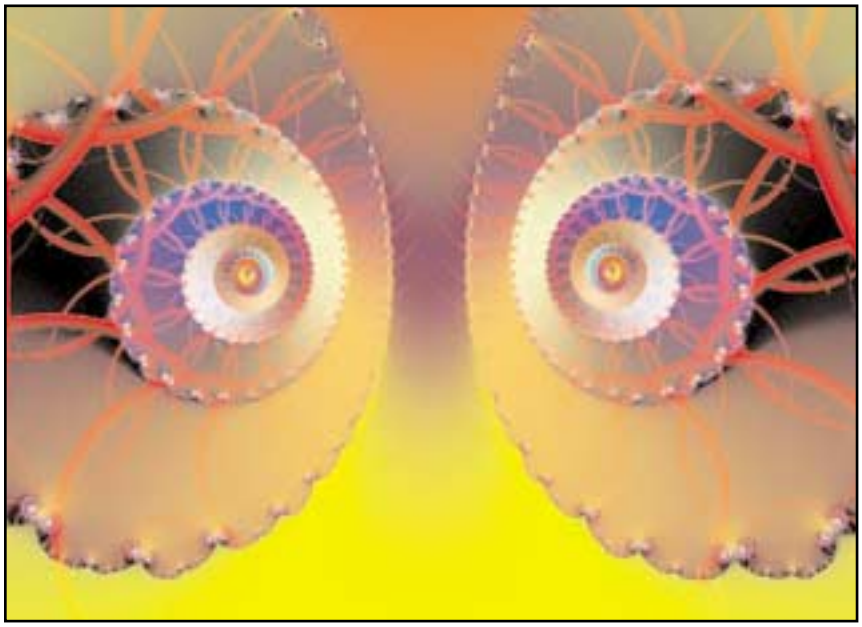


Figure 1: A computer generated fractal graphic.

Undulating Periodization

The essence of periodization is an undulating program that allows the individual undergoing resistance training to intersperse periods of rest with periods of intense lifting[5]. The peaks are short periods of very intense lifting approaching 90 - 100 percent of a one-repetition maximum (1RM) lift. The valleys are rest periods allowing the body's energy systems to re-fuel and allowing the neuromuscular system to adapt to the changing stressor. Without rest periods, overtraining will occur. It is also important to set up the volume of exercise (sets x reps) so that it displays the reverse fractal illustration. In other words volume and intensity follow opposite patterns in that while intensity increases, volume decreases. Reducing volume in conjunction with high intensity lifts allows an individual to further avoid overtraining and possible injury.

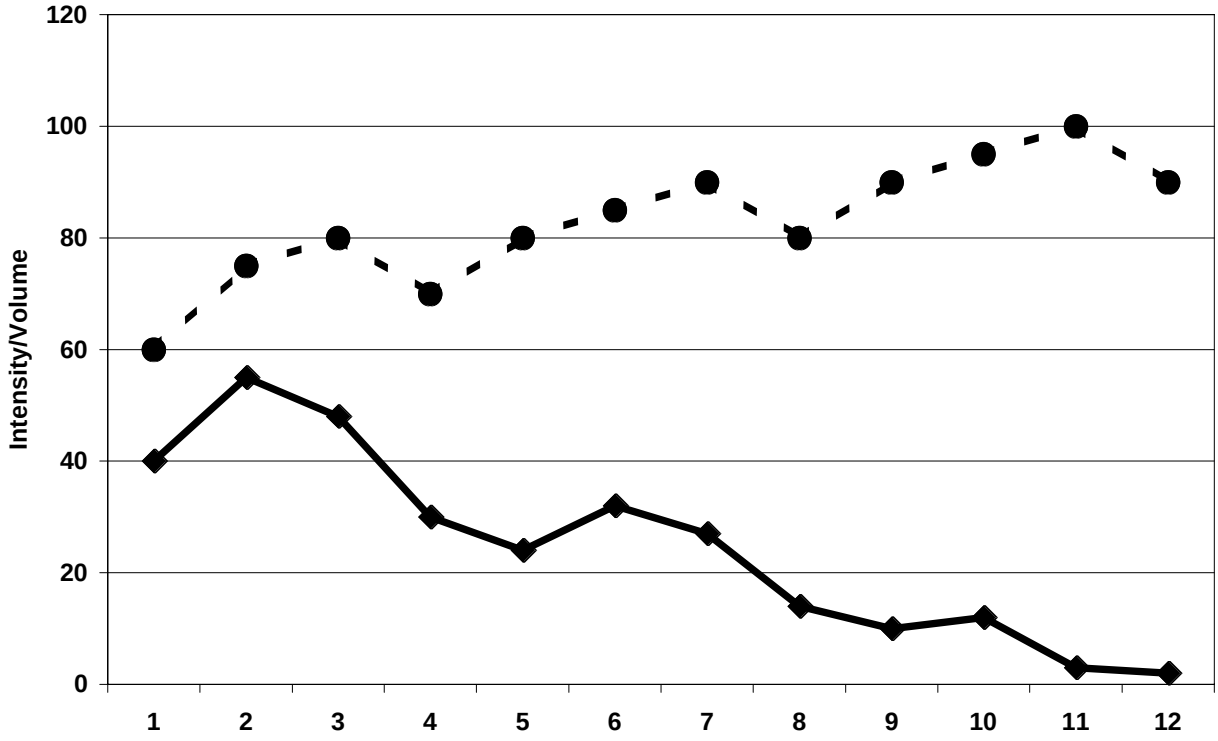


Figure 2: Training cycle for a year.

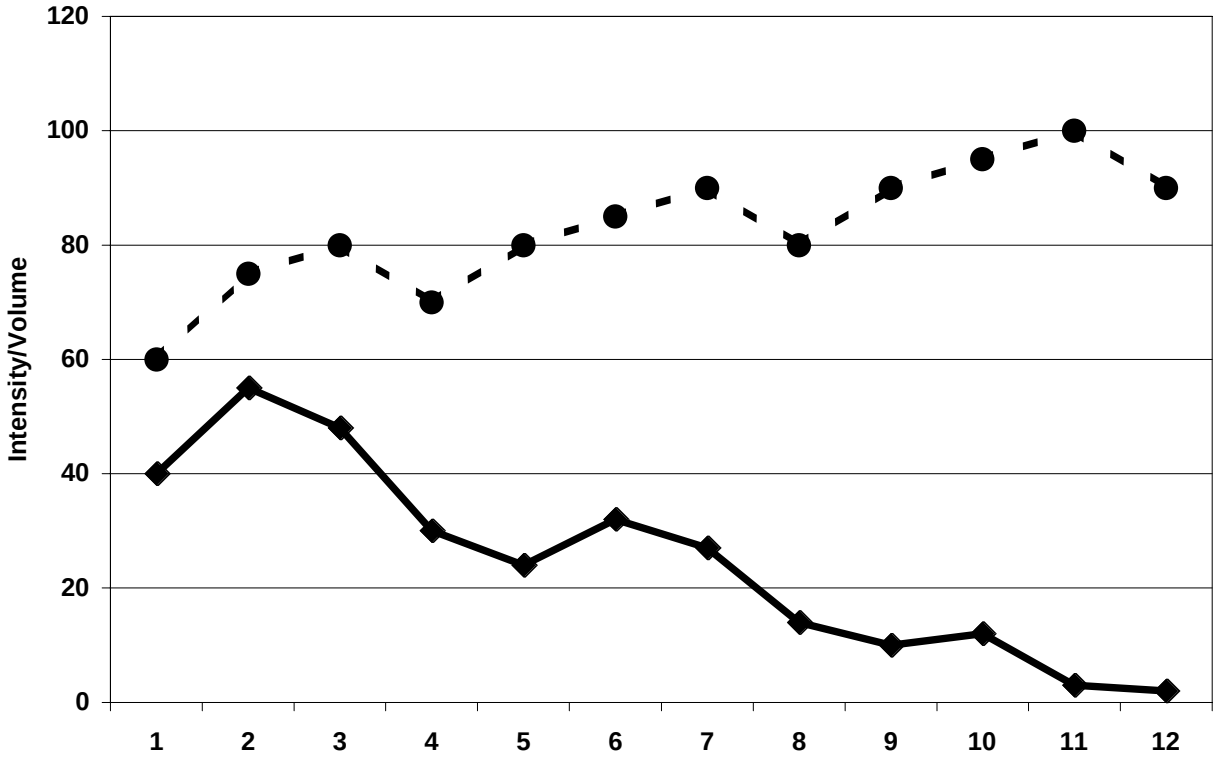


Figure 3: Training cycle for 3 months.

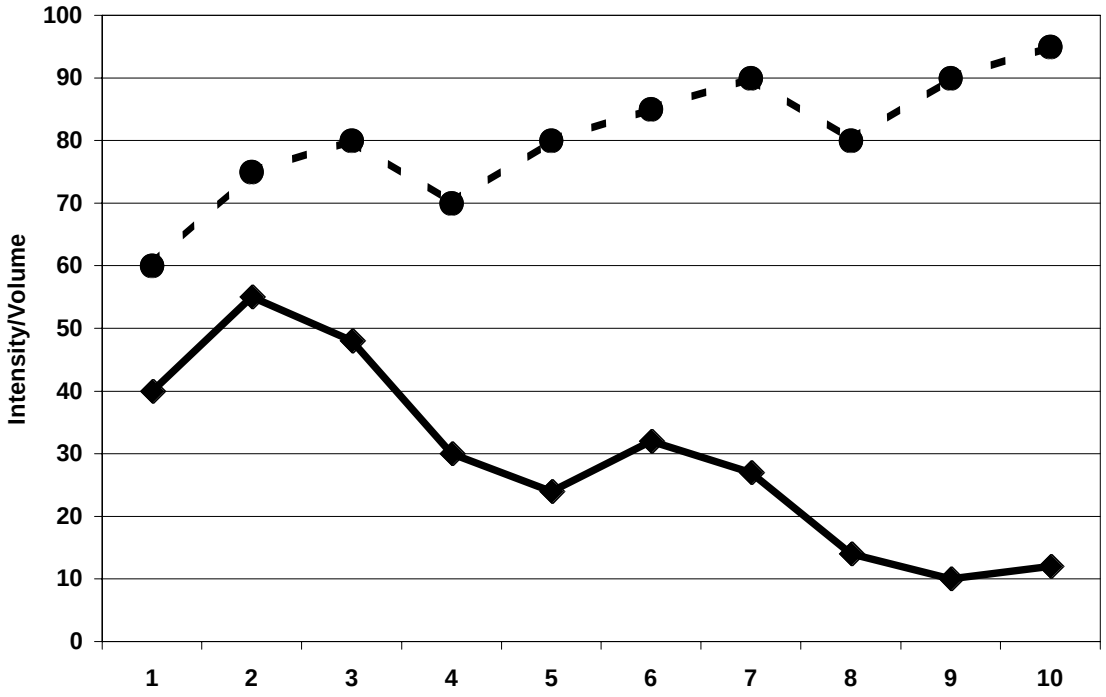


Figure 4: Training cycle for 2 weeks.

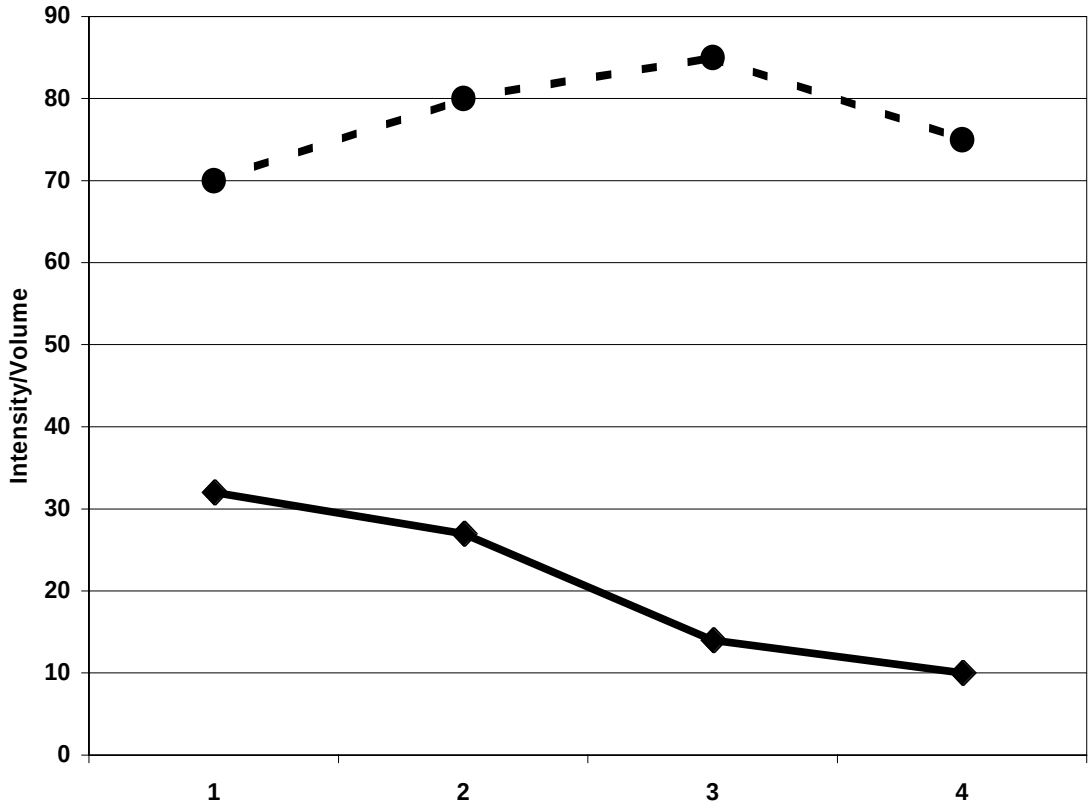


Figure 5: Training cycle for 1 day using 4 sets of a single exercise.

Fractal Nature

The hallmark of any periodization program is an emblematic peak and valley scenario over the 12-month period of one macrocycle (figure 2). The macrocycle depicted consists of approximately three 4-month periods or mesocycles. These mesocycles also have the characteristic peak and valley appearance resembling the macrocycle (figure 3). Mesocycles can be further broken down into smaller increments of training epochs of 1 to 2-week cycles or microcycles that also look similar to the original macrocycle (figure 4). Finally, even one single day of training may consist of peaks and valleys of intensity as one performs three or four sets of an exercise (figure 5).

Summary

One can see how a periodization model is fractal in nature. The pattern repeats itself across the time period depicted in any one graph[1]. In practical consideration then, when developing a periodized model for training, one need only develop one microcycle and then use that repeating pattern as an example for further meso and macrocycles. The peaks and valleys contributing to the overall wave-like format of any periodization program require greater reading and training than this article is capable of delivering but conceptually, a repeating pattern of hard and easy lifting days is at the heart of the diagram.

References

1. Brown LE, Knee RH. Monitoring Periodization with a Spreadsheet. *Strength and Conditioning Journal. 21(6)*:45-49, 1999.
2. Bassingthwaighte JB, Liebovitch LS & West BJ. *Fractal Physiology.* New York: Oxford University Press, 1994.
3. Lorenz E. *The Essence of Chaos.* Seattle: University of Washington Press, 1993.
4. Selye H. *Stress Without Distress.* New York: Harper and Row, 1974.
5. Stone MH, O'Bryant H, Garhammer J. A hypothetical model for strength training. *Journal of Sports Medicine, 21*:344, 1981.

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FitnessFrontlines

Edmund R. Burke, PhD, CSCS

Do you really know how hard you are exercising?

A new study by Glen E. Duncan, PhD, research fellow at the University of Florida Health Science Center in Gainesville, shows that it is a lot easier to determine that you exercised for 30 minutes than it is to figure out how vigorously you exercised. According to a study published in the journal Preventive Medicine, people often overestimate the intensity of their workouts. In the study, 94 men and women recorded how long and how hard they thought they exercised for two weeks, and then they checked their estimates against a heart rate monitor. The participants recorded accurately their exercise time, but almost half said they exercised moderately for at least 10 minutes, while, according to the heart rate monitors, only 15 percent actually did. They tended to overestimate of their activity. Miscalculating your intensity level can have repercussions. Underestimating the intensity of your workouts could lead to overeating and weight gain if you think you've burned more calories than you have. Secondarily, one may not reach a training intensity sufficient to ensure cardiovascular benefits.

Preventative Medicine. pp. 18 - 26, 2002

Work those hamstrings . . .

Is your lack of flexibility hindering your ability to perform exercises through a full range of motion, cutting short the benefits of doing them? The answer may be that you are just not flexible enough. A recent study at the Chinese University of Hong Kong investigated the effects of both a four-week and eight-week static stretching program on 40 healthy volunteers. The two test groups performed static stretching on their hamstrings, while another two groups acted as controls. Both stretching groups increased their range of motion, although no difference was found in the magnitude of the gains between the four- and eight-week protocols. Scientists concluded that both time courses are effective in improving hamstring flexibility. So if you have difficulty performing a stiff-legged deadlift or bent-over row due to stiff hamstrings, just four weeks of dedicated stretching should help you reach a little deeper, promoting the effectiveness of those and other important exercises.

Scandinavian Journal of Medicine & Science in Sports 11(2): 81 - 86, 2001

New technique found to increase muscle carbohydrate stores . . .

Paul A. Fournier, PhD, from the University of Western Australia, has released a study that provides new information about the well-known technique of carbohydrate loading for improved performance. Based on the familiar carbohydrate-loading regimen of two to six days of reduced-intensity exercise and high-carbohydrate consumption for attainment of high muscle glycogen levels, and on the knowledge that the rates of glycogen synthesis are very high during recovery from maximal intensity exercise, the present study sought to determine whether combining a short bout of high-intensity exercise with one day of high carbohydrate intake would result in the same or similar muscle glycogen levels. Athletes could then achieve carbohydrate loading for performance more quickly, without the deconditioning that often accompanies the classic two-to-six day regimen.

After muscle biopsy for a baseline, the subjects performed sprint cycling at 130 percent of VO2 peak for three minutes. The subjects then ingested 12 grams per kilogram of lean body weight over the next 24 hours, including carbohydrate-enriched beverages. Overall, a relative increase of 82 percent took place in muscle glycogen. The researchers concluded that their study showed for the first time that it is possible to accumulate supranormal muscle glycogen levels within only 24 hours by feeding athletes concentrated carbohydrates after a three-minute bout of high-intensity exercise.

Medicine & Science in Sports & Exercise 34:980 - 986, 2002

About the Author

Edmund R. Burke, PhD, CSCS, is Professor and Director of the Exercise Science Program at the University of Colorado at Colorado Springs. He served as Coordinator of Sports Sciences for the U. S. Cycling Team leading up to the Olympic Games in 1996 and was a staff member for the 1980 and 1984 Olympic Cycling Teams. Dr. Burke is a Fellow of the American College of Sports Medicine and a Certified Strength and Conditioning Specialist (CSCS) with the NSCA. He has authored or co-authored fifteen books on training, fitness and nutrition.

Understanding Running Injuries

By Janet Hamilton, MA, RCEP, CSCS

Running. It is perhaps the most natural form of exercise known to man. The simple act of placing one foot in front of the other would seem at first glance to be effortless and nearly without risk of injury. Quite to the contrary though, most studies that have included 500 or more participants reveal an injury incidence rate of 37% to 56% per year (depending on how the term "injury" was defined in the study). In other words, roughly one third to one half of all runners will experience an injury in any given year.

To put this in perspective, it helps to look at the number of injuries per hour of participation. When examined from this angle, the injury rate looks a bit more acceptable: 2.5 to 5.8 injuries per 1000 hours of participation; the lowest rate occurring in long distance runners and the highest rate among sprinters. Even with the relatively high number of runners experiencing an injury in any given year, the incidence is still 2 - 6 times lower than in all other sports. The known benefits of running (improved heart health, stress reduction, and enhanced overall fitness to name a few) far outweigh the risks for most individuals. Due in large part to its simplicity and accessibility, running remains one of the most popular fitness activities in America.

The majority of injuries experienced by runners are related to muscular and/or skeletal overload. Approximately 70% - 80% of injuries occur in the region from the knee down, with the knee itself being the site of about 25% of all injuries. The lower leg ranks a close second, with about 20% of all injuries occurring here. The foot and ankle come in third and fourth at 16% and 15% respectively. Numerous studies have been done to determine potential risk factors for various injuries and injury patterns and a few key items have been shown to be consistently involved. These include:

1. Number of training miles per week (there appears to be a sharp increase in risk of injury when running more than 40 miles per week);
2. Past history of previous injury;
3. Lack of experience (new runners appear to be at greater risk than those with greater experience);
4. Training intensity.

In addition, other risk factors that have been shown to be involved in some (but not all) studies include:

1. Lack of flexibility (too much flexibility has also been shown in some studies to be a risk factor);
2. Shoes;
3. Shoe orthotics;
4. Roadside running (the tilt of the road has been implicated in a few studies);
5. Malalignment problems (such as "knock-knees" or "bowlegs");
6. Strength imbalance.

The risk factors mentioned above can be broken down into four general categories: training, flexibility, strength and biomechanics. From a clinical standpoint, it is clear that runners' injuries are rarely caused by just one thing, and even more rarely resolved by just one intervention. The best course of action is to avoid injury in the first place by recognizing the risk factors and staying on top of things with preventative measures. Let's look at each of these categories of risk factors and make a few suggestions on how to improve your odds of avoiding running injuries.

Training

One of the most consistent factors involved in the onset of running injuries is training errors. These may include simple things such as increasing mileage too quickly, or running too many miles per week. Another training factor to consider is the intensity of the training on a day-to-day basis. Intensity can be increased by running on hilly terrain, or running at a faster pace. Combining an increase in training volume (more miles) with an increase in intensity (hill work and speedwork) is an invitation for an injury. Most runners should build their foundation of endurance first, and then begin to focus on increasing intensity.

Building endurance should take the form of progressively longer runs at an easy pace. Total mileage per week should not increase by more than 10% per week and most runners will do well to increase mileage only every other week. Though this may seem conservative, it is better to take a bit more time in the base-building phase than to have to take substantial time off due to an overuse injury. Once a mileage base has been established, intensity can be modified to provide additional stimulus for improvement. Most athletes should start with about 10% - 30% of their weekly mileage in the form of more intense running (hills, speed workouts) and the remainder of the weekly mileage in the form of easier workouts. Following this principle of "harder" and "easier" runs throughout a training week helps to avoid overuse and subsequent injury.

Flexibility

Studies examining the role of flexibility in runner injuries are inconclusive at best and this may be in part because the definition of "injury" in various studies is inconsistent, and because different researchers define "adequate flexibility" differently. From a purely common-sense standpoint though, if a muscle is functioning at or near the end of its available range of motion it will take only a small amount of additional load to push it over the edge to injury. The other factor to consider here is that a muscle with limited flexibility may provide additional load to the joints it crosses as well as the muscles that oppose it, thereby possibly reducing a runner's efficiency. When examining the frequency of various tendon injuries, three of the key areas to consider are the calf muscle group, the hamstring muscle group and the quadriceps muscle group.

There are several theories about the "best" way to promote flexibility. Some proponents say that static stretching (slow movements, 30 second hold) are best and others point to the dynamic nature of running as being best suited to a dynamic form of stretching (moderate speed, 2 - 3 second hold). The data supporting one form or another is inconclusive at this point so most runners can use a combination approach to their flexibility exercises, doing both static and dynamic forms of stretching on a regular basis.

The one principle that holds true no matter how you stretch is that the movement should not be painful and that stretching "harder" does not hold additional benefit and may actually contribute to further injury. Stretch gently, consistently, and with attention to good form. Though only four exercises are shown here, stretching all of the muscles of the lower extremities on a regular basis is a good idea.

A special note about Iliotibial Band Syndrome (ITBS or IT band syndrome) is in order here. This particular condition is the source of grief for many runners and is often misdiagnosed and mistreated. It presents with pain that is generally focused on the outside of the knee and is often made worse when running hilly terrain or faster intervals. Often attributed to running on the crown of the road (where the road slopes to the side to allow runoff of rainwater), or to "oversupination," in reality these two factors are rarely if ever involved. The common approach of "stretching" the Iliotibial band to resolve the symptoms is rarely successful because most of the time the symptoms are not due to a lack of flexibility in the lateral hip or Iliotibial band region. The IT band can be thought of as the "victim" rather than the "perpetrator." It is compensating for deficiencies elsewhere in the kinetic chain. Generally the source of the problem lies in inadequate "core" strength in the hips, lack of adequate flexibility in the calves and hamstrings, and excessive or late pronation of the foot that is not being adequately supported by the running shoes. However, in the extremely rare case of

iliotibial band tightness, gentle stretching of this region as well as the others (calves and hamstrings in particular) is warranted.

Strength

The role of strength in runner injuries appears to be related primarily to strength balance (between opposing muscle groups) or in the case of long distance runners, to strength endurance. Sprinters need good power and explosive strength; distance runners need to have adequate strength endurance to avoid the deterioration of their form as fatigue sets in. Gaining strength is a relatively simple thing—you ask your muscles to do more than they're used to and they'll respond by getting stronger. The more you can make the training activity look like the activity you're training for, the better will be the carryover of strength. In other words, doing bench presses probably won't make you a faster runner!

Hill running remains one of the most specific strength exercises a runner can do, however it brings with it a relatively higher risk of injury. Many runners incorporate hill running into their weekly routine and supplement this with functional strength training in the form of squats, lunges, and balance and reach exercises. The nice thing about functional strength training exercises like these is that there's no need for fancy or expensive equipment. Your body weight and perhaps a light dumbbell or two will be all the resistance needed if you're a distance runner. If you're a sprinter, a bit more weight will be needed and you'd be wise to consult with a Certified Strength and Conditioning Specialist to help you with specific power-building exercises. For the distance runner the simpler exercises presented here will suffice.

No matter if you're a distance runner or sprinter, the name of the game is to get your "core region" (hips, thighs, abdominals) as strong as you can. Functional strength training with body weight or light weights only can be performed 3 - 5 times a week without risking overuse. If heavier weights are to be used, consider strength training every other day. Most runners will find that doing their strength-training workout on their easier day (lower mileage or lower intensity running) is best. It's usually best to avoid strength training on days where a long run or higher intensity speedwork session is to be done. As with the flexibility exercises—form is important. Move at a steady pace through the exercise motion, making sure that you're in control at all times. Strength endurance will be built best with higher repetitions (15 - 30 per set) whereas explosive strength will be built with higher weight and lower repetitions (2 - 8 per set).

Biomechanics

This is really all about what happens when "the rubber meets the road." Your foot is a complex mechanism with two big roles to play. It must first be flexible to adapt to uneven terrain and absorb shock. Then it must become stable and somewhat rigid so that you have a firm foundation from which you can propel forward. These two somewhat opposing roles are played at different times in the contact portion of gait. When your foot first hits the ground it is supposed to "unlock" or pronate. When your foot is directly under you it should be transitioning to a more rigid lever for propulsion and by the time you're really pushing off, it should be "locked" and fully ready to deliver the force to the ground.

Since your foot is attached to your leg, and your leg is attached to your thigh, and your thigh is attached to your pelvis, etc … what happens at the bottom of this chain can have far-reaching impact. Injuries can result if a foot isn't doing the right motion at the right time or to the right degree. In other words, if your foot pronates a bit too far or stays pronated a bit too long, it won't be sufficiently rigid for a good efficient propulsion. The results could be strain on tissues and joints in the foot but more often the injury occurs up the chain in the lower leg, knee, hip or low back. There are a couple of ways to compensate for this: different shoes, and additional support within the shoe in the form of over-the-counter insoles or custom built orthotics.

Making sure that you're in the correct shoe for your particular gait pattern is perhaps one of the most important preventative measures you can take. Some running shoe stores employ sales people who have some experience in visual gait analysis. They'll watch you run in several pairs of shoes and help you determine the shoe that not only "fits" best but also "functions" best for your particular needs. If you don't have a technical running store near you, check with your local Physical Therapist or Podiatrist for assistance in the form of a gait analysis. For some runners, a shoe alone is not enough. Sometimes a support within the shoe is required. Over-the-counter arch supports are a reasonable first step, but most runners who need serious support will probably find that a custom built pair of orthotics is a far better choice.

Conclusion

If you're one of the many runners who experience a running related injury, take a few moments to do a bit of detective work and see if there are things you can do to minimize your risk. Look back through your training log for signs of training errors, check your shoes for wear, look seriously at your flexibility and strength training habits and see if any of these common factors have played a role in your situation. In running, as in life, an ounce of prevention is worth a pound of cure!

Figure 1 (above): Calf Stretch

Figure 2 (below): Hamstring Stretch

Calf stretch

This stretch is for the muscles on the back of your lower leg. Stand facing a wall, about an arm's distance back and place your hands on the wall at shoulder height. Place one foot back and the other forward as shown, and shift most of your weight onto the back (straight) leg. *Now for the important part: roll that back foot to the outside so that there is more weight on the pinkie toe side than the big toe side of your foot.* Don't turn the whole leg out though; the toes should still be facing straight ahead. Now lock your arch by lifting your big toe slightly and pressing your heel down. You should feel the stretch in the calf muscle, just below your knee. Hold the stretch for 30 seconds, then relax and change legs. Do this exercise with the knee straight to stretch the gastrocnemius muscle and with a bent knee to stretch the soleus. These are the two muscles in the back of the calf. You'll probably want to do this one several times a day for best results.

Hamstring stretch

Next on the hit list of muscles to stretch are those that span the distance from your buttocks to the back of your knee. This muscle group (there are actually three separate muscles) is called the hamstrings. Stand facing a chair or low stool and place the heel of one foot up on the chair. Make sure you keep your hips and other leg square to the surface you're propping your foot on. Keep the knee of the leg that is propped up slightly bent and *pull your buttocks back and chest up*. You should feel a stretch in the back of the thigh of the leg that is propped on the chair. Remember, you're not leaning over and trying to touch your toes, you're pulling your buttocks up and back . Hold the stretch for 30 seconds, and then switch legs.

Quad stretch

There are actually 4 distinct muscles that make up the quadriceps group (the muscles on the front of your thigh). Stand next to a wall for balance, then either grasp your ankle with your hand, or use a towel roll as shown here. You should be able to maintain straight alignment of your hips, shoulders and knees. If when you grasp your ankle your knee moves forward of the other leg, then you'd be better off to use a towel and get your body alignment straight. Pull up on the towel until you feel a stretch in the front of the thigh and hold for about 30 seconds. Repeat the process on the other leg.

Figure 3 (below): Quad Stretch

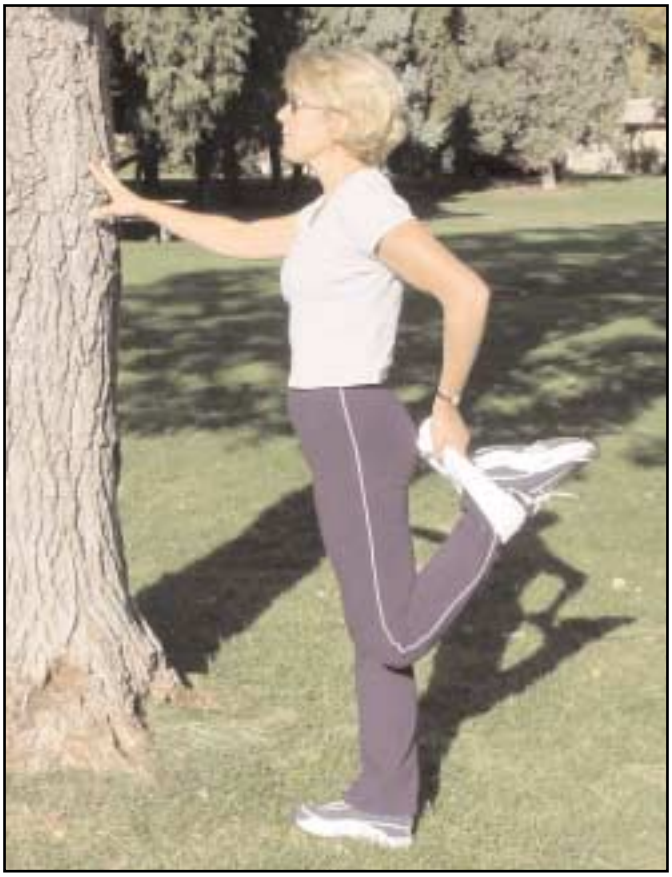

Figure 4 (above): Iliotibial Band Stretch

Iliotibial Band Stretch

Stand with your left side facing a wall, about an arm's distance away. Place your left hand on the wall at shoulder height and then cross your right leg over in front of your left leg, allowing the foot to rest lightly on the ground. The majority of your body weight will be on your left leg. While making sure to keep your shoulders and hips facing straight ahead, allow your hips to shift to the left (toward the wall) until a gentle stretch is felt on the left hip region. Hold the stretch for 30 seconds, then turn and place your right side toward the wall and repeat the process for the right hip.

Figure 5 (above): Squats

Squats

A squat is really nothing more than acting like you're going to sit down, and then changing your mind. To squat correctly, place your feet a shoulders width apart and keep your feet flat on the floor. Bend the hips and knees simultaneously, making sure to stick your butt back a little to insure you're not keeping your back vertical. Your back should be straight, but not vertical. This technique takes the strain off both the lower back and the knees and places it squarely where it belongs—your BUTT! You should squat only as deep as you are able to without having discomfort. Deeper isn't better if it hurts. The squat is the basis for nearly all other exercises. As far as strengthening goes, it is the easiest of the ones I'll present here. Squats are a good warm up for the fun to follow.

Lateral Rotation Lunge

The next most difficult exercises are lunges because they are a more one-leg-dominant exercise. They are very effective in developing explosive strength and can be done in multiple directions, depending on what you want to strengthen. Lunge only as far as you can, being able to return to home base in one push. No "bunny hops" permitted. Lunge as deep as you want as long as it isn't painful; the deeper you go, the more challenging it is to get back to home base. You're limited only by your imagination here. The lunge shown here is a rotation lunge and works the hamstrings, hips, quads and inner/outer thighs. Lunging in other directions will emphasize other muscles.

Figure 6 (below): Lateral Rotation Lunge

Balance and reach

Balance on your left foot and reach your right foot back and diagonally to the left as far as you can without touching the floor. The goal with these exercises is to gain both balance and FUNCTIONAL strength as opposed to "brute" strength. That way when you stumble on a root at the end of a long trail run, your body will "recognize" that position of lost balance and simply recover it much the way it does every day in your routine.

Figure 7 (above): Balance and Reach

Variations

As your balance improves, be imaginative—try reaching or lunging in different directions. New muscles will be challenged, so pay attention to which muscles you feel working and play with this a little. Perhaps try doing a few repetitions of the balance and reach exercises with your eyes closed (it will open up a whole new area of challenge!) Remember you're limited only by your imagination. As long as you don't break the cardinal rule—DON'T GO TO THE POINT OF PAIN—these exercises will be some of the most challenging and potentially rewarding strength exercises you've ever done.

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Technique and Speed Development for Running

By John M. Cissik, MS, CSCS

Running speed is an important factor for success in athletics. Obviously in track and field events the fastest athlete will usually win the race, jump the farthest or throw the javelin the farthest[2]. But speed is critical in almost every sport. Faster athletes will be able to get to the ball first, elude defenders, score, or catch the person with the ball more effectively. Running speed is so important that it is frequently used to evaluate athletic potential and to help in the selection of athletes for a team. While you will see that some aspects of speed are genetic, or inherited, there are certain things you can do to develop and improve an athlete's speed.

What contributes to speed?

Before talking about how to improve speed it is important to first understand the factors that influence speed. As you might imagine, there are many things that impact speed, including:

- The structural make-up of the athlete's muscles;
- How well the muscles are able to use fuel;
- Flexibility;
- Fatigue;
- Stride length and stride frequency; and
- Technique.

Let's look at each of these factors in a bit more depth.

Muscle Structure and make-up

Muscles are made up of a combination of fast-twitch and slow-twitch fibers. Fast-twitch fibers contract rapidly and forcefully while slow-twitch fibers contract more slowly and with lower levels of force. However, slow-twitch fibers do not fatigue as rapidly as the fast-twitch fibers. Different muscles, even within the same athlete, will have different percentages of fast and slow twitch fibers. Similarly, every athlete will have different percentages of fast and slow twitch fibers in a given muscle. The fiber-type make-up and the length of the fibers in a muscle is an inherited quality. If all other things are equal, athletes with longer muscle fibers and a greater percentage of fast-twitch fibers should have the ability to run faster[5] than athletes with shorter slow twitch fibers.

Using fuel

While muscle's architecture is genetic, its ability to use fuel is trainable. ATP (Adenosine Tri-Phosphate) is the substance that drives muscle contraction and there are three different "energy pathways" that the body can use to create ATP. These three systems are the creatine phosphate system (CP), the glycolitic/anaerobic system and the oxidative/aerobic system. The energy pathway that provides ATP for muscle contraction depends mainly on the intensity and the duration of the activity being performed. The CP energy pathway has the greatest impact on speed since it produces ATP rapidly, but only for a short period of time. Speed depends on how much ATP is on hand in the working muscles and on how much CP is available to create "new" ATP as it is used. The effectiveness of the CP system can be improved by making short, high intensity training a regular part of your running program.

Flexibility

Flexibility is also important for speed development and injury prevention[1]; it is important that the limbs be able to travel through a full range of motion without impediment to make the running movement fluid and efficient. To develop speed a runner should emphasize improving flexibility at the hip (the hip flexor and extensor muscles), the thigh muscles (hamstrings and quadriceps), and the muscles of the lower leg (both the calf muscles and the muscles at the front of the shin). While static stretching can be done, it is usually more effective to combine static stretching with dynamic stretching (stretching with movement). This will allow greater carryover to the running movement and speed development. Being flexible will also allow a runner to increase stride length and stride frequency[7].

Fatigue

Muscle fatigue occurs after repeated contractions because ATP is depleted and metabolic waste products accumulate in the muscle. As you might imagine, fatigue interferes with a muscle's ability to contract and negatively impacts technique. Just as you would not want to perform Olympic-style lifts or lift heavy weights when fatigued, performing speed work under fatigued conditions will reinforce improper technique and possibly lead to injury. Speed work should be performed when the athlete is fresh so that he may learn good technique and run quickly. When fatigue sets in and performance of the exercises begins to suffer, the speed workout should be terminated for that day.

Stride length and stride rate

Stride length refers to the distance a runner's center of mass travels with each stride[2]. Stride frequency refers to the number of foot contacts that are made per unit of time. Both stride frequency and stride length directly contribute to running speed. Essentially, Speed = Stride Length x Stride Frequency. From this equation it should be obvious that speed will increase if an athlete is able to take longer strides while maintaining stride frequency, and vice versa. Both stride length and frequency are trainable. With this said, it is important to realize that you reach a point of diminishing returns if you increase your stride length too much.

After a certain point, too long a stride length will slow an athlete down because he will begin to experience braking forces[3]. Newton's third law states that "for every action there is an equal and opposite reaction." When the foot hits the ground in front of the body, the force generated by the ground is directed back towards the runner, effectively slowing him or her down. Elite sprinters, who have already optimized their stride length, focus on increasing stride frequency to improve their speed. For most athletes, the trick is to find the optimal relationship between these two variables.

Technique

Finally, proper technique is paramount to performance, and poor technique is actually the limiting factor in most athletes' speed development. Good technique will allow a runner to move his or her limbs quickly and safely. Poor technique will result in poor movement efficiency, braking forces, and the overloading of certain muscles and joints that could possibly lead to injury. As technique is probably the most trainable and essential component mentioned above, the rest of this article will examine good running technique and outline drills to help develop an athlete's technique.

Sprint Technique

According to Jarver[4], speed performance will largely depend on the ability to improve the functioning of the nervous system and the coordination of muscles used to produce a movement pattern. The ability to coordinate muscle actions directly impacts technique. Failure to coordinate the muscles quickly and efficiently will result in slow speeds and possible injury.

For purposes of this article, we're going to divide running into two phases: the support phase and the recovery phase. Each leg has support and recovery phases. The support phase begins when the foot hits the ground and lasts until it breaks contact with the ground. The recovery phase begins when the foot breaks contact with the ground and lasts until it again makes contact with the ground.

In the support phase, the leading foot should land on the ground slightly ahead of the athlete's center of gravity (slightly in front of the hips). The foot should be driven down towards the ground by the hip extensor muscles; the hamstrings and gluteal muscles should be performing the majority of the work during the hip extension. The quadriceps (knee extensors) are also important at foot contact since they keep the athlete's knee from flexing excessively and dissipating elastic energy. As the foot contacts the ground it should be dorsiflexed, with the big toe pulled up towards the shinbone. This helps to maximize the amount of energy that can be stored by the calf muscles and then released to generate propulsion in a later phase of the running stride. The outside of the forefoot, not the heel, should contact the ground.

The athlete should then think about pulling himself over the support foot. The athlete should continue exerting force with the hip and knee extensors until his center of gravity passes over the support foot. At this point, the runner should focus on plantarflexing the foot (pointing the toes) with the calf muscles. When the toes leave the ground, the support phase has ended.

As an athlete enters the recovery phase, the ankle should immediately be dorsiflexed with the big toe pulled up toward the shin. As the foot leaves the ground, the athlete should flex

the knee and bring the heel up towards the hips/ buttocks as quickly as possible. This helps to "make the leg shorter" and allows the athlete to swing the recovery leg forward faster than he or she could if the limb was kept straight during the recovery phase. Remember, speed is what we are looking for, so even relatively "small" things like flexing the leg can help a runner gain valuable time in a race or competition.

As the heel is drawn towards the hip, the leg should be swung forward. The athlete should imagine he is trying to step over the opposite knee with the ankle. This will keep the leg "short" and speed high for as long as possible. As the ankle steps over the opposite knee the athlete should begin unfolding, or extending, the swing leg. It should be noted that the hip and knee extension that occur during this phase are due to a transfer of momentum, not an active contraction of the lower limb muscles[8]. As the leg unfolds and the athlete prepares for the next support phase, he should again focus on activating the hip extensors to drive the foot down toward the ground.

In addition to the lower body action, there are a few other pointers that an athlete should focus on. The first of these is posture. The athlete should run with the trunk erect. The head should be level and the hips should remain tall with very little vertical movement. Second, arm swing contributes to running speed. The athlete should focus on driving the arms both backward and forward to provide balance and generate momentum. The elbow angle should range from 60 degrees in front to 140 degrees in back[8] and the athlete should avoid swinging the arms across the midline of the body.

Obviously an athlete has to think about a lot of things going on in a short period of time when sprinting. This can be an overwhelming skill for many athletes to learn. Drills are a valuable tool and can aid the athlete in the learning and perfecting of specific running skills. Drills can help in the development of "ideal" sprinting technique and speed[9]. Note that while drills are important in the development of technique, and while they serve as a useful tool in the warm up, they are not a substitute for actual running and sprint training. By definition, drills are a part of the movement. Remember that the entire skill must be put together and practiced in order for an athlete to become faster.

Sprint Technique Drills

The following technique drills will be described in this article:

1. Ankling,
2. Butt kicks, and
3. A drills.

Ankling Drill

"Ankling" teaches an athlete how to lift the foot off the ground during the running motion. During ankling, the knees should remain straight. The athlete should step forward with the right leg with the foot dorsiflexed and big toe lifted up towards the shin. The outside of the right forefoot should contact the ground just in front of the athlete's center of gravity. The athlete should pull himself over the foot. As the athlete's center of gravity passes over the right foot (i.e. when the foot is now behind the athlete), the foot should go into plantarflexion (pointing the toes and pushing off the ground) until it leaves the ground. As the right foot leaves the ground, the ankle should immediately be dorsiflexed and the big toe should be lifted up in preparation for moving it in front of the athlete again. Begin practicing this drill with just the right foot for 10 - 20 yards. Then perform it with the left foot. After the athlete is comfortable with this approach, have him perform this drill alternating between the right and left sides.

Butt Kick Drill

"Butt kick" drills that are performed for running are slightly different than what most of us are used to. The goal of butt kicks is to teach the athlete to lift the heel up to the hips quickly during the recovery phase of running. The athlete should step forward with his or her right leg with the foot dorsiflexed and big toe lifted up, and proceed through the support phase as was discussed in the ankling drill above. As the right foot leaves the ground, it should immediately be dorsiflexed and the big toe should be lifted up. The heel should quickly be brought up to the athlete's hip. Note that as this is done the right knee will be lifted up. Unlike more traditional butt kick drills, the goal here is not to stretch the quadriceps, it is to practice getting the heel to the hips as quickly as possible. Initially this drill should be performed with the right leg for 10 - 20 yards. The athlete should then perform it with the left leg. After the athlete is comfortable with this approach, he should perform the drill alternating between the right and left sides.

A Drills

"A drills" combine the skills learned through ankling and butt kicks and add the high knee action that is important for running. Focusing on the right leg, proceed through the foot contact and support phase as described in the ankling drill above. As the right foot leaves the ground it should immediately be dorsiflexed and the big toe should be lifted up. The heel should quickly be brought up to the athlete's hip. As the heel is brought to the hip, the leg should be swung forward attempting to lift the knee as high as possible. When the knee is in its highest position, the foot should still be dorsiflexed with the big toe lifted up. As the leg is swung forward, the leg will naturally start to "unfold." Once the limb has swung forward the athlete should drive the foot down, using the hip extensor muscles.

The athlete should practice this drill as a "walk," initially with the right side, for 10 - 20 yards. The athlete should then switch to the left side. When the athlete is comfortable with this, he should alternate between the right and left sides. When the athlete is comfortable with the A Walk, he can make it more difficult by performing the drill as a "skip." Initially the athlete should train first the right side, then the left. Once he or she is comfortable then he may alternate between the right and left sides[6, 7].

Summary

Being able to run fast is extremely important for success in many sports. While many factors may be trained to help improve running speed, technique is one of the most trainable and one of the most important. Solid technique will result in a faster, more efficient runner. Poor technique will limit an athlete's speed. To help an athlete master the skill, the sprinting motion may be broken down into drills that train parts of the motion. Drills simplify a complicated skill, helping with mastery. They may also serve as warm up and conditioning exercises.

References

1. Barbaro, R. (2000). Elements of speed development. In Jarver, J. (Ed.) *Sprints and Relays 5th Edition.* Mountain View, CA: TAFNEWS Press, pg. 15 - 18.
2. Cunningham, M. (2001). Pure speed training. *Coaches Review, 74(2),* 26 - 28.
3. Faccioni, A. (1995). Assisted and resisted methods for speed development. In Jarver, J. (Ed.) *Sprints and Relays 4th Edition.* Mountain View, CA: TAFNEWS Press, pg. 63 - 69.
4. Jarver, J. (1978). Sprinting in a nutshell. In Jarver, J. (Ed.) *Sprints and Relays 1st Edition.* Mountain View, CA: TAFNEWS Press, pg. 9 - 13.
5. Kumagai, K., T. Abe, W.F. Brechue, T. Ryoshi, S. Takano, & M. Mizuno. (2000). Sprint performance is related to muscle fascicle length in male 100-m sprinters. *Journal of Applied Physiology, 88,* 811 - 816.
6. McFarlane, B. (1995). Speed…A basic and advanced technical model. In Jarver, J. (Ed.) *Sprints and Relays 4th Edition.* Mountain View, CA: TAFNEWS Press, pg. 14 - 19.
7. McFarlane, B. (1987). A look inside the biomechanics of speed. *NSCA Journal, 9(5),* 35 - 42.
8. USA Track and Field. (2001). *Coaching Education Program Level II Course: Sprints, Hurdles, Relays.*
9. West, T. & S. Robson. (2000). Running drills - are we reaping the benefits? In Jarver, J. (Ed.) *Sprints and Relays 5th Edition.* Mountain View, CA: TAFNEWS Press, pg. 64 - 67.

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