

# Strength Training For Distance Running: A Scientific Perspective

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## SUMMARY

ALTHOUGH STRENGTH TRAINING HAS BECOME COMMON AMONG MANY ATHLETES, ESPECIALLY THOSE IN STRENGTH/POWER/SPEED SPORTS, IS IT NECESSARY TO IMPROVE DISTANCE RUNNING PERFORMANCE THAT IS PRIMARILY LIMITED BY THE ABILITY TO TRANSPORT AND USE OXYGEN? THIS ARTICLE EXAMINES THE ISSUE OF STRENGTH TRAINING FOR THE DISTANCE RUNNER AND TAKES A CLOSER LOOK AT THE POSSIBLE BENEFITS OF STRENGTH TRAINING WHEN DONE FOR POWER.

I am sure that you have seen it looming in the corner of your gym like a mother who proselytizes about eating your vegetables: a big lime green exercise ball that has become the symbol of flat stomachs and represents the new craze among sports coaches—core training. Much has been written about strength training for the runner—everything from lunges while holding dumbbells in your hands to calf raises on the edge of a stair to endless repetitions (reps) of abdominal crunches while balancing on that big lime green stability ball. A stronger core aside, have you ever wondered if these training suggestions will really lead to a faster 5K or marathon?

### WHY STRENGTH TRAINING WILL NOT MAKE YOUR CLIENTS FASTER RUNNERS

Unlike most sports, which require strength, speed, and power to be

successful, distance running is primarily limited by the delivery and use of oxygen. As your clients run faster, the demand for oxygen increases. For the speed to remain aerobic, and therefore to be able to sustain a faster pace, the supply of oxygen to the working muscles and to the heart itself must be equal to or greater than the oxygen demand. If the demand for oxygen exceeds its supply, exercise becomes oxygen-independent (anaerobic) and fatigue is imminent. Therefore, to become better distance runners, your clients need to increase their supply of oxygen to the working muscles to match the increasing demand.

There are no studies showing that strength training increases oxygen delivery from lungs to muscles. The responsibility of oxygen delivery rests on the shoulders of the cardiovascular system. The greater your clients' stroke volume (the volume of blood pumped by the heart per beat) and cardiac output (the volume of blood pumped by the heart per minute), the more oxygen will be delivered to the muscles. In addition, greater muscle capillary and mitochondrial volumes increase their metabolic capacity to use the available oxygen. Traditional strength training, using a moderate amount of weight for 10–20 reps per set, or hypertrophy-driven and strength-driven weight training, using a heavy weight for only a few reps per set, does not increase oxygen delivery to and use by the muscles. A sample strength training program

for distance runners is presented in Table 1.

Largely, the physiological changes resulting from strength and endurance training are contradictory. For example, when the volume and intensity are high enough, strength training stimulates muscle fiber hypertrophy. This may increase body weight, which increases the metabolic cost of running. In addition, larger muscles, when obtained by an increase in contractile protein content, may have fewer capillaries and mitochondria per area of muscle, which would be detrimental to endurance. Endurance training causes muscles to respond in an opposite fashion by increasing capillary and mitochondrial volumes and densities to facilitate the diffusion and use of oxygen (2,7). Running many miles also decreases body weight, which improves running economy (the amount of oxygen used to maintain a given pace). Endurance training also has a “volume effect” on the heart, increasing the internal dimensions of the left ventricle so that it can maximize its stroke volume and cardiac output, whereas strength training has a “pressure effect” on the heart, increasing the thickness of the left ventricular wall.

Despite the different physiological adaptations between strength and

#### KEY WORDS:

distance running; strength training; endurance performance; power; running economy

**Table 1**  
Sample strength training program

Wk	Squats	Hamstring curls	Calf raises	Power cleans	Dead lifts
1	4-6 sets of 3-5 reps at 90% 1RM with 5-min rest	4-6 sets of 3-5 reps at 90% 1RM with 5-min rest	4-6 sets of 3-5 reps at 90% 1RM with 5-min rest	4-6 sets of 3-5 reps at 90% 1RM with 5-min rest	4-6 sets of 3-5 reps at 90% 1RM with 5-min rest
2	4-6 sets of 3-5 reps at 90% 1RM with 5-min rest	4-6 sets of 3-5 reps at 90% 1RM with 5-min rest	4-6 sets of 3-5 reps at 90% 1RM with 5-min rest	4-6 sets of 3-5 reps at 90% 1RM with 5-min rest	4-6 sets of 3-5 reps at 90% 1RM with 5-min rest
3	3 sets of 3-5 reps at 90% 1RM with 5-min rest	3 sets of 3-5 reps at 90% 1RM with 5-min rest	3 sets of 3-5 reps at 90% 1RM with 5-min rest	3 sets of 3-5 reps at 90% 1RM with 5-min rest	3 sets of 3-5 reps at 90% 1RM with 5-min rest
4	4-6 sets of 3 reps at 95% 1RM with 5-min rest	4-6 sets of 3 reps at 95% 1RM with 5-min rest	4-6 sets of 3 reps at 95% 1RM with 5-min rest	4-6 sets of 3 reps at 95% 1RM with 5-min rest	4-6 sets of 3 reps at 95% 1RM with 5-min rest
5	4-6 sets of 3 reps at 95% 1RM with 5-min rest	4-6 sets of 3 reps at 95% 1RM with 5-min rest	4-6 sets of 3 reps at 95% 1RM with 5-min rest	4-6 sets of 3 reps at 95% 1RM with 5-min rest	4-6 sets of 3 reps at 95% 1RM with 5-min rest
6	3 sets of 3 reps at 95% 1RM with 5-min rest	3 sets of 3 reps at 95% 1RM with 5-min rest	3 sets of 3 reps at 95% 1RM with 5-min rest	3 sets of 3 reps at 95% 1RM with 5-min rest	3 sets of 3 reps at 95% 1RM with 5-min rest
Start your clients with 2 sessions per week. Back off on the volume for weeks 3 and 6 for recovery.					
reps = repetitions; 1RM = 1 repetition maximum.					

endurance training, many runners still lift weights, partly in belief that it will prevent injuries. To this end, runners typically use light to moderate loads and a high number of rep programs that are geared toward increasing muscular endurance (the ability to sustain or repeat a submaximum force) rather than strength (the maximum amount of force muscles can produce). Although many studies have shown statistically significant increases in bone mineral density in response to strength training, the magnitude of increase in bone mineral density is only 1-2% (1,10,12,16). Some studies have even found that strength training has no significant effect on bone mineral density (3,12). Whether such a small increase in bone mineral density is enough to prevent running-related bone injuries has not been determined. As for the attempt at increasing muscular endurance with strength training, surely a mere 20-60 reps in the gym, despite them being performed at a higher intensity compared with running, are not going to increase muscular endurance over and above what your clients already achieve from their weekly running or what they would achieve by running more miles.

Although strength training may improve endurance performance in previously untrained individuals (13) as it increases their overall fitness level, more experienced and highly trained runners will likely not benefit from traditional strength training (4) and may be hampered by it, especially if it is performed at the expense of increasing running volume or intensity (6). Although a 25-minute 5K runner may improve his or her running performance by strength training because the overall training volume (and thus the improvement in overall fitness) is greater when performing both running and strength training, this runner is better served by spending more time running and improving the cardiovascular and metabolic traits associated with endurance.

Even the best marathoners in the United States do not strength train.

Research on the training characteristics of the U.S. Olympic Marathon Trials qualifiers found that these marathoners do little, if any, strength training (11). During the year of training leading up to the Olympic Trials, the men averaged less than 1 strength workout per week and the women averaged 1.5 strength workouts per week. About half of the athletes did not do any strength training at all. Thus, U.S. elite marathoners do not believe that strength training will make them better or they do not have the time to strength train given the time they devote to running.

Most runners, unless they are highly trained and have maximized their running training, do not need to strength train to improve their performance. That is not to say that your clients should not strength train, but only that it is not necessary unless (a) they have already maximized their running training (by increasing both mileage and intensity) or (b) they cannot handle the physical stress of running more miles or (c) they have reached their genetic limit for adaptation to their running training.

### WHY STRENGTH TRAINING MAY MAKE YOUR CLIENTS FASTER RUNNERS

Although strength training to improve distance running performance is not readily apparent, it may help your clients to become faster if done with the right type of program. That is because increasing their muscular strength will increase their muscular *power*, which is the product of force (strength) and speed. Athletic performance is ultimately limited by the amount of force and power that can be produced and sustained. In addition to the skeletal muscles' aerobic and anaerobic metabolic capacities, force and power are influenced by neuromuscular coordination, skeletal muscle mechanics and energetics, and efficiency of converting metabolic power into mechanical power (8).

When running, each foot is in contact with the ground for only a fraction of

a second, not nearly enough time to generate maximum force. It is far more important to increase the rate at which force is produced. The goal of runners' strength training is to get their muscles to increase their rate of force production, so they can have stronger muscle contractions in a shorter time. If you work with runners who want to lift weights, the best type of strength training for distance runners is ironically similar to what is performed by football players.

### POWER-TYPE STRENGTH TRAINING

Research has shown that power training, either with heavy weights (e.g., 3–5 sets of 3–6 reps at  $\geq 85\%$  1 repetition maximum) (5,6,9) or plyometric exercises (14,15,17), can improve economy and endurance performance by increasing muscle power production. Heavy weight training focuses on the strength component of power, whereas plyometric training focuses on the speed component.

None of the studies examining the effects of heavy weight training or plyometrics on endurance performance found changes in other cardiorespiratory measures important to distance running, such as maximal oxygen uptake or lactate threshold. This is an important finding because it suggests that the improvements in running economy do not result from cardiovascular or metabolic changes but rather from some other mechanism. When lifting very heavy weights (strength component), or when performing quick plyometric movements (speed component), your clients recruit nearly all of their muscle fibers, which serves as a training stimulus for the central nervous system. The result is that the muscles increase their rate of force development, getting stronger, quicker, and more powerful. The more effective muscle force production translates into better running economy. Although all runners can certainly benefit from an improved economy of movement, only a couple of studies have actually measured whether running performance improved after

power training (14,15). These studies found that performance did improve, using either a 3K or 5K time trial. Although it is plausible that muscles that are more powerful can help a runner for these short-distance races, which are run at or close to  $\dot{V}O_{2max}$ , it is unknown whether power training will improve performance for longer races, such as the marathon.

If you are planning on adding strength training to your clients' programs, make sure they use a very high intensity and very few reps to focus on neural adaptation rather than on muscle hypertrophy because adding muscle mass will decrease economy. Also, periodize their annual training plan to circumvent the incompatibility between strength and endurance training. Use specific periods of the year during which they focus on either endurance or strength/speed/power. Have them do the majority of their strength training during their speed (anaerobic) phase of training rather than during their aerobic endurance phase because speed, strength, and power are more closely related physiological traits than are strength and endurance. Likewise, have them do their strength/power workouts on their speed work days rather than on their easy run or long-run days. Although the studies showing an increase in running economy have used heavy weight training with traditional lifts or sport-specific movements or plyometric training, weightlifting including the snatch and power clean may also be beneficial to improve muscle power. A sample plyometric program for distance runners is presented in Table 2.

If your clients have already increased their running volume and intensity as much as they can, or if they cannot handle the physical stress of running more miles, power training with heavy weights and plyometrics may be the next step in their training programs. Therefore, next time your clients are in the gym and they see that big lime green exercise ball staring at them from the corner of the room, tell them to run the other way.

# Strength Training For Distance Running

**Table 2**  
Sample plyometric training program

Wk	Single leg hops	Bleacher hops	Double leg bound	Alternate leg bound	Squat jumps	Depth jumps	Box jumps
1	2 × 5	2 × 5					
2	2 × 5	2 × 5					
3	2 × 5	2 × 5	2 × 5	2 × 5			
4	2 × 5	2 × 5	2 × 5	2 × 5	2 × 5		
5	2 × 5	2 × 5	2 × 5	2 × 5	2 × 5	2 × 5	2 × 5
6	2 × 5	2 × 5	2 × 5	2 × 5	2 × 5	2 × 5	2 × 5

Single leg hops: (a) On one leg, hop up and down; (b) hop forward and back; and (c) hop side to side. Bleacher hops: Standing at the bottom of the bleacher steps on one leg, hop up the steps. Walk back down and hop up again on the other leg. Double leg bound: From a squat position with both legs, jump forward as far as you can. Alternate leg bound: In an exaggerated running motion, bound (which looks like a combination of running and jumping) forward from one leg to the other. Squat jumps: With hands on hips in a squat position, jump straight up as high as you can. On landing, lower back into a squat position in one smooth motion, and immediately jump up again. Depth jumps: From a standing position on a one-foot-tall box, jump onto the ground and land in a squat position. From this squat position, jump straight up as high as you can. Box jumps: From the ground, jump with 2 feet onto a box about one foot high, and then immediately jump into the air and back down to the ground. As you get experienced with the exercise, try jumping with one foot at a time.

For your clients to get the most out of plyometric training, it is important to concentrically contract their muscles immediately after eccentrically contracting them. To do this, tell them to spend as little time on the ground as possible between hops/bounds/jumps. The exercises should be done on a soft surface, such as grass, a track, or a gymnastics mat. Start your clients with 2 sessions per week of 2 sets of 5 repetitions (2 × 5) with full recovery between sets.



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