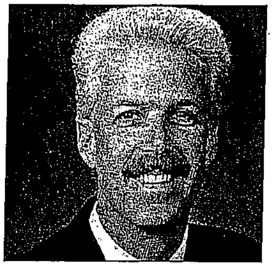
© National Strength & Conditioning Association
Volume 24, Number 3, pages 27–29

Treadmill Running to Improve Speed

Lee E. Brown, EdD, CSCS, *D
Arkansas State University
Jonesboro, Arkansas



Lee E. Brown
Column Editor
E-mail: lbrown@astate.edu

WHILE NO SANCTIONED SPORT competitions may ever take place on a treadmill, there can be distinct advantages to training on a treadmill if the training is done intelligently with an appropriately configured treadmill. There are 2 distinct advantages to treadmill training: an optimal learning environment can be created for improving running mechanics, and treadmill training conditions can safely elicit coordination strategies conducive to enhancing power output and running speed through the manipulation of incline and treadmill speed (4).

Treadmill running has some minor differences when compared with overground running due to decreased air resistance; however, running on a stiff and powerful treadmill has been shown to be virtually the same biomechanically and metabolically as running overground. A published report (1) using a specially instrumented treadmill capable of measuring both vertical and horizontal reaction forces demonstrated that the reaction force patterns of subjects running on the treadmill were nearly identical for the same subjects running overground. This data clearly refutes the notion that treadmill running is not desirable for training because the treadmill motor "pulls your leg back during stance and thus you don't have to put force in the ground/treadmill." In order for an athlete to keep the center of mass in the same position in space while a foot is moving backward on the treadmill belt, a resultant force must be applied to the treadmill belt surface that is sufficient enough to counteract the speed of the treadmill belt as well as the effects of the force of gravity when incline sprints are being performed. If the athlete is unable to apply such a force, the athlete will simply be carried off the back of the treadmill, or if the athlete applies a greater force, the athlete will move forward in relation to the treadmill.

Treadmill training can create an optimal learning environment for the athlete by taking advantage of the fact that the athlete remains in a relatively fixed position. The optimal learning environment created by a treadmill allows a coach or trainer to provide visual, audio, and kinesthetic feedback to the athlete. In this way, the athlete can see (using a strategically placed mirror), hear (instructions from the coach), and feel (through proper spotting technique) what he/she needs to do to improve running skills. Providing such feedback on a track becomes much more difficult and sometimes impossible. Proper sprint/running technique is a refined motor skill and requires a great deal of practice. An optimal learning environment will only enhance the process of skill acquisition.

Another benefit to treadmill training is that grade and speed can be manipulated to elicit neuromuscular responses that are greater than what an individual can do overground. If an athlete running overground (level or uphill) becomes fatigued, his/her running speed will decrease due to a concomitant reduction in power output. If an athlete training on a treadmill becomes fatigued, the treadmill will not slow down and the athlete can be forced (using proper spotting technique) into performing maximally or even supramaximally as he/she attempts to maintain the power output levels required for the duration of the exercise bout. We have had success using a combination of constant-speed level and incline runs as well as acceleration (dynamically adjusting the treadmill speed) bouts at a level or incline grade. Metabolic cost is also much easier to quantify and prescribe on a treadmill because you can estimate the power output required to perform a bout of exercise at a specific speed and grade.

Incline running has been shown to elevate the recruitment of key muscles responsible for increasing forward running speed. A recent investigation (3) demonstrated that incline treadmill running provides substantially greater recruitment (200–300%) of the hip extensors, knee extensors, and plantar flexors during stance and of the hip flexors and hip extensors during swing compared with level running at the same stride frequency. These muscle groups have been shown to be responsible for increasing forward acceleration and maintaining high velocity running speeds (2). In other research, EMG recordings of the lower abdomen and hip flexor have been 200% greater during incline running versus level running at the same stride frequency, thus providing excellent training for the core. While one could argue that you could simply run up a hill and get the same effect, you cannot maintain the same intensity overground that you can on a treadmill simply because an athlete will slow down once he/she starts to fatigue.

We are in no way suggesting that one should train only on a treadmill to improve speed. We have found that taking advantage of the optimal learning environment and coordination strategies elicited during appropriate treadmill training can more effectively augment speed training. Thus, a complete speed training program consisting of strength training, treadmill training, multidirectional plyometrics, and multidirectional movement skills can be especially effective. This was evidenced by Walker (4), who averaged 0.3 seconds improvement in 40-yard sprints and an average increase of 40 watts in Wingate tests following a 6-week treadmill training program. ▲

■ References

1. Kram, R., T.M. Griffin, J.M. Donelan, and Y.H. Chang. Force treadmill for measuring vertical and horizontal ground reaction forces. *J. Appl. Physiol.* 85:764–769. 1998.
2. Mann, R.A., G.T. Moran, and S.E. Dougherty. Comparative electromyography of the lower extremity in jogging, running, and sprinting. *Am. J. Sports Med.* 14:501–510. 1986.
3. Swanson, S.C., and G.E. Caldwell. An integrated biomechanical analysis of high speed incline and level treadmill running. *Med. Sci. Sports Exerc.* 32:1146–1155. 2000.
4. Walker, J.A., J. Frappier, S.C. Johnson, and S.C. Swanson. Effect of a 6-week incline treadmill training program on Wingate Test results and 40-yard sprint times. *Med. Sci. Sports Exerc.* 32:S37–S39. 2000.

John Frappier
Frappier Acceleration, Fargo, North Dakota

PROS
CONS

TREADMILL-BASED TRAINING programs claiming to develop speed have become popular in many parts of the country lately. Unfortunately, this rise in popularity has come with no justification through scientific and peer-reviewed research that would prove the treadmill as a superior training tool to other methods of speed development.

A basic speed model would identify 3 components: acceleration, maximal velocity, and speed endurance. Analyzing the speed development needs of the majority of today's most common sports would indicate that acceleration is the only component with real application to these sports. This signifies that acceleration is the area of speed development most sports should focus on.

The ability to effectively accelerate is a distinct skill requiring an optimal increase in both stride length and stride frequency. Time of foot contact goes through a transition of long foot contact at the onset of the acceleration phase, requiring a greater involvement of maximal strength as the body attempts to overcome resting inertia, to short foot contact toward the end of the phase, with a greater emphasis on max rate of force development. Further complicating this skill is that, in most sports, an athlete may accelerate for 3–20 yards, only to change direction and have to reapply the acceleration mechanics again. No treadmill can develop these skills so essential to an effective acceleration phase. When sprinting on a treadmill, you typically mount the treadmill at full speed and of course have nowhere to run but straight ahead.

The ability to effectively increase speed through increased stride length and/or rate is determined by the ability to apply productive forces during ground contact. It is possible to increase stride length or stride frequency without altering the ground force applied, but it will typically create a decrease in the other component, resulting in no effective change in speed. Force application to the ground is critical to the acceleration phase as the body works to overcome inertia. These issues would indicate that improving the ability to accelerate would require improving the ability to apply force to the ground.

Newton's law of action/reaction also lends itself to understanding what involvement a moving treadmill may have in enhancing force output. This law tells us that, for every action, there is an equal and opposite reaction. To say this another way, whenever two objects come into contact with each other, they exert the same amount of force on each other but in opposite directions. This relationship means that the acceleration of a body is directly equal to the external force applied to the body by the ground and is in the same direction as that applied force. If the acceleration of the body is directly equal to the applied force, then the greater the force applied to the body, the greater the acceleration. On a treadmill, the external force applied to the body is greatly reduced because the tread is moving backward. With the backward tread movement, the forward ground friction is reduced, which reduces the reaction force needed to propel the body forward, proportionally reducing the action force output required by the muscular system. If you were to generate the forces necessary to accelerate on a treadmill, you would run off the front end. Treadmill enthusiasts like to refer to a study by Kram (1) to argue against this point. However, a review of this study reveals that the speed of the treadmill used during the study was approximately 6.7 mph, which can best be described as a moderate jog. The types and intensities of force required for jogging are totally unlike those for sprinting. Furthermore, Kram (2) feels the treadmill is a poor simulator for sprinting because it does not mimic the inertial forces present in sprinting or, more specifically, the braking and propulsion phases that are present in every foot strike when sprinting.

While the treadmill may be found to have some value in the development of speed, to utilize it as the central component of a training program at the expense of more applicable and research-justified training methods is a serious training error, especially when you consider that, in commonly utilized periodization models, the components it may possibly develop would best be trained during the peaking phase, not 2–6 weeks before the season even starts. ▲

References

1. Kram, R., T.M. Griffin, J.M. Donelan, and Y.H. Chang. Force treadmill for measuring vertical and horizontal ground reaction forces. *J. Appl. Physiol.* 85:764–769. 1998.
2. Kram, R. Personal communication. 2000.

Doug Schweigert, MS, CSCS
Fargo, North Dakota