THE DEVELOPMENT OF SPEED:

BEFORE YOU HOP ON THAT TREADMILL...

By

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Doing a quick internet search for treadmill manufacturers, one can see what a lucrative business it is to convince a fitness enthusiast or athlete that treadmill running is the same if not more effective for speed development and conditioning than above ground running. First off, it is extremely convenient. You do not have to go anywhere. Literally! Second, it is much safer, as the obstacles presented with road/track running are far greater than running on a flat, rotating belt. Lastly, treadmills allow one to run at a chosen pace or incline with the click of a button. All this for the average price of $1500.00 on a machine that may be built to last roughly 5 years depending on the warranty you choose to purchase. Now, is this machine more effective than above ground running for the development of sprinting speed?

High speed treadmills are appearing around the country at SAQ (speed, agility, quickness) centers, touting remarkable gains in speed through the use of these expensive devices. Is this method really more effective than above ground running on track or turf surfaces with regards to the development of speed? To fully grasp this concept, one must look at the biomechanics of sprinting, the transfer of training effect of high speed treadmill running, and the role of other biologic capacities such as relative strength, rate of force development, and structural balance.

One of the main differences between sprinting on a treadmill and sprinting on a track/turf is the motion of the surface with which each foot strike makes contact. The surface moves below the athlete during treadmill sprinting, while the athlete moves across a fixed surface while sprinting on turf/track. This difference may create a difference in the activation patterns of the musculature used during sprinting. Sprinting consists of X different phases, each requiring near maximal activation of specific musculature to ensure maximum efficiency, which in turn leads to development of maximal speed.

Biomechanics

"Running occurs on the ground……sprinting occurs over it"

Percy Duncan

The drive (push off) phase occurs when the foot applies force against the ground to accelerate the body forward. Here the extensor mechanism is very active, receiving contributions from the hip extensors (glutes, hamstrings), the knee extensors (quadriceps), and the plantar flexors of the ankle. Following the drive (push off) phase is the support phase, where the foot contacts the ground. Here again, the extensor mechanism is highly active, accelerating the body forward through full (or near full) extension of the hip, knee and ankle. The recovery phase occurs when the foot is not in contact with the ground. "As the driving foot leaves the ground and begins the recovery phase, the heel is pulled toward the butt. As the high knee action begins and the lower leg advances through in a swinging like phase, the foot becomes "cocked", or dorsiflexed. This action is generated by the hip flexors (iliopsoas, rectus femoris, pectineus) which decrease the moment of inertia while increasing angular velocity (McFarlane 1987)."

Breakdown of Sprinting Mechanics (Baechle and Earle 2000):

1. "As the leg swings forward, eccentric knee flexor activity controls its forward momentum and helps prepare for efficient touchdown. Consequently, maximum muscle and lengths and extremely high stretching rates are achieved in the hamstring group (1)."
2. "During ground support, the role of the plantar flexors is indicated by the high moment at the ankle joint. Elastic strain energy is stored and recovered in the calf musculature. Eccentric knee extensor activity also allows elastic energy to be stored and recovered in the quadriceps muscle group (1)."
3. "Effort during the late support phase is neither essential to sprinting efficiency nor a high risk period for injury according to available research. The triple extension of the

hip, knee, and ankle during ground support must be directed toward generating propulsive force as early as possible (1)."

Table I: Movements occurring at each phase of sprint stride (Baechle and Earle 2000)

I. Early Flight

- Eccentric Hip Flexion: Decelerates backward rotation of thigh
- *Eccentric Knee Extension:* Decelerates backward rotation of leg and foot

II. **Midflight**

- *Concentric Hip Flexion:* Accelerates thigh forward
- *Eccentric Knee Extension:* Eccentric knee flexion

III. Late Flight

- *Concentric Hip Extension:* rotates thigh backward in preparation for foot contact
- *Eccentric Knee Flexion:* Accelerates leg backward, limiting knee extension

IV. Early Support

- *Continued Concentric Hip Extension:* Minimizes braking effect of foot strike
- *Brief Concentric Knee Flexion followed by Eccentric Hip Extension:* resists tendency of hip and ankle extension to hyperextend knee; absorbs landing shock
- *Eccentric Plantar Flexion:* Helps absorb shock and control forward rotation of tibia over ankle

V. Late Support

- *Eccentric Hip Flexion:* Decelerates backward thigh rotation; rotates trunk
- *Concentric Knee Extension:* Propels center of gravity forward
- *Concentric Plantar Flexion:* Aids in propulsion

  (Baechle and Earle 2000)

According to renowned strength coach Charles Poliquin, “when running in sports, you have to actively use the hamstrings to extend the hip; when you're running on a treadmill, the moving surface pulls the hip into extension for you. This difference causes you to fire the muscles used in running in improper sequence, not just in sprinting but also in hockey skating and speed skating (Poliquin 2007).”

During the drive phase the intention is to accelerate the body forward, yet on a treadmill, a percentage of the ground reaction forces are applied vertically during the support phase. If the ground reaction forces have a greater vertical component than horizontal, the athlete is jumping rather than sprinting, leading to a decrease in horizontal velocity due to the greater braking forces created by jumping. The athlete can maintain their sprint pace because the tread is moving below the athlete, allowing the athlete to increase their vertical force, thus creating a longer flight phase. This longer flight phase gives the athlete a sense that they are, in essence, sprinting faster, according to the pace on the computerized mph reading on the monitor.

Transfer of Training

On field linear sprints are rare in most team sports. These are typically reserved for track and field athletes. During a field sport, sprints may consist of a rapid acceleration, multiple change of directions (deceleration, stop, acceleration), and possibly an opportunity to reach maximal horizontal velocity once or twice a game (depending on the sport and position). High speed sprinting on a treadmill only takes into account the last capacity, maximal horizontal velocity. The treadmill is not designed to accommodate for individual acceleration, as it builds up to speed gradually, at its own pre-programmed pace. In most on field settings, acceleration, deceleration, and change of direction are the most important components. Without the ability to accelerate past opponents, there would be no opportunity for break-away speed (maximal horizontal velocity). On a treadmill it would be very difficult to train acceleration, deceleration, never mind change of direction. According to Schweigert (2002), “the ability to accelerate is a distinct skill requiring 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. 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 (2).”

Biologic Capacities

To utilize the treadmill as the central component of a strength and conditioning may be detrimental to the overall increase of athletic performance. A proper strength and conditioning program should consist of correction of structural imbalances/dysfunctions, general physical preparation, hypertrophic adaptation, functional adaptation, relative strength, muscular endurance, power, speed, agility etc… Sport consists of multiple or all of these capacities simultaneously at work. The use of high speed treadmill as the primary component will effectively decrease the amount of time and effort designated to the aforementioned physical capacities. This can lead to decreases in strength, muscular imbalances, and loss of horizontal power. According to Baggett, “the one thing that really stands out when you analyze the science of sprinting is that the predominant factor in running faster for teenage and adult athletes is the ability to generate and transmit additional muscular force into the ground. Faster running speeds are achieved with greater ground reaction forces in relationship to an athlete’s mass (Baggett 2005).”

An example of this would be a comparative analysis of two separate athletes. Athlete A, whom weighs 180lbs, squats 350 lbs, and possesses a 33” vertical and 35” reactive vertical leap. Athlete B also weighs 180lbs, squats 200lbs, and possesses a 24” vertical and 24” reactive vertical leap. All factors considered, it would appear that athlete A possesses much greater potential for achieving higher sprinting velocities than athlete B. According to Olympic speed Coach Charlie Francis, “Ben Johnson used to ½ squat 600lbs for 6 repetitions, bench press 407lbs for 2 reps, at a bodyweight of 178lbs (Francis 1992).” Though Johnson is better remembered as the culprit of the most infamous Olympic doping scandal, the speeds he was able to achieve due to the amount of force he was able to generate were remarkable. The base for those ground reaction forces started with his great strength relative to his body weight. Strength becomes the foundation on which power can be built.

“Ballistic, high velocity lifting is needed to improve your power development and transfer training effects to events such as sprinting where foot contact times are <100ms (Kraemer and Hakkinen 2002).” Without this explosive component, ground reaction forces or impulses, are lost in the ground and maximal velocity is never realized. If an athlete is spending the majority of their training sprinting on a treadmill and working on running technique, they may limit their potential for greater propulsive ground reaction forces.

Treadmills do have their place in the fitness community, but as a sole means for speed development and/or sport specific energy systems conditioning, they should never be a substitute for properly designed strength and power training, or above ground sprinting programs.

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