A three-point approach to testing running shoes

The American Academy of Podiatric Sports Medicine's assessment test—which focuses on heel counter firmness, torsional control, and flexibility—can help in selecting a shoe that will be biomechanically effective as well as comfortable.

By Bruce E. Williams, DPM

The athletic shoe industry is primarily market driven. Athletic shoes are touted for their ability to help their wearers run faster, jump higher, and perform better than their competitors. Advertising campaigns for athletic shoes are all about color, environment, and feeling. The shoes endorsed by the best player in the National Basketball Association make you "play" better on the court or make you "feel" like you can run faster in shoes touted by the world's fastest man.

Two adages come to mind: "Sell the sizzle, not the steak," and "Caveat emptor, let the buyer beware!"

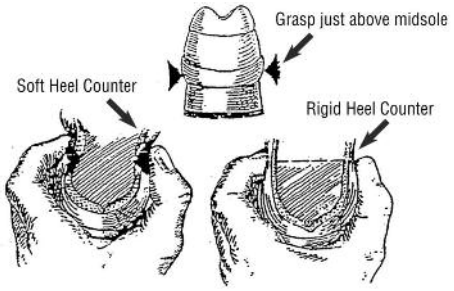
From the standpoint of a patient or a practitioner, it can be daunting to make a determination or recommendation of what shoe would be best for a patient/athlete to wear. How do you really know whether or why one shoe is better than another?

Some running magazines regularly do evaluations of running shoes. Unfortunately, some of the tests suggested and utilized by these magazines are not fully supported by the scientific literature, or they are considered to be extremely subjective.

The "wet test" for example, is touted by running shoe catalogs and many running and health and fitness magazines as a way for a runner to evaluate his or her medial arch height or contour. This test consists of wetting the foot with water and then standing at full weightbearing on a paper bag or piece of paper to visualize the foot's medial longitudinal arch contour. The arch type, as determined by the test, is supposed to help determine the type of shoe best suited for the runner. An athlete with a higher arch would be directed to a so-called cushioned or neutral shoe, one with a neutral arch to a stability shoe, and a low-arched runner to a motion control shoe.

Two studies that were done during U.S. Army basic training to evaluate whether visual arch height determination, or the wet test, really worked found that it did not measure up.[1,2] One study found that foot type categorizations based on plantar surface imprints matched categorizations based on caliper-based measurements of

The three-part test is quick and easy and provides objective metrics because it is repeatable and results can be compared from shoe to shoe.



Heel Counter Rigidity

Illustration by Mark T. Reeves, DPM

Figure 1. A running shoe should have a firm heel counter.

arch height in only 65% of nearly 4000 recruits.[1] The second study found that assigning running shoes to recruits based on plantar shape did not significantly reduce injury risk compared to assigning stability shoes to all recruits regardless of plantar shape.[2]

Another rating scale used by running magazines is the very subjective act of wear-testing. Most wear-testing is based on the perceived fit and comfort a shoe provides to an individual runner. Just because an athlete who has a certain arch height, weight, and body type and runs *x* number of miles per week rates a shoe highly does not mean it will work well for another athlete. A study comparing running shoes found comfort to be a subjective sensation based on individual preferences that was not related to the distribution of plantar pressure.[3] As most lower extremity practitioners know, foot function is extremely variable in a number of different ways from patient to patient.[4]

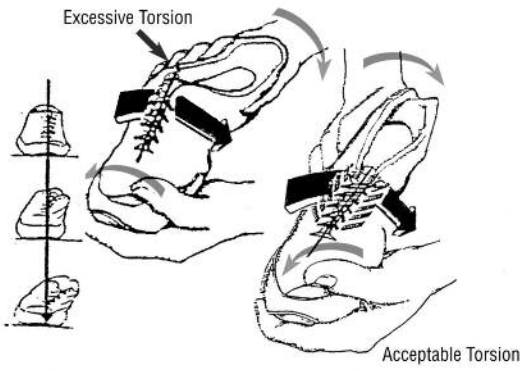
Three-point testing

The American Academy of Podiatric Sports Medicine utilizes a basic three-point testing methodology for evaluating athletic shoes. This evaluation process was developed by Mark Reeves, DPM, of Seattle and adopted by the academy board of directors more than 10 years ago. The academy teaches its members to perform this test and, in turn, instruct their staff and patients in it as well.

The focus of the testing is primarily on whether the shoe has a firm heel counter (Figure 1), whether the shoe has a firm resistance to torque when the heel and toe are twisted in opposite directions (Figure 2), and whether the most distal third of the shoe flexes easily while the middle third resists flexion (Figure 3). These techniques are all performed manually and can be done easily in shoe stores or in the office. The three-part test is quick and easy and provides objective metrics because it is repeatable and results can be compared from shoe to shoe. A certain amount of subjectivity is built into any type of manual evaluation, however, as different testers may have differing strength capabilities affecting their ability to flex, squeeze, or twist a shoe. The academy appreciates this, but at this time there is no other basic hands-on testing methodology available that provides a metric for comparing one athletic shoe to another, especially running shoes.

All three components of the evaluation are grounded in evidence. A study performed to evaluate comfort related to the function of three types of shoes found that of the shoes evaluated, the shoe that was the most comfortable had the highest torsional stiffness relative to eversion, the most forefoot flexibility, and the greatest degree of hardness at the midsole.[5] But the apparent advantages of those three shoe characteristics go beyond comfort.

Heel counter strength evaluation and usefulness in controlling foot function can be debated, but a recent study showed that maximum rearfoot eversion angle, maximum calcaneal eversion angle, and maximum eversion velocity decreased significantly with the use of custom foot orthoses in running shoes that did not have



Torsional Rigidity

Illustration by Mark T. Reeves, DPM

Figure 2. The shoe should allow the foot to pronate and supinate as needed in response to positioning stresses.

heel counters built in.[6] Stacoff et al, in a study of running shoes that did have heel counters, found that movement of the heel while running barefoot was similar but not identical to movement of the heel counter of a shoe.[7] Extrapolating the barefoot movement to that of the foot within a shoe, the authors suggested that the heel inside the shoe moves less and more slowly than the heel counter of the shoe itself, and thus the shoe could be regarded as offering protection of the rearfoot.

Torsion control in a shoe may play a more important role in sports in which lateral cutting is of primary importance. In court shoes and trail running shoes, for example, the foot is placed in very different positions due to varying terrain or lateral movements while running, jumping, and landing. The shoe should be able to allow the foot to pronate and supinate as needed in response to these positioning stresses.[8] In running shoes, an increase in motion-controlling properties built into a shoe often leads to a shoe that will be more resistant to twisting torque forces.[9] This may be acceptable for most road-running on flat surfaces, but it won't work in general for offroad running or other lateral cutting sports.

A new take on flexion

Finally, we come to the flexion properties of the sole of the shoe. This is probably the most important factor in evaluating any type of athletic shoe. The AAPSM test involves evaluating the ease of flexion of the most distal third of the shoe as well as the flexion resistance of the middle third of the shoe. This component of the evaluation is the most significant departure from other methods of evaluating running shoes.

Biomechanics labs and some magazines (see *Runners World* shoe lab at www.runnersworld.com and Michigan State University's Footwear Evaluation Laboratory at www.obl.msu.edu/footlab.htm) tend to evaluate only the flexibility of the front third portion of a running shoe, while choosing to ignore the potential for flexibility at the middle third of the shoe. Instead, labs evaluate the compression properties of the midsole of a shoe. While compression is a valuable thing to measure, many studies show that cushioning in running shoes is not necessarily beneficial.[12,13] These papers and studies show that cushioning properties of running shoes decreased consistently in less than 400 miles of running, and that very compliant or cushioned shoes may possibly increase the risk of injury because there is a correlation between cushioning compliance and excessive subtalar joint motion. In defense of cushioning, some studies have shown a decrease in shock in high-arched runners that may help to protect from bone injuries often suffered by this patient population.[14]

Another study analyzed the effect of midfoot cushioning on foot shape deformation and perceived sensation while standing on a support surface.[15] Extrapolating the results to footwear, the authors suggested that too much compression in the midfoot area can adversely affect the transition from heel strike to toe-off when walking or running. If the midfoot area experiences too much compression due to a nonrigid or flexible middle third of the shoe, then the foot will remain in a prolonged pronated position during the midstance period of gait. This may lead to a sagittal plane blockage of metatarsophalageal rotation because of metatarsal dorsiflexion as a compensation for the prolonged pronation at the rearfoot. If a shoe instead or in addition has a rigid forefoot component or lacks sagittal flexion at the front third of the shoe, this can also block or delay the transition of the foot, again at the metatarsophalangeal joint. The heel of the foot may begin to lift in these instances, but the heel itself is prevented from continuing to

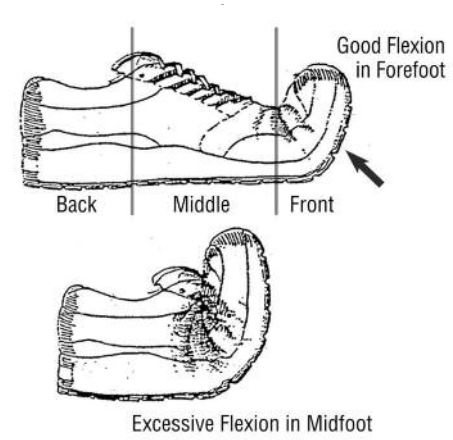


Figure 3. The most distal third of the shoe should flex easily while the middle third resists flexion.

MPJs from the lack of flexion at the front third of the shoe.[16]

In either of these instances, blockage of the sagittal plane progression of the foot may lead to significant compensations within the foot or other aspects of the lower extremity. One study that artificially blocked first MPJ dorsiflexion range of motion using a specially designed insole showed that this restriction leads to sagittal plane compensations at the ankle, knee, and hip joints.[16]

Nester and colleagues have been studying the nature of the midtarsal joint and midfoot ranges of motion for many years now. Some of the studies evaluating forefoot and midfoot ranges of motion[17-20] have found a significant amount of variability in sagittal plane motion between the lateral column of the foot (from the midtarsal bones of the cuboid to the fourth and fifth metatarsal bases) and the medial column (including the navicular, cuneiforms, and first through third metatarsal bases). What is being seen is that the majority of motion that allows for dorsiflexion of the forefoot on the rearfoot comes from the medial and lateral columns of the foot, primarily the first and fifth rays, and not so much at the midtarsal joint. The implication, Nester suggests, is that effective pronation control will require support across the entire midfoot as well as the forefoot.[18]

An athletic shoe's ability to resist midfoot and forefoot compensations for subtalar joint and ankle joint pronation is of paramount importance. Athletic shoes must allow for progressive, unhindered rolling motion from heel strike through midstance and

into active propulsion, or the body will begin to compensate at the ankles, knees, hips, and potentially the back.

Although it can be difficult to determine whether one athletic shoe is better than another, there are several things to keep in mind. The athletic shoe industry is market driven. Many shoe tests touted by running shoe magazines and catalogs are not backed by scientific literature and are too subjective in their recommendations. The AAPSM suggests evaluating athletic shoes utilizing a basic three-point, hands-on assessment based on scientifically researched principles. Of particular importance is the flexibility of an athletic shoe in its distal third and the resistance of flexibility in the middle third. Shoes that meet these guidelines will, in general, work much better for athletic patients and can potentially minimize negative mechanical compensations in the feet and at higher levels of the kinetic chain. ler

Bruce E. Williams, DPM, is a fellow and the immediate past president of the AAPSM. He is in private practice in northwest Indiana, where he specializes in sports medicine, biomechanics, and gait analysis.

References are available at www.lowerextremityreview.com