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Shoe Shock Absorption

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Shock absorption, by most patients, is considered the most important component in athletic footwear. In fact it is an important attribute. The typical ground reaction force for a heel to toe runner is 2.5 to 3 times their body weight for level surface running. The midsole is the center of a shoe's cushioning system. No part of the shoe has benefited from science more and affects performance more than the midsole. In early athletic shoes, especially in running shoes, midsoles didn't really exist. The original idea for the midsole, utilized a shower sandal glued between a nylon upper and outsole of a simple running shoe already on the market. This invention was given to running friends to test and provide feedback. Out of this innovation a plethora of midsoles have evolved, ranging from improved foam midsoles to complicated air and fluid systems.

Until the 1980's in-store perception of what a good cushioning system "felt" like, and by surveys in running magazines as to the "best" cushioning offered in shoes drove the market to develop improved and more reliable markers for midsole cushioning. As a result footwear manufacturers developed research labs, or contracted to outside labs in the race to develop the best rated cushioning midsole.

Shock absorption does appear to become increasingly important with age. Robbins, Waked and Krouglicof found that locomotor impact forces increased in late middle age. Furthermore, they speculated that this occurs when stability declines and osteoarthritis of weight-bearing joints develop. Because impact is negatively related to stability, the impact rise is probably caused by postural adjustments to instability resulting from irreversible neurologic decline. This heightened impact may account for the accelerated rate of weight-bearing joint osteoarthritis that begins in late-middle age. (i)

Experience or running style may have a significant impact on footwear needs as inexperience runners demonstrated greater braking and propulsion impulses. According to Lees and Bouracier, The greater the variability in these two variables indicates that they were using a less economical action. (ii)

The cushioning system plays a key role in the overall energy consumption of an athlete during an event. The natural cushioning system of the body is the musculoskeletal system. The fat pads in the foot also play a major role in protecting the foot from sudden and repeated impact. Operating this system requires the use of the body's stored energy as it is dependent on muscles contracting to help deal with the impact going through the system. This works fine under normal conditions, like relaxed walking over soft surfaces. When an athlete asks more of this system by increasing the frequency and force of impacts through training and participation in athletic events, more energy is needed to help maintain performance. A shoe's cushioning system can help by improving the

efficiency of, or reducing, the energy needs of the athlete.

There are five essential factors that contribute to shock absorption needs of an athlete's footwear:

1. The age of the athlete;
2. The athlete's form or style; the cushioning needs of an athlete are closely tied to an individual's biomechanics as well as to the specific sport the athlete is participating in. For example, a person's biomechanics might be such that they are a heel striker rather than a forefoot striker when running. In general, a heel striker exhibits a high impact force at the beginning of a stride cycle that is not seen in the impact record of a forefoot striker. Thus, the midsole system for a heel striker must pay particular attention to cushioning in the heel area.
3. The foot size to body weight ratio, as a heavy individual with smaller feet will be emitting more force per surface area,
4. The athlete's biomechanical pattern of gait. An altered pattern will not utilize as much surface area of the shoe's midsole to disperse force. And of course,
5. The repetitive impact nature of the athlete's sport.

Additionally, there are five factors that will influence the shock absorption longevity of an athletic shoe:

1. Environmental factors: Extremely hot, cold or wet conditions may impair a shoe's ability to perform optimally.
2. Age of the shoe: Obviously, nothing lasts for ever. A study performed at Tulane University found that most shoes lose 70 percent of their shock absorption capacity after 500 miles. This appears to be the critical point where an aging shoe will influence injury.
3. Frequency of use: Are the shoes worn daily, and for both athletic and non-athletic purposes? Many believe that rotating training shoes to allow for midsole re-expansion, and for the shoes to dry out between uses will impart a greater longevity.
4. Midsole materials: Most shoes are now made of closed cell foams, such as polyurethane, EVA, and Phylon. Polyurethane is stiffer and firmer, but lasts longer. Whereas, EVA and Phylon are softer and lighter, but will break down faster. Many athletic shoe companies address durability by introducing some type of hybrid midsole that integrates pressurized air or gas, liquid, or gel systems that typically do not lose their cushioning characteristics over time.
5. Do the shoes appropriately complement the biomechanics of the host?

Cushioning is complex. A conflict arises by trying to develop a cushioning system that is soft enough to satisfy a person's perception of a soft shoe when trying a shoe on in a store and, would also pass the tests set up by sport research labs under contract to measure cushioning for running magazines. This often resulted in a shoe that was so soft that it provided minimal stability and contributed to over-pronation or under-pronation, and therefore injuries.

ⁱ Robbins S, Waked E, Krouglicof N. Vertical impact increase in middle age may explain idiopathic weight-bearing joint osteoarthritis. Arch Phys Med Rehabil 2001 Dec;82(12):1673-7

ⁱⁱ Lees A, Bouracier J. The longitudinal variability of ground reaction forces in experienced and inexperienced runners. *Ergonomics* 1994 Jan;37(1):197-206