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**A Closer Look At
Minimalist Running Shoes**
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A Closer Look At Minimalist Running Shoes

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Given the increased popularity of minimalist running shoes, this author discusses their structural features and separates the marketing from the literature in examining the impact of reduced cushioning, reduced shoe mass and the “zero drop” phenomenon.



Minimalist footwear is the newest and fastest growing segment of the athletic footwear industry today.¹ The appeal for consumers seems to be the purported benefits of decreased injury risk and/or performance enhancing effects of minimalist shoes.

Manufacturers are marketing these shoes as more natural and more like being barefoot. According to Formula4 media, minimalist road running shoe sales were up 119 percent from March 2011 to March 2012 while minimalist trail running shoes grew to comprise 42 percent of all trail running sales during the same period.¹ These are dramatic changes in buying habits over a short period of time. Is this a fad, a trend or a paradigm shift?

Despite the fact that athletic footwear manufacturers spent the previous four decades extolling the virtues of their cushioning technologies and stability devices, some have now changed their tune and want to make sure you know that their shoes are now much more like “being barefoot.” Never mind all that stuff they used to tell us about cushioning preventing injuries and midsole technologies “guiding” the foot. There is a whole new way of thinking about running footwear and we can sum this up as “less is more.”

Some new manufacturers emerged early with this trend. Altra and Vibram (an established outsole company that had no previous branded footwear models) offer two popular running brands. Footwear manufacturers that were not known in the running business jumped in as well. Merrell, Terra Plana and Skechers are three new players. The established manufacturers such as Brooks, New Balance, Asics, Adidas and others have introduced minimalist lines to complement their established models. One manufacturer, Saucony, has not only introduced minimalist footwear but also reduced the heel height of almost all of its running shoe models.

One curious aspect of the minimalist trend is that most of the manufacturers that produce racing flats have not promoted their flats as minimalist. It is likely that their respective marketing departments were concerned that running consumers would not perceive the racing flats as authentic minimalist footwear so they instead produced new models.

Some proponents of minimalist footwear try to create the impression that this is new or revolutionary, but researchers, manufacturers and sports medicine professionals have long known that humans move differently shod versus barefoot, and that footwear characteristics influence gait. Lower profile footwear, such as racing flats and super light training shoes, have been available since the first running boom and were never big sellers. Companies have previously introduced lower profile models such as Adidas' "Feet You Wear" line of shoes from the late 1990s that were a commercial failure.

The minimalist type of footwear has been available all along. For some unknown reason, the tipping point came recently and piqued the interest of the media and running consumers.

Prior to the recent launch of the wave of minimalist shoes, traditional running shoes had been moving, albeit slowly, toward thinner midsoles and lighter weight. The distinctions among the three main categories had become less obvious too. Many cushioned (or neutral) shoes had some stability features while stability shoes were becoming lighter and more cushioned. The motion control category has seen decreasing sales numbers over the last few years probably because many runners found comfort and protection in shoes that were lighter and less clunky.

How To Define A Shoe As Minimalist

What exactly is a minimalist shoe? This really depends on whom you ask. As with any other category of footwear, there are no strict criteria that formally define a minimalist shoe. The manufacturers seem to be setting their own criteria. It is generally agreed that minimalist shoes have less of everything — less weight, less cushioning and less structure than conventional shoes. They are made to be light, flexible and minimally restrictive of foot motion within the shoe.

Some manufacturers will tell you that a minimalist shoe is one of the following: lighter, less cushioned, less elevated or less structured than a conventional shoe. Others may say that a minimalist shoe is all of those things. Still others would say that the minimalist shoe is the closest a runner could get to being barefoot. While a formal definition is lacking, there is general agreement that minimalist shoes have less structure and mass than conventional shoes.



A recent Internet search found shoes that were advertised as minimalist vary in weight from 2.2 oz. to 9.9 oz. and midsole/outsole thicknesses range from 4 mm to 20 mm. Midsole structural features can vary dramatically as well. Some minimalist shoes such as Vibram, Vivobarefoot and Minimus Trail (New Balance) have no midsole cushioning or support devices. Other shoes in this category have a cushioned midsole that is thinner and more flexible than conventional running shoes and also lack the traditional elevation of the heel (see "Pertinent Insights On The Zero Drop Phenomenon" later in this article). Altra and the Minimus 10 (New Balance) are examples of this type of minimalist shoe. Finally, some shoes in this category include stability devices. Examples include the Mirage 2 (Saucony) and the PureCadence (Brooks).

The following sections discuss the structural features in more detail as well as the purported benefits of each.

Does Minimalist Footwear Facilitate A More 'Natural' Way Of Running?

Many advocates of minimalist footwear emphasize that it promotes a more “natural” way to run. Many use the term to distinguish the different movement patterns between runners in shoes and barefoot. The most obvious difference is that 80 to 90 percent of shod runners are heel strikers while barefoot runners do not land on the heel. Other gait differences include a shorter stride length, a more flexed knee at contact and higher cadence.



The marketing. Most manufacturers associate their shoes with running patterns that are similar to barefoot running. They use terms like “barefoot-like movement,” “ground feel,” “natural alignment” and “natural stride” to promote the benefits of minimalist shoe models. While some manufacturers have backed off earlier claims regarding reduced injury rates due to some recent litigation, there are still references and inferences to decreased injury risk.

The science. Research has shown that barefoot running and some minimalist footwear (Vibram) promote a less dorsiflexed position of the foot at contact as well as a shorter stride length.² This decreases the likelihood of heel striking. Studies showed the knee range of motion during stance was lower in barefoot gait and the knee was more flexed at contact than barefoot as well.^{2,3} Kerrigan’s study suggests that these kinematic changes reduce torque forces on the knee.⁴ Researchers have linked the avoidance of heel strike to reduced impact loading rate, which is also a proposed means of reducing overuse injuries. To date, however, there are no studies that validate claims of reduced injury risk.⁵

The dilemma. While many manufacturers claim their shoes promote a more natural running form, most lack validating research on their specific shoe models and simply refer to research on barefoot running, which is obviously not the same. In addition, while knee loading may be reduced, the eccentric loading and pre-activation of the triceps surae increase with barefoot running but not necessarily with all minimalist shoes.^{6,7} Many manufacturers also have running form coaching videos on their Web sites in order to teach runners how to use the shoes and/or how to transition to them from conventional shoes. A significant part of most of these coaching instructions is to reduce stride length and increase cadence. This form change alone, regardless of the shoe, will affect limb stiffness and impact loading rates for runners.

The question then arises: is it the shoe or the conscious running form change that is more important? (Running form changes are not without risk but discussion of that topic is beyond the scope of this article.) We cannot overlook that not all minimalist shoes elicit the same “natural” movement patterns that the barefoot condition does. Many runners are still able to heel strike and land with the knee more extended when wearing minimalist shoes in comparison to running barefoot.

Pertinent Insights On The 'Zero Drop' Phenomenon

The term “zero drop” refers to the relationship of the heel height to forefoot height. Conventional running shoes typically have a two-to-one differential with the heel often being 1 cm higher or more. Minimalist shoes have reduced this differential to varying degrees. Zero drop refers to a

flat shoe construct with no difference between heel and forefoot. Some minimalist models have 4 to 8 mm of differential.



The marketing. Shoe companies contend that lower heel heights reduce knee loading, promote midfoot landing, are more “natural” and more comfortable.

The science. A study by Kerrigan and co-workers did show that loading of the knee is higher in shoes with elevated heels and authors have proposed that cushioned heels create a “pseudo-neuropathic” effect that makes heel strike painless.^{4,8} Heel striking in and of itself is not necessarily pathologic when running but hypothetically, heel striking combined with a longer stride and a more extended knee at contact may contribute to higher impact loading rates.

The dilemma. Even with a lower heel height, many minimalist shoes have cushioned midsoles that still allow runners to heel strike painlessly. In addition, the reduced heel height and mid- to forefoot landing pattern can increase the eccentric loading of the triceps surae.

While the force on the knee and loading rate may be less, this change does not automatically render the runner immune to injury. It essentially reduces the loading in one part of the limb and increases it in another.

Examining The Reality Behind Reduced Cushioning

As shoes became more and more cushioned between the 1970s and the 2000s, the midsole thickness increased. Consumers likely gravitated toward increasingly cushioned shoes because of the comfort benefits of cushioning. The softer midsole materials and elevated platform do cause some significant differences in kinematics and balance in comparison to barefoot conditions.

The marketing. By reducing the cushioning, companies says minimalist shoes can promote a “more natural foot strike” and enhance proprioception.

The science. Midsole cushioning does reduce transient shock impacts and peak plantar pressures.⁹ Research has shown plantar and midsole footwear characteristics to facilitate pronation and negatively affect balance.¹⁰⁻¹⁴ Multiple studies have shown that frontal plane motion is greater with conventional shoes in comparison to the barefoot condition. One study showed that balance is negatively affected even with a thin sock in comparison to being barefoot.¹² In addition, neuromuscular coordination strategies and limb stiffness are affected by the amount of cushioning in shoes.^{15,16}

The dilemma. Nigg and colleagues have referred to shoes as filters. They filter the sensory input to the plantar foot.⁷ A very simple way to describe the differences between conventional running shoes and minimalist shoes is that they are different filters. As runners do not respond in systematic ways to biomechanical interventions, the key question becomes: how much cushioning (or filtering) is too much or too little for any given individual? Certainly, manufacturers should not be claiming that their particular designs are optimal for all runners in terms of running form, pronation and balance. As for proprioception, minimalist footwear cannot enhance proprioception as some claim. Minimizing the amount of material between the foot and

the ground will likely have less of a negative effect on proprioception but certainly not enhance it.

A Critical Look At Reduced Shoe Mass

The marketing. Reduced shoe weight decreases the metabolic energy cost of running.

The science. Frederick has previously reported that the metabolic cost of shoe weight is approximately 1 percent per 100 grams so there does appear to be a cost of the weight of the shoe.¹⁷ However, some researchers have found that the difference is not always statistically significant and the differences of shoe mass do not fully explain the differences in running



economy. Only three of eight gait studies showed increased economy that was significant and/or consistent with benefit of decreased shoe mass.^{2,18-23}

Some have speculated that inhibited elastic energy storage and return in soft tissue or energy absorbed by midsole cushioning material may also play roles in decreased running economy.¹⁸⁻²⁰ In Franz's study, eight of 12 test subjects were more efficient in lightweight shoes (5.4 oz) than barefoot and that energy cost was 3 to 4 percent lower in the shoes than barefoot.²⁴

The dilemma. There is some controversy in that many of the studies showing reduced energy cost occurred in lab settings on runs of shorter duration. Questions still arise about energy cost savings over the duration of longer events such as marathons. Franz's study suggests that decreased cushioning may increase the workload of muscles and therefore increase energy cost.²⁴ There may be some muscle energy benefits to some cushioning but as would be expected, the optimal amount of cushioning is likely highly unique to each runner and would be affected by such variables as duration of run, pace, surface characteristics and even the level of fatigue.

What To Recommend To Runners Who Seek Minimalist Shoes

The questions that arise from our patients are ones that have been present for conventional running shoes all along. Which minimalist shoe is best for me? Will I get hurt trying minimalist shoes? Can I resolve a chronic and/or recurrent injury by switching to minimalist shoes?

I always emphasize to my runners that minimalist shoes do not magically make the impact forces of running disappear or automatically eliminate the risk of injury. Minimalist running footwear can elicit gait changes that may be favorable to some runners but those same gait changes can increase the risk of new injuries for those who transition too quickly or lack the strength and flexibility to make the transition. The impact forces of running do not disappear. They are redistributed. While the loads on the knees and hips may be reduced, the eccentric load on the triceps surae and the bending forces on the metatarsals increase. If runners have not carefully transitioned or are otherwise not prepared for these altered stresses, they may be vulnerable to injury.

It is my opinion that while some individuals may be able to use minimalist shoes exclusively, most people would be best served by using them as one of the tools in their footwear collection.

The minimalist movement is showing legs beyond running as well. The shoe's appeal has been spreading to water sports, fitness classes and casual use. Along with this broader appeal, the category is expected to continue to grow in the next few years so understanding the structural and movement pattern differences is imperative for anyone treating active patients.

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References

1. Sullivan M. Formula4 Media. Personal communication, May 12, 2012.
2. Squadrone R, Gallozi C. Biomechanical and physiologic comparison of barefoot and two shod conditions in experienced barefoot runners. *J Sports Med Phys Fitness*. 2009; 49(1):6-13.
3. Coyles VR, et al. Dynamic angular stiffness of the knee during barefoot and shod running. In: Henning E, Stacoff A (eds). *Proceedings 5th Symposium on Footwear Biomechanics*, 2001.
4. Kerrigan DC, Franz JR, Keenan GS, et al. The effect of running shoes on lower extremity joint torques. *Phys Med Rehab*. 2009; 1(12):1058-1063.
5. Jenkins DW, Cauthon DJ. Barefoot running claims and controversies: a review of the literature. *J Am Pod Med Assoc*. 2010; 101(3):231-246.
6. Komi PV, Gollhofer A, Schmidbleicher D, Frick U. Interaction between man & shoe in running: Considerations for a more comprehensive measurement approach. *Int J Sports Med*. 1987; 8(3):196-202.
7. Wakeling JM, Pascual SA, Nigg BM. Altering muscle activity in the lower extremities by running with different shoes. *Med Sci Sports Exerc*. 2002; 34(9):1529-32.
8. Robbins SE, Gouw GJ, Hannah AM. Running related injury prevention through innate impact-moderating behavior. *Med Sci Sports Exerc*. 1989; 21(2):130-9.
9. Shorten MR. Running shoe design: protection and performance. In Tunstall PedoeD (ed.): *Marathon Medicine*, Royal Society of Medicine, London, 2000, pp. 159-169.
10. Edington C, Frederick E, Cavanagh P. Rearfoot motion in distance running. In Cavanagh P (ed.): *Biomechanics of Distance Running*, first edition, Human Kinetics, Champaign, IL, pp. 135-164.
11. Luethi. In Johnson (ed.) *Biomechanics*, Human Kinetic Pub, 1987.
12. Shinohara J, Gribble P. Five-toed socks decrease static postural control among healthy individuals as measured with time-to-boundary analysis. Presented at the American Society of Biomechanics Annual Meeting, 2009.
13. Robbins S, Waked E, Allard P, et al. Foot position awareness in younger & older men: the influence of footwear sole properties. *J Am Ger Soc*. 1997; 45(1):61-66.
14. Yi Y, Park S. Effect of reduced cutaneous cues on motion perception and postural control. *Exp Brain Res*. 2009; 195(3):361-369.
15. Fiolkowski P, Bishop M, Brunt D, Williams B. Plantar feedback contributes to the regulation of leg stiffness. *Clinical Biomech*. 2005; 20(9):952-958.
16. Grigg P. Peripheral neural mechanisms and proprioception. *J Sports Rehab*. 1994; 3:2-17.
17. Frederick EC. In Lyden R (ed.): *Distance Running*, Sheridan Books, 2003.
18. Divert C, Baur H, Mornieux G, et al. Stiffness adaptations in shod running. *J App Biomech*. 2005; 21(4):311-321.
19. Perl D, Daoud A, Leiberman D. Effects of footwear and strike type on running economy.

Med Sci Sports Exerc. 2012; 44(7):1335-43.

20. Lieberman D E, Venkadesan M, Werbel WA, et al. Footstrike patterns and collision forces in habitually shod barefoot vs. shod runners. *Nature.* 2010; 463(28):531-535.

21. Burkett LN, Kohrt WM, Buchbinder R. Effects of shoes & foot orthotics on VO₂ and frontal knee kinematics. *Med Sci Sport Exercise.* 1985; 17(1):158-163.

22. Flaherty RF. Running economy and kinematic differences among running with the foot shod, with the foot bare and with the foot equated for weight. *Foot Ankle.* 1994; 14(6):347-352.

23. Kram R, Franz J. Letter to the Editor: Is barefoot running more economical? *Int J Sports Med.* 2012; 33(3):249.

24. Franz J, Wiernzbinski C, Kram R. Metabolic cost of running barefoot vs. shod: Is lighter better? *Med Sci Sports Exerc.* 2012; 44(8):1519-25.

Editor's note: For related articles, see "Barefoot Versus Shod Running: Which Is Best?" in the May 2012 issue of Podiatry Today or the DPM Blog, "Questioning Our Reliance On Motion Control Running Shoes," at <http://tinyurl.com/btfdukj>.