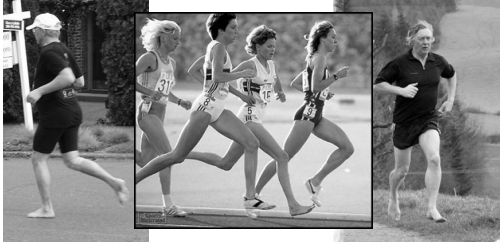


The Barefoot Running Controversy: Implications For Podiatric Practice



Douglas H. Richie Jr. D.P.M. FACFAS
Adjunct Associate Clinical Professor
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Acknowledgment

Dr. Richie acknowledges the contributions of original slides from Christopher MacLean Ph.D and Mr.Simon Bartold which appear on this handout.

THE BAREFOOT CRAZE TAKES OFF

Everybody's doing it !



The Barefoot Running Movement: *Who Cares?*



Barefoot Running: *Implications for Podiatric Practice*



Do you make footwear recommendations to your patients?



**Vibram Five-Fingers
Retail Sales**
2009 \$10 million
2010 \$50 million

**Minimalist Shoes will make up 25% of sales for all
performance running shoes in 2011**

Source: Outside Magazine, Feb 2011

Barefoot Running: *Implications for Podiatric Practice*

Will patients challenge the benefits of foot orthotic therapy?

PERSONAL BEST
Close Look at Orthotics Raises a Welter of Doubts

By GINA KOLATA

Benno M. Nigg has become a leading researcher on orthotics — those shoe inserts that many athletes use to try to prevent injuries. And what he has found is not very reassuring. For more than 30 years Dr. Nigg, a professor of biomechanics and co-director of the Human Performance Lab at the University of Calgary in Alberta, has asked how orthotics affect motion, stress on joints and muscle activity. Do they help or harm athletes who use them? And is the huge orthotics industry — from customized shoe inserts costing hundreds of dollars to over-the-counter ones sold at every drugstore — based on science or on wishful thinking? His overall conclusion: Shoe inserts or orthotics may be helpful as a short-term solution, preventing injuries in some athletes. But it is not clear how to make inserts that work. The idea that they are supposed to correct mechanical-alignment problems does not hold up.

The findings were somewhat puzzling: While the group that used inserts had about half as many injuries — defined as pain that kept them from exercising for at least half a day — there was no obvious relation between the insert a soldier chose and his biomechanics without it. That's why Dr. Nigg says for now it is difficult to figure out which orthotic will help an individual. The only indication seems to be that a comfortable orthotic might be better than none at all, at least for the activities of people in the military. So where does this leave people like Jason Stallman, my friend and colleague at The New York Times? Jason has perfectly flat feet — no arch. He got his first pair of orthotics at 12 and 13 and has worn orthotics all the time, for walking and running ever since. About a year ago he decided to try going without them in his everyday life; he still wears them when he runs. Every medical specialist Jason has seen tried to correct his flat feet, but with little agreement on how to do it. Every new podiatrist or orthopedist, he told me, would invariably look at his orthotics and say: "Oh, these aren't any good. The lab I use makes much better ones. Your injury is probably linked to these poor-fitting orthotics." So he tried different orthotic styles, different materials, different orthotics labs with every new doctor. That is a typical story, Dr. Nigg says. In fact, he adds, there is no need to "correct" a flat foot. All Jason needs to do is strengthen his foot and ankle muscles and then try running without orthotics.

Barefoot Running: *Implications for Podiatric Practice*

How do you explain the function and benefits of foot orthotic therapy to your patients?

Where is the evidence?

Barefoot Running: *Background*

BORN TO RUN

A Hidden Tribe, Super Athletes, and the Greatest Race the World Has Never Seen

Christopher McDougall

A NEW YORK
TIMES
BESTSELLER

May 2009

Full of incredible characters, amazing athletic achievements, cutting-edge science, and, most of all, pure inspiration, **Born to Run** is an epic adventure that began with one simple question: Why does my foot hurt? In search of an answer, Christopher McDougall sets off to find a tribe of the world's greatest distance runners and learn their secrets, and in the process shows us that everything we thought we knew about running is wrong. Isolated by the most savage terrain in North America, the reclusive Tarahumara Indians of Mexico's deadly Copper Canyons are custodians of a lost art. For centuries they have practiced techniques that allow them to run hundreds of miles without rest and chase down anything from a deer to an Olympic marathoner while enjoying every mile of it. Their superhuman talent is matched by uncanny health and serenity, leaving the Tarahumara immune to the diseases and strife that plague modern existence. With the help of Caballo Blanco, a mysterious loner who lives among the tribe, the author was able not only to uncover the secrets of the Tarahumara but also to find his own inner ultra-athlete, as he trained for the challenge of a lifetime: a fifty-mile race through the heart of Tarahumara country pitting the tribe against an odd band of Americans, including a star ultramarathoner, a beautiful young surfer, and a barefoot wonder. With a sharp wit and wild exuberance, McDougall takes us from the high-tech science labs at Harvard to the sun-baked valleys and freezing peaks across North America, where ever-growing numbers of ultrarunners are pushing their bodies to the limit, and, finally, to the climactic race in the Copper Canyons. **Born to Run** is that rare book that will not only engage your mind but inspire your body when you realize that the secret to happiness is right at your feet, and that you, indeed all of us, were born to run.

Christopher McDougall
Author of the National Bestseller, *Born to Run*:
A Hidden Tribe, Super Athletes, and the Greatest Race the World Has Never Seen

the barefoot running debate

"I can't prove this, but I believe when my runners train barefoot, they run faster and suffer fewer injuries."
— Vin Lananna, Director of Track and Field for the University of Oregon and seven-time NCAA Coach of the Year.

"Shoes do no more for the foot than a hat does for the brain."
— Dr. Mercer Rang, the legendary orthopedic surgeon and researcher in pediatric development.

ultrarunning 464 (5000) feet at least partially correct: the secret to top-free running isn't the proper shoe. It isn't stretching. It isn't even training mileage.

It's all.
(Like every other sport, healthy running is all about technique.)

But why hadn't I ever heard that before?

All over heard, over and over, was about shoes. Every podiatrist, sports physician, and running magazine preached endlessly about the absolute necessity of corrective footwear. I was never told what to do; I was only told what to buy.

So how did that square with the Tarahumara? They run multiple marathons — I'm talking about 100-plus miles at a time — on stony trails as hard as any city street. All they wear is the thinnest of horse-made sandals, with zero cushioning, no motion-control, and certainly no orthotics. I saw Tarahumara men in their sneakers spring around their teenagers. Caballo Blanco, the White Horse wanderer at the center of my book, watched a 15-year-old man cruise more than 50 miles up and down the canyon floor. So how were their legs holding up to a lifetime of running without running shoes?

The great barefoot swindle

Tarahumara Runner

Myths
Fact
Barefoot
Research

"One surprising advantage the Tarahumara seem to have over the rest of the world is their lack of technology. They essentially run barefoot or in sandals and experience very little in the way of injury. Over the years, running shoes have become more and more cushioned with more and more high-tech gadgetry attached. Rather than improving our runs, these developments seem to have worsened them. The latest gotta-have running shoe in the stores is causing the average runner to land in a continuous unnatural position, causing more harm over the long haul than good. I can say, as someone who's run many a marathon in little more than canvas and rubber, that there is some truth to this. Like the rest of our bodies, the foot is designed to run. Simplicity is key. A shoe shouldn't be a Lo-Z-Boy recliner."
— Bill Rodgers, marathon great and running specialty store owner, reviewing *Born to Run* for the *San Francisco Chronicle*.

"If we assume that most people have an alignment that is bad, one would think that shoes should be used to align the locomotor system appropriately. The facts are most people have an alignment that is fine. Shoes and orthotics do not align the locomotor system in a major way."
— Dr. Benno Nigg, founder of the Human Performance Laboratory at the University of Calgary and author of "The Biomechanics of Running Shoes."

"We found pockets of people all over the globe who are still running barefoot, and what you find is that during propulsion and landing, they have far more range of motion in the foot and engage more of the toe. Their feet flex, spread, splay and grip the surface, meaning you have less pronation and more distribution of pressure."
— Jeff Pisciotta, Senior Researcher, Nike's Sports Research Lab.

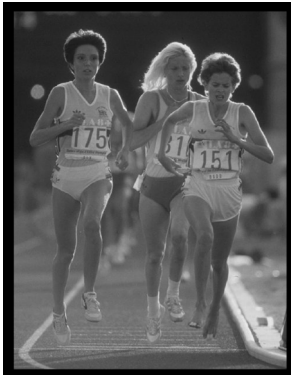
Barefoot Poster Boy Abebe Bikila

- 1960 Rome
- adidas sponsored athlete
- But nothing fits !
- wins gold running sans shoes
- This is considered the basis of proof that it is good for you

Part 2

- 1964 Tokyo
- Appendicitis*
- Poor chance of success
- adidas sponsored athlete
- Wins Gold medal
- By 4km
- Also breaks WR 2:12.11
- **Wearing shoes**
- **Poor choice of poster boy ?**

(c) allsport



World Record 5000m: Zola Budd (South Africa)

What is barefoot running

Definition:

Barefoot running is running while barefoot — without wearing any shoes on the feet.

A



So many shoe to choose from to run barefoot in

new site

Barefoot Running Shoes

HOME | VIBRAM | NIKE | NEWTON RUNNING | INOV-8 | KIGO | NEW BALANCE | VIVO BAREFOOT | BLOG | SUBSCRIBE

Welcome to Barefoot Running Shoes

Popular Barefoot Running Shoes

Men's

- Vibram FiveFingers Shoes
- Nike Free Shoes
- Newton Running Shoes
- Vivo Barefoot Shoes

Women's

- New Balance
- Inov-8 Shoes
- Kigo Shoes

Supposed Barefoot running effects

Pro's

- Makes feet stronger
- Enhances flexibility
- Increases senses
- Increases stability
- Strengthens little muscles

Con's

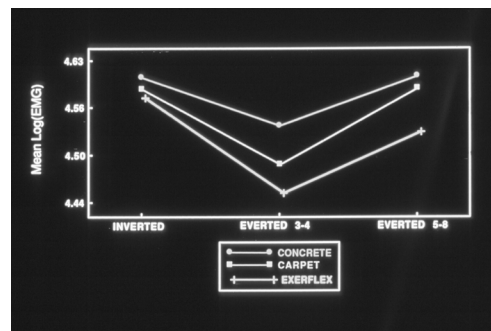
- lack of support leads to knee and ankle problems
- Poor running form causes muscle strains
- Susceptible to small acute injuries such as puncture wounds and bruises caused by debris

Shin Muscle Activity and Sports Surfaces

An Electromyographic Study

DOUGLAS H. RICHIE, DPM*
HERBERT A. DeVRIES, PhD†
CLIFFORD K. ENDO, DPM‡

Twelve human subjects were studied to determine the effect of three different floor surfaces on the medial shin musculature during stationary running. Electromyographic equipment, gated by an accelerometer affixed to the subject's shin, was used to separate the impact (eccentric) phase from the propulsive (concentric) phase of each running step. Excessive eccentric muscle activity has been associated with increased muscle damage, and recent investigations have linked medial tibial shin pain with actual structural damage to the muscle-fascial attachments to the posteromedial aspect of the tibia. Therefore, this study tends to verify the previous assumption that running on hard, noncompliant sport surfaces would predispose running and dancing athletes to shin muscle damage and resultant pain.



The great barefoot swindle

- Is your prescription of distance running shoes evidence based?
Richards, C.E., et al 2009 *Br J Sports Med*; **43**:159-162
- The Effect of Running Shoes on Lower Extremity Joint Torques
D. Casey Kerrigan et al *Physical Medicine and Rehabilitation* 2009
Volume 1, Issue 12.
- Foot strike patterns and collision forces in habitually barefoot versus shod runners
Lieberman *Nature* Vol 463 /28 January 2010

"Is your prescription of distance running shoes evidence based?"

British journal of sports medicine 2009
Craig Richards et al

They determined that there is no evidence to support wearing "distance running shoes featuring elevated cushioned heels and pronation control systems tailored to the individual's foot type."

- *His definition* is of 2 footwear features only !

The small print indicated that CER has a competing interest
as a partner in a footwear design company called "Barefoot on grass"



Examining the degree of pain reduction using a multielement exercise model with a conventional training shoe versus an ultraflexible training shoe for treating plantar fasciitis.

The physician and Sports Medicine DEC 2009 No4, VOL37

Or Heel pain reduction in your shoe v Nike Free & a couple of stretches.

Free v conventional sports shoe

what they said

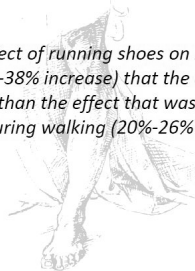
review report -This study reports on pain outcomes in individuals experiencing chronic plantar fasciitis while wearing a shoe with an ultraflexible midsole (Nike Free 5.0) (FREE) versus a conventional training (CON) shoe in a 12-week multielement exercise regimen, and after a 6-month follow-up. Adults with >or= 6-month history of painful heel pain were recruited and randomly assigned to wear 1 of the 2 shoes. All subjects completed the same exercise protocol. A visual analogue scale item tracked peak pain in the preceding 24 hours taken at baseline, 6- and 12-week points, and at the 6-month follow-up. Twenty-one subjects completed the program (9 FREE; 12 CON).

> Both groups reported significant improvements in pain by the 6-month follow-up, and the FREE group reported an overall reduced level of pain throughout the study as a result of lower mean pain scores at the midpoint and post-test compared with the CON group.

The exercise regimen employed in this study appears to reduce pain associated with chronic plantar fasciitis, and in doing so, the **Nike 5.0 shoe may result in reductions in pain earlier than conventional running shoes.**

Kerrigan et al., 2009

“Remarkably, the effect of running shoes on knee joint torques during running (36%-38% increase) that the authors observed here is even greater than the effect that was reported earlier of high-heeled shoes during walking (20%-26% increase).” – Kerrigan et al. 2009



Why jogging in runners is more harmful than heels
– *Herald.ie*

Running shoes 'worse than wearing heels'
– *New Zealand Herald*

Running shoes harder on joints than a pair of high heels: study
– *New York Daily Times*



Barefoot running good for the sole, study finds – *Globe and Mail*

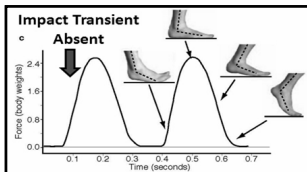
Barefoot runners have a safer stride: Researchers – *Vancouver Sun*



Nature 463, 531-535 (28 January 2010) | doi:10.1038/nature08723; Received November 2009

Foot strike patterns and collision forces in habitually barefoot versus shod runners

Daniel E. Lieberman¹, Madhusudhan Venkadesan^{1,2,3}, William A. Werbel^{1,3}, Adam I. Daoud^{1,3}, Susan D'Andrea³, Irene S. Davis³, Robert Ojiambo Mang'Eni^{1,2} & Yannis Pitsiladis^{1,2}

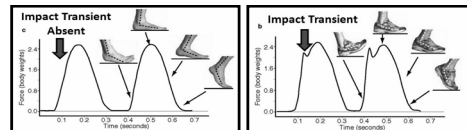


Funded in part by:



Forefoot contact and Injuries?

www.barefootrunning.fas.harvard.edu



Most runners get injured, up to 79% (van Gent et al., 2007)
Most runners Heel strike, up to 80% (Hasegawa et al., 2007)
Almost all runners use modern running shoes

The great barefoot swindle

- Running with shoes induces a heel strike thus increasing impact load
- Barefoot running induces a midfoot/forefoot strike (no RFS) which reduces impact peak
- This therefore equates to less likelihood of injury



Myths Fact Barefoot Research

Concluding remarks on injury stats

- We hear a lot about injury rates having gone up since the 70's... They have not (Taunton et al 2008)
- The vast majority of runners through the 70's and 80's were elite geeks
- Average marathon time was 3:10
- Today it is 4:30 (Hartner 2009)



Myths Fact Barefoot Research

While the reasons, percentages, and means for prevention remain debatable, the fact that runners are still getting injured is not. It's important, however, when comparing running injury rates over time, to consider how the running population has changed. Running USA's 2008 State of the Sport report states that the total number of finishers of U.S. road races rose from approximately 3.8 million to 8.9 million from 1987 to 2007, an increase of 134%. With the increase of road race finishers also comes a rise in marathon finish times. For example, median marathon finish times for men are shown to have increased from 3:32 in 1980 to 4:16 in 2008. What do these stats tell us? Over the years, we've seen many novice runners join the sport, pushing up marathon times and injury rates. Many of these new runners do not understand how to properly train, may be wearing shoes that aren't right for their foot and/or gait, and/or have underlying health conditions that make them more injury prone.

Currently, there is no conclusive evidence demonstrating barefoot/minimalist running reduces injury or that running in running shoes causes injury in every runner. We can only say that runners continue to get injured, and that we have been and will continue to conduct prospective and retrospective research in this area that will enable us to build the best products to keep people running healthy.

Before we go further into injury prevention—how our shoes help reduce the risk and what else can be done to prevent injuries—let's first look at the top running related injuries and the frequency with which they occur.

David M. Brody, in his work 'Running Injuries: Prevention and Management (Clinical Symposia)' published in 1987, states, "Up to 70% of [runners] will at some time sustain a running-related injury." He goes on to say, "The injuries are usually the result of faulty training techniques, biomechanical abnormalities, congenital or acquired conditions, or a combination of these factors." We believe a combination of the right shoe for you, a solid training program, proper strength training, and a focus on improving running form can reduce the risk and frequency of these injuries.

As you can see from the data below, knee injuries are the No. 1 affliction for runners. According to J. E. Taunton's study, "A retrospective case-control analysis of 2002 running injuries," knee injuries have hovered around the 42% mark over the last 25 years, but the percentage of those runners with Patella Femoral Pain Syndrome (PFPS) has decreased. The table below details these findings.

Frequency of Running Injuries		Top 5 Injuries That Occur in Runners	
Knee	42.1%	Patella Femoral Pain Syndrome	16.5%
		IT Band Injuries	8.4%
Foot/Ankle	16.9%	Plantar Fasciitis	7.9%
Lower Leg	12.8%	Shin Splints	4.9%
		Tibial Stress Fractures	3.3%
Hip/Pelvis	10.9%		
Achilles/Calf	6.4%		
Upper Leg	5.2%		
Low Back	3.4%		

Year	Percent of Runners with Knee Injuries	Percent of Runners with Knee Injuries Who Had PFPS
1980	42%	60%
1984	44%	50%
2002	42.1%	46%



The Evolution of Marathon Running Capabilities in Humans

Daniel E. Lieberman¹ and Dennis M. Bramble²



- Running has substantially shaped human evolution
- Running made us human – at least in an anatomical sense
- running is one of the most transforming events in human history
- the emergence of humans is tied to the evolution of running

Ground Reaction Force

- During heel-toe running in humans, the vertical component of the ground reaction force (F_z) has peaks.

(Cavanagh and LaFortune, 1980)

Nature **463**, 531-535 (28 January 2010) | doi:10.1038/nature08723; Received November 2009

Foot strike patterns and collision forces in habitually barefoot versus shod runners

Daniel E. Lieberman¹, Madhusudhan Venkadesan^{1,2,8}, William A. Werbel^{2,8}, Adam I. Daoud^{1,8}, Susan D'Andrea³, Irene S. Davis³, Robert Ojiambo Mang'Eni^{2,7} & Yannis Pitsiladis^{2,7}

Funded in part by:

Foot strike patterns and collision in habitually barefoot v shod runners

D. Lieberman et al Nature vol 463 jan 2010

3 adult groups of individuals who run a minimum of 20k pw.

- Habitually shod athletes from USA
- Athletes from the Rift valley in Kenya most of whom grew up barefoot but now wear cushioned shoes when running
- US runners who grew up shod but now habitually run barefoot or in minimal footwear

And 2 other groups of kids.

The US athletes (1&3) ran on a 20-23m long indoor track with a forceplate imbedded in it

The Kenyans(2) ran 20-23 m along an outdoor hard dirt track

Fore-foot- and mid-foot-strike gaits were probably more common when humans ran barefoot or in minimal shoes, and may protect the feet and lower limbs from some of the impact-related injuries now experienced by a high percentage of runners

b

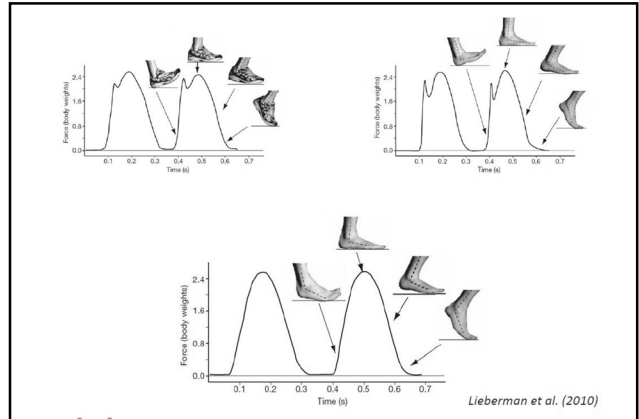
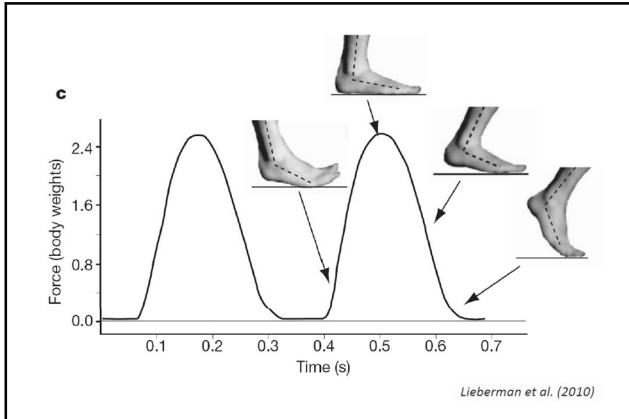
Lieberman et al. (2010)

a

Lieberman et al. (2010)


Vertical Ground Reaction Forces

De Wit et al. (2010)



Foot strike patterns and collision in habitually barefoot v shod runners
 D.Lieberman et al Nature vol 463 jan 2010
 Abstract : Humans have engaged in endurance running for millions of years, but the modern running shoe was not invented until the 1970s. For most of human evolutionary history, runners were either barefoot or wore minimal footwear such as sandals or moccasins with smaller heels and little cushioning relative to modern running shoes. We wondered how runners coped with the impact caused by the foot colliding with the ground before the invention of the modern shoe. Here we show that habitually barefoot endurance runners often land on the fore-foot (fore-foot strike) before bringing down the heel, but they sometimes land with a flat foot (mid-foot strike) or, less often, on the heel (rear-foot strike). In contrast, habitually shod runners mostly rear-foot strike, facilitated by the elevated and cushioned heel of the modern running shoe. Kinematic and kinetic analyses show that even on hard surfaces, barefoot runners who fore-foot strike generate smaller collision forces than shod rear-foot strikers. This difference results primarily from a more plantarflexed foot at landing and more ankle compliance during impact, decreasing the effective mass of the body that collides with the ground. Fore-foot- and mid-foot-strike gaits were probably more common when humans ran barefoot or in minimal shoes, and may protect the feet and lower limbs from some of the impact-related injuries now experienced by a high percentage of runners

Foot strike patterns and collision in habitually barefoot v shod runners
 D.Lieberman et al Nature vol 463 jan 2010
 3 adult groups of individuals who run a mile in 6-10 min
 (1) Habitually shod elite runners (10) who run a mile in 6-10 min
 (2) Habitually shod elite runners (10) who run a mile in 6-10 min
 (3) US adults who grew up shod but now habitually run barefoot or in minimal footwear
 And 2 other groups of kids.
 The US athletes (1&3) ran on a 20-23m long indoor track with a forceplate imbedded in it
 The Kenyans(2) ran 20-23 m along an outdoor hard dirt track
Then the media got hold of it!
 Fore-foot- and mid-foot-strike gaits were probably more common when humans ran barefoot or in minimal shoes, and may protect the feet and lower limbs from some of the impact-related injuries now experienced by a high percentage of runners

Foot strike patterns and collision in habitually barefoot v shod runners
 D.Lieberman et al Nature vol 463 jan 2010
Even the authors acknowledge that the media got it wrong.
 There is this on the authors website:
 "There are many discrepancies in the way the press has reported our paper "Foot strike patterns and collision forces in habitually barefoot versus shod runners"Please note that we present no data on how people should run, whether shoes cause some injuries, or whether barefoot running causes other kinds of injuries."
YOU WRITE WHAT YOU'RE TOLD!

THANKS, CORPORATE NEWS!
 We Couldn't Control The People Without You
 © 2009 by the American Psychological Association

CUSHIONING

- Impact peaks have little correlation to injury
- Joint arthritis is the same for runners and non-runners
- Decreased injury rate for athletes with high loading rates compared to low loading rates compared to low (Nigg,B. 1997 Current Opinions in Orthopaedics)

High impact has a +ve effect on bone mineral density

Summary of barefoot science



- Conflict of interest
- Authors with poor conclusions
- Authors with financial interest in the product.
- Media manipulation
- Barefoot enthusiasts incorrectly reading the science to start with

RUNNER'S WORLD

Feb. 28: New Study Says Barefoot Running is Different From Minimalist-Shoe Running. What Does This Mean? We Still Don't Know

02/28/2011 12:00 PM

A new study from a highly regarded running biomechanics lab might excite barefoot running purists. It might depress minimalist-shoe fans. It definitely raises new questions. And it might cause us to look at foot strike in a new way.

In any case, the study could not say if landing patterns or different kinds of shoes would reduce runner injuries. It wasn't designed as an injury study. It also didn't attempt to say if one form of running or running shoes was more efficient than another. (See the study abstract here.)

The study, from Joe Hamill's Umass lab, seems to imply that runners dislike heel-shock pain. To avoid heel shock, barefoot runners land first on the midfoot and then lower their heel to the ground, reducing heel impact and pain. But there's another way to reduce heel pain: You can wear shoes.

Surprisingly, the thickness (cushioning) of the shoes has little effect. Very thin minimalist shoes and very thick, highly cushioned shoes seem to perform about the same. This isn't actually much of a surprise if you have followed the Benno Nigg "new paradigm," which says that shoe cushioning doesn't do much of what it's presumed to do.

All the shoes had a 4 mm difference between midfoot height and heel height. Thus, none were the true "zero drop" minimalist shoes advocated by FiveFingers and similar shoe approaches, and none had midfoot ridges to force a midfoot landing (e.g., Newtons).

Hamill and colleagues asked 10 runners to run across a force plate in four different conditions: barefoot, and in three pairs of shoes that all weighed the same but differed in midsole thickness-cushioning.

The shoes made little to no difference in how the runners landed. They all came down on their heels with the foot dorsiflexed (toes pointing upward). And they produced nearly identical forces in all the shoes, thin or thick. On the other hand, when running barefoot, all 10 runners landed on their mid- or forefoot with a plantar-flexed foot (toes pointing downward).

The barefoot, plantar-flexed runners produced lower peak forces and loading rates than the runners in shoes. The runners all ran 6:40 pace before striking the force plate. The study didn't compare stride lengths or frequencies.

There was no difference between the barefoot and shod runners on a measure called knee stiffness. However, there was a big difference for ankle stiffness: The barefoot runners required much more ankle stiffness to control their heel-drop to the ground.

The authors note that the lower forces and loading rate of barefoot, plantar-flexed running "may appear beneficial" but caution that "ankle stiffness should be considered as well when assessing the pros and cons of different footfall patterns."

Hamill and colleagues conclude that their new study supports "the contention that the presence of footwear influences impact characteristics, but do not necessarily indicate that running without shoes or with a particular footfall pattern is beneficial for avoiding injuries." In other words, when you land on your forefeet, you produce different forces than when you land on your rear feet. Is one set of forces better than the other? We still don't know.



<http://ireport.cnn.com/docs/DOC-526081>

ORIGINAL ARTICLES

A Proof-of-Concept Study for Measuring Gait Speed, Steadiness, and Dynamic Balance Under Various Footwear Conditions Outside of the Gait Laboratory

James S. Wrobel, DPM, MS*
Sarah Edgar, BS*
Dana Cozzetto, BS*
James Maskill, BS*
Paul Peterson, BS*
Bijan Najafi, PhD*

Gait speed improved with custom foot orthoses, compared to barefoot and regular shoe condition.

Mediolateral range of motion of CoM reduced with custom compared to pre-fabricated orthoses.

Variation of gait speed decreased with custom foot orthoses compared to barefoot and shoes alone.

Decrease in gait unsteadiness may reflect an improved proprioception from increased contact area of custom foot orthosis compared to barefoot condition.

Gait & Posture 32 (2010) 29–33

Does footwear type impact the number of steps required to reach gait steady state?: An innovative look at the impact of foot orthoses on gait initiation Bijan Najafi*, Daniel Miller, Beth D. Jarrett, James S. Wrobel Center for Lower Extremity Ambulatory Research (CLEAR) at Scholl College of Podiatric Medicine of Rosalind Franklin University of Medicine & Science, 3333 Green Bay Road North Chicago, IL USA

"Our results suggest that gait is deteriorated (i.e. longer gait initiation, lower gait speed and increase in double support time) during barefoot condition compared to both shod alone and shod with foot orthoses conditions. As indicated previously, our results also suggest that foot orthoses improve dynamic postural control during walking by reducing the COM range of motion in mediolateral direction."

Gait & Posture 32 (2010) 29–33 Does footwear type impact the number of steps required to reach gait steady state?: An innovative look at the impact of foot orthoses on gait initiation. Bijan Najafi*, Daniel Miller, Beth D. Jarrett, James S. Wrobel Center for Lower Extremity Ambulatory Research (CLEAR) at Scholl College of Podiatric Medicine of Rosalind Franklin University of Medicine & Science, 3333 Green Bay Road North Chicago, IL USA

“We found that wearing habitual shoes with prefabricated foot orthoses enabled subjects to reach steady state walking in 3.5 steps compared to 5.2 steps for the barefoot condition and 4.7 steps for the habitual shoes alone condition.”

ELSEVIER
GAIPOST-2017; No of Pages 16

ARTICLE IN PRESS

Gait & Posture xxx (2008) xxx–xxx

Contents lists available at ScienceDirect

Gait & Posture

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Review

Effect of foot posture, foot orthoses and footwear on lower limb muscle activity during walking and running: A systematic review

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ABSTRACT

The aim of this systematic review was to evaluate the literature pertaining to the effect of foot posture, foot orthoses and footwear on lower limb muscle activity during walking and running. A database search of Medline, CINAHL, Embase and SPORTDiscus without language restrictions, revealed 504 citations for title and abstract review. These articles were translated to English and a final 46 articles underwent a two-tiered quality assessment. First, all articles were scored for their reporting of electromyographic methodology using a set of standards adopted by the International Society of Electromyography and Kinesiology. Thirty-eight articles displayed adequate reporting of electromyographic methodology and qualified for detailed review including a second quality assessment using a modified version of the Quality Index. These included six studies investigating the effect of foot posture, 12 the effect of foot orthoses and 20 the effect of footwear on lower limb muscle activity during walking or running. Meta-analysis was not conducted due to heterogeneity between studies. Some evidence exists that: (i) grounded feet demonstrate greater electromyographic activation of erector musculature and decreased activation of erector musculature; (ii) foot orthoses increase activation of tibialis anterior and peroneus longus, and may alter low back muscle activity; and (iii) shoes with elevated heels alter lower limb and back muscle activation. Most studies reported statistically significant changes in electromyographic activation, although these findings were often not well supported where confidence intervals were calculated. Most important, however, is that there is a need for further research of more rigorous methodological quality, including greater consensus regarding standards for reporting of electromyographic parameters.

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Effect of foot orthoses on lower limb muscle activation: a critical review

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Foot orthoses can be a valuable component of musculoskeletal rehabilitation, improving lower limb alignment, controlling motion and providing shock absorbency. Recent evidence suggests foot orthoses may also have a significant effect on lower limb muscle activation in young, healthy adults. This review examines the evidence for changes in muscle activation patterns when wearing orthoses, and explores the proposed mechanisms by which foot orthoses may bring about changes in lower limb muscle activity. Based on the current results it is proposed that different mechanisms may occur by which orthoses affect muscle activity, due to their differing construction and design.

Keywords: electromyography, EMG, lower limbs, muscle activity

Introduction

Health care professionals frequently prescribe foot orthoses (FOs) as a treatment modality for the treatment and prevention of overuse running injuries. A review of the literature demonstrates a wide-range of overuse lower limb injuries for which FOs have been used as a form of intervention, including

limb biomechanical alignment as foot movement is transferred to the tibia via a coupling mechanism. Therefore excessive inversion/eversion at the subtalar joint can be translated to increased external/internal tibial axial rotation.¹¹ Orthotic support at the medial arch of the foot is considered a standard corrective intervention for excess foot pronation and has been

4.5. Footwear studies

Numerous styles of footwear were included in the review, with the most commonly studied being shoes with varying heel height. Four of the five studies demonstrated significant changes in either lower back [50] or lower limb [32,51,52] EMG muscle activity with increasing heel height. Additionally, Gefen et al. [31] reported that peroneus longus and lateral gastrocnemius are more fatigable in habitual wearers of high-heeled shoes. Therefore, there is some evidence that extreme variations in heel height significantly affect the amplitude of lower back and fatigability of lower limb EMG muscle activity during walking.



Footwear Studies

A further eight studies investigated variation in athletic footwear design during running. The earliest and most recently published studies were from 1986 [49] and 2007 [32], respectively. Over this time, significant advances in muscle function analysis techniques such as wavelet analysis and muscle function MRI have occurred, which precludes the pooling of data extracted from earlier studies with similar methodology. Accordingly, no conclusions can be made with respect to the effect of athletic footwear on muscle function. As these newer techniques emerge and become more broadly accepted in the literature, there will be a need for greater consensus in reporting of important EMG parameters.

RIDDELL BASKETBALL SHOES

FEATURES:
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Gripsole With Cushioning—Cush. In Heel
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Clear Shock Sole System
Light Weight—Rubber Lugged Shock Sole—Open Toe Shock Sole

No. 36
School Price \$4.50

FEATURES:
White Rubber Sole
Non-Marking Sole
Plus All the Quality Features of No. 36
School Price \$4.50



4.4. Foot orthoses studies

The category of foot orthoses drew similar conclusions to the category of foot posture. Irrespective of the foot orthosis material, there is some evidence that peroneus longus and tibialis anterior EMG amplitude, and tibialis anterior duration is greater when wearing foot orthoses. These changes occurred in comparison to standard shoes alone during walking and/or sandals during running [29,30,35,36]. Other components of foot orthoses (i.e. those using hindfoot and forefoot wedging), textured insoles, heel cups and ankle bracing have also been reported to significantly affect lower limb or lower back EMG muscle function [37,38,40–42,44,58]. It is unclear, however, whether changes in muscle function using foot orthoses are consistent and predictable, even when the participants have similar foot posture [30,35,36]. Moreover, it is currently not known whether an increase or decrease in many of the measured EMG variables is beneficial or detrimental in relation to injury. While it makes intuitive sense that an intervention would be beneficial if it can bring muscle activity closer to that seen in a non-pathological population (measured via EMG), definitive evidence is still lacking. Accordingly, it is difficult to make conclusions about the effect of altered muscle function on clinically relevant conditions (e.g. tibialis posterior tendon dysfunction) [59].

Jim Weber, CEO, Brooks Sports

“Let’s look at a snapshot of the running population:

- At one end of the spectrum, we know there are runners who lack foot strength leading to severe pronation. They may strike heavily and need a great deal of support to run injury- and pain-free. We hear repeatedly from them that the **Brooks Beast** “saved their lives.”
- At the other end of the spectrum are the biomechanically blessed (and/or conditioned through training) who have natural healthy gaits and enjoy great efficiency. These gazelles may wear shoes, they may not.
- The vast majority of runners (including this middle-of-the-packer !) fall in between. And for us, we strongly believe most of our mileage should be logged in a performance running shoe, not barefoot . For us, supportive, cushioned footwear is not only beneficial, it also plays an essential role in delivering a comfortable, injury-free running experience”.



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Scott Jurek

- 7 time champion, Western States 100 Mile Endurance
- 2 time champion, Badwater Ultramarathon
- Running Coach
- Physical Therapist
- Consultant , Brooks Sports



Scott Jurek

PROS:

- Encourages efficient running form by promoting body awareness and tactile sensation.
- Increases running economy by having less weight on foot.
- Strengthens the foot-ankle complex and the rest of the kinetic chain (knee, hip, core and even upper body).
- Cross-trains running muscles (running on grass, sand) by breaking up the repetitive environment of running on hard surfaces.
- Prevents injuries due to all of the above.



Scott Jurek



CONS:

- Requires a big transition due to a dominant shoe-wearing culture.
- Requires proper implementation into training to avoid injury (i.e. too much, too soon mistake).
- Decreased efficiency and speed on trails and pavement, because the skin and protective structures of the foot are exposed to a greater load and sharp objects.

Potential Injuries

- Lacerations, blisters and contusions
- Forefoot/midfoot pathology
- Digital pathology
- Achilles tendon



BFR

“Overall, I feel that all runners can benefit from barefoot or minimal footwear training if implemented properly. Like any tool or training technique, it can encourage positive change and benefit the runner whether it is for performance or injury prevention. This in turn can enhance the running experience. Barefoot running does not have to be an all-or-nothing approach. Performance footwear has allowed the human body to reach new levels of performance on the track, road, and trail. Barefoot running can be used in training for all runners and can assist shoe manufacturers in developing footwear that complements the human body to continue exceeding all runners’ performance goals!” – Scott Jurek

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ANKLE MUSCLE STRENGTHENING EXERCISES



Calf Raises - Week 1
Place both feet on the ground shoulder width apart.
Raise up onto toes.
2 seconds out and 2 seconds in, control the motion throughout.

Day	Sets	Reps
1	1	20
2	2	20
3	2	20
4+	3	20

Calf Raises - Week 2
ALWAYS perform these exercises **AFTER** a run! These are the primary muscles that propel you forward while running and if these exercises are done before your run, the risk of injury increases due to fatigue.

Progress up to 3 sets of 20 repetitions over a 3-4 day period to avoid muscle soreness. Gently stretch before and after.



Calf Raises - Week 4
Place one foot on the ground at shoulder width.
Raise up onto toes and completely down.
2 seconds out and 2 seconds in, control the motion throughout.

BAREFOOT TRAINING SCHEDULE

For any new training program, whether it be interval training, hills, or barefoot running, the total volume of the new program should be no more than 10% of your total volume. For example, below is a basic progression program to complement the ankle muscle-strengthening program. For each runner, the progression will vary and you should consult with a trained professional if you feel any pain, signs, or symptoms consistent with an injury. Also, seek the advice of a sports medicine professional if you are concerned about developing an injury while running barefoot. The most common areas affected, when beginning a barefoot running program, are the toes, arch, inside of your ankle, calf muscles, and/or Achilles tendon.

- Week 1 - No more than 10% of your total volume (i.e. 1km if running about 10km that week)
- Week 2 - 20% of your total volume (2km)
- Week 3 - 30% of your total volume (3km)
- Week 4 - 40% of your total volume (4km)

At the end of week 4, our research shows that sufficient strength in the ankle stabilizing muscles will have been achieved which will decrease the potential for injury concomitant with the subsequent increases in barefoot running mileage.

It is recommended that you run on a level running surfaces such as a track or running path when accommodating to barefoot running. As well, asking a coach, trained in barefoot running mechanics, for advice regarding your mechanics is recommended during this period.

The great barefoot swindle

Why NOT to run barefoot



Myths Fact Barefoot Research

The great barefoot swindle

Why NOT to run barefoot



metatarsal fracture in Vibram shoes.
Chris Majewski, DPM, Germantown, MD, christofoot@hotmail.com



Myths Fact Barefoot Research

lets hear it from the barefoot crowd

- Tom Baker November 2, 2009 at 9:24 pm**
I'd rethink that if I were you! I have run for about a year and a half now with sneakers and had no issues. I bought the Vibrams with the hope to increase my times and gain better form. Well in one month I did get faster and improved my time and pace, however I broke my foot from a stress fracture. These damned things offer no shock absorption and thus caused a stress fracture. Now I'm screwed. I can't run for 6 to 8 weeks. I'm miserable, thanks Vibram! Thanks for nothing but pain.
- Chris April 26, 2010 at 12:26 pm**
Now I'm fielding questions from every runner that I meet asking WTF was I thinking running with these. I don't even have an answer... friggin' shoes. Quote:
I also recently broke my 4th metatarsal wearing the VFF. I have been wearing them for 6+ months, about 50 miles per week... and then the pain showed up on an everyday run. I didn't land on it funny or anything.
I'm really torn about what to do. I've never enjoyed running more than in the VFF, but I think they were a major cause of my broken foot. I've been running 50+ miles per week for years and this is the first significant injury I've had. Quote
- Brett V April 28, 2010 at 8:03 am**
I am responding to all of those that hurt themselves with the VFF's. I am an avid marathon runner that recently switched to Vibrams in February. I will say that because I was so excited about these shoes, I probably started running on them too much too soon. My first two weeks I only put in 3-5 miles with each run. Granted, I did some barefooting on the beach a few weeks before. Anyway, I continued my marathon training and didn't have any big problems. I loved running with them. However, two weeks ago I put a stress fracture on the upper side of my foot, 2nd and 3rd metatarsal. It occurred on a regular, and almost light, run a week after I had run 20 miles. I am so confused and torn what to do/I think I love running with my VFF's but received advice from the doctor not to.
I agree with the whole barefooting movement, but I wonder if I am one of those "classic cases" who jumped on the bandwagon before properly researching all necessary prepwork. Also, my doctor said he fears barefooting is the root gravity shoe fiasco where people will only realize their injuries after a significant time and it becomes a fad. Thoughts
- Rob Emel: I loved my VFF but I just got a stress fracture and my Dr. said that he gets a lot of folks with the same injury that are wearing them. Before you assume I am some rookie, I used into my miles for about 9 months and it was a short run. Now I am bummed and I am unsure if should try them anymore.**
- Quote:
I am a triathlete based in the US. Fed up with constant stream of injuries I started barefoot running early this year. Initially I did this under my own initiative, unaware of the growing community that exists online (unfortunately I'm the only person who has been the light around where I live). I have been doing pretty much all of my running in vibram five-fingers but have recently encountered a bit of problem picking up a stress fracture in my second metatarsal. This is a little disconcerting as I had been running regularly in the five-fingers for some months without issue prior to this. I did have very weak flat feet. Since using five-fingers my foot strength has improved but my feet are still flat and I think I have a way to go before I could call them strong. I was wondering if you could offer any advice as to how to get back into barefoot running (once the fracture heals) in such a way that this does not happen again? I have thought that maybe my transition was not slow enough (I suppose I should have built it in very gradually over 6 months) and that I should ditch the five-fingers to give me even more feedback and proprioception.

From Podiatry arena website on the topic of barefoot running

Lecture Handout Courtesy Of:

Allied OSI Orthotic Lab