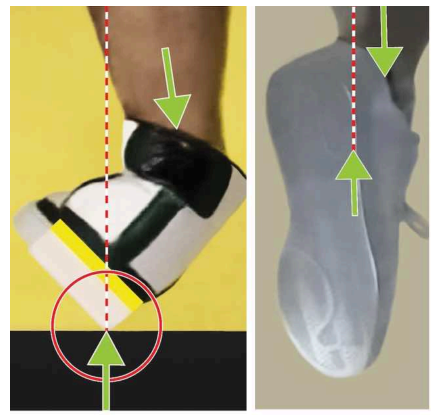
UNNATURAL INSTABILITY:

All Shoe Soles Have a Very Dangerous But Correctible Stability Defect

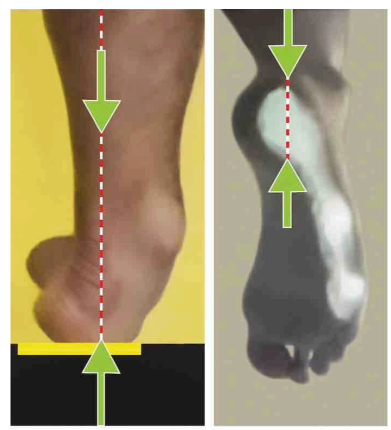
The ancient defect has caused a hidden catastrophe, conservatively estimated at 20,000 deaths, 3,200,000 ER visits, 700,000 hospitalizations, and $65 billion in medical costs in the U.S. each year. All are avoidable because the necessary structural corrections in sole design are proven and available for free use in the public domain. The redesigned shoe soles are far more stable and comfortable, which will increase shoe industry sales while saving lives.

A shoe sole is artificially unstable when tilted outward as far as the subtalar joint allows it naturally to go, into the typical lateral ankle spraining position. Like a seesaw, the entire ankle joint and the bodyweight force transmitted through it pivot on a knife-edge (the thin white streak) of a shoe sole that contacts the ground. The opposing forces are out of alignment, creating an unnaturally powerful destabilizing torque on the tilted ankle. The tilted ankle is supported by the wearer's ligaments and muscle tendons alone.



UNSTABLE SHOE

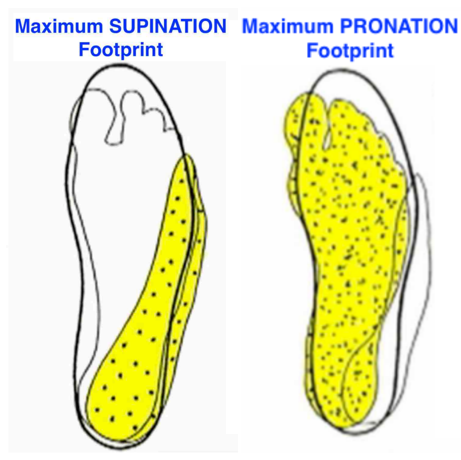
In contrast, **a barefoot is naturally stable when rolled into the same ankle spraining position**, with opposing forces inline and directly supported by leg, ankle, and heel bones, interlocked in perfect natural alignment. The bare sole enjoys a wide base of support, especially under the calcaneus or heel bone, as well as under the base and head of the fifth metatarsal bone (all three bones sites indicated by the large white areas of support).

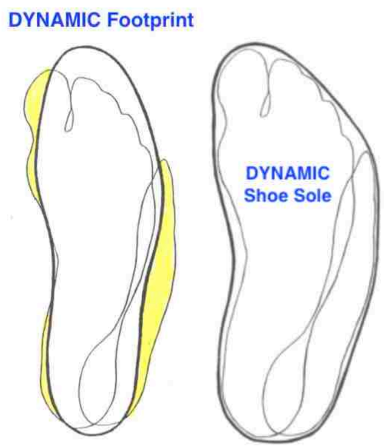


STABLE BAREFOOT

This artificial lack of stability in shoe soles is due to the foot sole simply rolling over the outside edge of the upper surface of the shoe sole, which causes lateral ankle sprains, breaks, and falls. When the wearer's foot rolls as far as the subtalar joint permits, as shown in **Maximum Supination Footprint** (below, in yellow, superimposed on an upper surface outline of a typical shoe sole), most of the side of the flattened foot sole is unsupported by the shoe sole. The upper of the shoe acts as a physical restraint that keeps the foot from rolling off the shoe sole, but instead the upper pulls the shoe sole up uncontrollably into an unnatural tilted position, resulting in ankle sprains, breaks and falls with serious injuries.

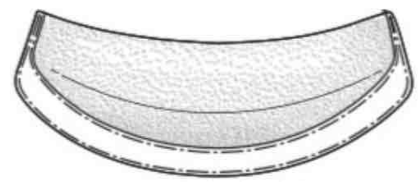
The same kind of mismatch exists between shoe sole and the **Maximum Pronation Footprint** (also in yellow) of the wearer's foot. The foot tends to roll onto or over the inside (medial) edge of the shoe sole's upper surface, unnaturally destabilizing the shoe sole by causing an inward tilt. When the rolling motion is extreme, uncontrollably tilting the shoe sole inward, the resulting gross instability provides an explanation for the ongoing epidemic of acute knee injuries, particularly among female athletes, including anterior cruciate ligament (ACL) ruptures and tears.





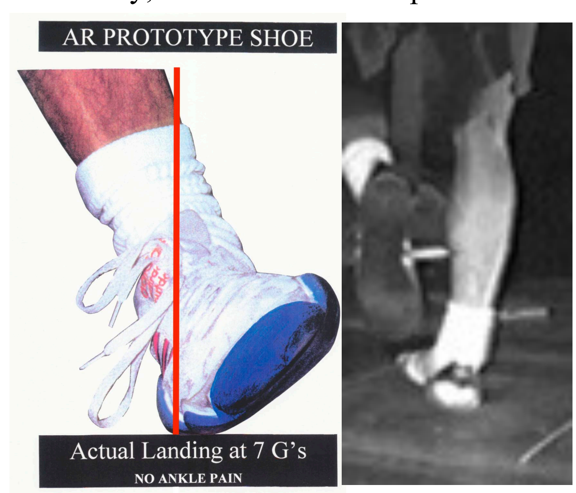
Controlled by the subtalar joint, the full range of normal motion of the foot sole during the extreme motion that often occurs in athletics and running extends the sides (in yellow) of the **Dynamic Footprint** far outside the sides of structural support provided by a conventional shoe sole.

To be as stable as the barefoot, the sides of a **Dynamic Shoe Sole** must extend as far as the foot's dynamic footprint to provide naturally safe locomotion. In addition, instead of being flat, the <u>extra width</u> of the Dynamic Shoe Sole must be curved up around the sides of the **<u>rounded</u>** sole of the foot to avoid creating unnatural destabilizing levers. The shoe sole must also be sufficiently **<u>flexible</u>** to flatten under a bodyweight load, as does the rounded barefoot sole, particularly the heel. Finally, the dynamic shoe sole must have a **<u>uniform thickness</u>** in frontal plane cross-sections to maintain natural barefoot lateral stability, as seen in the example heel cross-section.

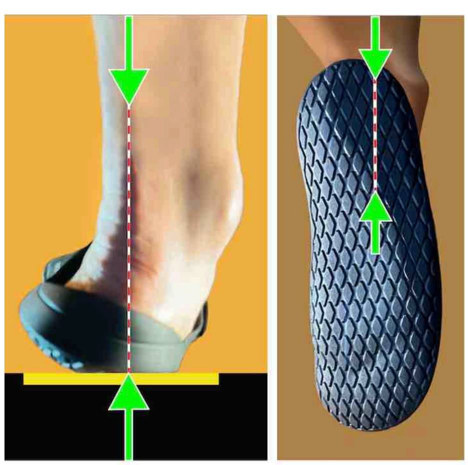


DYNAMIC SHOE SOLE

This is not a theoretical design. An **Anatomic Research Prototype shoe** incorporating these features was constructed in 1993 and tested at the biomechanics lab at U. Mass at Amherst. Its performance was unprecedented, proving capable of **stable single foot landings in the maximum supination position typical of lateral ankle sprains at peak forces as high as <u>4 to 7 G's without ankle pain</u>**.



That unique lab test was obviously impossible to perform in conventional shoes due to very high risk of serious injury, but a similar standing test indicated an ankle pain threshold in conventional shoes of as little as 0.25 G in the maximum supination position.



STABLE SOLE

The patented technology was exclusively licensed to **Adidas** from 1994 to 2003, but its pioneering commercial development then did not reach the full potential demonstrated by the AR Prototype. However, the required industry technologies have matured since then. And independent development by **Frampton Ellis** at **Anatomic Research** has continued since then, as shown in this new corrected and naturally stable sole of the **Frampton Ellis™** slide.

It is factory produced and fully stable, completely different like a barefoot. The utility patents covering the structural elements of this proven barefoot-based stability technology have expired, so those elements are now free and relatively easy to use by the footwear industry.

As a public service, samples of the corrected **Frampton Ellis™ slide** will now be made available by **Anatomic Research** to shoe companies so they can use the slides as general models to directly copy their utterly simple basic sole structure.

A **corrected athletic shoe** is shown here, also designed and developed by **Frampton Ellis** at **Anatomic**. It has a more complex upper, insole, midsole and outsole combination. It will also be made available when ready to serve as a new standard model of stability and comfort for the athletic footwear industry.

A simple example of such use of the corrected stability design among limitless potential redesigns is the most classic basketball shoe, the Converse ***All Star***. It has been modified by a *Photoshop* simulated integration of the ***ARIG slide*** <u>sole</u> structure into the classic ***All Star*** shoe <u>upper</u>.

The result shows little change to the basic look of the classic shoe. The sole sides go from vertical to tilted out about 20°. The sole sides are less angled than the flared sides of soles of running shoes that were introduced in the 1970's, but are now a part of a completely different internal sole structure, one that is finally stable after two thousand years of instability.

Ankle sprains are clearly unnatural and avoidable, but remain the most common cause of both athletic injuries and hospital ER visits. None of the sprains are preventable in conventional shoe soles, even when the best existing commercial shoe and ankle anti-sprain technologies are used.

If there could be any doubt of that, this reality is clearly demonstrated by superstar **NBA 2014 MVP Stephen Curry**, who is shown here wearing his signature performance basketball shoe and a state-of-the-art ankle brace on his nevertheless badly sprained right ankle.

Artificially unstable shoe soles cause unnatural ankle sprains and breaks, which also cause falls, often with serious injuries. According to the **CDC**, accidental falls resulted in 40,000 deaths, 6.5 million Emergency Department visits, and 1.4 million hospitalizations in the U.S. in 2019. The total annual <u>U.S.</u> medical cost of the accidental falls was about **$130 billion**, dwarfing the estimated total annual branded athletic footwear sales <u>worldwide</u> of about **$83 billion**.

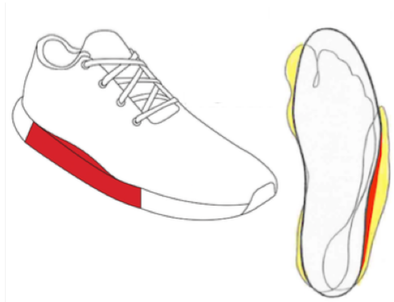
Given the strikingly gross stability defect clearly evident in existing sole design, a very reasonable conservative estimate is that half of those falls are caused by the obvious instability of footwear soles. If so, the roughly **$65 billion** in total annual U.S. medical costs of those avoidable falls each year more than doubles the annual total of U.S. branded athletic footwear sales of about **$31 billion**.

Unmistakably, this is a serious national medical problem with a magnitude of personal loss and economic damage that far exceeds the 9/11 attack in the U.S. And it recurs every year. Cumulatively, over the last two decades it totals almost as many deaths in the U.S. as caused by the opioid crisis. In contrast to that crisis, it has a proven, effective, and simple solution.

Moreover, the relative financial cost of a <u>one-time</u> general design and manufacturing correction within the footwear industry of the design defect of shoe soles is, without question, tiny compared to the **conservatively estimated <u>annual</u> U.S. medical costs of about $65 billion, for 3,200,000 ER visits and 700,000 hospitalizations, as well as 20,000 deaths**

Moreover, the relatively small one-time financial cost to the footwear industry should be paid for easily within the industry by a likely substantial increase in sales and profits fed by increased consumer demand for footwear that is much safer and, a major bonus, also much more comfortable. It is a unique **win-win solution** for both industry and its consumers!

Furthermore, as the quickest possible first step, **there is a simple structural fix that at least noticeably reduces the effect of the instability defect of conventional shoe soles.** It is a worthwhile increase in the stability that can be retrofitted with little expense almost immediately to existing conventional designs.



This relatively quick and easy initial fix involves only a minor extension of the middle part of the lateral side of the shoe sole. The extension simply eliminates a conventional **lateral indention** between heel and forefoot – a previously unnoticed stability flaw. The addition of a straight-sided **Midfoot Lateral Sole Extension** (shown in **red**) is located where the mismatch (in yellow) is greatest between the narrow shoe sole and the much wider bare sole footprint in extreme supination, thereby **substantially reducing an existing dangerous <u>trigger</u> of instability**.

Using the **midfoot lateral sole extension** can reduce the number and severity of lateral ankle sprains and falls during walking and standing, particularly among the elderly. It lowers injury incidence and severity for athletics to a much lesser, but still worthwhile degree.

In one example among many made and tested, a Nike ***Pegasus 38*** was physically modified by adding a straight-sided **midfoot lateral sole extension** to produce a more stable ***Pegasus 38***. As shown here (with touch-up assistance from ***Photoshop***), the structural sole change would be almost invisible in such a modified ***Pegasus 38*** that was made in actual factory production.

The instability triggered by the lateral indentation defect is greatest in the highly sculpted soles of many modern athletic shoes, but it also destabilizes old classics like the Converse ***All Star*** basketball sneaker. Both classic and new conventional shoe sole designs can be quickly redesigned with this simple fix to remove the dangerous trigger defect to provide a noticeably safer level of stability as soon as possible.

The basic science presented here is so simple and the results so unequivocal that it is quite unprecedented in modern research. Valid modern scientific studies done in sophisticated labs with lots of expensive equipment usually can produce test results with only very small differences that often are not statistically meaningful and also are often very difficult to replicate. Moreover, the vast majority of studies are never replicated, so their actual validity is unverified.

In this case, in contrast, the difference between shoe sole instability and barefoot stability is so dramatically different that anyone can prove it for themselves in the simplest way without any equipment other than an ordinary shoe. **<u>But never ignore this serious WARNING: never try tilting-out your ankle, especially while in a shoe, without firm support from a safety spotter to prevent a potentially dangerous fall</u>)**. Here, replication is easy, since dramatic proof of artificially unstable shoe soles is easy to obtain by anyone and valid beyond serious question.

It should also be noted here that there is no formal scientific or medical research that contradicts the research evidence presented here for the simple reason that there is no formal research whatsoever that examines the difference in extreme stability between shoe soles and barefoot soles. That enormous difference has been entirely overlooked, despite its now obvious relevance to ankle sprains and dangerous falls with thousands of deaths and billions in costs.

It's easy to understand why it has been missed. Despite their carefully cultivated reputation for being high tech, the footwear companies don't really do real research. They spend all of their R&D funding on the development of the deeply flawed but unexamined existing sole design. Even there, their total R&D funding is only 1/10 of the average R&D funding for all U.S. companies. And, of course, no private or Federal funding exists for truly basic research in footwear, generally, or soles in particular, the critical structural support component.

In light of this, it seems difficult if not impossible even to conjecture what a reasonable counter argument might be to the now obvious evidence presented here on the basic defect in footwear soles. The only possibility that comes to mind is a plea to believe industry experts, not your own lying eyes. Or in this instance, don't believe your own lying feet and shoes.

Instead, simply put, the irrefutable and easily reproducible evidence of the natural stability of the human ankle when barefoot absolutely proves that the well-known instability of the ankle in a shoe is due to the shoe, not the ankle. The instability of all current shoes is therefore clearly due to the **artificial defect** in their shoe soles.

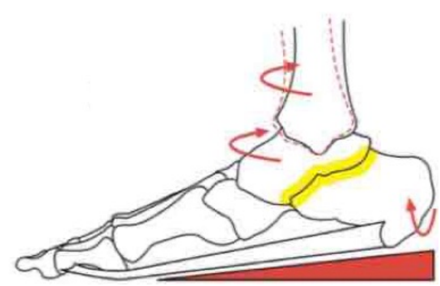
Consequently, there can be no reasonable defense of the status quo in footwear by its industry. No delay can be justified by footwear companies to immediately working with the greatest possible urgency to finally correcting the now obvious sole defect.

AN EVEN GREATER MEDICAL CATASTROPHE, ALSO HIDDEN IN PLAIN SIGHT

As destructive and costly as is the instability defect of the structure of conventional shoe soles, the overlooked effects of a different but also unnatural shoe sole structure are far worse and vastly more harmful.

The modern human body has been severely deformed by the unnatural rearfoot elevation created by the ordinary elevated shoe heel. Every year its pervasive effects on the human body appear to cause as many as **900,000 untimely deaths** and roughly **$1.3 trillion in avoidable U.S. medical costs – about a third of the entire U.S. total of medical care costs**.

For the past several centuries, nearly all modern humans have worn athletic and other shoes with elevated heels. They unnaturally supinate the **subtalar joint** (located between ankle and heel bones). New research provides unusually reliable proof that **during running both ankle joints are artificially tilted out 8° away from vertical and twisted out away from straight ahead by 18° during peak loads of 3 G's**. Both legs are therefore badly misaligned by ordinary shoe heels during the human body's highest repetitive bodyweight loads.



Under the uncomplicated operation of well-established anatomical laws of Wolff and of Davis, the result over a lifetime is bilaterally asymmetrical malformation of all of the bone, joint, and other anatomical structures of the modern human body – from toe to head, including the brain. Wide individual variation in specific deformities is determined by personal factors like footwear use, genetics, biological sex, and the pure chance introduced by accidental injury.

The often incredibly extensive deformity of the human body begins in early childhood and increases throughout life, reaching its greatest effect in the elderly. The artificial deformity has the potential to damage any structure of the body or degrade any function and to worsen any disease or injury, creating thereby an abnormally longer and higher level of pain and suffering.

Of course, this constitutes a public health catastrophe of such an extraordinary magnitude as to be totally unbelievable on its face. However, confirmation of its reality is provided by remarkably trustworthy new evidence. The evidence is based on a revolutionary new gold standard of joint motion measurement, one that reliably overturns the biomechanical results of all prior research on pronation during running. That prior research showed significant pronation of the subtalar joint at peak load during running, but those results were false and misleading. The new research unequivocally proves the opposite, that the actual position of the subtalar joint is always substantially in supination throughout the load-bearing stance phase of running.

Overturning at least a half century of running research, the correct new data indicates that the long-observed pronation in the subtalar joint during running is instead only a relative reduction in a much greater level of supination that remains throughout the stance phase of running. The new data shows that the **12º** inversion or supination of the subtalar joint at footstrike during running is reduced **7°** by motion in an eversion or pronation direction at midstance. **However, the subtalar joint remains inverted or supinated by at least 5° throughout running stance, even at the peak bodyweight load of 3 G's.**

Artificial shoe heel-induced supination is therefore only reduced by an unnatural pronation motion, which occurs only in reaction to the artificial subtalar joint supination. Such pronation does not occur in the feet or ankles of barefoot runners who have never worn shoes.

As significant as this new empirical data is, it was overlooked before now and was simply reported with other data in a running research study by **Peltz** et al. in 2014 that was funded and directed by **Nike**, the study being focused on an unrelated hypothesis. Just by happenstance, then, that data now provides extraordinarily reliable confirmation of the artificial coupling of elevated shoe heels and unnatural subtalar joint supination. I believe that it now justifies an extremely extensive level of formal research into its probable anatomical and medical effects, which appear to be extensive and disastrous, based on compelling preliminary evidence in human anatomy, biomechanics, and orthopedics uncovered in my initial research.

Ultimately, finding optimal individual treatment and/or prevention options to correct the extensive and highly complex deformation of the modern human body will require use of generative **artificial intelligence** computer systems. Those **AI** systems will connect to big data from millions of sensor-equipped smartphones connected to their users' configurable footwear soles with sensors and body sensors. I described this basic AI approach in an initial U.S. patent filing in 2015, based on earlier U.S. patent filings first dating from 2013.

See the most recent abridged and full drafts of this research and analysis in the **Research** section of my website: **www.AnatomicResearch.com**.