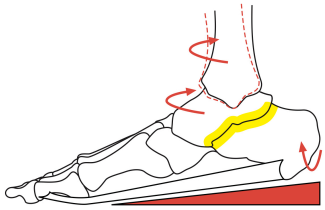
UNNATURAL MISALIGNMENT & DEFORMITY

A new gold standard for 3D joint measurement confirms that when running with elevated shoe heels each foot's subtalar joint is supinated, tilting out the ankle joint 8° and twisting it out 18° at peak repetitive loads of 3 G's, deforming the entire human body from childhood on

Ordinary **elevated shoe heels** obviously raise the heel of a wearer's foot when standing, thereby automatically plantarflexing the wearer's **ankle joint**. In biomechanics, it is well-settled science that ankle plantarflexion is coupled with supination of the **subtalar joint** (the joint connecting the ankle and heel bones). It therefore follows logically that elevated shoe heels must supinate the subtalar joint (**Ellis, 2019, *Footwear Science***). As simple and obvious as that unavoidable conclusion may seem, it has been overlooked until now.



That oversight may have been unavoidable because the motion of the subtalar and ankle joints has been impossible to measure accurately in the past, particularly during running. Now, however, for the first time, truly accurate measurements of the subtalar and ankle joints during running have been made in a Nike study that used the new gold measurement standard**,** 3D radiographic and CT scan-based computer modeling **(Peltz** et al., **2014, *Journal of Biomechanics***).

Included in the Peltz data is proof of the unexpected opposite of a long-standing scientific paradigm that pronation of the subtalar joint and eversion of the ankle joint predominate during running midstance, especially at peak loads. **Instead, both subtalar and ankle joints were found to be substantially supinated at midstance during running, with an extraordinary average combined total of about 8° of inversion and 18° of external rotation at peak repetitive loads of 3 G's.**

The subtalar joint position contributed an average of about **5°** of the tibial inversion and the ankle joint position contributed about **10°** of tibial external rotation. Although from initial footstrike to midstance during running the inversion of the subtalar joint was reduced by about **7°** by motion in a pronation (eversion) direction, the subtalar joint remained supinated (inverted) by at least about **5°** throughout stance. Therefore, greater artificially-induced supination is only reduced in reaction by lesser unnatural pronation motion. Barefoot runners who have never worn shoes do not so pronate.

The artificial misalignment of the talus and tibia away from vertical and straight ahead – with an **8°** outward tilt and **18°** outward twist – would be expected to have profound effects on the human body's structure, but has not been explored before.

During running, that structure is subjected to three times body weight, the highest repetitive loads the human body experiences. Under Wolff's and Davis's Laws, those peak repetitive loads of 3 G's have the capability to gradually remodel the bones and ligaments of joints during each of the millions of running strides that occur in a lifetime, especially in critical growth years of childhood and adolescence. Extensive initial research indicates that every part of the modern human body is affected.

For example, the trochlear surface of the ankle joint of a **modern habitually shoe-wearing Englishman** has an angled lateral extension and a shorter medial side, together indicating a horizontal rotary motion built into the bone (**FIGURE 1A**).

In comparison, a parallel-sided talus of an **ancient barefoot Anglo-Saxon** has no apparent rotary structure and therefore likely functioned as a stable hinge joint (in the sagittal plane), the primary purpose of the ankle joint (**Figure 1B**).

The artificial restructuring of the modern ankle joint contributes to explaining why ankle spraining is the most common sports injury and also the most common cause for hospital ER visits.

Figure 1A

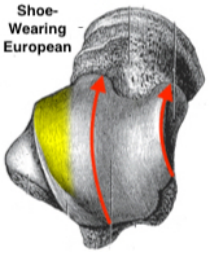
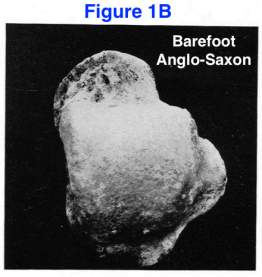


Figure 1B



Similarly, an abnormal rotary torsion – well-known as the unexplained "screw-home mechanism" – is a unique feature built into the tibial bone structure of the modern knee joint (right side) of an habitually **shoe-wearing Modern European** (**FIGURE 2A**). It gradually enlarges and weakens the modern knee, promoting osteoarthritis and ACL injuries.

In contrast, the rarely injured natural barefoot knee (**FIGURE 2B**) of a non-shoe wearer, a **barefoot Australian Aborigine**, has a smaller, simpler structure, with no abnormal built-in horizontal rotary motion, as do equivalent tibia samples from Caucasians of India and ancient Rome. It also has stronger, more secure ligament attachments, such as for the iliotibial tract (circled in **red**)

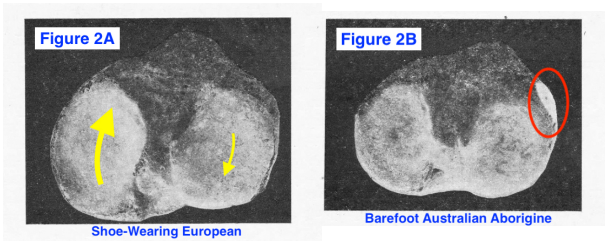



Figure 2C
Modern Knee Joint

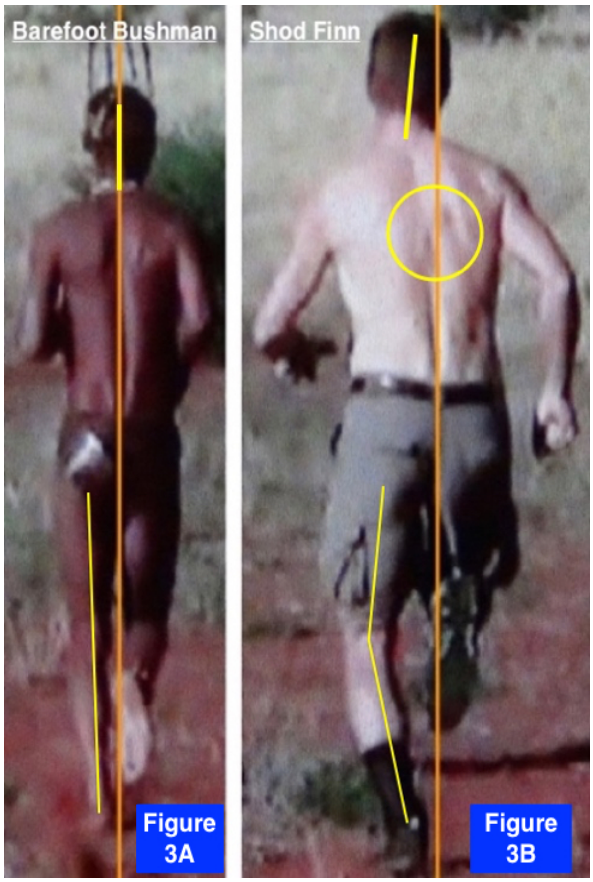
The asymmetrically twisted and malformed menisci highlight the abnormality of the modern knee. The medial meniscus is pushed far forward, the lateral slightly backward (**FIGURE 2C**).

In evolutionary terms, it is well-established that the human body was born to run. However, in modern "evolution-in-reverse", an artificial transformation of the human body from natural to deformed has occurred from running with supination-inducing modern shoe heels.

During locomotion, especially running, the supinated subtalar and ankle joints automatically twist and tilt the entire skeletal structure of the bipedal human body into a bilaterally asymmetrical position. This includes both legs, as well as the pelvis, and everything supported by it, including lumbar, thoracic, and cervical spines, and head.

This deformed prototypical modern human body is unlike a **barefoot African Bushman** (**FIGURE 3A**) who, having grown up always barefoot, has natural body structure when running at peak load of 3 G's in midstance: symmetrical with vertically straight legs and level pelvis, with no leg crossover and well-defined spine, as well as no apparent foot supination or pronation. Evidence indicates that Caucasians and Asians who have never worn modern shoes, such as Zola Budd and Kim Phuc when young, have the same vertically aligned body structure as the African.

In contrast, the modern body of the **shoe-wearing Finnish marathoner** (**FIGURE 3B**), having grown up with modern shoes with elevated heels and supinated feet, is tilted and bent away from a vertical centerline. He has a twisted pelvis and bent-out thoracic spine with shallow definition and unnatural torsion abnormally distorting his chest, possibly pressuring the heart and thereby promoting heart disease. His neck and head are tilted-in to counterbalance his tilted-out thoracic spine, creating artificial rotary torsion on his brain.



The **Peltz** study data also indicates that modern runners when barefoot show similar subtalar and ankle joint supination at peak loads even without elevated shoe heels. That evidence of such a '**preferred movement path'** would be expected, given the extensive permanent changes to all of their bones. It explains why the barefoot running revolution ignited by the 2009 best seller, "***Born to Run***," was destined to fail, as it did.

In summary, the prototypical modern human body has been shockingly deformed – artificially by footwear, not by genetics. That results in unnaturally exaggerated anatomic differences between sexes and also between genetically diverse human populations.

The overwhelming bulk of evidence points to a new and different understanding of what is normal in human anatomy, despite the fact that gross human anatomy has remained almost entirely unchanged for the past century and a half. Nevertheless, the available evidence indicates that the modern human body has been severely and permanently deformed by the unnatural rearfoot elevation created by the ordinary shoe heel.

Based on this preliminary evidence, the best available estimate indicates that **every year the pervasive effects of the unnatural deformity likely cause as many as 900,000 untimely deaths and about $1.3 trillion in avoidable medical costs in the U.S. alone, as well as an extraordinarily excessive level of unnecessary pain and suffering.**

How the common, everyday shoe heel manages to create such widespread deformity in every part of the modern human body is the focus of my second book. See the most recent abridged and full drafts in the **Research** section of my website: **www.AnatomicResearch.com**.

RESEARCH NOTE:

I have conducted over a period of many years a very comprehensive analysis of all the peer-reviewed research I could find in many different disciplines like biomechanics, anatomy, orthopedics, podiatry, physical anthropology, archeology, and various others that were related to shoe heel-induced supination. The **Endnotes** of my unabridged book now totals over 75 pages, mostly listing the many peer-reviewed articles I reviewed and concluded were relevant. Far more articles were reviewed but judged to be less relevant.

REFERENCES

Ellis, F. E. (2019). Shoe heels cause the subtalar joint to supinate, inverting the calcaneus and ankle joint. ***Footwear Science*** 11, S176-177.

Peltz, C. D., Hakadik, J. A., Hoffman, S. E., McDonald, M., Ramo, N. L., Divine, G., **Nurse, M.** and Bey, M. J. (2014). Effects of footwear on three-dimensional tibiotalar and subtalar joint motion during running. ***Journal of Biomechanics*** 47, 2647-2653, especially Figures 4, 5, 7 & 8. The study was funded and directed by **Nike**, for which **Matthew Nurse** is Vice President of Research.

LIST OF FIGURES

Introductory Figure Adapted from **Figure 10.183** from ***Sarrafian's Anatomy of the Foot and Ankle***, Third Edition. Armen S. Kelikian, Ed. (2011), Lippincott Williams & Wilkins. Adapted from Hicks, j. H. (1961) The three weight-bearing mechanisms of the foot. In: Evans, F. G. ed. ***Biomechanical Studies of the Musculo-Skeletal System.*** Springfield, IL: Charles C. Thomas.

Figure 1A Talus Figure 270 (highlighted) from the ***1918 Edition of Gray's Anatomy***.

Figure 1B Talus from Plate XXXI of John Cameron (1934). ***The Skeleton of British Neolithic Man.*** London, Williams & Norgate Ltd.

Figures 2A & 2B Comparative views of the European and Australian Aborigine tibial plateaus (lower surface of the knee joint) from W. Quarry Wood (1920). The Tibia of the Australian Aborigine. In the ***Journal of Anatomy*** Vol. LIV: Parts II & III (January and April): 232-257, Figure 1 on page 235.

Figures 3 A&B A cropped rear view still photo frame of a Bushman (A) and Shod Finn (B) from a ***YouTube*** video clip of "Barefoot running Bushman versus me (shod Finn) https://www.youtube.com/watch?v=H1Ej2Qxv0W8. Published on May 26, 2013.

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