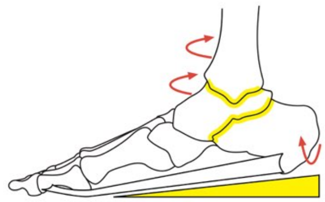
SUMMARY: Conclusive evidence based on a new gold standard for 3D measurement indicates that ordinary elevated shoe heels supinate both the subtalar and ankle joints throughout the stance phase of running, even at peak load, deforming the entire modern human body



Elevated shoe heels obviously raise the heel of a wearer's foot, which is technically called plantarflexing the wearer's **ankle joint.** In biomechanics, it is settled science that plantarflexion supinates the **subtalar joint**, which is directly under the ankle joint. It therefore follows directly that elevated shoe heels must supinate the subtalar joint (**Ellis, 2019, *Footwear Science***). As simple and logical as that conclusion may seem, it has been entirely overlooked scientifically.

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. During running, those joints are subject to three times bodyweight, the highest repetitive loads the human body experiences. Under Wolff's and Davis's Laws, those peak loads have the capability to remodel the bones and ligaments of joints during running, especially during the critical growth years of childhood and adolescence, when running is frequent.

Now, however, for the first time, truly accurate measurements of the subtalar and ankle joints during running have been made in a study that used the **new gold measurement standard,** 3D radiographic and CT scan-based computer modeling **(Peltz et al., 2014, *Journal of Biomechanics*)**.

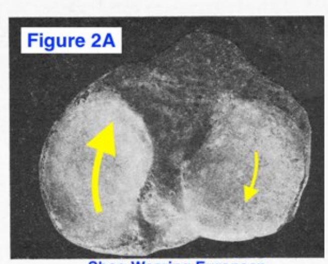
The Peltz results are startlingly unexpected. They are the opposite of the previous scientific understanding that pronation of the subtalar joint and eversion of the ankle joint predominated during running midstance, especially at peak load. Instead, **both subtalar and ankle joints were found to be substantially supinated during midstance running, with an extraordinary average combined total, at peak load, of about 8° of inversion and 20° of external rotation**. The subtalar joint position contributes an average of about 5-6° of the tibial inversion and the ankle joint position contributes about 12° of tibial external rotation.

The probable effects of the artificially realigned tibia – with an 8° outward tilt and 20° outward twist – on the structure of the modern human body have never been explored, but initial research indicates that the effects are extensive.

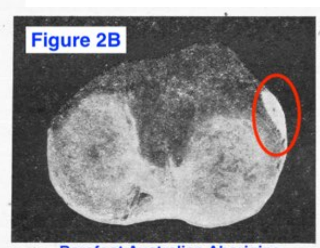
For example, the trochlear surface of the ankle joint of a **modern habitually shoe-wearing Englishman** has an angled lateral extension and a shorter medial side, together indicating a rotary motion built into the bone structure (**FIGURE 1A**).

In comparison, an exemplary parallel-sided talus of an **ancient barefoot Anglo-Saxon** has no apparent rotary structure and therefore likely functioned as a stable hinge joint, the primary purpose of the ankle joint (**Figure 1B**, omitted here). The artificial restructuring of the modern ankle joint explains why ankle spraining is the most common sports injury and also the most common cause for hospital emergency room visits.

Similarly, an abnormal rotary torsion – well-known as the unexplained "screw-home mechanism" – is built into the tibial bone structure of the modern knee joint of an exemplary habitually **shod Modern European** (**FIGURE 2A**). It gradually enlarges and weakens one or both knees, promoting osteoarthritis and ACL injuries.



Shoe-Wearing European



Barefoot Australian Aborigine

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

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

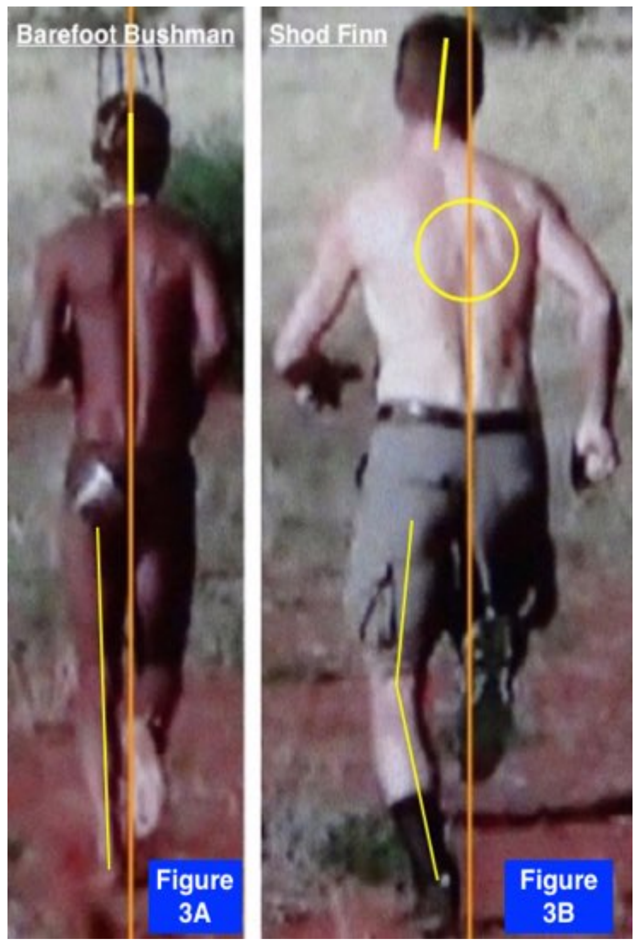
During locomotion, especially running, the supinated subtalar and ankle joints automatically twist and tilt the modern body's entire skeletal structure into a bilaterally asymmetrical position, including both legs, as well as the pelvis, and everything supported it, including the spine, torso, arms, and head.

This deformed prototypical modern human body is unlike an exemplary **African Bushman** (**FIGURE 3A**) who, having grown up always barefoot, has natural body structure when running at peak load in midstance: symmetrical with 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 young Zola Budd and Kim Phuc, have the same vertically aligned body structure as the African.

In contrast, the exemplary modern body of the **shod 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.

In summary, the prototypical modern human body has been deformed – artificially by footwear, rather than determined by genetics – resulting in unnaturally exaggerated anatomic differences between genetically diverse human populations and also between genders.

The overwhelming bulk of evidence points to a new and different understanding of what is normal in human anatomy, despite the conventional wisdom that gross human anatomy is the most settled of all the sciences.



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

Research Note:

I should also include here a note about the extent of my research effort. I have conducted over a period of many years a 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, including many articles available only at the Library of Congress and the National Library of Medicine, not online. The **Endnotes** of my unabridged book now totals over 73 pages, mostly listing the many peer-reviewed articles I reviewed and concluded were relevant, and specifically noting the exact pages and/or specific figures that were considered most relevant. Far more articles were reviewed and deemed not sufficiently relevant to include.

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.

LIST OF FIGURES

October 21, 2019