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. As simple and logical as that conclusion may seem, it has been entirely overlooked scientifically.

That oversight may have been unavoidable in a practical sense, because the motion of the subtalar and ankle joints has been very difficult to measure, particularly during running.

That has been a major problem. Running is very important, since that is when those joints are subject to almost three times bodyweight, the highest and most repetitive loads the human body experiences. Under Wolff's and Davis's Laws, those peak loads during running have the capability to remodel the bones and ligaments of joints, especially during the critical growth years of childhood and adolescence, when running is frequent.

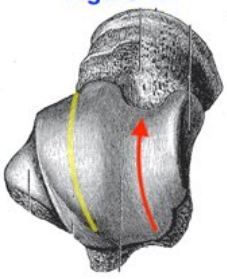
Now, however, for the first time, truly accurate measurements of the subtalar and ankle joints during running have been made in a study **(Peltz et al., 2014**) that used **new gold standard** 3D radiographic and computer modeling techniques.

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

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

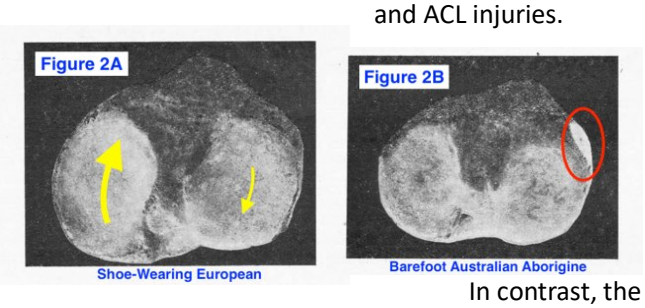
For example, the trochlear surface of the ankle joint of a **modern habitually shoe-wearing Englishman** has an angled lateral extension and a shorter medial side, together indicating a rotary motion built into the bone structure (**FIGURE 1A**).

Figure 1A



In comparison, an exemplary parallel-sided talus of an **ancient barefoot Anglo-Saxon** has no apparent rotary structure and therefore is more likely to function as a stable hinge joint, the primary purpose of the ankle joint (**Figure 1B**). The artificial restructuring modern ankle probably explains why ankle spraining is both 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 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.



In contrast, the rarely injured natural barefoot knee (**FIGURE 2B**) of an exemplary non-shoe wearer, a barefoot **Australian Aborigine** (as well as other examples from Caucasians from India and ancient Rome), 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**).

In evolutionary terms, it is already well-established that the human body was born to run. In terms 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 skull.

This deformed prototypical modern human body is unlike an exemplary **African Bushman** (**FIGURE 3A**) who, having grown up 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 not 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 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.

REFERENCE

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

Introductory Figure **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:

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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.

See also Figure 61 (below) Upper talar surface of ancient Egyptian and modern European, from Jones, F. W. (1949). ***Structure and Function as Seen in the Foot.*** London: Bailliere, Tindall and Cox.

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.