FIRST DRAFT

Modern Human Anatomy:
The Effect of Shoe Heels on the Human Body

If you just follow the evidence wherever it goes, you can end up in a completely unexpected place. What at first seemed inconsequential can lead to remarkable results.

So it is here. This started as an informal investigation into a single rather odd effect of the common shoe heel. Of course the shoe heel itself seems to be no more than an innocuous structural afterthought.

Over many years, however, the initial investigation gradually developed into a surprising story about solving an unexpected mystery. And the unexpected solution has highly unlikely consequences. It leads directly to a basic rethinking of our understanding of the very structure of the human body.

If that sounds barely believable -- if not outright impossible – for any effect of mere shoe heels, the available evidence all points clearly in that direction. However improbable the solution of the mystery, the evidence is carefully assembled into a logical overall picture, as one piece leads inexorably to the next. It is all solid science, including hundreds of peer-reviewed articles from well-regarded medical and scientific journals.

Like any good mystery, this one begins with an important clue. Or, in this particular case, a set of two clues.

Many classic mysteries involve fresh footprints at the crime scene, but it is just plain coincidence that in this case too the first clues are footprints. However these are not fresh footprints. They have been buried since 1939 in a long forgotten medical journal report.

The report is from a Clifford **James** at the Melanesian Mission Hospital in the island of Malaita, next to Guadalcanal in the British Solomon Islands in the South Pacific. Although this could hardly be a less current or more obscure source, at least the medical journal is the prestigious British journal, the ***Lancet***.

Despite their age and obscurity, the footprints turn out to provide both unique evidence and a valuable direction in which to go to find a solution to the mystery. The mystery itself, unlike most popular mysteries, is not about solving a murder. Nor is it fiction.

It does, however, involve life and death, because it is a medical mystery, one that involves many real lives and many real deaths. So many, in fact, that it is far more likely than not it also involves you, and your own life and death. How that can possibly be will become all too apparent as the mystery is unraveled before your eyes.

Starting with just the few footprint clues, solving the mystery step by step slowly will uncover a shocking medical discovery of a many major human anatomical deformities that somehow have remained completely hidden for centuries, until now.

So, to start, take a look at the clues. The footprints of barefeet offer a key to unlocking the mystery.

FIRST CLUE **SECOND CLUE**

FIGURE 1A **Identical** **FIGURE 1B** **Different** (Normal Shoe-Using **European** in yellow)

(**European** in Solid Lines, Barefoot **Native** In Dashed Lines)

THE FIRST CLUE: Different Races Have Identical Footprints

In the **first set of footprints**, **FIGURE 1A on the left below**, two separate bare footprints are superimposed on each other, the first of a barefoot Solomon Islands native[1] and the second of a European. Both had never worn shoes (which of course makes the European a very rare laboratory specimen). The footprints are essentially identical.

FIGURE 1A provides extraordinarily unique evidence that race is definitely not a factor in determining the natural, inherent shape of the human foot. Both racially different feet were the same, and both never wore shoes.

Those identical footprints indicate that all human feet have the same basic shape if left to develop bare, without the influence of footwear. Foot shape is fundamentally the same for both Caucasians and Polynesians.

THE SECOND CLUE: Normal Shoe Use Creates A Different Footprint

In the **second set**, **FIGURE 1B on the right above**, another two bare footprints are superimposed on each other. Again, the first of a barefoot island native and the second of a European, but this time a different European (in yellow), one who normally wore shoes. The bare footprints are very different.

FIGURE 1B provides what proves to be the most crucial clue. It shows starkly what will turn out to be the most important change to feet made by shoes.

That change is that the normally shoe-wearing European's bare (yellow) footprint is rolled unnaturally to the outside relative to the natural barefoot footprint. Technically, this rolled outward foot position is called **supination** (in contrast to rolling inward, which is called pronation).

FIGURE 1B provides strong evidence that shoes must be the cause of this difference in foot shape between races, since shoe usage is the only difference between the two footprints.

If you are a bit too inherently skeptical to accept these clues from the old **James** reference as good enough evidence to continue reading, before quitting please consider this unpublished data recently provided by Dr. Steffen **Willwacher** from his 2015 award-winning running biomechanics study (cited in **Endnote 4**).

His data is that the static reference angle of ankles is **4** degrees of inversion (virtually identical to supination) for 129 males and **5** degrees of inversion for 93 females -- all middle-aged runners measured while standing in their own shoes.

So Willwacher's results generally confirm those of James regarding modern foot supination. So now let's get back to James.

The old footprints in the **James** study provided the first really definitive evidence ever found that shoes alone change the shape of the modern human foot, whereas racial differences do not.[2] (Although some earlier research does take significant steps in that direction.)

It is important to note that this overlooked simple but direct evidence from James contradicts the widespread general belief that human anatomical differences are race-based, unalterably determined by genes.

However, an even more important question remains: how exactly do shoes change the feet? Many studies before and since have implicated shoes as the prime suspect underlying the many well-known problems of the modern foot. But none of them show precisely how shoes do it.

So how do shoes change feet? What mechanism is involved? The footprint clues provide us with a key line of questioning to begin our investigation in earnest.

We will forcus specifically on the following question: why and how exactly do shoes cause the foot to roll to the outside, to supinate. That is the critical question.

To begin, we need a little background on the shoes themselves. In 2009, Christopher McDougall's best-selling book, ***Born to Run***, was published. Echoing pioneering scientific work by Harvard professor Daniel Lieberman and others, McDougall recounted strong evidence that the human body has fundamentally evolved to run and to do so relatively injury-free while barefoot.

In stark contrast, injury rates in modern running shoes have remained unchanged at about 70% per year since the 1970's, when running and jogging became widely popular.

Around those scientific facts McDougall wove the true story of an incredibly tough 50 mile race in the rocky, hilly Copper Canyon of Mexico. The race was won by an untrained primitive runner, a Tarahumara Indian, who wore only semi-barefoot sandals. He triumphed over the all-time-world's-best ultramarathoner, a modern Western champion who wore modern running shoes.

After the book was published, an almost overnight barefoot running revolution was born. Many runners began going barefoot or running in more barefoot-like "minimalist" shoes like the Vibram Five Fingers. Many of the leading biomechanics scientists involved in running shoe research and design announced publicly that it was time to "start over."

But now, several years later, we have arrived at a major impasse. The barefoot running revolution rather quickly fizzled out. The reason is pretty simple: high injury rates overall have not changed much, if at all, either with "minimalist" running shoes or by going barefoot. In reaction, "maximalist" running shoes have also come and gone.

With Never-Ending 70% Annual Injury Rates Looking Inevitable, Running Shoe Design Has Nowhere New to Go

We are now hopelessly trapped in a dead-end. There are no obvious new alternatives left to try, only old ones to try again. If we were born to run, why does running unavoidably cause so many injuries?

As we shall seem it turns out that we just never understood the real problem, which involves a new and different understanding of human anatomy and basic biomechanics.

As you read on, always keep in mind during this journey the simple evidence you have seen in **FIGURE 1B** above, that **shoes cause feet to roll unnaturally to the outside;** that is, to **supinate** abnormally. That clue is the primary key to unlocking the deepest part of the mystery that is uncovered here.

The Automatic Reaction of the Ankle Joint to Elevated Shoe Heels

The lower leg bone is the shinbone (the tibia). The shinbone is joined to the ankle bone (the talus) of the foot to form the ankle joint. The ankle joint is a fairly simple joint that works like a hinge. It has an easy to understand structure and function.

So too, putting an elevated shoe heel under a heel of a human who is standing upright and stationary causes a fairly simple and automatic direct reaction by that human. In order to maintain balance in the same upright stance, the leg is unconsciously and automatically straightened from the slightly bent knee position the higher heel causes. The shinbone automatically moves backwards in an amount equal to the amount by which the elevated shoe heel tilts the foot downward. Otherwise, unbalanced, you fall forward on your face.

In other words, if the elevated shoe heel raises the foot heel and tilts the foot downward by 10 degrees, then the shin bone must move backwards on the ankle joint by 10 degrees. This adjustment maintains the same upright, straight leg standing position. It is a simple and automatic compensation. The ankle joint is then in what is called a plantarflexed position. See **FIGURE 2**

FIGURE 2 **Elevated Shoe Heel Forces Lower Leg Automatically Backwards**

There is nothing complicated in this automatic, self-adjusting reaction to the elevated shoe heel that takes place in the ankle joint. However, hidden underneath is a much more complicated joint reaction.

Shoe Heels Critically Affect the Subtalar Joint Under the Ankle Joint

That is because directly underneath the main ankle joint (shown in yellow in **FIGURE 3A**) is yet another ankle joint, the subtalar joint (shown in yellow in **FIGURE 3B**).

It is located between the ankle bone and the heel bone (the calcaneus). As you can see by comparison, the subtalar joint has a much more complicated structure and apparently different function than the ankle joint.

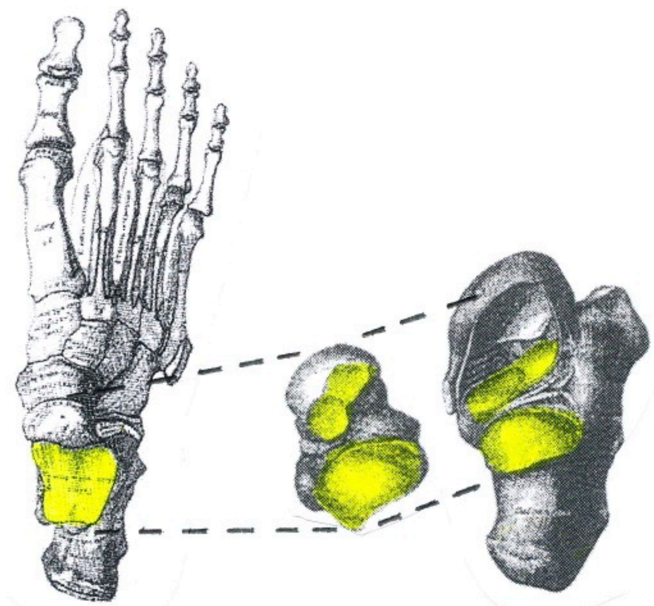


FIGURE 3A **Ankle Joint** **FIGURE 3B** **Subtalar Joint** (Joint Surfaces in Yellow)
(Top of Ankle Bone) (Bottom of Ankle Bone & Top of Heel Bone Are Shown)

The subtalar joint also is affected directly by the elevated shoe heel. However, it is dissimilar and therefore affected in a much different way than the ankle joint because of its more complicated structure and function.

It doesn't need to operate like the ankle joint because the ankle joint already provides the simple hinge joint that is necessary to allow the shinbone to move forwards and backwards over the foot.

The principle function of the subtalar joint is different. It provides sideways, left to right motion of the foot on the ground. This side-to-side motion capability is essential so that the foot can adapt to irregularities in the ground surface during locomotion. Conceptually, that's pretty straightforward too.

But the subtalar joint also has a less obvious function. It is an even more essential component of a locomotion system that controls the rigidity of the foot. This rigidity control is critical so the foot can fulfill two most basic but entirely different functions while walking or running.

The Subtalar Joint Enables the Foot to Alternate Between Rigid and Flexible

During the first half of the stance phase after landing, the foot must be flexible so as to absorb the shock of a ground reaction force produced by our full body weight when we land and to adapt to the shape of the ground. During the second half of the stance phase, the foot must be rigid to function as a propulsive lever to push off the ground.

The subtalar joint performs this dual and contradictory role by enabling what is mostly a slight sideways rolling motion of the foot on the ground. The foot's sideways rolling motion is called pronation when rolling to the inside to absorb landing shock through greater flexibility.

During pronation, the main longitudinal arch of the foot depresses toward the ground, and the heel bone tilts inward from a neutral, generally vertical position. At this point of the running stride, the heel bone – the base of the subtalar joint -- is load-bearing on the ground.

The foot's slight sideways rolling motion is called supination when rolling to the outside to create a more rigid propulsive lever in a plantarflexed position. During supination, the main arch is raised and the heel bone tilts outward from the neutral, vertical position as the heel is raised prior to the toe-off phase of propulsion. At this point of the running stride, the heel bone is off the ground and not load-bearing

This rigid propulsive lever is unique to the human foot. Our closest living non-human relatives, the chimpanzees, do not have it.

The Effect of Elevated Shoe Heels On the Subtalar Joint Has Not Been Well Understood Before Now

The subtalar joint's role in pronation and supination motion is well understood. What has somehow been overlooked almost entirely is that **the elevated shoe heel also automatically causes the subtalar joint to roll the foot slightly to the outside in supination**.

As a result of the shoe heel-induced supination motion, the heel bone is artificially tilted out and the foot becomes more rigid. And this happens when the heel bone is load-bearing on the ground. In a literal sense, this is a pivotal change. When standing upright, the foot is no longer in a natural, neutral position.

If the height of the elevated shoe heel is moderate, then the associated tilting-out and rigidity of supination is also moderate. If the elevated shoe heel is greater, then the amount of tilting-out and rigidity of supination will also be greater.

This supination adjustment of the foot to an elevated shoe heel is automatic - a direct function of human foot anatomy and biomechanics. It occurs for two reasons primarily.

Elevated Shoe Heels Automatically Shift the Position of the Subtalar Joint Outward

First, a powerful ligament called the plantar aponeurosis (located on the bottom of your foot sole) connects your heel bone to your toes. When the foot is level on the ground, the plantar aponeurosis is relatively loose, so the foot is flexible and most capable of conforming to any irregularities of the ground, in order to provide a stable base of support for the leg. See below **FIGURE 4.3 A**.

When the heel bone is raised during the propulsive phase of running or walking, it automatically bends your toes upward toward you. That mechanism automatically tightens the plantar aponeurosis so that it acts mechanically like a windlass that forces the foot into a supinated position with both a higher, more rigid arch and a tilted out the heel bone. This creates a rigid propulsive lever with which to push off. See below **FIGURE 4.3 B**.

The elevated shoe heel artificially puts the foot into this position all the time – including throughout the entire load-bearing phase -- not just during the toe-off propulsive phase of running or walking.

The Natural Windlass System (Without Shoe Heels)

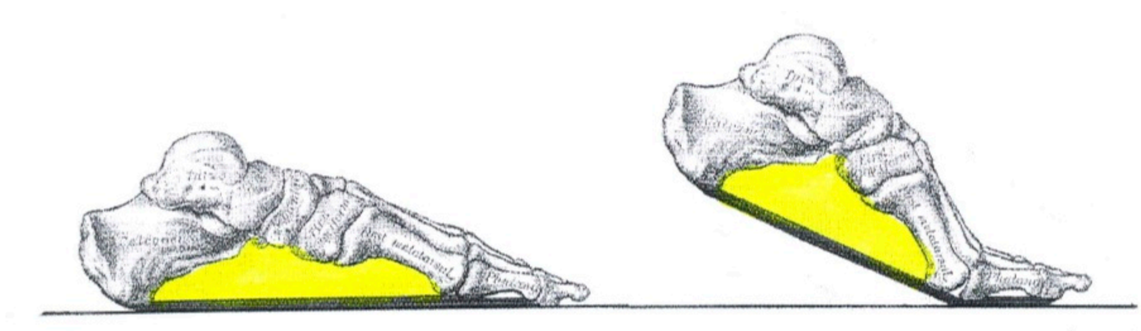


FIGURE 4A Supporting Foot Flexible **FIGURE 4B Propulsive Foot Rigid**

Second, a midtarsal joint connects the heel and ankle bones with the middle part of the foot (called the midtarsal of the foot). The windlass action of the plantar aponeurosis acts as a locking mechanism for the midtarsal joint.

When the foot is automatically plantarflexed by the elevated shoe heel, the foot is supinated by the windlass action and the midtarsal joint is gradually locked into an ever more rigid supinated position, away from a pronated position. In this way, the human foot becomes a uniquely rigid propulsive lever.

FIGURE 5, which shows a front view of the ankle bone (the talus, in yellow) and heel bone (the calcaneus), which are joined together by the subtalar joint. **FIGURE 5** shows how the subtalar joint operates. The ankle bone rotates on top of the heel bone – tilted inward in pronation and tilted outward in SUPINATION, shown below on the right.

The Subtalar Ankle Joint's Range of Motion

FIGURE 5 PRONATED Rotated Inward **SUPINATED Talus Rotated Outward**

In the SUPINATED position on the right, the axis of each of the joints connecting the front of the ankle and heel bones to the rest of the foot are crossed, locking the joints to make the foot rigid for propulsion. In pronation, they are parallel, unlocking the subtalar joint. The windlass mechanism is the principal way the position of the subtalar joint is synchronized with the position of the ankle joint.

Both the windlass action of the plantar aponeurosis and the locking role of the midtarsal joint have been very well known in the associated fields of anatomy and biomechanics for many decades, as is their mutual interaction with the subtalar joint to form an effective part of the human locomotion system. It is a bio-mechanism that is definitively settled science.

Foot Supination Automatically Rotates the Lower Leg (Tibia) to the Outside

Also definitively settled science is another bio-mechanism. It is that any foot supination motion, such as that caused by the elevated shoe heel, automatically rotates the lower leg (or tibia) to the outside, as demonstrated in a classic study by Gustav **Rubin.**[3]

FIGURES From Rubin Study Supination of Barefoot Rotates Tibia to Outside

Unnaturally Twisted Knee: Maximally Loaded and Maximally Flexed

Running plays a decisive role in producing abnormal structural change. That is because, forced by the abnormal twisted outward foot supporting it, the knee is also twisted outward while flexed at the maximal load-bearing point during the midstance phase of running (in the middle below). The greatest repetitive stress on bones and joints occurs then, at about 2-3 times body weight.

This is critical in altering the natural development of bone structure, since according to Wolff's Law, bone formation occurs in reaction to the maximum stresses to which the bone is routinely subjected. For the human body, the peak routine body weight load occurs when running, especially during childhood, when running is a constant activity. (The most frequent parental command is either “Don’t Run!” or “Stop Running!”, both of which are routinely ignored.)

In contrast to **FIGURE 6B**, **FIGURE 6A** shows natural, unshod and therefore un-twisted midstance knee position pointed straight ahead.

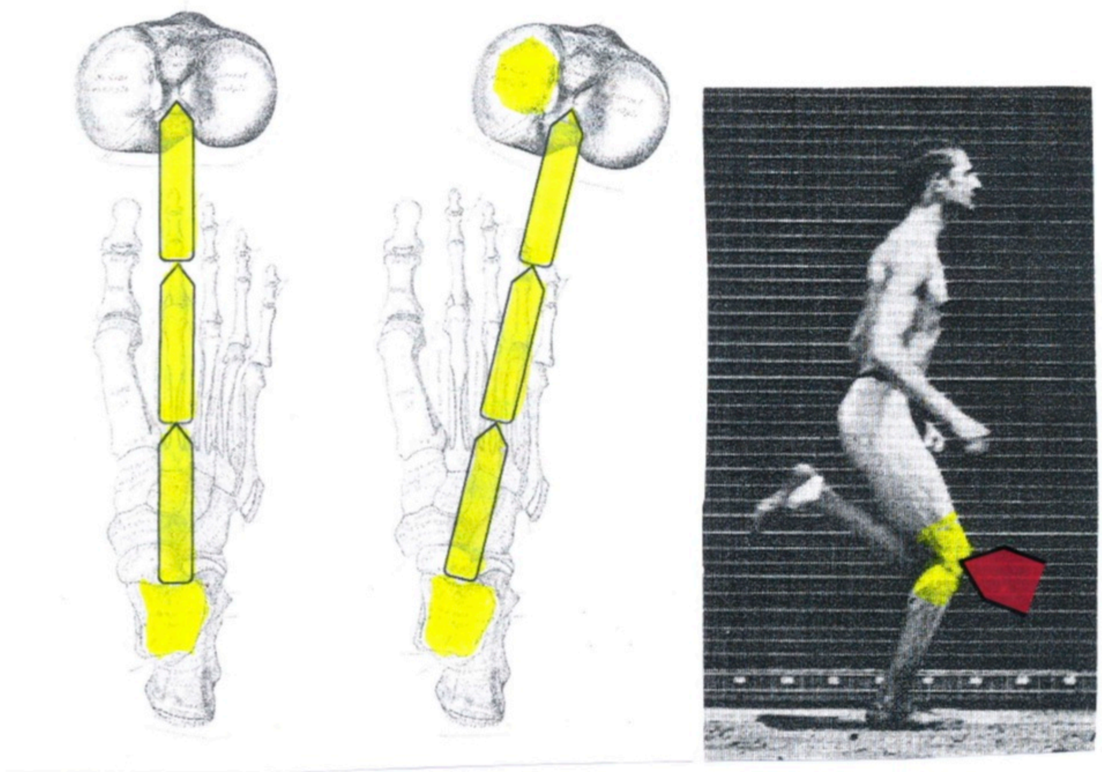


FIGURE 6A **Natural** **FIGURE 6B** **Shoe Heels** **FIGURE 7** **Peak Load & Flexed**

Incidentally, the footprints clues cited in the James report (**FIGURES 1 A&B**) are all the more powerful as evidence because the footprints were taken with knee bent forward, forced down, supported on that single leg alone.

So it was taken in roughly the typical midstance running position shown in **FIGURE 7** above (although at only about 1 full body weight, rather than the 2-3 times full body weight typical in running).

FIGURE 6B, which shows the unnatural, maximally loaded, tilted out knee position caused by shoe heel running, also shows that the inside (medial) half of the knee joint abnormally carries most of that maximal load, as much as 80-90% for some individuals.

Runners’ Legs Forced Into an Inherently Unstable, Tilted-Out Position

FIGURE 8A below shows a front prospective view of the tilted out runner’s leg of **FIGURES 6B** above, with the resulting 2-3 time body weight of the runner being angled from vertical, following the support structure provided by the lower leg bone. Whereas the leg would be stable if vertical, it is unavoidably unstable in the tilted out position.

In the terms of simple classical physics, this angled vector of body weight resolves into a vertical component vector and a horizontal component vector, as shown below in **FIGURE 8B**. The horizontal component is the key factor, since it unnaturally forces the subtalar joint inward, causing the foot to pronate inward more than naturally needed.

FIGURE 8A **FIGURE 8B**

A natural, vertical leg is inherently in equilibrium, with the downward body weight force balanced by a matching upward ground reaction force. In contrast, the unnatural shoe heel sets up a fundamental structural instability shown above in **FIGURES 8A&B**.

Summing up, as shown above in **FIGURES 6B & 8A, the shoe heel forces the knee to tilt unnaturally outward in the frontal plane and rotate externally in the horizontal plane.**

Simultaneously the ankle is unnaturally forced inward by the unstable force vectors resulting from the tilted lower leg, as shown in FIGURE 8B, resulting in unnatural pronation. This dual interaction is strictly mechanical. It is automatic and unavoidable.

Shoe Heels Artificially De-Couple Natural Joint Motions

A few months ago I sent a copy of the first draft of the full book version of this article to E. C. "Ned" Frederick, Ph.D., for a preliminary review. Dr. Frederick has for many decades been one of the best-known scientists in the field of footwear biomechanics and is the former head (actually the first) of R&D at **Nike** and currently the Editor (also the first) of **Footwear Science**. He also played a significant role in helping to license my barefoot-based shoe sole technology to **Adidas** in the 1990's, where it became **Adidas'** core footwear technology for many years (See www.AnatomicResearch.com.)

Ned was kind enough to provide a quick and dirty analysis of my relatively long and complex book (including over 50 pages of Endnotes), of which I believe the most significant concern he raised is as follows. Although the static lower leg bio-mechanisms described above in **FIGURES 4A&B, 5, 6B & 8A** are settled science, many studies in recent years indicate clearly that these static mechanisms are "**de-coupled**" when running.

That is to say, joint linkages measured when stationary may be assumed to be rigid relationships but become flexible under dynamic conditions. That observation could be interpreted as generally meaning that the known static bio-mechanisms have less effect in a dynamic situation, sometimes much less.

If so, then all the effects of shoe heels that I was describing in this article were also de-coupled when running, and perhaps were therefore less or much less significant. So that is potentially a big issue, given the central importance of running to my analysis.

I was already aware of many of these studies, but had not specifically addressed the issue in my draft book. In the course of my research I had interpreted the known running de-coupling effect to be clearly supporting the opposite conclusion, but had not formally presented my position. My personal thanks to Ned for taking the time to raise this important but unresolved issue so it can be directly addressed as it should be.

My opposing conclusion is that, during running, the shoe heel itself -- as the automatic bio-mechanism described above in **FIGURES 6B & 8A** -- actually causes the observed **de-coupling** of the lower leg bio-mechanisms. Simply put, shoes heels cause the de-coupling, thereby disrupting the otherwise direct joint linkages. To put it another way, de-coupling is the direct effect of shoe heels.

Those bio-mechanisms include the normal, well-proven internal/external rotation motion of the tibia in the horizontal plane and eversion/inversion of the foot in the frontal plane that would otherwise be expected from stationary testing, as shown above by Rubin.

So, in reaction to the issue constructively raised by Ned, I set out to find better research support for my opposite conclusion. Fortunately, I found it almost immediately in the latest issue of ***Footwear Science***.

I found it in data from the earlier cited study by Steffen **Willwacher**, Irena Goetze, Katina Mira Fischer and Gert-Peter Bruggemann. The study is titled "The free moment in running and its relation to joint loading and injury risk," in ***Footwear Science*** (2016), Vol. 8, No. 1, pages 1-11 particularly pages **4-9** and **Figures 4-6**.

The study is the winner of the **Nike Award for Athletic Footwear Research**, the highest award presented in Liverpool, UK 2015, at the **XIIth Footwear Biomechanics Symposium**, a biannual conference sponsored by the **International Society of Biomechanics.**

What I found was that with some formal analysis the actual physical existence of the artificial de-coupling shoe heel bio-mechanism can be proven mathematically using the unusually large data set from the **Willwacher** study**.** The proof is surprisingly solid. See the full analysis in **Endnote 4.**

Another major mystery solved by just following the lead provided by our original footprint clues. You might rightly ask if there is some other, competing scientific explanation for the decoupling effect. The answer is no. The existing official explanation is that it just happens.

Also, Strong Evidence of Shoe Heel-Induced Knee Tilting & Rotation Provided By Data from the Willwacher Study

As seen in the Knee Moment Frontal Plane graph of Figure 4 of the same study by Steffen

Willwacher and others,[4] awarded the largest prize in footwear biomechanics, there is strong evidence of a powerful **external knee adduction moment (or torque).** This external torque forces the knee to tilt out into a bow-legged or varus position in the frontal plane.

There is also a similarly powerful **external rotation torque** in the Knee Moment Transverse or horizontal Plane graph of Willwacher's Figure 4. This external torque forces the knee out into a twisted-out position in the horizontal plane.

As expected, both torques peak at midstance when the knee is maximally flexed and under peak body weight load.

FIGURE 8C External Knee Torque in Both Frontal & Horizontal Planes

FIGURE 8D Increased Unnatural Knee Moments

So, the dual torques shown above in FIGURE 8C act powerfully together to both tilt out and externally rotate the knee toward an artificial varus or bow-legged (or adducted) position shown above in FIGURE 8D, as is predicted by the preceding discussion of the biomechanical effect of conventional shoe heels.

Another recent study of runners indicates that average maximum position of the knee when running is about **8 degrees of varus or bow-legged position**.[5]

Other Research Studies Have Also Experimentally Confirmed the Twisting Effect of Elevated Shoe Heels on Ankle Joint and Foot

In summary, the elevated shoe heel is an artificial structure that activates a mechanism in the subtalar ankle joint that twists each foot to the outside into a supination position. The simple twisting mechanism is an automatic and unnatural external rotation.

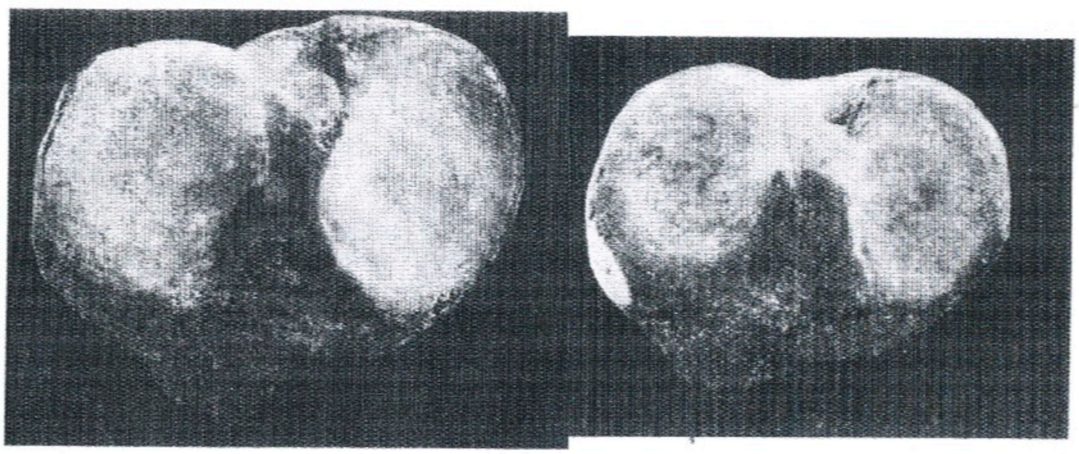
Since 2002, four different peer-reviewed biomechanical studies have confirmed this basic mechanical relationship between elevated shoe heel and tilting-out supination, in addition to the Willwacher study cited above.[6]

The Modern Knee is Restructured By the Unnatural Rotary Torsion of Running With Shoe Heels

The abnormally tilted out position of the lower leg on the knee joint shown in **FIGURES 6B & 8A** creates unnatural increased pressure on the inside or medial portion of the knee and reduced pressure on the outside or lateral portion

That abnormal and extreme stress causes an unnatural restructuring of the knee while tilted out. The tilting creates an unnatural rotary motion, unbalancing the load on the knee by massively over-loading the medial (inside) portion. The unnatural rotary torque becomes built into the shape and structure of the modern knee joint. The result over time is that nearly all runners become former runners due to knee pain, and of those, many become non-walkers due to knee arthritis caused by their deformed knees.

As you can see in the left section of the photograph below in **FIGURE 9A**, the modern European knee has an abnormal rotary motion (in the horizontal plane) molded into the bone. The primitive barefoot knee of an Australian aborigine shown in the right section **FIGURE 9B** is natural and therefore does not show any evidence of rotary motion, as is also true of primitive barefoot knees of Caucasians of India and ancient Romans.



The proximal aspects of a European and an Australian tibia of approximately the same length. The greater breadth and more massive character of the European epiphysis are clearly demonstrated. The two bones were photographed at the same distance from the camera.

FIGURE 9A Shod European Rotary Knee FIGURE 9B Barefoot Aborigine Knee

Data from the Willwacher study (graph on Knee Angles in Transversal Plane – in Endnote 5)) provides clear evidence of this abnormal rotary motion in the modern knee. It shows a knee internal and external rotation range of motion during the stance phase of running of about 8 degrees, and total rotation motion of about 20 degrees in the transverse (or horizontal) plane with every full running stride

The motion is irregular, initially internal 1º, then external 2º, and then internal 8º. The individual range of variation between the 222 runners is very high, as expected given each individual's specific genetic adaptation to their own particular, highly variable shoe heel use.

Graphical data from the same source on Knee Angles in the Frontal Plane is even more erratic, with 1º abduction, then 1º adduction, then 3º abduction, and then 2º adduction.

Like the Knee, the Ankle is Restructured By Unnatural Rotary Torsion

Like the rotary modern knee, the modern ankle joint shown in **FIGURE 9D** shows the same rotary motion induced enlargement, compared to the primitive barefoot Egyptian ankle joint shown in **FIGURE 9C**. **FIGURE 9E** shows more definitively the unnatural rotary structure built into the modern ankle joint (trochlear ankle joint surfaces highlighted in yellow).

FIG. 9C Barefoot **9D** Modern **FIG. 9E** Modern Rotary Ankle Structure

Both Ankle Joints Point Unnaturally to the Outside, Not Straight Ahead

The higher the artificial heel, the greater the outward twisted position of the supinated feet. In particular during childhood but throughout life, that simple twisting mechanism gradually changes the shape and function of every part of the human body, including the knee.

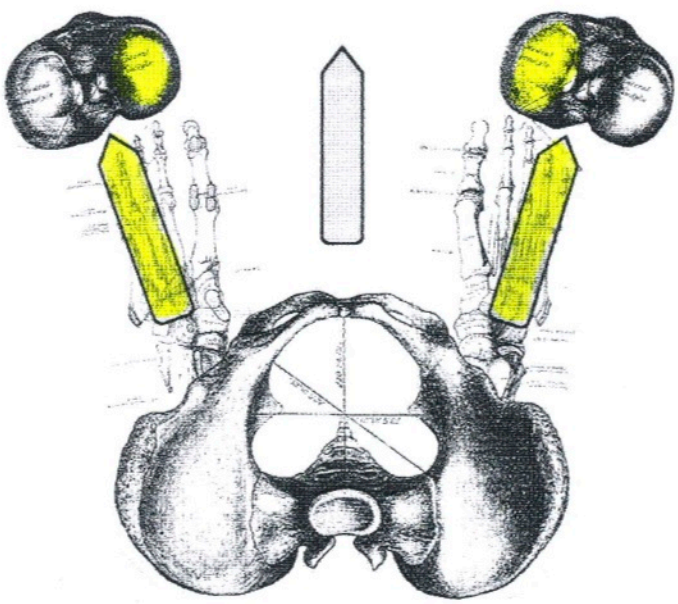


FIGURE 10 Both Ankle Joints & Knees Are Twisted Unnaturally to the Outside

As illustrated in **FIGURE 10**, the ankle joint of the right foot is twisted outward to the right, and the ankle joint of the left foot is twisted outward to the left; both instead of straight ahead. Consequently, both knees are also forced to the outside unnaturally, with most of the body weight load shifted to the inside (medial) half of the knee (in yellow).

FIGURE 11A Front View of Hip joints **FIGURE 11B Rear View**

The thigh bone are also rotated unnaturally to the outside by shoe heels, excessively exposing the femoral heads to abnormal wear in the hip joints, as shown in the front view of **FIGURE 11A**. Conversely, in the rear view of **FIGURE 11B**, the femoral heads are completely covered and located abnormally within the hip sockets.

It should be noted as well that the actual structural orientation of the hip joint is not optimized for standing fully upright and walking (as typically shown above). Instead, the hip joint orientation is optimized for running in a flexed position (when maximally loaded at 3 times body weight), as shown above in **FIGURE 7**.

Until now, the exposed position of the hip joint has been thought incorrectly to have resulted from incomplete human evolution to bipedal from quadrupedal locomotion. In other words, the evolution from 90º leg flex to 0º straight is not finished, whereas actually evolution is complete at 45º leg flex, which is exactly optimal for the maximum body weight load at midstance when running (**FIGURE 7**).

The Basic Alignment of Human Legs Altered By Shoe Heels

This very basic structural instability directly affects everyone wearing shoe heels, but each individual adapts in their own particular way. Many factors are in play, including unlucky injuries, but generally those with stiffer subtalar joint and foot arches maintain the supinated foot position, which causes their legs to bend outward into a **bow-legged** position. See **FIGURE 12A** below.

Those generally with more flexible subtalar joint and foot arches rotate inward in pronation in reaction to the unnatural horizontal component vector, which causes their legs to bend inward into a **knock-kneed** positions. See **FIGURE 12B** below.

<u>The Major Types of Leg Deformity in the Modern Human Body</u>

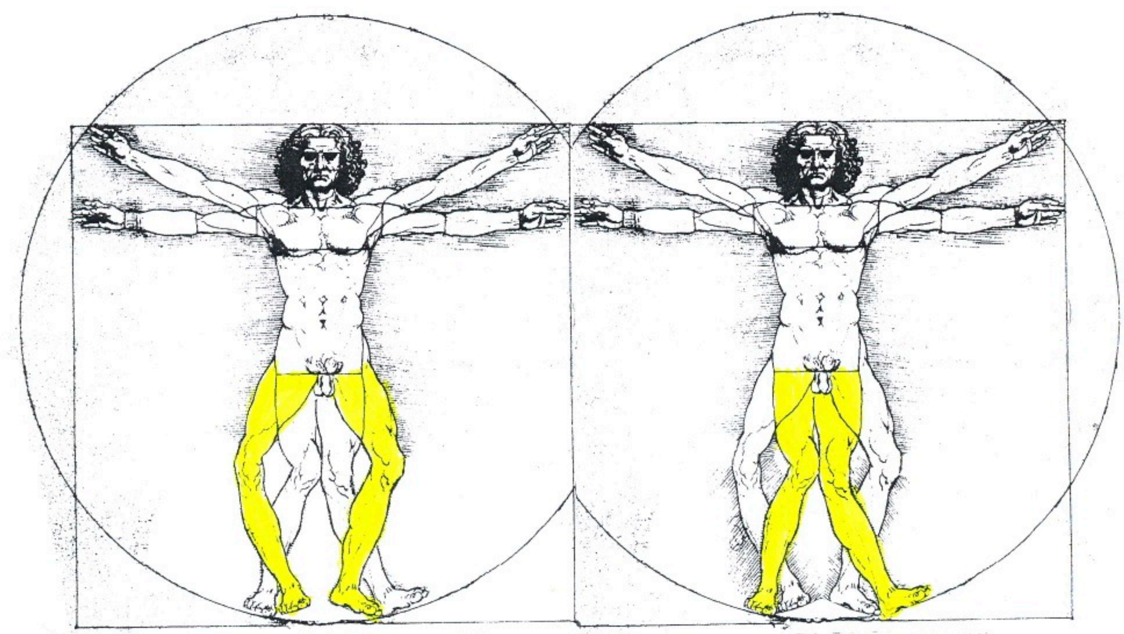


FIGURE 12A Bow-legged **FIGURE 12B Knock-kneed**

What is truly odd here is that both positions - bow-legged and knock-kneed - are opposites, but both result directly from the same thing: the inherently unstable position caused by shoe heels, as illustrated above in **FIGURES 8A & 8B**.

So the inherent instability of shoe heels creates an unnaturally wide spectrum of individual adaptations to compensate. A lucky few are precariously balanced in the middle with vertical legs, but the differences among all the rest are greatly exaggerated.

The Illiotibial Tract Plays a Crucial Structural Role in Rotating the Pelvis Backwards and Forwards

As shown below in **FIGURE 13A**, the illiotibial tract is a long ligament connecting the pelvic crest to the upper, outside edge of the tibia. It forces the pelvis to rotate backwards when the tibia rotates outward, when the foot supinates, including the supination caused by elevated shoe heels (as shown above in **FIGURE 6 B**).

Conversely, the illiotibial tract forces the pelvis to rotate forward (in the sagittal plane) when the tibia rotates inward, when the foot pronates in reaction to the unnatural horizontal force vector caused by shoe heel-tilted lower leg (again, as shown above in **FIGURES 8A & 8B**).

FIGURE 13A **FIGURE 13B** **FIGURE 13C**

The Natural Differences of Male and Female Are Unnaturally Exaggerated By Shoe Heels

One of the most surprising results is that bodies of most men and women are made much more different and in an unnatural way. Most **men tend to become bow-legged**, as shown above in **FIGURE 12A**, often with a noticeable bending motion to the outside when flexed during locomotion. Called varus knee thrust, it weakens their legs and makes them poorer jumpers.

The unnatural twisting mechanism is the same in women, but in contrast, most **women tend to become the opposite, knock-kneed**, as shown above in **FIGURE 12B**. This is primarily because of their frequent use of much higher heels, effectively wider pelvis (due to relatively shorter thigh bones), and greater joint flexibility –all of which cause their legs to rotate inward.

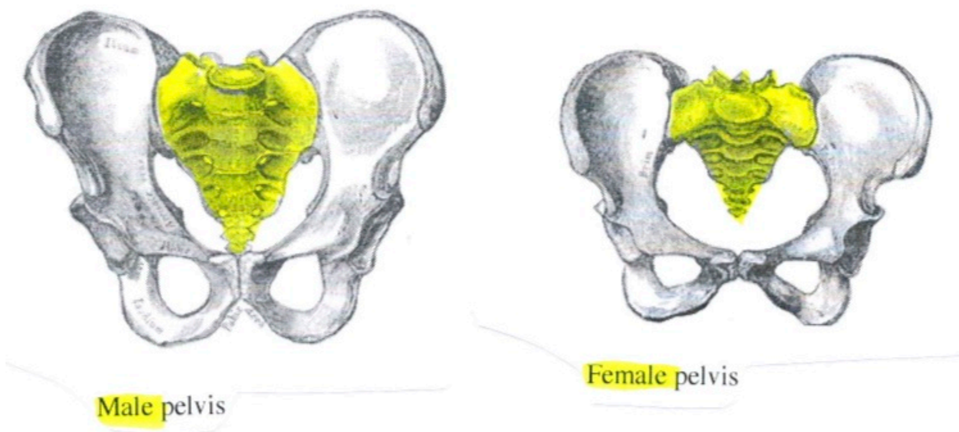
The male pelvis is typically flattened and automatically rotated backward, as shown in **FIGURE 13B**, because of its mechanical connection to the outward twisted knee by a critical ligament, the illiotibial tract. That rotation flattens the male lower back and male butt, and softens the belly.

The female pelvis is also first flattened, but then rotated forward in additional compensation, as shown in **FIGURE 13C**, resulting in an excessive rounding of the female lower back and butt, making pregnancy and childbirth unnaturally difficult.

The Base of the Spine Is Rotated Out of Natural Position in Both Male and

Female Pelvis

Note in **FIGURES 14 A&B** how the sacrum (in yellow), which supports and positions the spine and therefore all parts of the body above the pelvis, is rotated abnormally backwards in the male (below left and above in **FIGURE 13B**) and abnormally forward in the female (below right and above in **FIGURE 13C**). Each is in a different and unnatural position to provide direct support the spine above it.



FIGURES 14 A&B Male Pelvis and Female Pelvis Have Different Sacrum Positions

The unnaturally different supporting positions of the sacrum shown above force the curvature of the spine typically to decrease in modern men, shown in **FIGURE 15 B** below, making it inherently more static.

In contrast, the curvature of the spine is typically increased in modern women, shown in **FIGURE 15 A** below, making it inherently more dynamic. Note the drastically different sacroiliac joints (in yellow), which join the sacrum to the ilium of the pelvis. The sacroiliac joints are infamous as sites of intractable (and unnatural) pain.

FIGURES 15 A&B Female (Dynamic) and Male (Static) Sacrums (Sacroiliac Joint in yellow) and Spinal Columns

In addition, sexual performance, satisfaction, and fertility are all reduced for both sexes by the unnatural asymmetrical mismatch in pelvic position and abnormal pelvic functional ability. Shown below **FIGURE 12A** is extreme example of the effect of pelvic asymmetry on modern male genitalia.

FIGURE 16A **Extreme Example of Modern Male Asymmetry**

Equivalent female asymmetries exist as well, although in a much more subtle way, and of course the breasts are often less than perfectly matched.

Childbirth Is Made Dangerous By the Warped Shape of Female Pelvic Birth Canal

The main problem in human childbirth is the size and shape of a human baby's head. The head is huge, twice the size of our closest animal relative, the chimpanzee. The head on the skeleton of a newborn is so large it makes the skeleton look like it must belong to a space alien with an enormous brain (although at least not in the shape of the popular "cone heads" of 1990's Saturday Night Live). See **FIGURE 16B** below.

The bone of the female pelvic brim and the baby's relatively huge skull are about the same size (see **FIGURE 16B** below). So the fit is far tighter than other primates. But mismatched in shape also, so that the baby must enter the birth canal sideways, and then make a difficult 90 degree turn, all because of the unnaturally flattened brim and pelvis.

The head of the fetus has somewhat flexible sutures within the bone of the skull that help the fetus squeeze through the birth canal. However, that inherently difficult birth passage is the most traumatic event to which the fetus's brain is exposed, so the danger to it is great and any damage can have severe aftereffects extending throughout later life.

Moreover, as shown on bottom right in the last drawing in **FIGURE 16B**, the unnatural asymmetry of the mother's body can affect the way the fetus is carried within the womb for its nine-month development period. The fetus' position may be unnaturally asymmetrical, for example, affecting its development unnaturally, both before and after birth.

FIGURE 16B Huge Fetal Head and Unnatually Warped Pelvic Opening
Pelvic Tilt and Right/Left Structural Asymmetry During Running

Critical to our understanding of the misalignment problem is that the word “pelvis” is Latin for basin. See **FIGURE 16C**. That basin is piled high with our internal organs. See **FIGURE 16D**.

It would seem likely that tilting that basin into an abnormal backwards or forwards orientation would likely shift our intestines and bladder out of their natural positions, slowing down or even temporarily blocking passage of their contents. Heartburn, indigestion, gas, constipation, diarrhea, hemorhoids, and incontinance are likely direct effects of the abnormal position of the digestive system.

FIGURE 16C Pelvic Basin **FIGURE 16D** Internal Organs Held In Pelvis

All of the other internal systems either contained by and/or supported by the pelvis would likely be similarly affected as well. The other major and minor organs have a multitude of interconnections and interactions that are amazingly complicated and often quite delicate. The function of these organs and the interdependent systems of these organs is likely to be degraded in approximate proportion to the degree of abnormal pelvic tilting.

During Running Both Legs Are Tilted In, Unnaturally Crossing Over Each Other

A major alignment problem caused by shoe heels results in the pelvises of both sexes tending to be abnormally tilted down on one or both sides, and also twisted into an asymmetrical position.

Above the tilted pelvis, the spine and chest also become unnaturally twisted and bowed out, pressuring the heart and arteries (as seen below on left figure **FIGURE 17A**, the abnormal bulging right shoulder blade, compared to the right **FIGURE 17B**), and thereby causing cardiovascular disease.

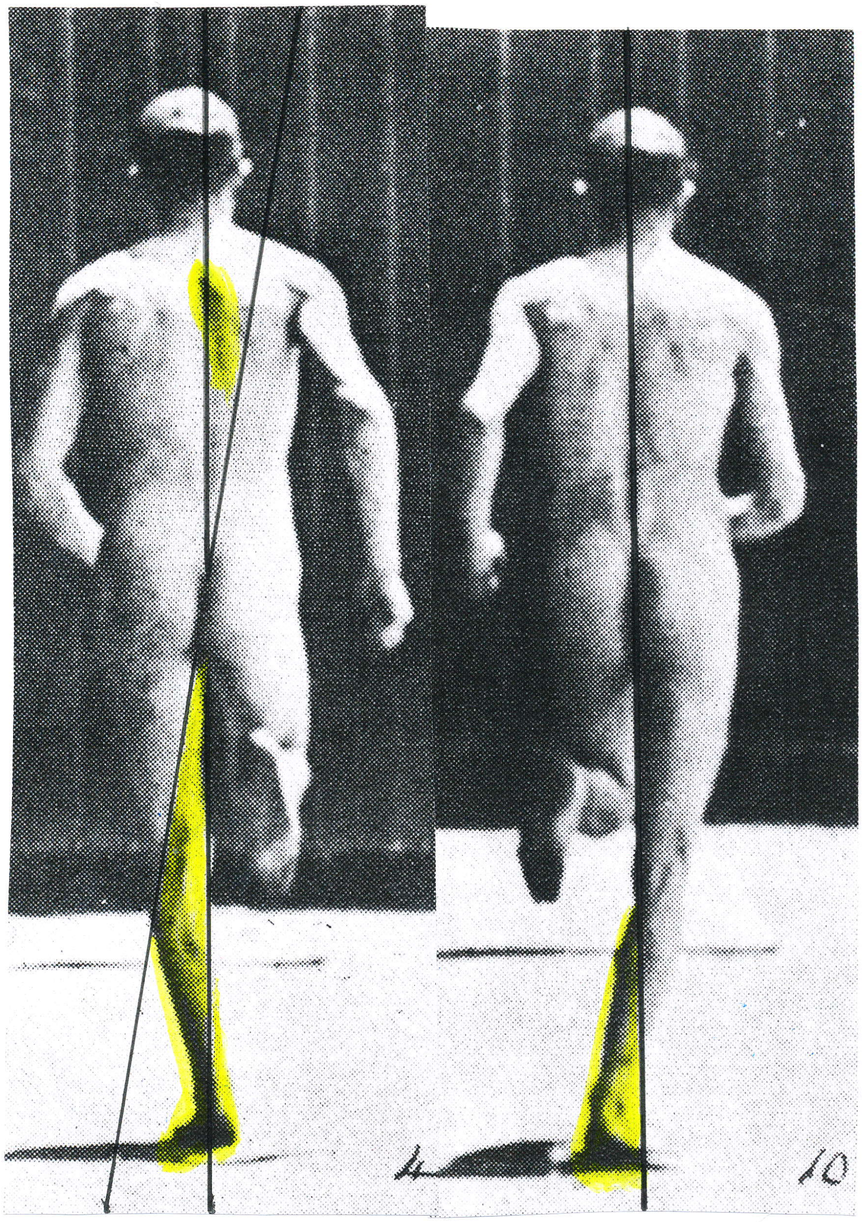


FIGURE 17A **FIGURE 17B**

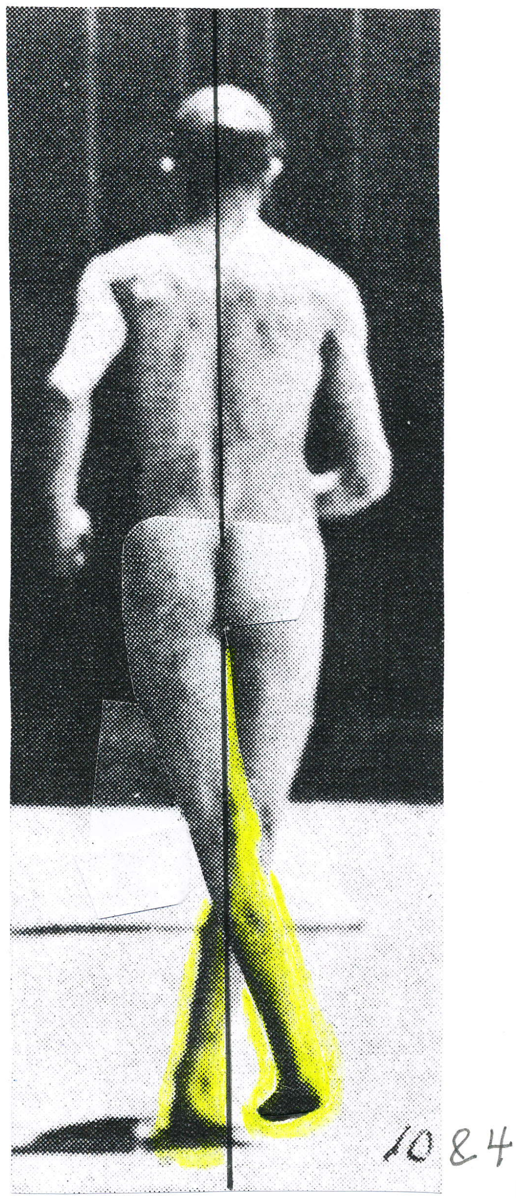


FIGURE 17C

Typical But Bizarre Running Leg Positions At Maximum Flex and Load

Both views **FIGURES 17 A&B** above shown at midstance, the pelvis tilted down on left leg, but level on right leg. The most typical but bizarre biomechanical result is that the right leg crosses over more (about **10** degrees inward) than the left leg relative to the body's center. But relative to the pelvis, the left leg is actually tilted inward much more (about **20** degrees, twice as much as the right leg).

Willwacher Study Data Confirms Abnormally Tilted-In Legs At Midstance

The award-winning Willwacher et al. study[2] generally confirms the above results, although it has data only on the right leg and shows the leg inward tilt (hip adduction) as about **15** degrees for both sexes, as shown in Hip Angle Frontal Plane graph of Figure 6.

Unpublished additional study data indicating about **14** degrees of inward tilt for 129 males has been provided by Dr. Willwacher and is close to the less precisely measured 10 degrees for the individual male illustrated above in **FIGURE 17B**. For 93 females, the right hip adduction is higher at **17** degrees.[7]

In utter contrast, a barefoot African Bushman is shown in the midstance position of running in **FIGURE 17D** above with <u>no</u> crossover and vertical legs with level, un-tilted pelvis. Also note his straight, well-defined spine.

Both Legs Together Form an Immobilizing X-shape at Midstance in Running, Relative to the Pelvis

If you level the pelvis for the left leg at midstance (taken from **FIGURES 17 A&B** and superimposed in **FIGURE 17C**), you can begin to see how truly bizarre is the abnormal structural running position of the modern human body. Remember, this is the maximal load-bearing position, 2-3 times bodyweight, the greatest stress to which the human body is routinely subjected during the childhood growth phase.

This is astonishing. In every stride the runner's legs are maximally loaded sequentially in a bizarre X-shaped, crossed position relative to the pelvis.

As seen in **FIGURES 17 A&B**, the **unnatural mechanical <u>tilting out</u> effect of shoe heels on both legs paradoxically causes both legs to <u>tilt inward</u> instead, called hip adduction**.

That contradictory result is because both legs are connected to the pelvis, within which is located the body's center of gravity, which firmly resists side-to-side motion. The body's lack of relative lateral mobility dictated by the Newton's inertia law forces both legs inward.

An Even More Bizarre Change in Supporting Leg Position From Standing to Running

Again from unpublished data from Dr. Willwacher's study the standing or static hip angle for 129 males is **3** degrees of <u>ab</u>duction or tilting-<u>out</u>, not adduction (tilting-in), and **2** degrees of abduction or tilting-out for 93 females.

But, at the beginning of the stance phase in running, the starting hip angle for the males is immediately **8** degrees of adduction (tilting-in), not abduction. This is an extraordinary full **11** degree tilting-inward, an immediate change in the transition from standing to running on the same support leg.

The hip angle for women is **10** degrees of tilting-in, again starting immediately at the beginning of the running stance phase, and an equally extraordinary full **12** degree tilting-inward immediate change from standing to running on the same support leg.

FIGURE 17E Effect of Growing Up Barefoot

In **FIGURE 17E** Kenenisa Bekele of Ethiopia is shown finishing the second fastest marathon in history (2 hours, 3 minutes, 3 seconds) with vertical legs and no crossover, demonstrating the biomechanical racing advantage of growing up running barefoot (the primary reason for the almost total dominance of distance racing by Africans, especially from Kenya and Ethiopia).

The Only Solution to the Immobility Problem Caused By Severe Crossover Is Pelvic Tilt

The bizarre X-shaped legs situation shown in the **FIGURE 17C** photograph directly above is pretty well summarized in the drawings below. Both legs are tilted so far in by the mechanical action of shoe heels that they cross over each other (shown in **FIGURE 18A** on the left below). So the only way for the human body to move forward without tripping over its own legs is for one side of the pelvis to tilt down, so the feet no longer cross over (shown in **FIGURE 18A** on the right below).

That is shown in the male running in the previous **FIGURES 17 A&B** photographs above. To move forward, his left pelvis tilts down, which effectively reduces the inward tilt of his left leg. His right leg tilts in more and crosses over under his center of gravity, while his pelvis is level. This is the most common male resolution to the major structural misalignment.

With Higher Heels, Both Sides of the Female Pelvis Alternately Must Tilt Down During Locomotion

FIGURE 18A Crossover Forces Pelvic Tilt FIGURE 18B Female Pelvic Dual Tilt

The typical female solution to the problem is different from the male. Due to their higher heels, wider pelvises/shorter femurs, and more flexible joint, the most common female resolution to the misalignment problem is to tilt the pelvis down on each side alternately (shown walking above in

FIGURE 18B).

As you can see, the typical inward tilt caused by the high heels worn is very substantial, even at the reduced knee flexion angles and body weight loads during walking (compared to running). Modern female crossover is even greater than modern male crossover.

However, female legs typically appear to be more vertical relative to the ground and positioned more directly under the body's center of gravity (roughly at the small of the back), because of the severe pelvic tilting.

So the obvious conclusion is that the underlying reason high heels are so popular with both women and men is that they automatically require massive pelvic tilting gyrations in order to simply move forward when walking.

The Force Behind This Abnormal Pelvic Tilting Is Overpowering

Back to running, because there is an extremely important point to be made here. Based on frontal plane data from Figure 4 of the Wallwacher study, the peak hip torque (or moment) at midstance is about 2 Nm/kg. This is about 8 times greater than the peak ankle torque of about 0.25 and about 3 times greater than the peak knee torque of about 0.65.

This means is that there is much greater relative force causing hip adduction than knee adduction and far more than that causing ankle eversion.

And it is critical to understand that this overpowering torque is really forcing pelvic tilt downward, not hip adduction inward (i.e. tilting the thigh bone inward). Of course in both cases the hip joint action is bringing the pelvis and thigh bone together in exactly the same way relative to each other.

But if the pelvis tilts downward, then the support leg – maximally flexed and loaded at midstance – can become less crossed and more vertical instead of more tilted, as shown on right in **FIGURE 18A** above. (The low leg on the tilted down side of the pelvis is flexed upward and unloaded, airborne during running or walking, so it is tucked out of the way.)

The inertia of the main body mass supported by the pelvis preempts the possibility of the substantial side-to-side motion that would be required by hip adduction forcing the support leg to tilt in.

Instead, the main body mass overpoweringly forces the pelvis to tilt down toward the supporting leg, thereby straightening it and allowing the running body to move forward in the most energy efficient way. Otherwise, incapacitating crossover occurs between the legs.

Both pelvic tilt and crossover are unnatural and directly caused by the adverse effect of elevated shoe heels on the subtalar ankle joint.

Every individual compensates for this reality in a slightly different way, but each of both ankle, knee, and hip joints on both legs is affected to some extent.

The Stark Differences of Barefoot and Modern Bodies During Running

In the natural barefoot Bushman body running in midstance, below on the left in **FIGURE 19**, you see straight legs pointed ahead, level pelvis, well-defined, relatively straight spine and upright head.

FIGURE 19 Barefoot Bushman & Shod Finnish Man (Marathoner) Running

In contrast on the right above in **FIGURE 19**, you see the bowed-out leg pointed outward, tilted pelvis, deformed spine and back (with vertebrae protruding unnaturally between the shoulder blades), and head tilted to the right – all typical of the shoe heel-deformed modern body (a Finnish marathoner), also shown running in the same midstance position.

(From a fairly recent (May 26, 2013) video clip on **YouTube** titled "**Barefoot running Bushman versus me (shod Finn)**" https://www.youtube.com/watch?v=H1Ej2Qxv0W8.)

The Functionally Twisted Modern Runner Is a Moderate Version of Permanently Twisted Scoliosis

The functionally twisted skeletal structure of the modern runner above right in **FIGURE 19** shows the early stages of the same kind of structural deformities that progress to a much more exaggerated and permanent state in a disease called scoliosis, shown in the photograph below **FIGURE 20A**.

In fact, scoliosis is just an extreme case for what passes for "normal" in the abnormal modern human body. The same kind unnatural asymmetrical spine twisting is present to a greater or lesser degree in most modern bodies because of twisting effect of shoe heels.

The widespread epidemic of back pain is the direct result, affecting nearly 30% of all U.S. adults each year. Sometimes unusually fit adults like Coach Steve Kerr are incapacitated even years after back surgery.

FIGURE 20A Scoliosis   FIGURE 20B Femur Neck Inclination

In addition, the femur neck inclination called coxa valga in which the angle of the femur neck is greater than 125 degrees is associated with scoliosis. See the coxa valga femur on right in **FIGURE 20B** above. It is also associated with hip adduction like the abnormally exaggerated hip adduction in running shown above in **FIGURES 17C & 18B**.

This suggests the probability that running with shoe heels is the underlying cause of scoliosis for those predisposed to the illness, predominately women, whose hips generally adduct more in conjunction with greater pelvic tilt, like that shown in **FIGURE 18B**.

Moreover, being unable to run in safety, the blind therefore do not get scoliosis (at least did not during the period before guide runners became a common option fairly recently).

The Twisted Posture of Young Modern Runners Looks Like Elderly

Although severe scoliosis is relatively rare, the effect of age on posture looks very similar and is directly caused by the effects of shoe heels. See **FIGURE 21** below and note particularly the typically crossed legs like **FIGUREs 17C & 18A&B** obviously a direct effect of shoe heel-induced supination and resulting knee cant discussed earlier.

FIGURE 21 **Normal & Elderly Poor Posture Showing Lower Leg Crossover**

Substantial Asymmetry Is Universal in the Abnormal Modern Human Body

Heretofore, all biomechanical studies of the lower extremity during running test only one leg, but a recent, precedent-breaking study[5] by Radzak at al. specifically collected data on both right and left legs to evaluate asymmetry during running. The differences they found were astonishingly great.

The average left ankle of runners everted (roughly like pronation) about **32** degrees and inverted (like supination) only about **3** degrees. In contrast, the right ankle everted about **16** degrees and inverted about **12** degrees. So, when running, most runners do nothing except pronate with their left foot, but pronate and supinate almost equally with their right foot.

Similarly, the average left knee has a maximum varus position of about **11** degrees, but the average right knee has only about a **5** degree varus position, less than half as much.

The reported hip differences are much less, but that is because they apparently ignore the critical pelvic tilt and only report differences relative to vertical, which masks what is really going on. Even so, the right hip angle is cut in half in a fatigued state, whereas the value for the left hip remains about the same in the rested state, as do the above knee and ankle measurements.

Racial Differences Are Also Exaggerated By Shoe Heels

Just like sex differences, racial differences are abnormally exaggerated by shoe heels. Besides the feet shown in **FIGURE 1B,** most other differences between the modern European human body and that of "primitive" races (who happen to also be barefoot) are also directly caused by shoe heels.

In the unique example below in **FIGURE 22** (again from a relatively old and obscure, but good medical source), the same individual male demonstrates that the simple realignment of his legs from knock-kneed (more typical of African descent) to bow-legged (more typical of Caucasian) drastically changes the resulting thigh musculature along the same typical racial lines. The racially distinctive leg musculature is clearly determined only by varus/valgus leg alignment, not by race.

FIGURE 22 Vastus Lateralis Muscle Is Hyper-developed on Left, Under-developed on Right

The Precursor of Heart Disease?

The misalignment deformities of old age start early in life from running. The torsional distortions in the chest area are often substantial, as seen in **FIGURE 23,** likely leading to unnatural pressure on the heart and eventually heart disease.

The distortions appear to be greater on the right side, which may be generally protective to the left side-oriented heart. However, since the pelvis is tilted-down substantially to the right, the spine is actually curved far to the left side relative to the pelvis, so the abnormal torque and excessive pressure may focus directly on the heart. That unnaturally distorts and stresses the heart, at the point in the running stride when the body is subjected to peak body weight.

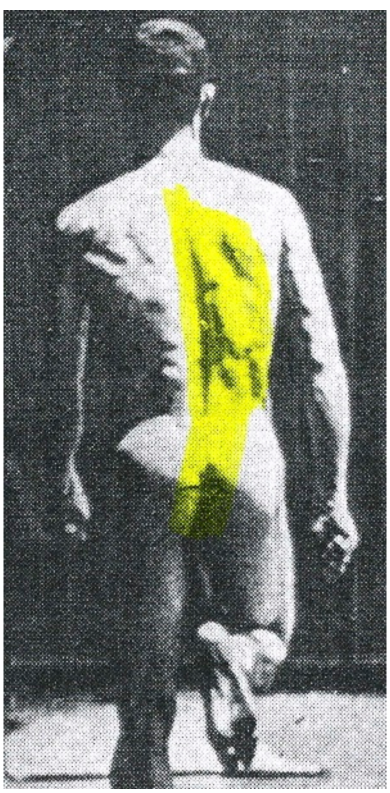


FIGURE 23 Chest Structural Distortions At Midstance Related to Heart Disease?

FIGURE 17A shows the same unnatural chest distortion and pelvic tilt, and in addition at the same time includes the 20 degree inward tilt of the left leg, increasing the degree of overall structural abnormality.

Natural Human Performance Has Much Higher Limits

What we now regard as highly exceptional is much closer to the natural norm of human potential. We only fail to realize this because of our current deformities anchor us well within unnatural limits. To give you another example of what I am trying to say, look at this picture in **FIGURE 24** of the limbo king of New York City performing in the 1960's. This picture demonstrates an almost unbelievable performance extreme. But all of us have the genetic potential to come much closer to it than our limited imaginations allow.

FIGURE 24 An Example of Natural Human Performance

The Effect of Shoe Heels on the Skull and Brain: Just Like the Knee

FIGURES 25 A-C. Ryun and Bannister Running With Extreme Head & Neck Torsion Motion In All Three Dimensions

The body part that most unexpectedly appears to have been affected by elevated shoe heels is the part farthest away from the heels: the human brain. This is because the abnormal effects are exaggerated in the motion of the head while running with shoe heels.

Famous photos of Roger Bannister and Jim Ryun setting world records in the mile both indicate abnormal head motion that is similarly exaggerated, as seen in **FIGURES 25A-25C**. While these head motions may seem extreme but also very occasional, they are just exaggerated examples of common abnormal motion of a reduced but still significant and endlessly repetitive routine nature.

As seen below in **FIGURE 26A**, Multiple World Record Holder and Olympic Sprint Champion Usain Bolt's head tilts significantly to the left at midstance on one leg when running, whereas it is upright at midstance on the other leg. This is an amazing amount of left/right asymmetry given his almost superhuman level of athletic performance.

It suggests that such skull position asymmetry or more is widespread throughout the human population, although it is apparently never studied biomechanically. For example, even the unusually comprehensive study by Radzak et al. noted above,[5] which uses 27 reflective markers all over both sides of the test subject's body, has no markers on the cervical spine nor on the skull.

FIGURE 26A **Bolt's Left Tilted Head** **FIGURE 26B** **Typical Bowed-Out Neck**

The typical leftward tilt of the Bolt's head when running must over time alter the permanent structure of the cervical vertebrae of the neck, causing them to bow out in compensation to the asymmetrical position and load, like the typical example shown below (not Bolt) in **FIGURE 26B.**

As seen above in **FIGURE 26B**, this asymmetrical position of the cervical vertebrae bowing out to the right to compensate for leftward tilt of the modern skull thus becomes quite evident even at rest in a stationary position. Arterial hyperdevelopment on the right side also appears to be abnormal. And **FIGURE 26B** is just a typical example taken at random of modern neck structure.

Vision Illustrates the Structural and Functional Problems Within the Abnormally Supported Skull

Just consider vision as a fairly simple example. The most common modern problem is near-sightedness (myopia), which results from an abnormal elongation of the eye.

If the skull is typically bent backwards as noted by the excessive curve of the cervical spine, then the new, more downwardly directed force of gravity is going to increase pressure on the back of the eye. That gradually tends to lengthen it over time (and continues over time), moving the retina at the back of the eye backwards and increasingly out of focus.

If the skull is bent sideways too, then that creates asymmetry between the right and left eyes. Add in twisting motion as well, so the abnormal skull motion is in all three dimensions. The result is asymmetry within either or both eyes (astigmatism), and well as different levels of myopia in each eye. Note the complex and delicate structural arrangement of the muscles controlling the eye, as shown in **FIGURE 26C**.

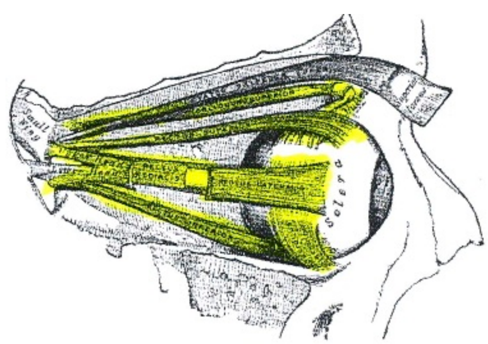


FIGURE 26C Delicately Balanced Eye Muscles

Similar mechanisms are at play for the all the other deficits inside and outside the skull that were listed above. Of course, as usual, there are no known direct causes for any of these listed headcentric problems. By default, the accepted current wisdom is that they all just happen; for example, poor eyesight probably caused by eyestrain from too much reading.

The Modern Brain's Asymmetrical Structure Shows the Same Rotary Torque As the Knee

The brain has been made much more bilaterally asymmetrical by shoe heels, as has all of the human body. Incredibly, the asymmetrical shape and structural of the modern brain shows the very same unnatural rotary torque that is built into the modern knee joint.

The functional effect of this abnormal structure is that the brain appears to have been enhanced in its highest level of mental functions, which are language and logic. The evidence suggests that the asymmetrical brain change includes an important increase in the size of the left hemisphere's dorsolateral prefrontal cortex, the specific part of the brain that handles the highest mental functions.

Albert Einstein's Brilliant Asymmetrical Brain

An extraordinary supporting example seen in **FIGURE 27**: Albert Einstein's brain (top view) was asymmetrical in exactly this way, with unnatural rotary torque squeezing the right hemisphere forward and compressing it relative to the wider left hemisphere (in yellow), which has expanded into a greater maximum diameter, with the increase in the size located in the areas of the critical left hemisphere's dorsolateral prefrontal cortex.

(Top View, Front of Brain at Bottom)

FIGURE 27 Einstein's Brain With Right Hemisphere Squeezed Forward & Compressed Relative to Hyper-Developed Left Hemisphere With Expanded Width Beyond Centerline*

* Note how parallel left and right parts of Einstein's brain are asymmetrically shifted

Steven Hawkings' Brilliant Brain But Asymmetrical Body Due to ALS

Steven Hawkings' exceptional brain is likely to be similarly asymmetrical, due to his ALS (amyotrophic lateral sclerosis or Lou Gehrig's disease), which has forced his body into a deformed structure like that of scoliosis, as seen above in **FIGURES 28 A-C.** His overall structural lateral asymmetry is already evident in the picture from his college days. The asymmetrical size and shape of his eyes today strongly suggest similar underlying brain asymmetry.

FIGURES 28 A-C Steven Hawkings' ALS Asymmetry

The Renaissance and Reformation, and The Rise of Modern Science and Technology

Remarkably, elevated shoe heels were introduced into use in Western Europe during the same historical period as the very beginning of modern science and technology that created the modern world. Elevated shoe heels therefore may have in an inadvertent way provided a brain boost that ignited the revolutionary explosion of invention and progress that occurred then. Although that direct causation is almost unimaginable, it is a logical possibility.

The Major Downside of Unnatural Brain Asymmetry: Dementia

An excellent TED Talk titled *Why Helmets don't prevent concussions – and what might* by David Camarillo, Ph.D. of Stanford University was made April 24, 2016 (see www.ted.com). Dr. Camarillo provides good evidence that the conventional understanding of brain concussion and related dementia is fundamentally wrong.

The true problem is that the jello-like brain tissue in a critical central portion (shown in red) is being stretched by up to 50% of its normal volume. See below **FIGURE 29**.

It turns out the location of that maximally stretched portion is particularly unfortunate, because it is the precise location of the principal network connection between the right and left hemispheres of the brain. The physical brain structure located there is the corpus callosum, circled in red as shown in the normal brain in **FIGURE 30** below.

In an abnormal brain subject to repeated concussions shown below in **FIGURE 31**, which is that of a retired former NFL football player who suffered from chronic traumatic encephalopathy (CTE), the corpus callosum is severely deteriorated, indeed much more deteriorated than any other portion of the brain.

Repeated Asymmetrical Sideways Head Motion Causes Repetitive Stress Injuries to the Human Brain

It seems logical to conclude that if extreme traumatic forces cause excessively violent sideways motion leading to acute injury like concussions and CTE, then highly repetitive abnormal sideways motion like that caused by shoe heels in running is like to cause repetitive stress injuries to the brain gradually over time. That would be particularly true over a lifetime, the unnatural effects being cumulative.

Moreover, the unnatural effects would be focused on the critically important corpus callosum, which is the principal physical connection between the left and right hemispheres. The shoe heel-induced brain torque discussed earlier (see again **FIGURE 27**) would inherently cause the tissue of the corpus callosum between the shifting hemispheres to stretch unnaturally.

So it seems reasonable to conclude that there is a strong possibility, perhaps even a probability, that the same injury mechanism that is apparent in concussion on an acute basis also adversely affects the brain on a chronic basis due to repetitive stress. This line of thinking suggests the obvious possibility that dementia may generally be a repetitive stress injury to brain tissue caused by shoe heel-induced body and brain asymmetry due to unnatural torques. Even the plaque in the brain tissue of Alzheimer's patients may be due to the unnatural stretching from shoe heel-induced asymmetry.

Previous studies have shown that mechanical forces create unnatural tensile strain that disrupts the ability of cells to develop and continue functioning normally. That disruption has been implicated in causing diseases like osteoporosis, deafness, atherosclerosis, cancer, osteoarthritis, muscular dystrophies, and developmental disorders.[8]

In the brain, with its jello-like consistency the disruption effect is potentially worse than in other parts of the body. The roughly 85 billion neurons in the brain are structurally supported by glial cells and the neurons are connected to other neurons by about 100 trillion branches that terminate in about 100 trillion synapses – all extremely fragile structures likely degraded by unnatural cellular repetitive stretching.

Moreover, a review of the available evidence indicates a close relationship between cognitive disorders and gait disorders.[9] So, based on the preceding discussion, gait disorders wrought by shoe heels may possibly or even probably predate the cognitive disorders and actually cause them.

First Real Proof That Going Barefoot Is Not the Solution For Most

But the unfortunate reality is that once the physical abnormalities discussed above become well developed, as they do in most individuals, those changes become locked into actual bone structural changes in the foot, ankle, knee, hip, pelvis and spine. Those joints involved become permanently malformed. So just getting rid of elevated shoe heels is not the simple, obvious solution it might otherwise seem to be.

As noted earlier, the footprints clue cited in the old James report in the Preface (**FIGURES 1 A&B**) is all the more powerful as evidence since the footprints were taken with knee bent forward, supported on that single leg alone, so it was taken in roughly the typical midstance running position shown in **FIGURE 7** above (although at only 1 full body weight, rather than 2-3 times typical of running).

Although obvious, it is nonetheless just as significant that those footprints were taken of bare feet. That provides good evidence that normally shod feet continue to roll unnaturally to the outside in the supination position even when bare, as clearly shown in **FIGURE 1B** because the foot and ankle bones, and associated ligaments, muscles and tendons, have been re-formed abnormally by shoe heels.

Therefore, instead of being an easy solution, simply going barefoot instead of correcting those abnormalities makes them worse for most individuals who have grown up wearing shoe heels! All the more perverse, those individuals whose shoe heel-induced deformities are worse than average will have even greater adjustment problems trying to run barefoot.

So those who need help the most are the least likely to get it barefoot. Only those with less of a problem to start with are likely to be able to transition safely to barefoot running.

This is why running shoe design is currently at a dead-end. There is no easy or immediate solution currently available, or even a known solution. Finding a solution for those individuals most in need will be an extraordinarily complex problem.

Smartphone and Cloud Control of Configurable Shoe Sole Structures Will Provide the Solution

Finding a specific solution for each individual's structural problems is impossible with current methods. A comprehensive solution will require high technology in the form of shoe soles with sensors and configurable structures that are controlled by the wearer's smartphone connected to clouds of computers, so that artificial intelligence using machine learning techniques can be applied to the big data from many millions of wearers.

As an inventor, I filed U. S. and international patent applications, and received my first U. S. Patent on this technology, Number US 9,030,335, on May 12, 2015. The title of the patent is "**Smartphone App-Controlled Configuration of Footwear Soles Using Sensors in the Smartphone and the Soles**.*"* It is also available on the Internet at my website: **AnatomicResearch.com** or at the **USPTO** website, together with five additional new on directly related patents: US 9,063,529, US 9,100,495, US 9,160,836, US 9,207,660, and US 9,375,047.

A short time after the first patent above issued, an unsolicted but highly laudatory third party **YouTube** video complete with animation on my newly issued patent was discovered inadvertently in an Internet search. The patent was singled out from many thousands of other patents for unusual praise. You can see it by searching for the title, "**Smart Shoe – finally humanity invents the shoe that it deserves**", or at the link: **https://www.youtube.com/watch?v=CjBhghWDMoM.**

Lack of Privacy and Security of Highly Personal Data in Smartphones & the Cloud: An Insurmountable Problem?

There is however a major roadblock to the indispensable new approach described above. There exists no way to safely create and store this extremely personal data, not currently and not in the immediate future.

The continual theft of huge databases from both businesses and government provides constant proof of this never-ending and ever-increasing problem. Your smartphone and personal computer similarly lack reliable protection, as do all other computers, including the cloud.

The seemingly insurmountable problem is that reliable cybersecurity does not currently exist and is not even theoretically possible using existing methods, all based on software. But a basic change at the most fundamental possible level of hardware architecture can provide a practical, foolproof solution to this otherwise intractable problem.

More on this problem and solution in Chapter 34 of my draft book under "Research" at my footwear website: www.AnatomicResearch.com or at my computer security architecture website: www.GloNetComp.com.

The Only Immediate Relief: New Forms of Stretching and Exercise That Specifically Counteract the Adverse Effects of Shoe Heels

Unfortunately, it will take time for this technology to be developed and made commercially available on a widespread basis. This is likely to take several years.

In the immediate future, the only relief in sight does not involve footwear. Instead, new forms of stretching and exercise are in the process of being developed and tested.

Preliminary results suggest the high potential of several approaches for providing very substantial relief from the adverse effects of shoe heels. Several exercise and stretching approaches even look promising as possible "magic bullets" in terms of providing dramatic personal improvements.

Demonstration videos will be posted on my website, www.AnatomicResearch.com, as they become available.

If you are a diehard runner, I would make two suggestions. First, try a switch to alternating between running and walking, or run/walking.

And/or, second, alternate between running on one day, with strength building and stretching on the other day. Obviously, some other non-running aerobic exercise can be added into mix, as well as variable direction running sports like soccer, basketball, tennis, etc.

What Approach To Take In Choosing Between Shoes and Barefeet

Switching between the use of shoe heels and bare feet, especially in rigorous sports and exercise, is itself a likely source of injury. Especially so in the not uncommon example of running barefoot and then wearing conventionally heeled shoes immediately before and after.

Instead, for now, I think the best you can do is to try to moderate the adverse effects of elevated shoe heels. To do that, you should avoid your shoes with higher heel, both athletic and street shoes. You might even try moccasins or slippers with low heels instead of barefeet or flip-flops.

The basic idea is to try to reduce the amount of change or transition between different heel heights by converging toward the middle in terms of heel heights, neither too high nor too low.

I think this approach is particularly important for women with special regard to high heels, especially spikes. I think you have to come down gradually from these higher heels, especially if you are a serious athlete.

I believe high heels are a particularly serious health problem for women. So many women have such a strong desire to wear them, apparently for sexual allure more than anything else, according to surveys.

Strictly from the point of view of sexual allure, there are other, more direct and healthy approaches to increasing such allure. Healthier potential alternatives might include articles of clothing that are more shear and/or more revealing and/or enhancing (Spanx, etc.) and/or more absent. Almost any approach is better than wearing high heels.

Only the Very Young Can Go Barefoot – Almost Everyone Else Is Already Too Deformed

In contrast, for the very young – those whose bodies have never been adversely affected by elevated shoe heels -- the solution is simple. Only for them, their best available health option is to go barefoot or wear the most minimal of shoes, those without elevated shoe heels.

Also, for their brain health it is critical that they are allowed adequate exercise every day. The brain evolved specifically to make motion possible and coordinating body movement remains its primary function in humans.

So your children should get at a minimum a full hour total of recess time or physical education at school. If they are not, organize with other parents and demand it! Nothing else they could do in that excise hour will help as much to learn.

To Summarize the Effect of Shoe Heels: Broken Bodies, But Better Brains (Although More Prone to Dementia)

In summary, elevated shoe heels have had a terrible effect on the structure and function of every part of the human body – except perhaps the brain, the highest functions of which shoe heels may have enhanced! Overall, a human catastrophe, except for the brain! Even that gain may be more than offset by the loss of widespread dementia.

Gross human anatomy has for a long time been considered the most settled of all the sciences, which is to say that everything of importance has already been discovered, most of it by at least a hundred years ago. However, the opposite is true.

What we have thought for centuries was normal human structure and function is rather an abnormal state of unnatural disease. As to knowing what is really normal for humans, we are currently limited by the very fragmentary sources of available information.

Massive Medical Expenses

Given its direct bio-mechanical effect on virtually every part of the modern human body, the associated medical costs for shoe heels in the U. S. alone could well be as high as $1.5 trillion per year. That translates to something quite absurd, like well over $1,500 in medical costs that accrue for each and every pair of shoes sold each year (assuming $100 average price per pair).

Perhaps even more important, the quality of life provided by elevated shoe heels throughout a lifetime, including from fetus to birth, is drastically reduced in terms of poorer health and wellbeing throughout life, but especially late in life for the elderly.

A True Moonshot On the Magnitude of the Original 1960's Moonshot -- Far More Justified Than the Original

Today the term "moonshot" is routinely overused. The term is attached to too many unfocused and questionable projects that have no realistic chance of achieving tangible benefits in the foreseeable future.[6]

In this case, however, a true 1960's moonshot-level project to solve the massive medical problems caused by shoe heels is fully justified. That is because in the relatively near term, the real world benefits on planet Earth would likely dwarf those that were actually gained by going to the moon. There is no other project with anything close to the same "bang for the buck".

First Step: A Center for Theoretical Human Anatomy

Nearly all of the research that bears on the medical problems described in this article is taking place in a vast number of different and unconnected silos, all separated by specialty and/or organization. No one anywhere has anything like a complete picture of the overall problem.

A partial list of organizations that must cooperate effectively to successfully accomplish the required moonshot includes at least a multitude of major footwear companies, high tech companies including smartphone, social media, database and cloud companies, research universities, medical care and research facilities, public and private foundations, as well as U.S. and foreign government research and regulatory entities.

A partial list of specialties that similarly must cooperate effectively include all medical care and related research specialties, particularly anatomy, biomechanics, physical anthropology, computer hardware including networks and software, and cybersecurity.

The 1960's moonshot was run by the government, specifically NASA, which resulted in lots of bucks, but not very much bang, except on the moon. A private non-profit coordinating foundation, a new Center for Theoretical Human Anatomy, with mostly private and some government support can do much better, spending less and achieving much more for humans on planet Earth.

What the Human Anatomy Moonshot can achieve, worldwide, is billions of lives immeasurably improved and/or saved, as well as trillions in medical expenses saved every year.

The Major Moonshot Goals: Failure Is Not an Option

The first goal would be to discover as quickly as possible exactly what is the natural human body: a detailed and accurate understanding of its structure and function, completely unaltered by the effects of footwear, especially elevated shoe heels. Currently it is unknown.

The second goal would be development the most effective treatment modalities for all those billions who unavoidably continue to suffer and die from the multitude of adverse effects of past use of shoe heels. Currently not known.

The third goal would be to identify whatever beneficial and/or adverse effects that conventional footwear has on the human brain, and to determine whether such benefits can be maintained or increased without the adverse effects of shoe heels. Also not currently known.

Start Up of the Theoretical Human Anatomy Center

The coordinating non-profit foundation, the Center for Theoretical Human Anatomy, needs to start up as quickly as possible. I am willing to contribute my time to the Center and also my extensive patent portfolio of over 100 U.S. and foreign patents that enable the new technologies required for success.

I will allow my patent portfolio to be freely used by all companies that provide reasonable financial support and operational cooperation to the Center sufficient for it to function effectively, commensurate with the Center's role in providing focus and coordination to the human anatomy moonshot.

This is a very modest requirement, since commercial development and use of the patent portfolio will be immensely profitable for these companies and will solve (or reduce as much as possible) huge problems in the existing commercial products upon which they depend.

Private individuals and organizations are needed immediately to provide initial startup funding and infrastructure to jump-start the critical coordination activities of the Center as quickly as possible.

A group of key leading experts must to be pulled out of their disconnected individual specialty silos now to focus on the big picture. We need an effective working group with the right people to share their knowledge with each other to build the solutions that will make this human anatomy moonshot a success.

The Limiting Factor in Modern Medicine: Treating Symptoms Instead Providing Prevention or Cures

From arthritis to back pain, from heart disease to sexual dysfunction, even from cancer to constipation – in fact, virtually every non-infectious disease located in every part of the human body – all currently have no known direct cause. The consensus of expert opinion is, these diseases just happen.

Consequently, without specific known causes, most of modern medical care can only use trial and error methods to treat the symptoms of disease, instead of curing the disease itself, or even preventing the disease in the first place.

This absence of either basic cures or prevention for most major human diseases continues today, despite the vast array of new and dazzling medical technologies that are constantly being introduced. The improvements in health care are continual, but typically incremental rather than breakthroughs.

But incredibly, a strong case is made here for a single underlying direct cause or primary contributing factor for nearly all of these non-infectious diseases. The underlying problem is shoe heels.

Moreover, the same basic cause very substantially weakens the entire human body, making the body much more susceptible to infections and unnaturally less able to fight them effectively. Finally, the same cause makes the human body far more prone to all types of injury, whether from incidental accidents or long term overuse.

Far more than the Apollo 13 mission is at stake here – including incalculably more lives – so "failure is not an option," far more now than then!

There really is no way to describe the untenable situation that we as shoe-wearers are all now in except to say that all of us are Guinea Pigs. At least for now, we are all inadvertently trapped, involuntarily enrolled in a huge, unguided experiment that began when we took our first enfant steps in baby shoes and continues through today.

This book below is a first attempt to discover at least the rough outlines of our trap in as much detail as currently possible. That is the first step in finding the fastest way to escape the trap.

The Details Are Available in the First Draft of the Book

To recap, it turns out that we do not really know very much about what is really normal for humans. Only very fragmentary sources of good information are currently available.

But we can make educated guesses based good evidence, as we do in the surprising story that follows in the more detailed first draft of my new book (see it under the tab "**Research**" on my website: www.AnatomicResearch.com.

You will also find there highly detailed **Endnotes** listing all of the hundreds of peer-reviewed references cited in the book and other associated materials, as well as many supporting **Selected Video** clips.

ENDNOTES:

1. Pardon the offensive language. I am just quoting this old study, which all too typically uses Colonial racist language of that era. The study also refers to the “natives” as “savages,” probably in shocked reaction to their headhunting and cannibalism, both still common practices in 1939 in the area of New Guinea.

Using slightly more modern terms, the race of the natives would be considered Polynesian and that of the “Europeans” would be Caucasian. To be most correct today, you would just say that the two groups from different geographic areas have discernible genetic differences.

The study is **James**, Clifford S. (1939). Footprints and feet of natives of the Solomon Islands. In the ***Lancet***: 2: 1390-1393. Malaita, the island in the study, is next to Guadalcanal, site of famous U. S. Marine and Naval battles against the Japanese just a few years later in 1942 during World War II.

AUTHOR’S NOTE: this article is a relatively condensed version of the much more detailed first draft of my new book (see it under the tab “**Research**” on my website: www.AnatomicResearch.com.

You will also find there highly detailed **Endnotes** listing all of the hundreds of peer-reviewed references cited in the book and other associated materials, as well as many supporting **Selected Video** clips.

2. Another old study also shows in **FIGURES B-D** the shoe-wearing European heel bone tilted out in the unnatural supination position, compared to barefoot Africans. Note the level lines of the Achilles tendon attachment on all three samples, which shows the characteristic supination-based structural tilt to the outside in (D) European versus barefoot Africans (B & C).

Although less complete than the James Solomon Islands study, since it does not show the calcaneus of a European who has never worn shoes, it does show uniquely how the supinated or tilted out position is actually baked into the structure of the bone.

FIGURES B-D Only the European Heel Bone (D) in SUPINATED Position

3. Rubin, Gustav (1971). Tibial Rotation. In ***Bulletin of Prosthetic Research*** - *Spring* 1971, 95-100, especially pages **96-97**.

4. Willwacher, Steffen, Irena Goetze, Katina Mira Fischer and Gert-Peter Bruggemann. (2016). The free moment in running and its relation to joint loading and injury risk. In ***Footwear Science*** Vol. 8, No. 1, 1-11 particularly pages **4-9** and **Figures 4-6**. Winner of the **Nike Award for Athletic Footwear Research**, the highest award presented at the **XIIth Footwear**

Biomechanics Symposium in Liverpool, UK 2015**.**

Simple Mathematical Proof that Shoe Heel-Induced Foot Supination Causes Joint De-Coupling - Provided By Data from the Willwacher Study and Rubin Study:

The Rubin study on supination of barefeet found that for every 1 degree of supination, the tibia is rotated outward (or externally) by about 1.7 degrees, a ratio of 1:1.7. This is an inherent, automatic linkage that happens strictly by the mechanical interaction of biological parts, principally the shin bone, the ankle bone, and the heel bone, as well as the main foot sole ligament (that is, the tibia, talus, and calcaneus, as well as the plantar aponeurosis).

More precisely, this **direct coupling** between shoe heel-induced subtalar joint supination and tibial outward rotation is strictly bio-mechanical. It is therefore just as inevitable as if it were a direct mechanical interaction of gears. It is strictly automatic.

It is in fact the closest biological equivalent of a strictly mechanical interaction between parts. But, like the automatic mechanical interaction of a multitude of relatively simple geometric parts of a clock, this is an automatic interaction of a much more limited number of human bone parts, all with far more complex, non-geometric anthropomorphic shapes.

The Ankle Angle Frontal Plane graph of Figure 6 of the Willwacher award-winning study shows ankle eversion (effectively identical to supination) of about **11** degrees for the average of all 222 runners under a maximum body weight load at midstance while wearing their own mostly conventional running shoes. See **Selected Willwacher Graphs** below.

According to the Rubin study ratio of 1:1.7, the **11** degrees of inward rotating **ankle** eversion should be directly coupled with fully **18** degrees of internal rotation of the tibia (and knee joint). Instead, in the Knee Angle Transverse Plane graph of Figure 6 of the Willwacher award-winning study, there is only **8** degrees of internal rotation of the **tibia (and knee joint)**, fully **10** degrees less that should be there according to **Rubin's Ratio of 1:1.7**.

The Mysterious Missing 10 degrees of Inward Tibial Rotation

This is an important mystery. Why is the 10 degrees missing? Less than half as much inward tibial rotation occurs in Willwacher's testing when running in shoes compared to Rubin's static testing of barefeet.

The only available explanation is the outward rotation of unnatural supination caused by shoe heels! Simply put, unnatural shoe heels must cause the abnormal joint motion de-coupling.

Selected Graphs from Figure 6 of Willwacher's Study

This 10 degree discrepancy indicates clear evidence of a very substantial **de-coupling** during running in shoes of the directly parallel linkage between ankle and tibia rotation found in Rubin's stationary study of barefeet.

In fact, the substantial de-coupling shown in the Willwacher study provides clear proof of the direct mechanical effect of shoe heel-induced supination on knee motion in the transverse plane. The inescapable conclusion is that the shoe heel-induced unnatural supination actually causes the abnormal decoupling, which is otherwise inexplicable, as it has remained until now!

The math is simple. The missing **10** degrees of inward tibial rotation is a result of **10** degrees of outward rotation that must be caused by about **6** degrees of shoe heel-induced supination, using Rubin's Ratio of 1:1.7.

The equal rotations of **10** degrees in opposite directions cancel each other out, leaving the observed inward rotation of only **8** degrees when running in shoes.

That final result neatly proves mathematically the existence of a direct bio-mechanical de-coupling effect of shoe heel-induced ankle joint supination and its directly resulting tibial external rotation, based on the **Willwacher** prize-winning study, which is particularly authoritative because of its exceptionally large and therefore statistically valid sample size (222 runners)!

Data from the Willwacher study (graph on Knee Angles in Frontal Plane – shown above) also provides clear evidence of the extraordinarily high individual range of variation of knee abduction/adduction motion between the 222 runners, as expected given each individual's specific genetic adaptation to their own particular, highly variable shoe heel use.

The frontal plane knee motion shown is also the most erratically variable of all the lower limb joint motions measured in the Willwacher study, suggestive of wide individual variation in compensating for the excessive lateral instability in the modern knee joint due to the unnatural effect of shoe heels.

An Unusually Large Sample Size, But Highly Selected Instead of Random

By the way, the Willwacher study sample size is much larger than a typical biomechanics study, and includes both men and women. However, unfortunately it must also be pointed out that the runners studied are middle-aged, so on a de facto basis they are highly selected biomechanically, since they apparently have remained runners after surviving many years of annual injury rates as high as 70%.

Moreover, the study's runners were also limited to those runners who had been injury-free for at least the past 6 months, which makes them very unique indeed, again given the typical 70% annual injury rates.

Therefore, the test subjects were not at all randomly selected and do not at all reflect the overall population, even of their age group. Rather, they are highly filtered, elite winners who have triumphed in a lifelong "survival of the fittest" race in an age group in which nearly all other runners are former runners.

So a truly random study of subjects in this age group would likely including only a small number of active runners to be studied, which of course is why the study and all other running studies are not randomized and therefore do not at all represent the overall population.

This is an extremely serious problem, since it means that there are no existing biomechanical studies on running that examine the effect of shoe heels on the general population. It is expected that in general such effect is far more adverse, with much greater abnormal distortion of joint motion and skeletal structure.

On the positive side, the unique older runners in the Willwacher study above provide a rational guide to interpreting the study results. It is reasonable to conclude that the middle aged runners' relatively straight-to-slightly-valgus legs enabled them to avoid injury and continue running far longer that typical.

Given that Willwacher's data shows that the knee is being torqued into an unnatural varus position, it seems clear that the most effective compensation by runners successful in the long term is moderate pronation that offsets nearly exactly the abnormal torque caused by shoe heels. The same relatively straight-to-slightly-valgus legs is seen generally in world class champions.

However, a quick trip to the mall will convince you that this is not true for the overall population. A large portion of the males are significantly bowlegged when walking, whereas a similar portion of the females are significantly knock-kneed, as discussed in detail earlier.

An important further note: like all running biomechanical studies, the Willwacher study tests and provides results for only one leg, the right, ignoring the other leg on the generally accepted assumption that both legs are the same. However, that convenient assumption has now been definitively proven wrong, because the general case is instead that the right and left legs are in fact asymmetrical in form and function (see Endnote 5 directly below).

5. **Radzak**, Kara N. et al. (2017). Asymmetry between lower limbs during rested and fatigued state running gait in healthy individuals. In *Gait & Posture* 51: 268-274, particularly **pages 270-272** and **Tables 2-3**.

6. Many Research Studies Have Experimentally Confirmed the Twisting Effect of Elevated Shoe Heels on Ankle Joints and Foot

A relatively recent study in 2012 by Danielle **Barkema**, Timothy Derrick, and Philip Martin experimentally confirmed the existence of this artificial supination effect of shoe heels on the ankle joints and foot. Specifically, in an experiment with 15 women, they found that

> **As heel height increased** for both fixed and preferred [walking] speeds, rearfoot angle became more positive throughout stance, i.e. the center of the ankle joint shifted laterally relative to the heel point of contact, which contributes to **an inversion-biased ankle orientation** (Fig. 4).

See **Barkema**, Danielle D. et al. (2012). Heel height affects lower extremity frontal plane joint moments during walking. In *Gait & Posture* 35: 483-488, particularly pages 483, 485-487 with Figures 2 & 4. See also Cronin, Neil J. (2014). The effects of high heeled shoes on female gait: A Review. In the *Journal of Electromyography and Kinesiology* 24: 258-263. particularly pages 258 and 261.

Another walking study, also in 2012, by Alicia **Foster**, Mark Blanchette, Yi-Chen Chou, and Christopher Powers indicated an increase from low heels (1.3 cm or ½ inch) to high heels (9.5 cm or 3½ inches) coincides with a peak ankle inversion angle increase from 3 degrees to 9 degrees. The high heels take the foot to near maximum supination, since less than 8 degrees has been reported to be about the maximum passive range of motion for inversion.

See **Foster**, Alicia et al. (2012). The Influence of Heel Height on Frontal Plane Ankle Biomechanics: Implications for Lateral Ankle Sprains. In *Foot & Ankle International* 33: 64-69, particularly pages 64, **67 with Table 1** and **Figure 3B**, and 68.

In an earlier study with 37 women in 2000, Makiko **Kouchi** and Emiko Tsutsumi also found that as the height of a shoe heel increases, the foot supinates, as did a study with 13 women in the same year by Darren **Stefanyshyn** and others.

See **Kouchi**, Makiko & Tsutsumi, Emiko (2000). 3D Foot Shape and Shoe Heel Height. In *Anthropological Science* 108: 4: 331-343, particularly page **331**, 336-338 with **Figures 5-7**, and **342**. **Stefanyshyn** et al. (2000), The Influence of High Heeled Shoes on Kinematics, Kinetics, and Muscle EMG of Normal Female Gait. In the *Journal of Applied Biomechanics* 16: 309-319, particularly pages 309, 313-316. See also **Hong**, Wei-Hsien et al. (2013). Effect of Shoe Heel Height and Total-Contact Insert on Muscle Loading and Foot Stability While Walking. In *Foot & Ankle International* 34: 2: 273-281, particularly pages **273**-274, 276-**277** with **Figure 3(b)**, and 279 with Figure 5.

In addition, a study in 2002 by Timothy **Derrick**, Darrin Dereu, and Scott McLean indicated that foot becomes more inverted at impact at the end of an exhaustive run in conventional running shoes, demonstrating a direct cause and increasing effect, even in a relatively short period of time.

See **Derrick**, Timothy R. et al. (2002). Impacts and kinematic adjustments during an exhaustive run. In *Medicine and Science in Sports and Medicine* 998-1002, particularly pages **998** and 1000-**1001 with Table 2**. See also **Clarke,** T. E. et al. (1983). The effects of shoe design parameters on rearfoot control in running. In *Medicine and Science in Sports and Exercise* 15: 5: 376-381, particularly page **377 with Fig. 1**.

7. A recent example is the titanic $1 billion fiasco in brain research, as summarized in a ***Scientific American*** article by Stefan Theil titled, "Trouble in Mind" October 2015, pages 34-42. See also Henry **Markram**, "The Human Brain Project" in ***Scientific American***, June, 2012, pages 50-55.

8. **Sears**, Candice et al. (2016). The many ways adherent cells respond to applied stretch. In the *Journal of Biomechanics* 49: 1347-1354.

9. **Valkanova**, Vyara and Ebmeier, Klaus P. (2017). What can gait tell us about dementia? Review of epidemiological and neuropsychological evidence. *Gait & Posture* 53: 215-223.

<u>ABSTRACT: Modern Human Anatomy</u>

The book presents a shocking discovery, a major scientific breakthrough in human anatomy. The entire structure of the modern human body is abnormal and seriously deformed, causing arthritis and a multitude of other common diseases.

Based on a careful and extraordinarily detailed synthesis of peer-reviewed research, the book presents compelling proof that major racial differences in human anatomy are wholly artificial - <u>not</u> genetically based as commonly accepted.

However unlikely, the key structural and functional differences between "modern man" and the barefoot "primitive" races are simply differences caused by footwear use. Unlike the "primitive" barefoot, the modern foot is rolled to the outside by footwear into an unnaturally rigid **supination** position (the opposite of pronation). See **FIGURE 1.**

The modern supinated foot subtly and automatically twists both lower legs to the outside. During running the twisted knee is repetitively flexed under a peak load, 2-3 times body weight. That peak load controls bone formation. The twisted knee builds an abnormal rotary torsion into its basic structure during childhood growth and later.

That twisted structure de-stabilizes, weakens, and deforms the modern knee compared to the rarely injured barefoot "primitive" knee, which has a smaller, simpler structure, with no abnormal built-in rotary motion. See **FIGURE 2**.

The artificial foot supination also automatically <u>tilts-out</u> both legs. But since both legs are attached at the hip to the pelvis and torso, the tilting-out effect is reversed. Instead, both legs are <u>tilted-in</u>, because the inertia of the body's mass overpowers the tilting sideways forces when running.

As a consequence, the modern runner's pelvic side is forced to tilt down abnormally to avoid having the feet cross over centerline into each other. The pelvic side tilt is substantially asymmetrical between right and left legs. See **FIGURES 3 A&B**.

If the modern runner's pelvis somehow remained level instead of tilting down, his feet would become so entangled that running would be impossible. See **FIGURE 3C**.

In contrast, the African Bushman who grew up barefoot has straight legs and level pelvis when running, with no foot crossover. See **FIGURE 3D**.

The tilted down side of the pelvis abnormally twists and tilts the spine and skull. The modern human brain is twisted, showing an abnormal built-in structural reaction to rotary torsion, just like the modern knee. Often the result is unnatural onset of dementia.

However improbable, the effect on the modern brain can also be to enhance it. Albert Einstein's asymmetrical brain has a compressed right hemisphere shifted forward and a hyper-developed left, and parallel right/left hemisphere parts shifted. See **FIGURE 4**.

How anything as commonplace and thoroughly innocuous as shoes manage to do all this, and much more – and a first look at the true structure and function of the natural, un-deformed human body – are revealed in detail in this book.

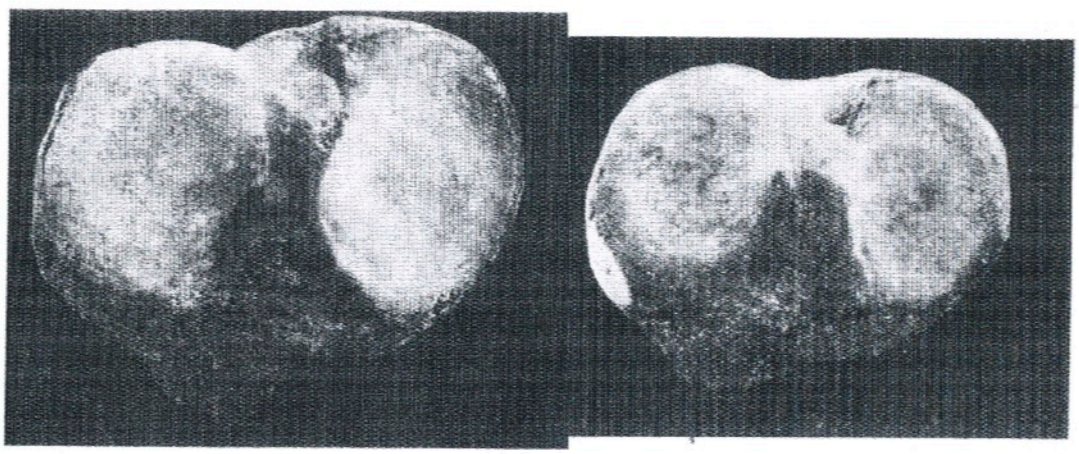
1) The SUPINATED Bare Footprint of a Normally Shoe-Wearing European

FIGURE 1A Same Footprints* **FIGURE 1B Normal Shoe-User European (in yellow)**

(Europeans in Solid Lines, Barefoot Natives In Dashed Lines)

* Both the Native and the European (a very rare specimen!) have never worn shoes

2) Modern (Shod) And Primitive (Barefoot) Knees Compared



The proximal aspects of a European and an Australian tibia of approximately the same length. The greater breadth and more massive character of the European epiphysis are clearly demonstrated. The two bones were photographed at the same distance from the camera.

FIGURE 2A Shod European Rotary Knee **FIGURE 2B Barefoot Aborigine Knee**

3) Modern Runner With Tilted-In Legs Relative to Tilted Pelvis To Avoid Severe Crossover - Unlike Natural Barefoot Runner With Vertical Legs & No Pelvic Tilt

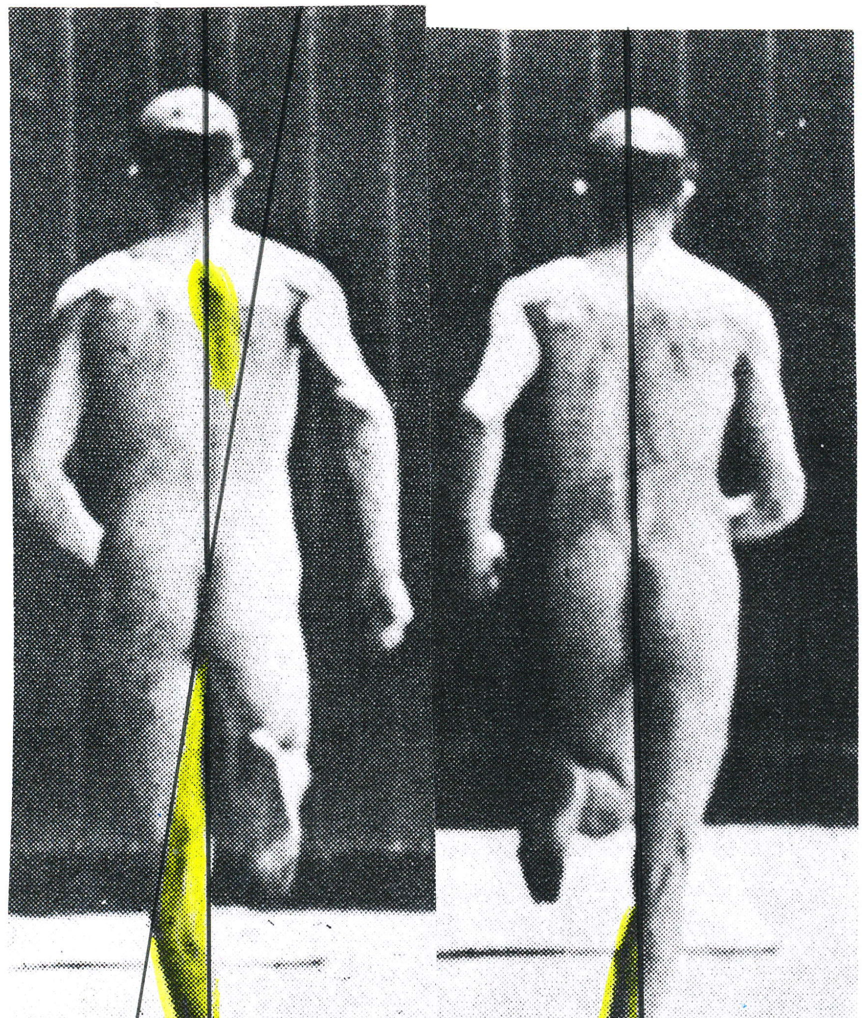


FIGURE 3A **FIGURE 3B**

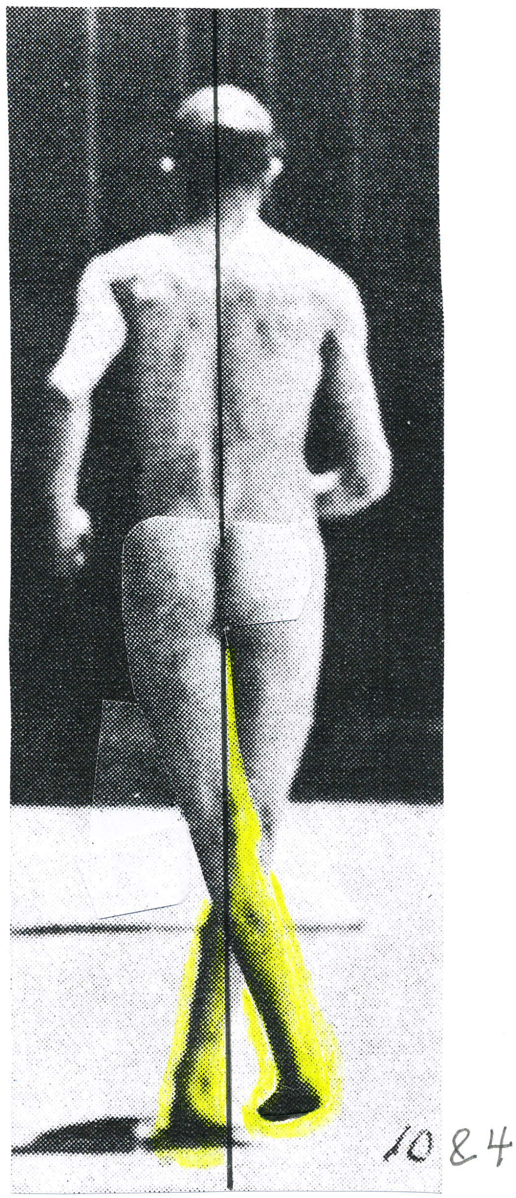


FIGURE 3C [**FIGURE 3D]**

4) Albert Einstein's Asymmetrically Twisted and Deformed Brain

(Top View, Front at Bottom)

FIGURE 4 Right Brain Hemisphere Is Squeezed Forward & Compressed, Relative to Hyper-Developed Left Hemisphere With Expanded Width Relative to Centerline