**Barefoot Running:**

**A Biomechanical Approach to Injury Prevention**

*"The head cannot say to the feet, I have no need of thee! God has so adjusted the body that there may be no discord. If one member suffers, all suffer together; if one member is honored, all rejoice together " - Paul in First Corinthians.*

For millions of years humans have engaged in distance running as a form of survival and advancement. Our evolutionary history consisted of constant bipedal movement: we ran to eat, we ran to avoid predators, and we ran to spread across the globe. Running has simply been encoded ancestrally into our genetic makeup as a natural process. So then, why is it that today over thirty-percent of runners are beset by injuries every year and at least two out of every three runners will have experienced some kind of running related trauma by the end of their careers?

Have we simply lost touch with our primitive ancestors? It could be that running has become too stressful of a sport and runners today just aren't made of what they used to be. During a long run, "each shoe lands on the ground some 800 times a mile. In a ten-mile run, that's 8,000 times.

Multiply that by the weight of a 150-pound person and you have a total impact of 600 tons" (Fixx 134). Maybe it's not a coincidence that with 8,000 jolts pulsing from our feet to the rest of our bodies, we are getting injured at such an increasingly high rate. But then again, our prehistoric friends were able to handle the blow with nothing more than their bare feet. So why can't we?

Harvard scientist, Dr. Daniel Lieberman, asked himself this same question as he set out to determine "how runners coped with the impact caused by the foot colliding with the ground before the invention of the modern shoe" (Jungers 14). Lieberman studied the foot-strike patterns of various runners, along with the kinematic force the runners generated. The study consisted of five subject groups containing both habitually barefoot and shod runners from the United States and Kenya. The runners were instructed to stride along a 25-meter track while Lieberman and his associates used high-speed video cameras and force plates to measure the amount of kinetic force generated from each runner's foot-strike. The results were shocking: the habitually barefoot runners from Kenya were generating less force and had smaller collisions between their feet and the ground than the shod Americans (Jungers 8). But how could this be possible? Aren't running shoes supposed to soften the blow between our feet and the ground?

The researchers found that although heavily-cushioned running shoes are comfortable, the shoes actually limit the foot's proprioception1 and distort the natural process a runner's foot will undergo when contacting the ground. The subjects who wore shoes during the experiment had a significantly more dorsiflexed (rear-foot) gait. On the other hand, the studies showed that the habitually barefoot runners were striking the ground more efficiently with a plantar-flexed (fore-foot) gait. Lieberman had found his answer: prehistoric barefoot runners were able to cope with the impact because running barefoot meant running on their toes. The kinetic forces generated from the rear-foot shod runners were far more unforgiving and impacted the coherence and biomechanical process of their feet. Each shod runner endeavored a substantially greater force; the runners were training with increased tension on their bones, muscles and tendons.

Furthermore, runners allow themselves to become more susceptible to injury by running in cushioned shoes. All runners must become familiar with the biomechanics of the human foot to make intelligent decisions about barefoot running and its positive effects on the human body.

With a firm understanding of the human foot and its biomechanical process, one can acquire greater insight into the physical science of injuries that plague runners today. Containing approximately one-fourth of the bones in the human body, the human foot is without a doubt one of the most intricate and sophisticated devices known to man. Within the foot is the complex architectural structure known as the arch; author Christopher McDougall, characterizes the human arch as the "greatest weight-bearing design ever created...a high-tensile web of twenty-six bones, thirty-three joints, twelve rubbery tendons, and eighteen muscles, all stretching and flexing like an earthquake-resistant suspension bridge" (McDougall 176). When a runner embarks on a run, the foot will undertake an elaborate biomechanical process in which the foot naturally absorbs shock and attempts to balance the rest of the body. Initially, the heel strikes the ground and the arch follows as the heel instantaneously collapses. From there, the muscles, bones, and tendons of the foot will shift inward (pronate) and outward (supinate), balancing the body. Next, the foot will roll onto its ball raising the heel as the rubbery tendons of the arch retract and flex like an "earthquake-resistant suspension bridge." Lastly, the foot will accelerate off its ball, simultaneously readying itself to duplicate this cycle. Scientists and researchers have found that with the institution of the running shoe, this process has been substantially compromised. The foot has evolved so that the arch strengthens under stress; the more pressure exerted, the tighter the arch will toil and compress. The mechanics of the human foot can be directly associated to an actual architectural structure in a sense that, "no stonemason worth his trowel would ever stick a support under an arch; push up from underneath, and you weaken the whole structure" (McDougall 176). When a runner overcompensates with heavily cushion running shoes, he or she is throwing a wrench into their foot's biomechanical process and is thereby becoming more vulnerable to counter-productive injury.

As humans, our ability to walk and run on two legs distinguishes us from apes and our extinct relatives. This form of locomotion has been a part of our nature for millions of years, but the human race has been "unshod for more than 99% of that time" (Jungers 14). It wasn't until the 1970's that the modern running shoe came into play; since then, running related injuries have been steadily increasing. Harvard scientist, William L. Jungers claims that "many running shoes have arch supports and stiffened soles that may lead to weaker foot muscles, reducing arch strength". One of the most common running impairments associated with heavy-cushioned shoes is Achilles Tendinitis: the inflammation of the heel tendon caused by overuse and muscular incompetence. Runners will frequently find themselves aggravated by painful tingling sensations throughout their feet inducing either strained calf muscles or tendon related damages. Today, most runners that are victimized by Achilles Tendinitis share a mutual irritant: an elevated heel resulting in a shortened Achilles. A shortened Achilles tendon means the Achilles is doing less work---if the Achilles is doing less work than the tendon ultimately becomes weaker. Undoubtedly, runners who have weaken foot and leg muscles are more likely to become crippled by painful injuries. An example of this would be what many have called "flip-flop-itis": the outbreak of Achilles tendinitis after women have made the switch from heavy high-heeled boots in the winter to flip-flops in the summer. Although, four-inch heels may look stylish and feel somewhat comfortable, they actually shorten the Achilles tendon. Inevitably, because these women have such abbreviated tendons, when they make the sudden summertime transformation to minimalistic flip-flops, they're painfully surprised.

Wearing shoes suffocate the foot and interfere with its mobility. Assuredly this minimizes the foot's potential to develop into the muscular and robust structure it was conceived to be. Overall, the human foot has been compromised by shoes; there may be shoes designed for certain types of feet but with over seven billion people living today, it’s pretty hard to find that "perfect shoe". Those ensnared in the unwavering quest for the perfect shoe are unfortunately lost. There is none. These runners are entangled in a web of confusing options and interchangeable variables which make finding a compatible shoe extremely difficult. For example: although a basic Nike retailer will provide the consumer with a plethora of options, "some people have a 9.5 size shoe and they're 5 feet tall and some people have a 9.5 six shoe and they're 6 feet tall" (Tefelski). Every runner's foot will not only absorb shock and carry weight differently, but each foot will have varying physical dimensions. Dr. Denton, owner of the Fleet

Feet running store in Davis, California, believes that there is "no single best shoe for runners, and it is impossible to say that shoe ABC will eliminate injury XYZ" (Burfoot 14). Fortunately, all runners are already equipped with the most biomechanically efficient running "machine" known to man: the human foot. The foot is the body's foremost weapon in fighting the war on injury. Before runners proceed in removing the shoe, they must fully comprehend the complex biomechanical functions of the foot.

By understanding the functions and mechanical process of the human foot, runners can draw conclusions regarding the barefoot running theories that are currently circulating the media.

The foot's primary function is to be supportive; the foot is capable of withstanding force and strengthening under pressure more effectively than any other part of the human body.

The secondary function of the human foot is to balance the body and absorb shock as the body adapts to uneven terrain. With over two-hundred-thousand nerve endings the foot is intended to act as an antenna, transmitting crucial data from the ground up (Sternbergh 4). Although feet may have been designed to travel barefoot, they were not constructed to run or walk on tough pavement roads; industries like Nike, Brooks and Sacouny have compensated by creating cushioned shoes with soft memory-foam and gel. The main problem with this design concept is that with heavily cushioned shoes, the foot becomes "corrupted": the nerves are suppressed and the foot's natural process is warped. Evidence shows that the prehistoric foot evolved to run on uneven unnatural surfaces; with the evolution of pronation and supination the human foot was able to adapt to these surfaces. Over-pronation is the foot's natural tendency to rotate down and inward on the medial side over fifteen degrees. In more recent years, the term over-pronation has had a negative connotation; runners attempt to correct this rudimentary function with highly priced over-supportive running shoes.

These supportive shoes or "posted" shoes are designed to prevent the foot from rolling inward and crashing down onto the medial side of the shoe; these shoes often have excessive cushion, firm foot-beds, and stiff arch supports. The opposite of over-pronation is oversupination which is the foot’s ability to become rigid and strike onto the outside of the foot rolling outward. This type of gait will absorb shock more productively and require runners to wear a neutral shoe. Currently there is a huge statistical gap between the over-supinators and over-pronator: "Twenty percent of the population would fall into the "supinated foot" category, whereas eighty percent of the population would be considered over-pronators" (Superfeet The Premium Insoles). Runners who over-pronate today are aware of the dangers that may arise from running in a neutral unposted shoe---injury. As a result of this dilemma, runners have entered what has been referred to as the shoe paradox: when running in the wrong shoe we get injured and are forced to buy a more supportive shoe; we have become so mistakenly attached to running in shoes that we believe it to be more natural than running in our barefoot "when in fact wearing shoes simply creates the need for wearing shoes" (Sternbergh 3). In the present climate, frustrated runners are asking themselves: *How can we get out of this paradox?*

In most instances the answer is simple, lose the shoe lose the pain. However, this is not always the case. Despite the fact that the human foot was devised to traverse barefoot, many runners today are casual runners, not training actively. Runners' feet are unquestionably "the most abused and neglected part of the body...they do the most work and receive the least attention" (Sheehan 85). Sedentary or casual runners have a considerably greater chance of obtaining an injury than active runners. British National track Coach, Brian Mitchell, suggests that "over centuries, the feet have always been able to adapt, but not to inactivity" (Sheehan 85).

It was once said that at age 22, President Abraham Lincoln could wrestle, out run, and out lift any man in Sangamon County. Honest Abe once walked thirty-four miles in one day just to hear a famous lawyer argue a case in court (Sheehan 86). Unlike present day athletes, President

Lincoln was no "week-end runner". President Lincoln used his feet as they were intended and remained ceaselessly ambulant. Today, with the combination of lethargic "week-end" runners and shod runners, a generation of feeble-footed athletes has emerged. It is important that all runners understand that the bioengineering of their feet requires constant movement. With this knowledge runners can transition gradually into a barefoot running life style; preventing injury with the human foot as their best tool. Transitioning into a more natural barefoot existence may very well prevent injury to the body's most biomechanically fragile and faulty structure: the knee. Dr. Richard Schuster, reports that "nearly 75% of runners seeking help have chronic knee pain" and one of the most frequent injuries that plague runners today is runner's knee . Medically know as chondromalacia, this knee injury originates from the erosion of the cartilage covering the underside of the knee cap. Runner's knee is the most prevalent injury affecting runners. In

2006 a team of rheumatologists from Rush Medical College in Chicago conducted tests measuring the force of torque runners exerted on their knee joints when walking. The group of scientists results showed that "the impact on the knees was 12 percent less when people walked barefoot than it was when people wore padded shoes" (Sternbergh 3). The human body is assembled so that the body's weakest joint (the knee) contains the only ligament separating the body's strongest joint (the hip) and the ground. So it is only logical to limit adverse forces on the knee whenever possible. Barefoot walking and running is a step in that direction (no pun

intended).

In the past years there has been a rise in barefoot running and a subculture of minimalistic runners has emerged. These runners all share the common belief that less is more: less shoes means more room for the foot to strengthen. The shoe industry has steadily began to accommodate runners whom wish to train with less on under their feet. Companies like Nike,

New Balance and Vibram have been able to readjust and adapt to the emerging barefoot culture.

The revolutionary organization Vibram, has produced a series of FiveFinger shoes designed to replicate the instinctive way our ancestors traversed. The primary goal of the FiveFingers is to "encourage forefoot striking, meaning your forefoot will contact the ground first then engage muscles in your feet and lower legs as your heel touches down" (Vibram USA Inc.). These shoes and other similar models have successfully attempted to simulate what the barefoot Kenyans revealed in Dr. Daniel Liberman's experiment: forefoot low-impacted running. This approach to running is not only more mechanically reasonable, but it also results in fewer injuries. Overall, minimalistic shoes like the Vibrams have been giving runners a prehistoric advantage: runners are spending more time on their toes and less time at their podiatrists.

All runners are united by the same uniform principle: each step taken on a run brings us closer to our ancestral past. As runners "we reach directly back along the endless chain of history, we experience what we would have felt had we lived ten thousand years ago...we are a reasserting as modern man seldom does, our kinship with ancient man, and even with the wild beasts that preceded him" (Fixx 128). As the manufacturing process and design of running shoes has become more and more sophisticated, runners have lost touch with this "ancestral past." In recent years, various studies and experiments have demonstrated that, from a physiological and biomechanical standpoint, barefoot running makes perfect sense. The human foot is the most inherently well-designed and fundamental tool a runner has. With the knowledge of the biomechanics of the human foot, and the advantages of barefoot running, runners will be suffering from much fewer running related injuries.

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