RUNNING SHOES IN RELATION TO RUNNING INJURIES
A REVIEW OF THE CURRENT LITERATURE

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ABSTRACT

Background: There is a controversy regarding the claims made by shoe companies about the functional capabilities of their shoes. Millions of dollars are spent each year convincing the shoe buying public that a running shoe should provide shock absorption from the impact forces of the ground, control over-pronation, and decrease their running times. The current scientific literature seems to suggest that these features actually increase the likelihood of injuries.

Objective: There is a need for chiropractors and especially chiropractic sports physicians to understand what is in the literature pertaining to shoe design and actual function, not the claims made by the shoe manufacturer pertaining to the physical properties of a particular shoe. Hopefully this review will also showcase the lack of quality scientific literature by the shoe companies and will spark some interest in producing such needed references.

Data Selection: A literature search utilizing Medline database was conducted at Logan College of Chiropractic. The subject heading "running shoes" was entered with the subheading of "running injuries." This generated 45 documents. A total of twenty documents were chosen for this review. The dates chosen for review ranged from 1980 to 1997. Nineteen of the sources are journal articles, while one source is a textbook.

Data Synthesis: The data were studied to find valid scientific research backing up the various shoe companies shoe performance claims. Data were also studied to find outside scientific research on running injuries, and their correlation to particular shoes' features.

Conclusion: A shoe after all is just a shoe. Something to protect the foot from external trauma, abrasion, laceration and perhaps the excesses of temperature. Today's running shoes have not been shown by scientifically valid studies, to be any better than those of yesteryear. They alter the body's ability to avoid excessive stress by distorting sensory input and reducing natural shock moderating reaction to VGRF. The plethora of "hi-tech" features in today's shoes, while required for the competitive marketplace, do little, if anything to improve foot function or physical performance.

INTRODUCTION

Chiropractors who specialize in treating athletic injuries are often asked by their patients to recommend which shoe to buy. The problem is many doctors make their suggestions on which shoes to purchase based on the claims made by the shoe manufacturer pertaining to the physical properties of a particular shoe, not on scientific literature. The shoe companies are spending millions of dollars each year trying to convince the shoe buying public that a running shoe should provide shock absorption from the impact forces of the ground, control over-pronation, and lower their running times. Scientific data that has been collected and published in the last eighteen years suggests that features in shoes designed to absorb more shock and control excessive rearfoot motion actually increase the likelihood of injuries.

CUSHIONING

The foot strikes the ground approximately 600 times per mile, absorbing 2 to 3 times the body's weight.[1-3] Based on this information, it would be logical for an uninformed person to assume a shoe that would absorb more ground shock or vertical ground reaction force (VGRF) would be the one to use. In reality this is not the case.

Reflex activity in the leg is designed to react to pressure or the relative hardness underfoot. "Only pressure, not impact or shock, can be sensed by the foot and there are no transducers in the body capable of receiving shock waves of the relatively high frequencies (8-25 Hz) produced during foot strike."[4].

During barefoot running the body compensates for the lack of cushioning by plantar flexing the foot at contact and positioning the point of contact under the body, resulting in a softer landing. Reducing the hardness that the foot senses, changes the body's proprioceptive response or shock moderating behavior. In fact, the softer the surface the less adaptation there is to VGRF.[5] Placing a yielding material in the midsole of a running shoe alters impact sensation

that results in a sharp reduction in shock moderating behavior, thereby increasing impact.[6-8] Scientific data that has been collected and published in the last ten years suggests that features in shoes designed to absorb more shock and control excessive rearfoot motion actually increase the likelihood of injuries.[1,9-11]

Athletic shoes are a support surface interface composed of relatively soft compressible materials designed to protect against injuries occurring in sports through force of vertical impact. Impact remains high with their use because humans land harder with them. In a study by Robbins and Waked[12], they tested their hypothesis that this hard-landing strategy is an attempt to improve stability, by compressing the material to a less destabilizing thinner-stiff variety. They tested this hypothesis by comparing impact and balance on materials consisting of ethyl-vinyl acetate (EVA) foams of varying stiffness, identical to that found in soles of athletic footwear. They concluded that steady state vertical impact was a negative function of interface stiffness, with the softest interface producing the greatest vertical impact. Balance and vertical impact are closely related according to these authors. This supports the hypothesis that landing hard on soft surfaces is an attempt to transform the interface into a form associated with improved stability. According to these findings, currently available sports shoes and mats are too soft and thick, and should be redesigned to protect the persons using them.

At the heart of this information gap about the functional qualities of running shoes is the failure of many manufacturers to use more expensive testing techniques using human subjects. The effects of energy absorbing materials may appear excellent when used in vitro materials tests, but perform poorly in subject tests. A good example of this is sorbothane. Sorbothane is a visco-elastic polymer which exhibits high energy absorption in materials testing, and is often indicated for the prevention and treatment of running related injuries. Subject tests done on this

material actually contraindicate its use. Lafortune and Maguire[13] found that using insoles made from a visco-elastic polymer actually increased tibial impact loading by 26% in some cases. Evaluation of sorbothane insoles on United States Marines did not reveal any beneficial effect, and in fact the soldiers using the product had an increased incidence of foot and lower leg injuries.[14]

In a study conducted by Marti et al.[10], the relationship between running injuries and running shoes was examined. Among 5,000 runners it was found that users of the more expensive running shoes had a higher incidence of injury. The study revealed that the more shock absorbing qualities a shoe had, the more it cost (in more ways than one). Epidemiological comparisons of running injuries in recent years would indicate less chance of injury in less expensive shoes and/or older models made prior to this industry-wide obsession with shock abosorption.[3,10,15] In another study by Robbins and Waked[16], they stated that no scientific data suggest athletic footwear protect well. Furthermore, expensive athletic shoes are deceptively advertised as safeguarding against injury through "cushioning impact," yet they account for 123 percent greater injury frequency than the cheapest ones. This study tested the hypothesis that deceptive advertising creates a false sense of security with users of expensive athletic shoes, thereby inducing attenuation of impact-moderating behavior, increased impact, and injury.

A random sample of 15 healthy young men selected from the general population and with a mean age of 31 participated in this study as volunteers. All participated actively in sports and leisure activities, and all were free of conditions affecting their ability to walk, run or balance.

The volunteers confronted four surfaces: a bare force moment platform and three platforms covered by identical shoe sole material made to appear different. The three platforms

were advertised divergently by messages that resembled advertisements. The other two group messages included a warning message and a neutral message.

Ground reaction forces were recorded for ten barefoot footfalls. Impact varied in relation to advertising claims. Impact was greatest with the deceptive message and lowest with the warning message. The impact from the neutral message did not differ appreciably from that prompted by the deceptive message, yet was significantly greater than that produced by the warning message.

These data provide a plausible mechanism explaining higher injury frequency in users of expensive athletic shoes. The authors suggest that deceptive advertising of protective devices may represent a public health hazard that presumably could be eliminated through appropriate regulation. They also reveal a tendency in humans to be less cautious when using new devices of unknown benefit because of overly positive attitudes associated with new technology and novel devices.

SHOE DESIGN AND EFFECTS ON REARFOOT MOTION

A lot has been written and discussed linking subtalar joint overpronation with lower extremity sports injuries. While this hypothesis is widely held by the general public (largely due to a misinformed media), it flat out has not been supported by scientific data to date.[15] What researchers point to as the heart of the injury process where pronation is concerned is the velocity of that movement..[17] This theory bears consideration in light of the fact that many runners who have had a life long overpronation tendency were injury free until they took up a regime of running. Reports that running related injuries are uncommon in unshod populations[1] supports the thought among experts in biomechanics that the lower extremity is quite durable.

Shoe manufacturer's preoccupation with cradling the plantar surface of the foot in comfort causes some unwanted kinematic adaptations in the foot/ankle complex. In addition to decreasing the body's shock attenuating abilities, cushioning in shoes encourages greater calcaneal eversion.[3,4] The only method of controlling overpronation at the subtalar joint is by an in shoe orthotic. Shoes claiming to "control" pronation may actually aggravate the problem. In fact, running shoes with soft midsole material significantly increased maximum pronation and total rearfoot movement in laboratory tests.[18] When one runs behind a patient who has recently purchased a pair of the new age running shoes designed to control rearfoot motion, one will be immediately convinced of the shoe's ineffectiveness in controlling foot/ankle motion. Stacoff and Kaelin[19] in a study on heel height and pronation found that pronation was decreased in heel heights at a range of 2.3 to 3.3 cm, but increased above and below these settings.

The sophisticated running shoes of today certainly look fast and athletes may feel they are running swifter than before, but once again the data indicate that running in well cushioned shoes not only slows one down but requires greater oxygen uptake as well. Bosko and Rusko[20] were able to show that running in thicker more energy absorbent shoes significantly increased oxygen uptake in their subjects. This was due to longer contact times with the running surface and reflex muscle activity in the muscles of the leg.

CONCLUSION

Many practioner's may have observed that there has been an increase in the incidence of lower limb injuries during the past decade, despite the innovations in footwear advertised as "protective" and "preventative."[7] A review of the literature clearly supports the fact that footwear restricts normal foot function confuses the afferent input into the nervous system thereby increasing injury incidence. A patient who experiences pain or discomfort while running

on a natural surface (like sand or dirt), likely has biomechanical imbalances within his/her musculoskeletal system. Placing such a person in soft, shock absorbent running shoes disturbs the body's ability to "feel" the discomfort and to make adjustment to prevent injury. A shoe is after all just a shoe. Something to protect the foot from external trauma, abrasion, laceration and perhaps the excesses of temperature. Today's running shoes have not been shown by scientifically valid studies to be any better than those of yesteryear. They alter the body's ability to avoid excessive stress by distorting sensory input and reducing natural shock moderating reactions to VGRF. The plethora of "hi-tech" features in today's shoes, while required for the competitive marketplace, do little, if anything to improve foot function or physical performance.

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