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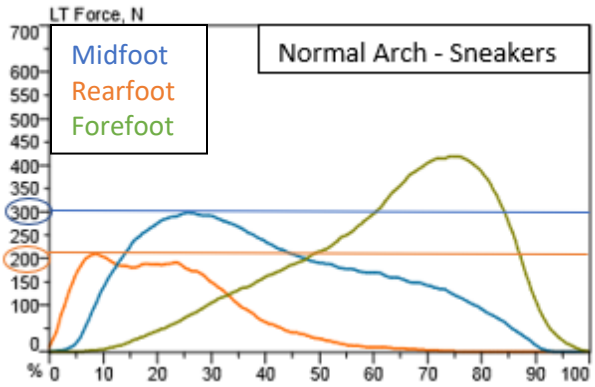
The Effects of Footwear on Ground Reaction Forces and Ankle Kinematics in Subjects with Different Arch Heights

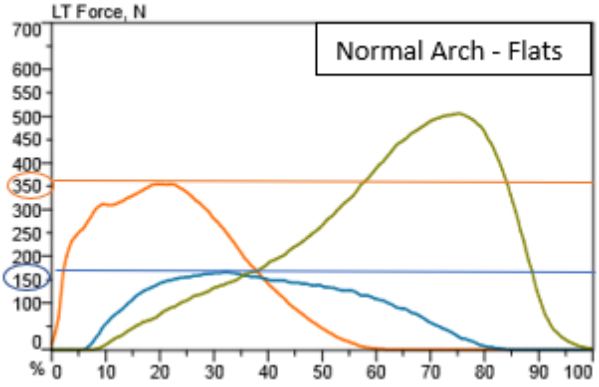
Abstract

Background: Previous research on footwear focuses on the forces experienced on the foot when wearing minimalist or maximalist shoes, which are specific to a research setting and not typically worn by the everyday individual. Most of these studies also target running mechanics at a high skill level, which does not impact the general population. Regarding arch height, literature suggests that individuals with pronated feet demonstrate more midfoot pressure as opposed to having a normal arch height with more forefoot pressure. For our study, we wanted to focus on prolonged walking as this is a more frequent mode of locomotion for a majority of people throughout the day. We sought to investigate how different types of footwear impact pressure distribution on the foot and ankle kinematics in people with different arch heights. We considered arch height to determine differences in injury risk and the possibility of recommending appropriate footwear to individuals to reduce such risk.

Methods: Our experiment took place in the Movement Analysis Lab in CHS and consisted of two subjects, one with normal arch height and another with pronated feet (as determined by measurement of the Longitudinal Arch Angle). Each subject walked on the pressure treadmill at a self-selected speed for two trials, 20 minutes each (determined to be prolonged walking as per recommended time for daily exercise). The subjects wore sneakers for the first trial, to represent high supportive footwear, and either flats or sandals for the second trial, to represent low supportive footwear. Data was collected on ground reaction forces using the pressure treadmill and ankle kinematics using the Hudl application on an iPad.

Results: Results were gathered at the 19th minute of each walking trial and demonstrated that sneakers (ie. more supportive shoes) disperse force throughout the whole foot while less supportive shoes (flats or sandals) increased localized pressure, therefore, creating high pressure points that can create pain and possibly future injury. Sneakers were more effective at reducing ground reaction forces on the subject with a normal arch (600N to 550N) while the subject with pronated feet experienced less overall ground reaction forces in both shoes (550N). Sneakers prioritized pressure at the midfoot while less supportive shoes demonstrate increased pressure at the rearfoot regardless of arch height (see graphs below).





Conclusion: Based on our results, we concluded that more supportive shoes may be more effective at reducing injury when walking, which is in agreement with previous literature. Regardless of shoe type, there was increased pressure at the medial forefoot in the subject with normal arch heights and at the heel and great toe in the subject with pronated arches. As a result, people with normal arches may be predisposed to injuries around the first metatarsal phalangeal joint, while their peers with flat feet may be at a relatively increased risk for injuries at their heel and great toe. Practitioners, including physical therapists, should consider the relative risk for injury when examining and treating patients as pain and injuries in the foot can significantly affect structures further up the kinetic chain. In addition, practitioners should recommend supportive shoes, such as sneakers, for clients who walk for prolonged periods of time for exercise or employment, regardless of arch height. Additional research is needed to further examine the effects that shoe type and arch height can have on risk for injuries in the lower extremity.

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