Effects of level surface and incline treadmill running on center of pressure (COP) and joint kinematics

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BACKGROUND: Treadmill training is a common form of exercise to boost cardiovascular health, endurance, and strength. However, it can also increase an individual's risk for overuse injuries and chronic musculoskeletal issues.[1] Understanding how the conditions of the treadmill can impact joint kinematics and center of pressure can help clinicians and the general public avoid these injuries while continuing to benefit from treadmill training. Research has proven that increasing the treadmill incline will alter the dispersion of load placed on the foot, causing the center of pressure of the load to increase in the midfoot and forefoot and decrease in the hindfoot[1]. Furthermore, a Harvard study on cross country runners found that rearfoot striking patterns were twice as likely to develop an overuse injury compared to other striking patterns[2]. Additionally, increasing the incline can increase the range of motion that lower extremity joints move through, dispersing the force through a greater range of joint motion[5]. This research suggests that an incline would be beneficial to reducing overuse injuries. However, less is known about the exact threshold of treadmill incline parameters necessary to see these benefits.

PURPOSE: The purpose of this experiment was to understand the effects of level versus incline treadmill running on joint kinematics and center of pressure to determine the optimal running conditions for reducing overuse injuries.

METHODS: During the study, participants were recruited of similar age and gender (both female, age 23 and 24), history of regular running (mid distance-distance runner, 10-20 miles a week), with a similar self-reported heel-strike pattern. Foot wear used were different brands of traditional running shoes with the same amount of heel lift. Each participant ran at a speed of 8:57 mile pace (6.7 speed). The Noraxon® Pressure Treadmill was used for the different running

conditions (incline levels of 0, level 1 and level 2). Each participant ran for one minute at each condition, with no rest breaks between incline changes. The last 30 seconds of running was recorded, with the data condition obtained through the Noraxon® system. Throughout each condition, the Hudl® technique app for 2D sagittal plane motion analysis of the hip, knee and ankle of each participant.

RESULTS: In both subjects, the heel transient which was apparent during level 0 incline running decreased in level 1 incline and even more in level 3 incline, as shown in figure 1. In this study, we also found that in both subjects there was a decrease in all vertical ground reaction forces in the rearfoot, midfoot, forefoot as incline increased, seen in figure 2. Additionally, there does not appear to be a direct relationship between increases the incline of the treadmill and changes in joint angles in the sagittal plane (i.e. no results seemed to increase or decrease consistently).

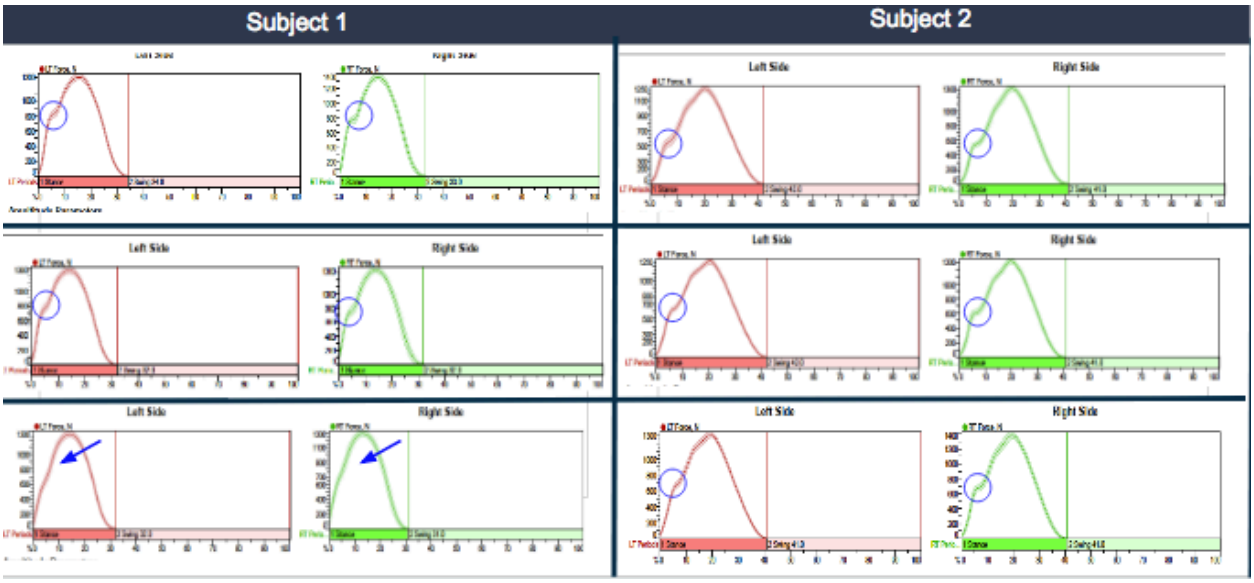

Figure 1: Force pictures taken on Noraxen pressure treadmill during level 0 incline, level 1 incline and level 3 incline focusing on heel transcient during the different inclines of running

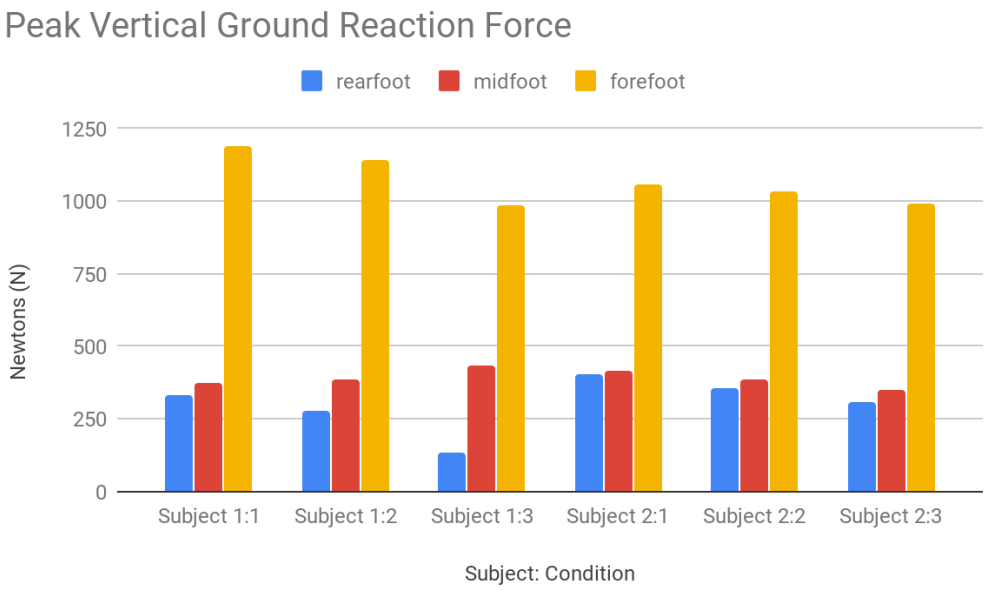

Figure 2: Vertical ground reaction forces through the rearfoot, midfoot and forefoot during the different inclines of running.

CONCLUSION: Minimal changes to an incline can impact ground reaction forces and foot strike patterns. We were unable to prove the effect of increasing an incline on risk of injury. This is an area of future investigation, with a larger sample size and a longer duration of study time. This is important to look into, as many people run not just competitively - but also recreationally and for therapeutic purposes. The shift from rearfoot strike to forefoot strike followed our hypothesis, while showing that each runner will have variances in running pattern based off of foot structure, prior injuries, and self-selected running strategies. There is no universal treadmill condition that is beneficial for all populations, so general parameters cannot be appropriately established. Therefore, a holistic approach is necessary to fully understand what running recommendations may be best for an individual.

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