Vertical Ground Reaction Forces Produced in Shod Running vs. Barefoot Running During a Moderate-Intensity Jog

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ABSTRACT

The focus of this study was to compare ground reaction forces produced in shod running vs. barefoot running during a moderate-intensity jog. Ground reaction force data was collected indoors on a 16-foot firm, flat surface using a force platform. Prior to data collection, each subject was asked to select a comfortable running pace. The subject-selected running pace was to remain consistent and was used for all trials. Each subject completed five trials barefoot and five trials in their personal running shoes at the subject-selected speed in a random order. No significant difference was found between the vertical ground reaction forces produced by shod (M=321.05, SD=58.11) and barefoot running (M=317.79, SD=57.98), t(df)=15, p=0.21. However, the calculated mean forces produced by shod running were greater than barefoot running. Results indicate that the differing ground reaction forces produced by shod and barefoot running most likely occurred on an individual basis and therefore cannot be generalized to a larger population.

INTRODUCTION

Many avid shod and barefoot endurance runners experience joint pains and various injuries throughout their running careers (Gross, 2012). Endurance running is one of the most common activities where overuse injuries in the lower extremities occurs. Research has shown that 35-56% of all runners (recreational and competitive) suffer from an overuse injury each year (Braunstein, Arampatzi, Eysel, & Bruggemann, 2010). Shod runners typically experience knee and lower extremity injuries, whereas barefoot runners generally experience metatarsal injuries. The different forms of injuries prevalent among shod and barefoot runners are attributable to differences in biomechanics of running (Gross, 2012).

The most injurious part of running is the footstrike, or the moment the foot collides with the ground. This collision can occur in three ways: a rearfoot strike, where the heel lands first; a midfoot strike, where the heel and the ball of the foot land at the same time; and a forefoot strike, where the ball of the foot lands prior to the heel of the foot. Barefoot endurance runners typically utilize a forefoot or midfoot strike running pattern, and shod endurance runners most commonly use a rearfoot strike running pattern (Lieberman et al., 2010). Each footstrike produces vertical ground reaction forces that increase linearly as running speed and stride length increase (Gross, 2012). These sudden, and very strong collision forces travel rapidly up the body and may contribute to the occurrence of many running-related injuries (Lopes, Hespanhol, Yeung, & Pena Costa, 2012).

The focus of this study was to compare ground reaction forces produced in shod running vs. barefoot running during a moderate-intensity jog. It was hypothesized that running shod would produce stronger vertical ground reaction forces than running barefoot. It was also hypothesized that running barefoot would produce weaker vertical ground reaction forces than shod running. The results of this study could help endurance runners to choose the style of running that suits their running needs best in order to prevent injury.

EXPERIMENTAL DESIGN AND METHODS

Prior to testing, each subject was familiarized with the ground reaction force data collection process. Ground reaction force data was collected indoors on a 16-foot firm, flat surface using a force platform. The force platform was placed 12 feet from the start line and 4 feet from the end line. Prior to data collection, each subject was asked to select a comfortable running pace. The subject-selected running pace was to remain consistent and was used for all trials. Each subject completed five trials barefoot and five trials in their personal running shoes at the subject-selected speed in a random order. After the completion of each trial, measurements from the force platform were recorded. Paired t tests were utilized to evaluate the data collected from the force platform since the same subjects were tested twice; barefoot and with their personal running shoes.

Retrieved from: http://icanhasscience.com/current-events/the-science-behind-barefoot-running/

Table 1. Paired t-test Source Table.

	Barefoot	Shod
Mean	317.79	321.05
Variance	3362.13	3377.24
Standard Deviation	57.98	58.11
Observations	16	16
Pearson Correlation	0.96	
df	15	
t Stat	-0.84	
P(T<=t) one-tail	0.21	
t Critical one-tail	1.75	

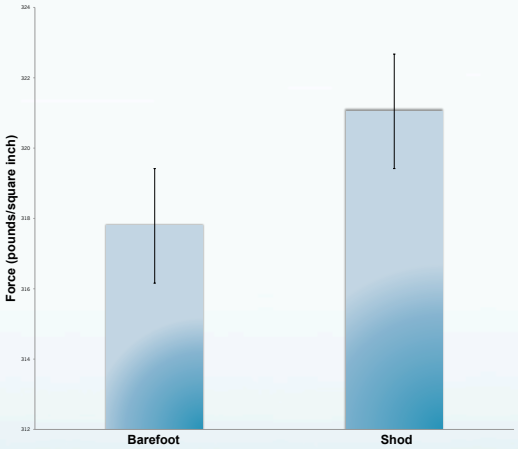

Figure 1. Comparison between mean vertical ground reaction forces produced by shod and barefoot running.

RESULTS

Subjects:

There were 16 subjects that participated in this study (8 males, 8 females). The age range of the subjects was 20-30 years (21.625± 2.473). All subjects were classified as moderately active, were uninjured at the time of testing and had been wearing their personal running shoes for a minimum of one month, three times per week for 30 minutes.

Shod running was not shown to produce significantly stronger vertical ground reaction forces than running barefoot. Barefoot running was also not shown to produce significantly weaker vertical ground reaction forces than shod running. Therefore, no significant difference was found between the vertical ground reaction forces produced by shod (M=321.05, SD=58.11) and barefoot running (M=317.79, SD=57.98), t(df)=15, p=0.21; an alpha level of 0.05 was used for all statistical tests. However, the calculated mean forces produced by shod and barefoot running did differ (Figure 1), though their differences were not significantly different.

DISCUSSION

No significant difference was found between the vertical ground reaction forces produced by shod and barefoot running. Therefore, both hypotheses were disproved. However, the mean vertical ground reaction forces produced by shod running were greater than those produced by barefoot running.

Kinematic analyses have shown that barefoot runners with a forefoot strike generate smaller ground reaction forces than shod rearfoot strikers. This difference is due to more plantar flexion at landing and more ankle compliance during impact with a forefoot strike running pattern (Lieberman et al., 2010). However, a study conducted by De Wit, De Clercq & Aerts (1996) found that barefoot running produced greater vertical ground reaction forces than shod running (Logan et al., 2010). Although this study did not find a significant difference between the vertical ground reaction forces produced by shod and barefoot running, this conclusion could be attributable to high variability and a minimized treatment effect.

To improve this study, it is recommended that a larger data collection space be utilized. The data collection space used in this study was 16 feet, with the force platform located 4 feet from the wall. This setup was not optimal because subjects were naturally slowing down as they approached the force platform (to avoid hitting the wall), which could have altered the data. In the future, it is recommend that a data collection space that is at least 10 feet larger than the force platform approach deck on either side is used to avoid faulty data.

CONCLUSIONS

Shod running was not shown to produce significantly stronger vertical ground reaction forces than running barefoot. Barefoot running was also not shown to produce significantly weaker vertical ground reaction forces than shod running. Therefore, both hypotheses were disproved. However, the calculated mean forces produced by shod and barefoot running did differ (Figure 1), though their differences were not significantly different.

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