DO FEMALES REQUIRE DIFFERENT RUNNING FOOTWEAR?

D.J. Stefanyshyn, P. Stergiou, B.M. Nigg, A.I. Rozitis, and B. Goepfert
Human Performance Laboratory, University of Calgary

INTRODUCTION

Currently there exists a lack of information related to female running, or female movement patterns in general. Footwear manufacturers, produce female footwear based on data collected on male subjects. Thus, despite known differences in aspects such as body mass, knee joint alignment, joint laxity, etc., female footwear does not take these aspects into account. In fact, a comprehensive analysis of female running biomechanics has not been performed. The purpose of this investigation was to determine if female runners have different biomechanical factors than male runners and to use this information for appropriate footwear design.

METHODS

Forty-two male and forty-one female subjects were recruited for this investigation. All subjects were regular runners running a minimum of 10 km/week (36.5 ± 20.2 km/week). Subjects were self-classified as either pronator or normal runners. Of the forty-two males runners recruited, 20 classified themselves as pronators, 20 as normals and 2 as supinators. Of the forty-one females recruited, 21 classified themselves as pronators and 20 as normals. All subjects were free from recent lower extremity injury or pain. Informed written consent in accordance with the University of Calgary's Ethics Committee was obtained from all subjects.

Kinematic, kinetic, pressure and EMG data were collected on the left foot of each subject while running barefoot and with the two different shoe conditions (a neutral shoe and a pronation control shoe). Kinetic data were collected with a Kistler force platform sampling at 2400 Hz. Kinematic data were collected simultaneously with the kinetic data using a Motion Analysis six video camera system at 240 Hz. Spherical reflective markers were placed on the thigh, shank and shoe for kinematic data collection. For the barefoot condition, markers were placed on the calcaneus. Pressure distribution data under the plantar surface of the left foot were collected with a PEDAR pressure insole system. Five steps were collected for each shoe condition at a frequency of 99 Hz. Pressure data were collected simultaneous to the kinematic and kinetic data. Electromyographical activity of the gastrocnemius, tibialis anterior, rectus femoris, vastus medialis and biceps femoris muscles were collected using a surface electrode EMG system. Skin preparation consisted of shaving the appropriate areas and treating with isopropyl alcohol wipes to ensure dead skin removal. Rectangular electrodes (40 x 20 mm) (Novotrode 20) were placed in the middle of the muscle bellies in an attempt to minimize cross-talk and remained in the same placement for data collection of all the conditions. Inter-electrode spacing was 22 mm and was accurate to ±1 mm as determined by the manufacturer. The signals were sampled at 2.4kHz.

The order of the shoes was randomly assigned and five running trials (4 ± 0.2 m/s) were collected for each shoe condition. The running speed of the subjects was monitored with photocells placed just before and just after the force plate. Prior to calculation of any variables a fourth-order low-pass Butterworth filter was used to filter the kinematic data (cutoff frequency of 12 Hz) and the kinetic data (cutoff frequency of 100 Hz). Rarely, trials were excluded on the basis of being extreme outliers due to difficulty in tracking. EMG data were filtered using a fourth-order Band-Pass Butterworth filter with cutoffs of 10 and 350 Hz. Analysis of the EMG data consisted of calculating the average root mean square for the activity of each muscle during five ground contacts.

RESULTS AND DISCUSSION

The results of this study indicate that females appear to be influenced by footwear differently than males. In general, female eversion was higher than male eversion when running barefoot (Figure 1). However, male eversion increased when running in a neutral shoe compared to barefoot while female eversion decreased under the same circumstances. The pronation control shoe had in the average a slightly positive influence on males, reducing eversion but a slightly negative influence on females, increasing eversion. Thus, pronation may be a different factor for males and females.

When further dividing gender according to self-selected pronation, it is evident that the largest positive effect of the pronation control shoe occurs for self-selected male pronators (Figure 2). Eversion is significantly reduced by 1.4° for this group. In contrast, the largest negative influence of the pronation control shoe occurs for the self-selected female pronators. Eversion increased by 1.1° for this group ($p=0.081$). Similar results were found when subjects were grouped according to either barefoot or shod eversion. Male pronators tended to have a reduction in peak eversion when wearing the pronation control shoe, although the differences were not significant. Female pronators tended to have an increase in peak eversion with the pronation control shoe ($p=0.108$ for shod pronators and $p=0.028$ for barefoot pronators). Thus, when considering self-selected pronators, the function of the pronation control shoe was reasonable for males but inappropriate for females.

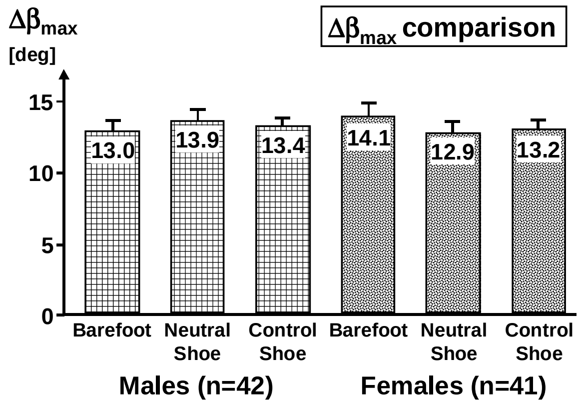

Figure 1: Change in maximal eversion during barefoot and shod running for both males and females for running in the neutral and pronation control shoes.

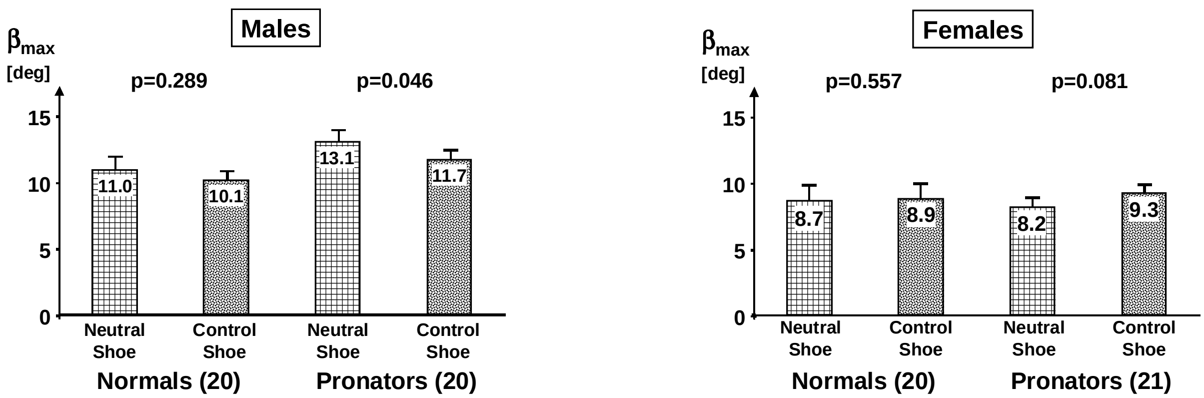

Figure 2: Male and female maximal shoe eversion when running in the neutral and pronation control shoes. Data are presented for self-selected normals and pronators.

The loading rate of the impact force was significantly higher for females than males in both shoes (Figure 3). There was no significant difference in the magnitude of the impact force between genders indicating that females experience the peak vertical ground reaction force sooner than males. This was an interesting result, since absolute magnitudes were compared. If the loading rates are normalized to body weight, the differences are even more dramatic since the average female mass was 63.6 kg and the average male mass was 74.5 kg. These results indicate that the tested footwear was too hard for females. The average subjective rating of heel cushioning supports this statement. Females indicated that they would prefer more cushioning in the heel region for both the neutral and pronation control shoe.

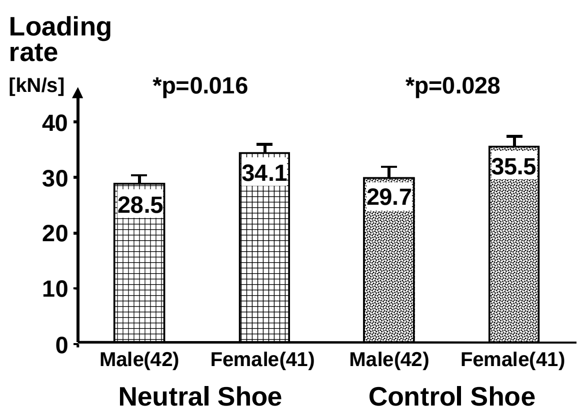

Figure 3: Male and female maximal impact force loading rate when running in the neutral and pronation control shoes.

ACKNOWLEDGEMENTS

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