INTRODUCTION

An increasing number of distance runners are transitioning to barefoot running, spurring research in this field. Barefoot running has been postulated to be potentially less injurious than shod running due to a shift to a more anterior initial contact, thereby reducing the magnitude of the ground reaction force (GRF) passive peak [2] and associated collision forces [1]. The purpose of this study was to challenge the prevailing paradigm that promotes barefoot running on the basis of an absence of the passive peak, and to characterize the GRF changes in barefoot running before and after exertion.

METHODS

Three habitually shod distance runners (Table 1) performed over-ground barefoot running at their self-selected speed, before and after exertion. All subjects included in the study ran a minimum of 12 kilometers (km) per week, and reported no significant injuries over the preceding 12 months. The exertion protocol was a barefoot run of 1.6 km at a self-selected speed, as suggested by Lieberman et al. (2010) when transitioning from shod to minimalistic footwear running [1].

Three-dimensional kinetics were recorded from force platforms (AMTI; Watertown, MA). The amplitude of the passive and active peaks from the vertical force, and braking and pushing peaks from the anterior-posterior force [2] were calculated and normalized to body weight (BW). Loading rate was quantified as the linear slope between initial loading (200 N) [1] and the passive peak, and is reported in body weight per second (BW s\(^{-1}\)). Percent change and the associated effect sizes (ES; Cohen’s \(d\)) between the two conditions are reported for the various measures.

RESULTS AND DISCUSSION

Intra-subject results are presented in Table 1.

Loading Rate

Following the exertion protocol, despite a reduction in running speed, all subjects demonstrated an increase (92-167%, ES 2.35) in loading rate (Fig. 1).

Vertical Forces

There was a marked decline (20-30%, ES 2.82) in the average passive peak vertical force post-exertion, and a decline in the vertical force subsequent to this passive peak (Fig. 1). There was also a reduction (1-9%, ES 0.93) in the average active vertical peak following the exertion protocol (Figs. 1 and 2).
Figure 2: Average braking, pushing, passive and active peaks, pre- and post-exertion.

Anterior-Posterior Forces

Following the exertion protocol, there was a decline in average braking (15-39%, ES 1.47) and pushing peaks (30-40%, ES 5.64) for all subjects (Figs. 2 and 3). This can likely be attributed to the reduction in running speed during the post-exertion condition, which would effectively reduce the magnitude of deceleration of the body at initial contact.

Figure 3: Representative anterior-posterior GRF curves pre- and post-exertion running at 5.1m s\(^{-1}\) and 3.7m s\(^{-1}\) respectively.

CONCLUSIONS

The most interesting finding from this preliminary investigation is that despite a reduction in running speed post-exertion, the loading rate increased in all subjects (Table 1). In contrast with previous studies that reported a reduced magnitude in the GRF following the passive peak [2] or elimination of the passive peak all together [1] during barefoot running, all subjects included in this study demonstrated two distinct peaks during the post-exertion condition. These findings will inform the design of expanded, controlled prospective studies, which are needed to better understand the effects of exertion on habitually shod individuals transitioning to barefoot running.

ACKNOWLEDGEMENTS

We acknowledge the guidance of Dr. Sean Yu in data analysis.

REFERENCES


Table 1: Demographic and ground reaction force characteristics of each subject included in the study

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Weight (kg)</th>
<th>Gender (M/F)</th>
<th>Condition</th>
<th>Speed (m/s)</th>
<th>Loading Rate (BW/s)</th>
<th>Passive Peak (BW)</th>
<th>Active Peak (BW)</th>
<th>Braking Peak (BW)</th>
<th>Pushing Peak (BW)</th>
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