THE INFLUENCE OF VARIATIONS IN SHOE MIDSOLE DENSITY ON THE IMPACT FORCE AND KINEMATICS OF LANDING IN FEMALE VOLLEYBALL PLAYERS

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INTRODUCTION

The primary purpose of an athletic shoe midsole is to protect the body from repeated impacts between the foot and the ground (Schwellnus, Jordan, & Noakes, 1990). Extensive research has been conducted on the effects of constructional changes in the midsole of running shoes (Barnes & Smith, 1993; Clarke, Frederick, & Cooper, 1983; Gerritsen, van den Bogert, & Nigg, 1995; Gillespie & Dickey, 2003; Lafortune, Hennig, & Lake, 1996; Nigg & Liu, 1999; Wright, Neptune, van Den Bogert, & Nigg, 1998). Running is a repetitive activity that allows athletes to get into a rhythm. When the midsole density of an athletic shoe is altered, a runner subconsciously responds to these differences by making kinematic adaptations after a series of repetitive and rhythmic gait cycles (Fuller, 1994). As a result research has indicated that impact forces during running remain constant regardless of the density of the midsole (Nigg & Segesser, 1992). There is, however, limited research determining what effect variations in midsole density will have on a non-repetitive activity that involved landing from a height. Therefore, the purpose of this study was to determine the influence of variations in athletic shoe midsole density on impact forces after landing from a volleyball spike approach jump.

METHODS

Twenty elite female NCAA volleyball athletes (age 21.1 ± 2.84 years; height 178 ± 3.81 cm; weight 72.82 ± 6.65 kg) were recruited to participate in this study. Subjects gave their informed consent and were randomly assigned to three shoe conditions: control midsole, soft midsole, and hard midsole. All shoes were the same in appearance and varied only in the density (durometer measurement) of the midsole (Table 1). For each of the athletic shoe midsole conditions, the subjects performed 10 successful volleyball approaches and spike jumps; landing onto two force platforms to measure impact forces (Figure 1). Ground reaction forces were sampled at 1500Hz using two AMTI force plates and all measurements were converted to bodyweights (BW). Kinematic data was collected simultaneously with the kinetic data using a six camera Motion Analysis system. All kinematic data was sampled at 120 Hz and low pass filtered at 10 Hz. A total of 27 retroflective markers were placed bilaterally on specific anatomical landmarks for data collection. Data was collected for each subject for a total of 30 trials (10 trials × 3 midsole conditions). A one-way repeated measures analysis of variance was used to compare the three different shoe conditions ($\alpha = .05$).

	Shoe Condition	Durometer
	Soft Midsole	45 Asker C
	Control Midsole	55 Asker C
	Hard Midsole	65 Asker C

Table 1: Shoe Midsole Condition

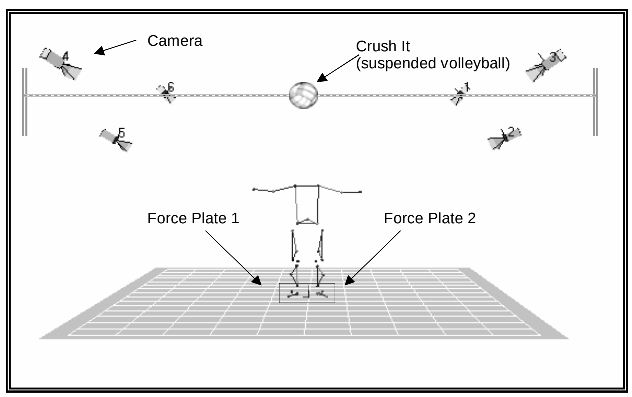


Figure 1: Experimental Set-up

RESULTS AND DISCUSSIONS

Peak vertical ground reaction forces:
Variations in athletic shoe midsole density did not significantly affect peak vertical ground reaction force (GRF) upon landing after a volleyball approach jump and spike (Figure 2). On average peak GRFs were 5 times bodyweight. As the midsole density increased vertical GRF did not significantly change. This response in GRF with changes in midsole density can be considered a neuromuscular adaptation. Jump height was measured during kinematic data collection and no significant differences were found in jump height (Figure 3). There were also no significant differences found between athletic shoe midsole densities for right or left loading rates.

Figure 2: Peak Vertical GRF

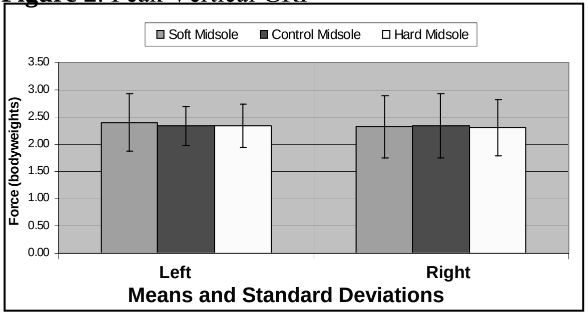
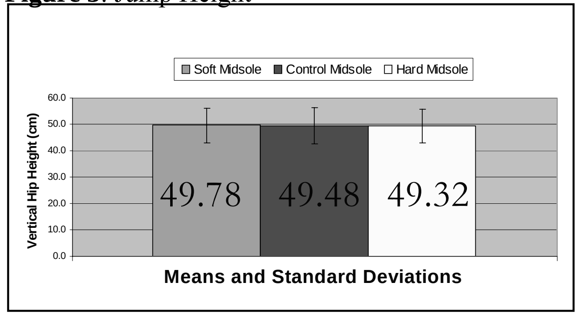


Figure 3: Jump Height



Angular displacements:

The angular displacement of interest at the ankle was plantarflexion and dorsiflexion. The angle at initial foot contact, peak vertical GRF, and maximum angular displacement were analyzed during the jump landing. No significant differences were identified for left or right ankle position at impact or maximum flexion angle. The kinematic data revealed a significant difference (p=.047) in right side ankle position at peak GRF. When wearing athletic shoes with the hard and control midsoles athletes decreased plantarflexion at peak GRF upon landing. No significant differences were indicated on the left side at peak GRF.

The angular displacement of interest at the left and right knee was flexion. No significant differences were identified for left or right flexion angle at initial foot contact, at peak vertical ground reaction force, and the maximum angular displacement was analyzed.

CONCLUSIONS

Variations in athletic shoe midsole density had no affect on peak vertical GRF upon landing. This result agrees with the current literature on variations in athletic shoe midsoles and running. Similarities in vertical GRF could not be explained kinematically. It is also possible that athletes adapt differently each time they land during non-rhythmic skills masking any changes in vertical GRF due to midsole density. It is possible that athletes may also use neuromuscular adaptations to account for changes in midsole density during impact. Further research is needed to sufficiently explain the role of athletic shoe midsole densities during non-rhythmic athletic activities.

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