A COMPARISON OF THE CUSHIONING EFFECT OF A POPULAR RUNNING SHOE AND A SHOE USING A NEW SPRING TECHNOLOGY DURING RUNNING

Mike Flores, M.S. and Darla R. Smith, Ph.D.

The University of Texas at El Paso, El Paso, Texas, USA

The purpose of the study was to compare the cushioning effect of the Nike Air Pegasus 2004 and the Spira Volare IITM during running. Measured variables were peak force, peak force relative to body weight and time-to-peak force. It was determined that time-to-peak force was not significantly different (p=0.1745) between the Spira and the Nike. There were significant differences found in peak force values (p=0.0184) with Nike exhibiting higher forces than Spira. Peak forces normalized to body weight exhibited a significant shoe by gender interaction (p=0.032). Further analysis revealed the Nike had significantly higher forces than the Spira for females (p=0.0048) but not for males (p=0.8544). It was concluded that the Spira Volare II is similar to the Nike Air Pegasus 2004 in time-to-peak force but significantly lower in peak forces, particularly for females.

KEY WORDS: peak force, time-to-peak force, shoe cushioning.

INTRODUCTION: Shoe construction plays a critical role in the comfort and the function of a shoe. The construction of a shoe can impact the forces on the tissues and joints of the lower body and therefore influence injury. For example, ground reaction forces during running can reach two to three times body weight (De Wit, De Clercq & Aerts, 2000). Shoe cushioning, a construction feature, has been found to decrease the amplitude of the vertical ground reaction force during impact (Nigg, Cole, Bruggemann, 1995). Shoe cushioning is determined by the amount of ground reaction force exhibited between the ground and shoe interface. It has been suggested that the key parameters in the evaluation of forces during running are peak force and time-to-peak force (Hamill, 1996).

Traditionally, running shoe soles have been constructed from materials such as ethyl vinyl acetate (EVA) or polyurethane. Shoe construction features have included many cushioning technologies such as encapsulated EVA, gel pads and other innovative force impact absorbing materials (Asplund & Brown, 2005). Newer technologies emphasize constructions such as rubber shock absorbers, air cells or springs embedded within shoe soles. Spira™ Inc. developed a shoe with a unique spring system technology called WaveSpringTM. The spring technology is relatively new as the first spring-shoes were introduced in El Paso, Texas in January 2002. Spira's innovative WaveSpringTM construction has been marketed to athletes and other consumers that spend extended periods standing and moving. However, to date only one study has tested the cushioning effect of the Spira (Flores & Smith, 2004).

A mechanical shoe-drop model was used to test the cushioning effect of the WaveSpringTM technology found in Spira's ShoeSpring SSR1TM. The Spira ShoeSpring SSR1TM and the Nike Air Pegasus 2003 were significantly lower in peak forces and significantly higher in time-to-peak force values compared to the Asics Gel-Nimbus III and the Adidas Ride. However, the Spira and Nike were not significantly different in either cushioning variable from each other (Flores & Smith, 2004).

The current study tested the Nike Air Pegasus 2004 and the Spira Volare IITM. The selection of the shoes was based on previous research results, the high popularity of the Nike Air Pegasus line and the new modification in the spring technology of the Spira. The purpose of the study was to compare the cushioning effect of the Nike Air Pegasus 2004 and the Spira Volare IITM during human running.

METHOD: Ten (5 female, 5 male) healthy and experienced runners volunteered to participate. Ground reaction forces were quantified using an AMTI force platform. Each subject was provided with a pair of Nike Air Pegasus 2004 and a pair of Spira Volare IITM running shoes.

The subjects were asked to complete 10 successful trials as close as possible to a target velocity of 4.5 m·s-1 (10.06 mph). The velocity range was set at ± 5% m·s-1 of the target velocity. Trials were accepted if the running velocity fell between 9.8 mph and 10.3 mph as measured by a radar gun. Previous studies have used a ± 5% m·s-1 velocity range when conducting human locomotion studies (McCaw, Heil & Hamill, 2000; Clarke, Frederick & Cooper, 1983).
The cushioning effect of each shoe was determined by measuring peak ground reaction force and time-to-peak force (McCaw, Heil & Hamill, 2000). Shoes that exhibited lower peak force and greater time-to-peak force were deemed to have a greater cushioning effect. For each trial, peak force and time-to-peak force values were averaged for each subject in both Spira Volare II and the Nike Air Pegasus 2004. The mean values of the ten trials for each shoe were compared on both cushioning variables using a general linear mixed model analyses for repeated measures with alpha set at 0.05. Additionally, the force variables were normalized to body weight for each participant and each shoe condition to determine any gender effect. Gender effect was examined using a general linear mixed model analysis with repeated measures with alpha set at 0.05.

RESULTS: The Spira Volare II exhibited significantly less force (Figure 1) than the Nike Air Pegasus 2004 (F=8.26, p=0.0184). Time-to-peak force was not significantly different between the Nike (77.8 ms) and the Spira (82.6 ms)(F=2.17, p=0.1745).

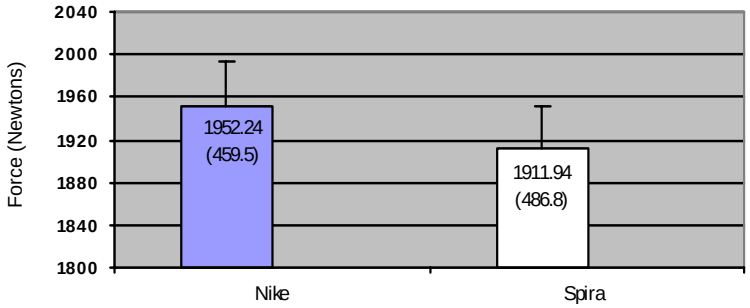

Figure 1. Mean (SD) Peak Force (Newtons)

Peak force normalized to body weight is presented in Figure 2. A significant shoe by gender interaction was found (p=0.0320). Further analysis revealed a significant difference between the Nike and the Spira for the females (p=0.0048) but not for the males (p=0.8544).

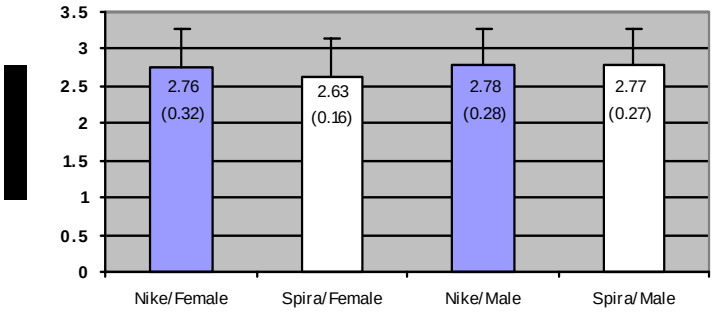

Figure 2. Means (SD) for Peak Force Normalized to Body Weight

DISCUSSION: The purpose of the study was to determine the peak force, peak force relative to body weight and time-to-peak force during running to evaluate the cushioning effect of the Nike Air Pegasus 2004 and the Spira Volare IITM. A significant difference (p=0.0184) was found in peak force between the WaveSpringTM technology of the Spira Volare II and the air

cell construction of the Nike Air Pegasus 2004 but there was no significant difference (p=0.1745) in time-to-peak force. The Nike Air Pegasus 2004 and the Spira Volare II exhibit two very different designs. Construction of the Nike Air Pegasus 2004 is similar to previous designs of the same model. The Spira Volare II underwent substantial modifications from previous ShoeSpring models. Changes to the Spira Volare's spring system that incorporates 3 springs (Figure 3) rather than 2 springs from previous models may have impacted the significantly lower peak force result (1911.94 N, SD=468.8) as compared to the Nike Air Pegasus 2004 (1952.24 N, SD=459.5). Peak force values were also normalized to body weight to determine gender effect. A significant shoe by gender interaction was found (p=0.0320). A significant difference in peak force per body weight was found between the Nike Air Pegasus 2004 and Spira Volare II for the females (p=0.0048) but not for the males (p=0.8544). Lower impact forces for female subjects may have resulted from a smaller body mass or the shoe's design.

Figure 3. Spira's WaveSpringTM Technology

CONCLUSION: Based on the results of the current study, the researchers conclude that the Spira Volare II is similar to the Nike Air Pegasus 2004 in time-to-peak force. The Spira Volare II appears to provide greater reduction of peak forces. The change in the Spira's construction may have impacted the significantly lower peak force result as compared to the Nike Air Pegasus 2004. Any cushioning advantage of the Spira over the Nike is apparently the result of either the design of the women's shoe or the lower impact forces exhibited by the smaller participants. The researchers concluded that the Spira Volare II is a reliable choice for improved cushioning in females based on lower peak force results.

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