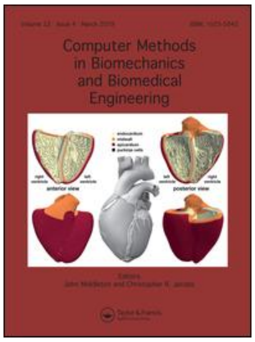

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Effects of shoe drop on running mechanics in women

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KEYWORDS Female; shoe-drop; running; kinematics; ground reaction force

1. Introduction

During the last decade, there has been an increasing enthusiasm in minimalist shoe trend. Consequently, many running shoes companies have promoted a lower drop of their shoes that could cause biomechanical running pattern transition toward a forefoot strike pattern. To date, several cross-sectional (Horvais and Samozino 2013; Chambon et al. 2015) and longitudinal (Malisoux et al. 2016) studies have focused on the combined effect or not of shoe drop and stack height at the heel. These studies showed considerable impacts on running kinematics and kinetics. Chambon et al. (2015) observed a strike pattern closer to forefoot strike at touchdown in the shoe version with 0 mm drop compared to 8 mm drop. Moreover, the shoe drop has recently been associated with injury risk (Malisoux et al. 2016). These authors reported that low-drop shoes were associated with a lower injury risk in occasional runners, while this shoe version was associated with a higher injury risk in regular runners. Most of the previous studies, however, were performed with male participants. Although it could be highlighted gender specificity, no study has compared the effects of shoe drop on running mechanics in female runners so far. Moreover, Kubo et al. (2003) revealed that women have lower stiffness and hysteresis of tendon structures than men. Therefore, the aim of this study was to investigate the effect of the shoe drop in female runners on the lower limb kinematics and kinetics.

2. Methods

2.1. Subjects

Fourteen healthy female recreational runners (21.4 ± 4.7 years, 164 ± 5 cm, 58.1 ± 6.5 kg) participated in the study.

2.2. Experimental set-up

After a 5 min warm-up with their personal running shoes, the preferential running speed of each participant was determined. Three conditions of shoe drop (D0, D6, and D10 mm respectively) were tested in randomized order. For each shoe condition, subjects were asked to perform 5 trials at her preferred speed along a 12 m runway in which 6 force platforms (Kistler, Winterhour, Switzerland) were embedded into the floor to measure ground force reaction at 2000 Hz. Running speed was checked with photocells. At the same time, 12 cameras of an optoelectronic motion capture system (Motion analysis corporation, Raptor 4, Santa Rosa, USA) tracked 20 reflective markers at 200 Hz to record kinematics of every trial. Ankle, knee, hip joints angles, net moments and ground reaction forces were computed with Visual3D software (C-Motion, Germantown, USA). Kinematics and force data were low-pass filtered at 30 Hz (4th order Butterworth) and 50 Hz (20th order critically damped) respectively. The adjusted Zatsiorsky-Seluyanov's anthropometric table was preferred to match female characteristics (de Leva 1996). Statistics were computed in Matlab (The Matworks, Natick, USA). Standard statistical methods were used to compute means and standard deviation of the parameters studied for each participant and each condition. Curve analyses, one dimensional statistical parametric mapping (SPM), of the whole kinematics and kinetics time series were performed (Pataky et al. 2015). SPM ANOVA followed by Bonferroni *post hoc*, were used with alpha maintained at 0.05 throughout.

3. Results and discussion

The kinematics results are summarized in the Table 1.

Foot/ground angle and ankle dorsiflexion angle showed lower values at touchdown during D0 condition compared to D6 and D10 ($p < 0.05$). Moreover, the SPM analysis showed that this difference was also present for both angles at the last 40% of the stance phase ($p < 0.001$). Concerning knee and hip joints angles there was no significant difference between the three conditions, neither

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Table 1. Mean values and standard deviations for all the experimental conditions.

	D0	D6	D10
Stance phase (ms)	272 ± 37	273 ± 36	272 ± 35
Foot/ground angle at TD (°)	15.8 ± 6.2	20.0 ± 6.1*	20.7 ± 6.4*
Dorsiflexion angle at TD (°)	5.8 ± 8.6	9.7 ± 7.5*	9.1 ± 7.5*
Knee flexion angle at TD (°)	−14.3 ± 3.7	−14.0 ± 3.8	−13.0 ± 3.9
Hip flexion angle at TD(°)	35.4 ± 7.2	35.7 ± 6.8	35.9 ± 6.6

*Indicates a significant difference with D0 condition. All significant effects were considered at $p < 0.05$. D0 : 0 mm drop condition, D6 : 6 mm drop condition, D10 : 10 mm drop condition; TD : touchdown.

at touchdown, nor during the stance phase. The present results are in agreement with a previous shoe drop study on men (Chambon et al. 2015). Moreover, these authors did not report any effect of the drop along the stance phase. Despite the stance phase duration was similar in all conditions, the antero-posterior ground reaction force was higher during the first part of the stance phase in D0 condition ($p < 0.001$). This was associated with a shorter braking phase ($p < 0.05$) and longer push-off phase ($p < 0.05$) in D0 compared to D6 and D10 conditions. Consequently, this result implies a quicker foot switch between the touchdown and push-off. Vertical ground reaction force exhibited higher values right after the transient peak between 16% and 27% of the stance phase in D0 condition compared to D6 and D10 conditions ($p < 0.01$). This result might be explained by a better tolerance to impact in D0 condition (Komi 2000).

Concerning joint moments, D0 showed an increased net joint ankle flexion moment during the braking phase ($p < 0.001$) and a reduced net knee flexion moment ($p < 0.001$) in the push-off phase compared to D6 and D10 conditions, (Figure 1). These observations are directly linked, so a shoe without drop seems to be interesting to attenuate knee strain at the expense of the ankle joint.

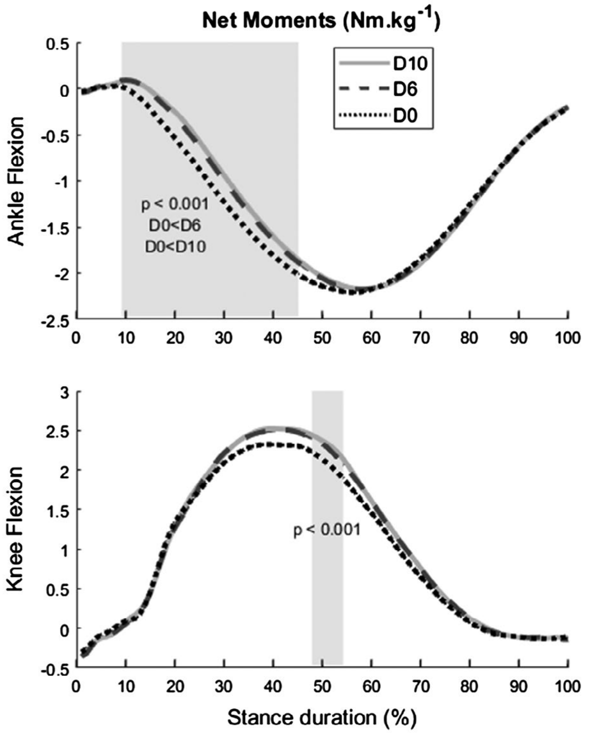

Figure 1. Ankle (top) and knee (bottom) net flexion moments normalized with the body mass and the stance duration during running with drop 0 mm (D0, dotted lines), drop 6 mm (D6, dashed lines) and drop 10 mm (D10, plain lines). Shade time periods represent significant differences (SPM ANOVA) between the three conditions.

4. Conclusions

As already observed in men, our results showed a significant effect of shoe drop on lower limb kinetics and kinematics in women runners. The present study brought new information concerning the influence of shoe drop on ankle and knee net flexion moments. Particularly, our findings indicated that a given shoe drop may be more adapted to minimize the net moment applied at a joint. For example, a higher drop could be interesting in women with stiff Achilles tendon like high-heeled wearers (Csapo et al. 2010), however, a shoe without drop could be a great alternative for women with knee pain or weakness.

References

Chambon N, Delattre N, Gueguen N, Berton E, Rao G. 2015. Shoe drop has opposite influence on running pattern when running overground or on a treadmill. Eur J Appl Physiol. 115(5):911–918.

Csapo R, Maganaris CN, Seynnes OR, Narici MV. 2010. On muscle, tendon and high heels. J Exp Biol. 213(15):2582–2588.

Horvais N, Samozino P. 2013. Effect of midsole geometry on footstrike pattern and running kinematics. Footwear Sci. 5(2):81–89.

Komi PV. 2000. Stretch-shortening cycle: a powerful model to study normal and fatigued muscle. J Biomech. 33(10):1197–1206.

Kubo K, Kanehisa H, Fukunaga T. 2003. Gender differences in the viscoelastic properties of tendon structures. Eur J Appl Physiol. 88:520–526.

de Leva P. 1996. Adjustments to Zatsiorsky-Seluyanov's segment inertia parameters. J Biomech. 29:1223–1230.

Malisoux L, Chambon N, Urhausen A, Theisen D. 2016. Influence of the heel-to-toe drop of standard cushioned running shoes on injury risk in leisure-time runners: a randomized controlled trial with 6-month follow-up. Am J Sports Med. 44(11):2933–2940.

Pataky TC, Vanrenterghem J, Robinson MA. 2015. Zero- vs. one dimensional, parametric vs. non-parametric, and confidence interval vs. hypothesis testing procedures in one-dimensional biomechanical trajectory analysis. J Biomech. 48:1277–1285.