SHOE MASS EFFECTS ON PERFORMANCE IN A COUNTER-MOVEMENT JUMP

John W. Whitting¹, Sandro R. Nigg¹, Elysia M. Davis², Benno M. Nigg¹
¹The Human Performance Laboratory, University of Calgary, Calgary, Canada. jwhitting@kin.ucalgary.ca
²adidas Innovation Team, adidas Ltd., Portland, U.S.A.

INTRODUCTION
Research has demonstrated that adding mass to a shoe can influence physiological performance during running [1,2]. However, there is no evidence with respect to the possible effects of additional shoe mass on performance in sports such as basketball, where jumping is an important and frequently performed activity [3]. Therefore, the purpose of this study was to determine the effects of different shoe masses on performance during a counter-movement jump (CMJ).

METHODS
The adizero crazy light basketball shoe was modified to have 3 different masses (350 g, 500 g and 650 g) for a size 12 US shoe. Kinematics (240 Hz; Motion Analysis Corporation, CA, USA) and ground reaction forces (2400 Hz; Kistler Instrumente AG Winterthur, Switzerland) were captured while 11 male basketball players performed 30 CMJ trials on 2 separate days in each of the shoe conditions. Performance was determined by calculating peak jump height using an approximated center of mass position (KinTrak, Human Performance Laboratory, AB, Canada). Additionally, peak knee and ankle joint powers were calculated. Shoes were put on the athlete’s feet by a research assistant. However, subjects were asked to subjectively rate the shoes according to their perception of shoe mass. A 2-way repeated measures ANOVA was used to determine if there were any main effects of shoe mass on performance for all data sets. A 3-way repeated measures ANOVA was used to find possible effects of shoe mass on performance when subjects were in a non-fatigued (NF: trials 1 to 5) and a fatigued (F: trials 26 to 30) state. Where appropriate, post-hoc t-tests were performed and all statistical analyses were conducted using IBM SPSS statistics (Version 19.0; SPSS Inc., IL, USA), with an alpha level set at 0.05.

RESULTS
The results demonstrated significant main effects of shoe mass on peak ankle joint power and peak jump height (Figure 1, jump height overall; Table 1, ankle joint power and jump height in NF and F states). There was also a significant main effect of fatigue state, indicating a reduction in performance for all variables at the end of the 30 trial sets. Post-hoc analyses also revealed that peak ankle joint power and peak jump height were significantly lower in the heavy shoe, compared to the light and medium shoes, overall and in each of the fatigue states. There were no significant differences between the medium and the light shoe mass conditions. Additionally, there were no significant differences between shoe conditions for any subjective ratings of shoe mass.

DISCUSSION AND CONCLUSIONS
No difference was observed in jump height between the light and medium shoe conditions, although jump height was significantly lower in the heavy shoe condition. Interestingly, peak ankle joint power was also significantly lower for the heavy shoe condition, indicating a possible effect on jump height. These findings were consistent for all analyses and were independent of fatigue. Furthermore, CMJ performance was not influenced by subjective perceptions of shoe mass as subjects were unable to perceive differences in mass. Therefore, it is speculated that extreme light shoes may not have a significant influence on performance in basketball jumping, while shoes that are too heavy may be detrimental.

REFERENCES

ACKNOWLEDGEMENTS
The authors acknowledge adidas for providing shoes and financial support for this study.

Table 1: Mean (± SD) data for peak ankle joint power and peak jump height during the non-fatigued (trials 1 to 5) and fatigued (trials 26 to 30) states (n = 11). * Significantly different to light and medium conditions (p < 0.05).

<table>
<thead>
<tr>
<th>Shoe mass condition</th>
<th>Peak ankle joint power [W/kg]</th>
<th>Peak jump height [cm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-fatigued</td>
<td>Fatigued</td>
</tr>
<tr>
<td>Light (350 g)</td>
<td>1.23 (0.03)</td>
<td>1.08 (0.03)</td>
</tr>
<tr>
<td>Medium (500 g)</td>
<td>1.26 (0.04)</td>
<td>1.09 (0.03)</td>
</tr>
<tr>
<td>Heavy (650 g)</td>
<td>1.19 (0.03)*</td>
<td>1.01 (0.03)*</td>
</tr>
</tbody>
</table>

Figure 1: Means (± SD) for peak jump height across all 30 CMJ trials in each shoe mass condition on 2 test days (n = 11).