The purpose of this study was to investigate the differences between the minimally restrict natural foot movement. New designs of minimalist footwear (Huaraches) have been developed (Fig. 1). These designs have been identified as causing adaptation in running style resulting in a more midfoot running (Morio et al., 2009). Running barefoot compared to shod has been identified as causing adaptation in running style resulting in a more midfoot footfall compared to heel striking in shod conditions (Hamill et al., 2005). A new design of minimalist footwear (Huaraches) have been developed (Fig. 3) with minimum cushioning (4mm tread) and string uppers designed to minimally restrict natural foot movement.

**PURPOSE**

The purpose of this study was to investigate the differences between the main COP variables measured in barefoot (BF), Huaraches (Hu) and typical running shoes (TRS) during running (Fig. 3).

**METHODOLOGY**

Seventeen healthy female participants were examined (aged 21.2±2.3 years, height 165.4±5.6 cm, mass 66.9±9.5 kg, foot size 6.8±1.0 UK). Participants performed five footfalls in each footwear condition (Barefoot, Huaraches and TRS) at a controlled speed of 12km/h±10% over a footscan pressure plate (RedScan International, 1mx0.4m, 8192 sensors) (Fig. 1). Trials were not accepted if the controlled speeds were not met. COP data was collected at 500Hz and various times (Initial Metatarsal contact (IMC), initial forefoot flat contact (IFFC) and heel off (HO)) during foot to ground contact were identified (Fig. 2). anterior-posterior and medial-lateral displacement and velocity data were calculated at these time points (Willems et al., 2005).

**RESULTS**

The results demonstrated that significant differences (P<0.05) were found between the TRS and both the BF conditions (IMC, IFCV time, IMC, IFFC & HO VEL X) and the Hu conditions (IMC, IFCV time, IFCV & HO VEL X). No significant differences between the BF and Hu were reported (Table 1) suggesting similar COP movements under the plantar region of the feet in both conditions.

**DISCUSSION**

The significant differences in the IMC and IFFC time variables (P<0.05) between the TRS compared to the BF and Hu conditions, suggest a flatter foot placement (in BF and Hu) as previously reported in barefoot compared to shod conditions (De Wit et al., 2000).

As highlighted in Fig. 4, the COP for the BF and Hu shoes tend to demonstrate a more laterally positioned COP. This is confirmed with a significantly (P<0.05) more medially placed COP in the TRS conditions compared to the BF conditions (IMC, IFCV & HO VEL X) and Hu conditions (IFFC & HO VEL X).

The similar results found throughout the BF and Hu conditions suggest that any potential health benefits that may be prevalent in barefoot running (Leberman et al., 2010) may be achieved in minimalist footwear of this type of design.

**CONCLUSION**

The results of this study suggest that the Hu shoe offers the protection of a shoe outsole whilst minimising the changes in COP variables identified previously as being identifiers of risk factor for the aetiology of exercise induced lower leg injuries (Willems et al., 2005).

**FUTURE RESEARCH**

Previous research has suggested that the thickness of cushioning in running shoes may not have a significant effect on loading characteristics (Hamill et al., 2011) during foot to ground impact. The Hu design of shoe is available in different sole thickness. Testing if similar effects of sole thickness are observed in this design of shoe warrant investigation to identify an optimum design for a general population.

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**Table 1: Means and standard deviations of centre of pressure variables. **

<table>
<thead>
<tr>
<th>Footwear Condition</th>
<th>IMC time (ms)</th>
<th>IFFC time (ms)</th>
<th>HO time (ms)</th>
<th>IMC X-comp (%)</th>
<th>IFX X-comp (%)</th>
<th>HO X-comp (%)</th>
<th>IMC VEL X (%/ms)</th>
<th>IFFC VEL X (%/ms)</th>
<th>HO VEL X (%/ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barefoot</td>
<td>13.5±5.5</td>
<td>20.6±8.2</td>
<td>120.6±21</td>
<td>11.2±8.7</td>
<td>11±6.3</td>
<td>4.2±3.6</td>
<td>0.089±.69</td>
<td>-25.33</td>
<td>-25.08</td>
</tr>
<tr>
<td>Huarache</td>
<td>13.1±4.4</td>
<td>24.7±11</td>
<td>125.9±18.6</td>
<td>12.3±6.8</td>
<td>4.9±2.7</td>
<td>1.7±3.4</td>
<td>0.057±.68</td>
<td>-159±28</td>
<td>-159±067</td>
</tr>
<tr>
<td>TRS</td>
<td>31.4±11.5</td>
<td>41.4±14.4</td>
<td>129.5±28.8</td>
<td>-0.159†</td>
<td>4.4†</td>
<td>4.4†</td>
<td>-0.32†</td>
<td>-320±38</td>
<td>31.4±0.39†</td>
</tr>
</tbody>
</table>

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**REFERENCES**


