# THE TRAJECTORY OF THE CENTRE OF PRESSURE DURING RUNNING IN BAREFOOT, MINIMALIST FOOTWEAR AND TRADITIONAL RUNNING SHOE CONDITIONS IN FEMALES



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#### INTRODUCTION

Centre of pressure (COP) variables recorded during running have been identified as indicators of exercise induced lower leg injuries (Willems et al., 2005). Footwear has been identified as a potential restriction to the freedom of movement and flexibility that can be achieved in comparison to barefoot 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

RS scan machine laptop (2 power points needed)

amera c floor

Timing gates on tripoda

The purpose of this study was to investigate the differences between the main COP variables measured in barefoot (BF), Huaraches 4mm (Hu4) and typical running shoes (TRS) during running (Fig. 3).

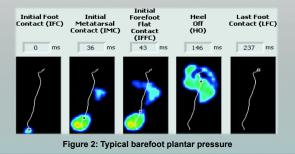
16m 10cm

Mat at end of corridor

Figure 1: Lab setup

# METHOD

Seventeen healthy female participants were examined (aged 21.2±2.3years, 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 (RsScan 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).

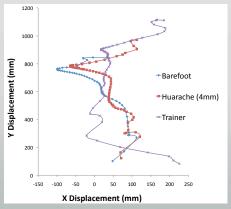


## STATISTICAL ANALYSIS

Repeated measures ANOVA were used to determine the differences between footwear conditions. COP displacement and velocity values were normalised to a percentage of foot width and length. Post-hoc analyses were conducted using a Bonferroni correction to control type I error (Table1).



Figure 3: Dorsal and lateral aspect of the Huarache minimalist footwear with a 4mm tread and the standard Airtech running trainer



#### Figure 4: Typical centre of pressure paths for a single participant

#### RESULTS

The results demonstrated that significant differences (P<0.05) were found between the TRS and both the BF conditions (IMC, IFC time, IMC, IFFC & HO X-comp & HO VEL X) and the Hu conditions (IMC, IFC time, IFFC & HO X-comp & 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.

Table 1: Means and standard deviations of centre of pressure variables. +=Significantly different (P<0.05) from Barefoot, ¥=Significantly different (P<0.05) from Huarache, %=Percentage of foot width

Footwear Condition	Barefoot	Huarache	TRS
IMC time (ms)	13.5+5.5	13.1 <u>+</u> 4.4	31.4 <u>+</u> 11.5†¥
IFFC time (ms)	20.6+8.2	24.7 <u>+</u> 11	41.4 <u>+</u> 14.4†¥
HO time (ms)	120.6+21	125.9 <u>+</u> 18.6	129.5 <u>+</u> 28.8
IMC X-comp (%)	11.2+8.7	10.1 <u>+</u> 10.3	6.1 <u>+</u> 7.3†
IFFC X-comp (%)	11+6.3	12.3 <u>+</u> 6.8	4.6 <u>+</u> 5.7†¥
HO X-comp (%)	4.2+3.6	4.9 <u>+</u> 2.7	1.7 <u>+</u> 3.4†¥
IMC VEL X (%/ms)	.089+.69	.0578 <u>+</u> .66	124 <u>+</u> .58
IFFC VEL X (%/ms)	25+.33	159 <u>+</u> .28	320 <u>+</u> .38
HO VEL X (%/ms)	25+.08	159 <u>+</u> .067	.32 <u>+</u> .093†¥

#### 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 BF conditions (IMC, IFFC & HO X-comp) and Hu conditions (IFFC & HO X-comp).

The similar results found throughout between the BF and Hu conditions suggest that any potential health benefits that may be prevalent in barefoot running (Lieberman 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 out-sole 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.

#### REFERENCES

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