

ACUTE DIFFERENCES IN SAGITTAL PLANE LOWER LIMB KINEMATICS BETWEEN BAREFOOT, MINIMALISTIC SHOES, AND SHOD RUNNING IN MALE ATHLETES

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INTRODUCTION

It has been suggested that running barefoot (BF) can be viewed as a condition where both external protection as well as shock reduction is at a minimum, and as a result, changes in running style could be expected compared to when running shod (SH) [1, 2]. Several authors have revealed changes such as greater knee flexion and less dorsiflexion at footstrike while running BF compared to SH [1, 4, 5]. This greater knee flexion may be an effort to decrease excessive impact forces and the potential for injury [6]. As yet few studies have examined the sagittal plane lower limb kinematics while running in minimalist footwear (MF) [3, 4]. Therefore, the purpose of this study was to determine acute changes in knee and ankle sagittal plane kinematics, as well as spatio-temporal variables at footstrike when habitually SH runners change to BF and MF running. More specifically, we wanted to determine whether MF running was effective in mimicking BF running from a kinematic standpoint.

METHODS

Twelve habitually shod, recreational male runners (Age 21.58 ± 1.26 yrs, height 180 ± 5 cm, weight 77.2 ± 10.4 kg) performed six running trials in each running condition (BF, SH and MF) in randomized order, on a 12 m indoor runway at a self-selected pace. The mean self-selected running speed of the subjects at footstrike was 3.63 ± 0.08 m.s⁻¹ (Table 1). Rest periods between running conditions were 3 minutes. Lower limb kinematic variables were recorded simultaneously using a six-camera T10 Vicon motion capture system (200Hz). 22 reflective body markers (14mm) defined the 3D kinematics of the pelvis, left and right thighs, shanks, and feet. Marker placement was unchanged between the running conditions. Each subject was given a new pair of Vibram FiveFingers® (sprint model) shortly prior to testing, while subjects ran in their own shoes for the SH trials. Group differences were examined with ANOVA for repeated measures for followed by post hoc Scheffe analysis.

RESULTS AND DISCUSSION

No significant differences in knee and ankle sagittal plane kinematics at footstrike were observed between BF and MF running ($P > 0.05$) (Figure 1). Greater knee flexion at footstrike was found in the BF and MF running conditions compared to SH ($P < 0.01$), ($P < 0.01$). However, greater ankle dorsiflexion at footstrike was observed only when running BF compared SH ($P < 0.05$). This finding suggests that sagittal plane motion at the ankle at footstrike in MF running serves as an intermediate between BF and SH running.

Contact time (s) with ground was significantly shorter in both the BF and MF conditions compared to the SH condition ($P < 0.001$), ($P < 0.01$) (Table 1.) In contrast,

step frequency (steps.min⁻¹) was found to be significantly higher in the BF condition compared to SH ($P < 0.05$).

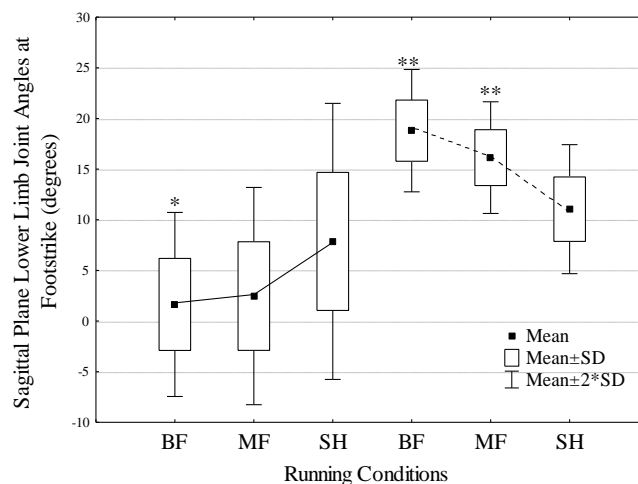


Figure 1. Sagittal Plane Lower Limb Joint Angles at Footstrike between Running Conditions. Positive angles indicate Ankle Dorsiflexion (—) and Knee Flexion (- - -) angles respectively. */ ** statistical difference from SH ($P < 0.05$)/ ($P < 0.01$)

CONCLUSION

It appears that immediate adaptations would occur to lower limb kinematics in the sagittal plane when transitioning from SH running to either BF or MF running. The non significant differences in knee flexion and ankle dorsiflexion at footstrike imply that MF seems to be effective in mimicking the BF condition with respect to the sagittal plane. Changes observed in step kinematics with BF and MF running may be due to changes in touchdown geometry and the consequent joint movements which occur at footstrike.

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Table 1. ANOVA results for knee and ankle joint kinematics (degrees) as well as spatio-temporal variables at footstrike between three running conditions BF: Barefoot, MF: Minimalistic Footwear, and SH: Shod. Shown are the means \pm SD. * / **Statistically significant difference from shod ($P < 0.05$)/($P < 0.01$)

Variable	BF	MF	SH
Knee Flexion ($^{\circ}$)	18.79 \pm 3.02**	16.14 \pm 2.76**	11.05 \pm 3.18
Ankle Dorsiflexion ($^{\circ}$)	1.64 \pm 4.54*	2.47 \pm 5.36	7.87 \pm 6.81
Contact Time (s)	0.210 \pm 0.02**	0.218 \pm 0.02**	0.246 \pm 0.02
Step Frequency (steps.min ⁻¹)	170.42 \pm 8.83*	165.27 \pm 5.71	161 \pm 6.09
Self-selected Running Speed (m/s ⁻¹)	3.64 \pm 0.26	3.73 \pm 0.34	3.53 \pm 0.42

