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Introduction

Recreational running is a popular recreational activity often used to improve health and well-being of the participants. Sustaining injuries that stop people from running can therefore be detrimental. One of the most prevalent overuse injuries in recreational running populations (Chang et al., 2012; Ellapen et al., 2013) has been reported as patellofemoral pain which is a result of the pressure experienced between the posterior surface of the patella and the anterior distal aspect of the femur.

Footwear designers have attempted to develop shoes to reduce rate of injuries in populations. One such design is a heelless shoe that appears to adjust the footstrike pattern of the participant during running (Sinclair et al., 2014). Such adaptation to movement may influence knee joint kinetics and kinematics altering the pressure between the patella and the femur.

Purpose of the study

The purpose of this study was to test if running in heelless shoes compared to conventional running shoes will significantly affect the patella contact loading.

Methods

Participants

Twelve male runners (age 27.22 ± 4.76 years, height 1.79 ± 0.09 m and body mass 78.65 ± 8.26 kg, shoe size 8-10 UK) consented to take part in this study.

Participants ran at 4.0 $m.s^{-1}$ ±5% over an embedded force platform (Kistler National Instruments, Model 9281CA) sampling at 1000Hz with their right foot (Sinclair et al., 2014). Running velocity was quantified using timing gates. Runners completed five successful trials in each footwear condition (Saucony pro grid guide II and heelless (Healus™)).

Kinematic data was captured at 250 Hz via an eight camera motion analysis system (Qualisys). To model the body extremity segments in six degrees of freedom the calibrated anatomical systems technique was used (Cappozzo et al., 1995).

Ground reaction force and marker trajectories were filtered at 50 and 12 Hz respectively using a low pass Butterworth 4th order zero-lag filter and analysed using Visual 3D software (C-Motion) .

Patellofemoral contact force (PCF) (B.W) was estimated through the biomechanical model of Ho et al., (2012) using knee flexion angle (KFA) and knee extensor moment (KXT). The moment arm of the quadriceps was calculated using a non-linear equation, based on cadaveric information presented by van Eijden et al., (1986). PCF was estimated using the Quadriceps force and a constant which was described in relation to KFA using a curve fitting technique based on the non-linear equation described by Eijden et al., (1986). Patellofemoral pressure (PP) (MPa) was calculated using the PCF divided by the patellofemoral contact area (Ho et al., 2012),

Differences in knee loading parameters between the two footwear conditions were examined using repeated measures ANOVA (alpha = 0.05).

Results

Table 1 presents the knee kinetic variables obtained as a function of footwear. The results indicate that when compared to a conventional footwear (control shoe), running in the heelless footwear significantly reduces the knee loading parameters.

Table 1: Knee joint kinetics (Means ± standard deviations) as a function of footwear.

	Conventional		Heelless		
	Mean	***SD***	***Mean***	***SD***	
Peak KXT (Nm.kg)	3.15	0.64	2.98	0.59	*
Peak PCF (B.W)	4.25	0.99	4.04	0.87	*
Peak PP (MPa)	13.41	2.66	12.85	2.51	*

Notes: * = Significant difference

The results show that peak KXT was significantly higher ($p \leq 0.05$, $\eta2=0.52$) in the conventional footwear compared to Heelless. Similarly, peak PCF ($p \leq 0.05$, $\eta2=0.40$) and PP ($p \leq 0.05$, $\eta2=0.39$) were also shown to be significantly greater in the conventional footwear.

Discussion and conclusion

The results of this study suggest that the heelless running shoes may reduce the likelihood of athletes sustaining discomfort and overuse injuries at the patellofemoral joint. It should be noted that whilst a reduction in susceptibility to injury appears to be prevalent in the results of this research, longitudinal studies on the effects of such footwear use are warranted. Alteration of knee joint kinetics may influence the kinetic chain and loading of the musculoskeletal system in other areas thus a holistic approach to footwear choice is warranted. However for athletes with a history of knee pain the heelless footwear may warrant selection over conventional footwear.

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