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SWEAT DISTRIBUTION AND PERCEIVED WETNESS ACROSS THE HUMAN FOOT

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Keywords: Intra-regional sweating; feet; sweat mapping; exercise; footwear comfort.

Introduction

Investigations of intra-segmental sweat distribution at the foot consistently report sweat rates to be greatest from the dorsal surface compared to the plantar surface (~70% and ~30% respectively) (1,2). However, detailed comparisons of foot sweat rates from existing literature are difficult due to differing ambient temperatures, heating techniques, exercise modes and socks/footwear used. In addition, the relationship between sweating on the foot and perceived skin wetness is unknown. This study investigated regional foot sweat distribution to aid footwear design and assessed the relationship between sweat distribution and perceived wetness.

Methods

14 trained female runners performed 60 minutes of treadmill running with ambient conditions of 25°C, 50% RH. 35 minutes of running were performed at a low intensity (55% maximal heart rate) followed by 25 minutes at a higher intensity (75% maximal heart rate). Sweat rates from the right foot were measured at 14 zones using technical absorbent material and a 100% cotton sock applied during the last 5 minutes of each work intensity. Local sweat rates were derived from changes in pad mass. Infrared images pre and post pad application were recorded to evaluate local and mean foot skin temperature. Wetness perception was assessed prior to pad application. Participants exercised in standardised clothing, socks and running shoes.

Results

Heart rates averaged 134 ± 3 bpm and 157 ± 2 bpm during low and high exercise intensities respectively. Corresponding core temperatures were $37.8 \pm 0.2^\circ\text{C}$ and $38.2 \pm 0.3^\circ\text{C}$. Participants presented evidence for a non-uniform distribution of sweating on the foot. Highest local sweat rates were observed from the medial ankle, medial dorsal and central dorsal. Lowest local sweat rates were observed from the toes. Sweat rate significantly decreased with exercise intensity at the arch, ball and outer foot regions ($p < 0.05$). Participants sensed differences in wetness at different zones (dorsal, toes, heel, sole; $p < 0.01$) with wetness perception increasing significantly with exercise intensity ($p < 0.05$). Despite the toes having the lowest sweat rates, they were perceived as being one of the wettest zones during both exercise intensities.

Conclusion

The present study provides a detailed view of sweating across the foot surface for trained female runners. In accordance with previous studies, sweat rates were greater from the dorsal surface compared to the plantar surface. Perceptions of wetness increased with exercise intensity across all zones but sensations of wetness did not correspond with areas of high

sweat production. It is important to consider that footwear comfort may not be dominated by a single zone and possibly not the zone with the highest sweat production.

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