

MEETING ABSTRACT

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# Effects of sweating on distal skin temperature prediction during walking

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From 15th International Conference on Environmental Ergonomics (ICEE XV)  
Portsmouth, UK. 28 June - 3 July 2015

## Introduction

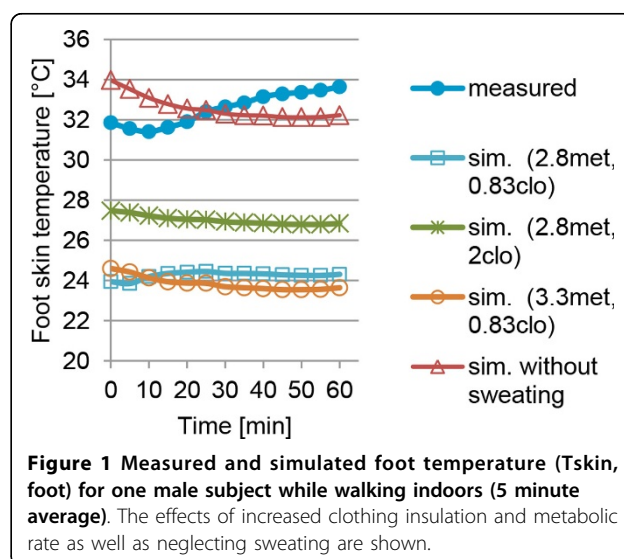
Thermal sensation models require a high quality prediction of local skin temperatures ( $T_{skin,x}$ ) from thermoregulation models. However, most thermoregulation models are validated for  $T_{skin,mean}$  under laboratory setting. The objective of this study is to investigate the challenges of simulating distal skin temperatures  $T_{skin,distal}$  during walking.

## Methods

For this study, the skin temperature ( $T_{skin}$ ) of human subjects (4 males, 2 females) is measured at 15 sites (locations according to [1] plus fingertip) while walking indoors (2.8 met). The subjects wear an everyday outfit consisting of underwear, jeans, T-shirt, long-sleeved shirt, socks and shoes (0.8 clo) [2]. The temperature is recorded every 60 seconds during a one hour experiment. The measured data is then compared to the computed  $T_{skin,x}$  of the mathematical thermoregulation model ThermoSEM [3].

## Results

The computed  $T_{skin,mean}$  are within 2 °C of the measured temperatures. The measured  $T_{skin,foot}$  range from 29 °C to 34 °C for all subjects with an increase of 2-3 °C in the course of one hour walking. The computed  $T_{skin,foot}$  largely underestimate the measured values by 4 to 9 °C (Figure 1, light blue squares). For  $T_{skin,hand}$  it differs only 1 to 4 °C. The clothing insulation and metabolic activity are estimates and might differ from reality. By raising the clothing insulation at the foot to a maximal measured value of 2 clo (see [2]) the computed temperatures increase by 3 °C (Figure 1, green crosses). The increase of metabolic rate leads to slightly lower computed



**Figure 1** Measured and simulated foot temperature ( $T_{skin,foot}$ ) for one male subject while walking indoors (5 minute average). The effects of increased clothing insulation and metabolic rate as well as neglecting sweating are shown.

$T_{skin,foot}$  (Figure 1, orange circles). Lower  $T_{skin,foot}$  at increased metabolic rate is due to evaporative heat losses over the entire body because of sweating. If the sweating is neglected in the model, the computed and measured results are in better agreement (Figure 1, red triangles).

## Discussion

Even though the exclusion of sweating leads to improved results for  $T_{skin,foot}$  the main issue is the latent heat transport from the foot skin surface to the environment. The current clothing model only includes a total evaporative resistance taken from [4] due to the absence of studies on detailed local evaporative resistances. Therefore new experiments on local (evaporative) clothing resistances are needed.

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## Conclusions

In order to account for the reduced heat losses when wearing vapour resistant clothing (e.g. shoes), clothing models should differ between sensible and latent heat transport from the skin to the clothing and from the clothing to the environment. Furthermore, experiments are required to quantify the local evaporative resistances more accurately.

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Published: 14 September 2015

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doi:10.1186/2046-7648-4-S1-A31

Cite this article as: Veselá *et al*: Effects of sweating on distal skin temperature prediction during walking. *Extreme Physiology & Medicine* 2015 **4**(Suppl 1):A31.

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