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PO Box 117
221 00 Lund
+46 46-222 00 00

Cold induced vasodilation during continuous exercise in the extreme cold air (– 30.6 °C)

Chuansi Gao^{1*}, Li-Yen Lin², Amitava Halder¹, Kalev Kuklane¹

¹Thermal Environment Laboratory, Department of Design Sciences, Lund University, Box 118, 221 00 Lund, Sweden

²Department of Testing and Certification, Taiwan Textile Research Institute (TTRI), New Taipei, 23674, Taiwan

Introduction

Cold induced vasodilation (CIVD) in previous studies was mostly evoked by cold water immersion at 0, 5, and 8 °C of the upper or lower extremities without performing physical work.

The objective of this study was to investigate individual variations of finger CIVD in relation to the core and mean skin temperatures during continuous exercise in the extreme cold air (-30.6 °C).

Methods

Four young and healthy male subjects wore cold protective clothing ($I_{cl} = 1.89$ clo) and walked at 4 MET (232.8 W/m²) on a treadmill in a climatic chamber ($T_a = -30.6$ °C, $V_a = 0.4$ m/s) for 90 min (Fig. 1).

The rectal and little finger temperatures were measured. The mean skin temperature (T_{sk}) was calculated below.

$$T_{sk} = 0.07 (T_{forehead} + T_{upperarm} + T_{forearm}) + 0.175 (T_{chest} + T_{scapula}) + 0.05 T_{hand} + 0.19 T_{thigh} + 0.20 T_{calf}$$

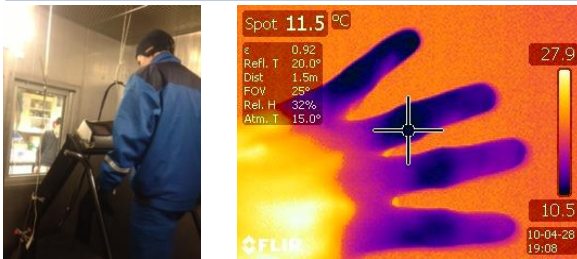


Figure 1. A subject walking in the climatic chamber

Table 1. Finger CIVD

	Mean	SD
Onset time (min)	14.6	3.5
T_{min} (°C)	3.8	3.4
T_{max} (°C)	16.5	3.6
T_{finger_mean} (°C)	7.9	1.4
Amplitude ($T_{max} - T_{min}$)	12.7	4.4
Frequency (number of waves)	7.5	4.7

Results

CIVD in the little finger occurred when the subjects' rectal temperatures (T_{re}) were relatively stable in the range of 37.1 – 38.1 °C and the T_{sk} in the range of 32.0 – 25.3 °C.

Within these ranges, periodical responses of the finger CIVD were not dependent on the T_{re} and T_{sk} changes (Table 1 and Fig. 2-5).

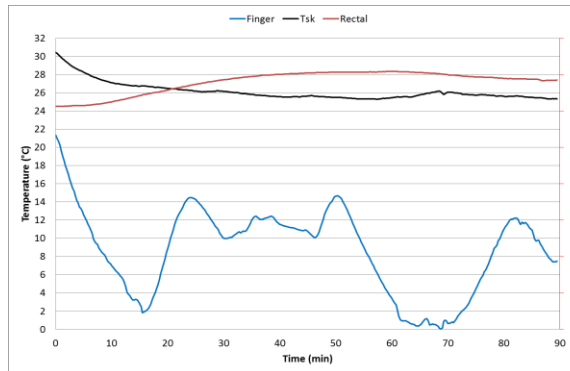


Figure 2. Finger, mean skin and rectal temperatures, S1

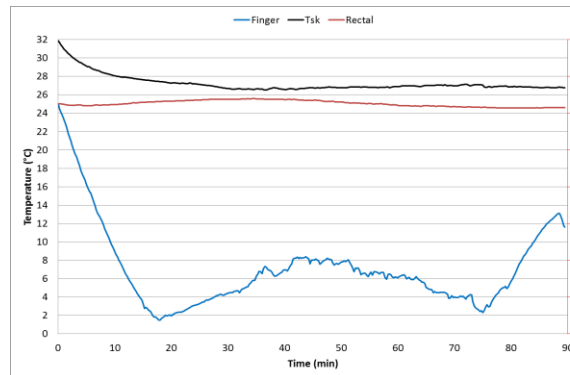


Figure 3. Finger, mean skin and rectal temperatures, S2

Conclusions

The finger CIVD varies from individual to individual. Its occurrence is not dependent on T_{re} and T_{sk} changes within the T_{re} and T_{sk} ranges (37.1 – 38.1 °C and 32.0 – 25.3 °C), but it is associated with the local cooling of the extremities during continuous 90 min walking at 4 MET in the extreme cold air (-30.6 °C).

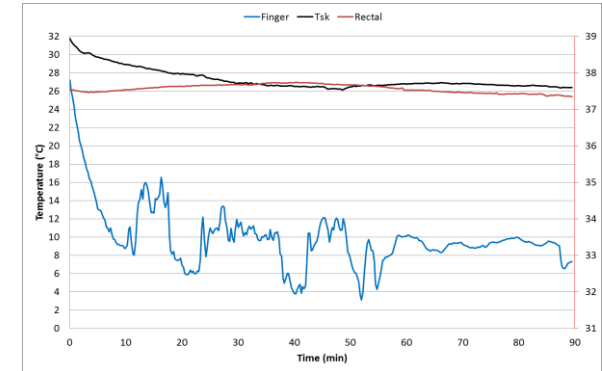


Figure 4. Finger, mean skin and rectal temperatures, S3

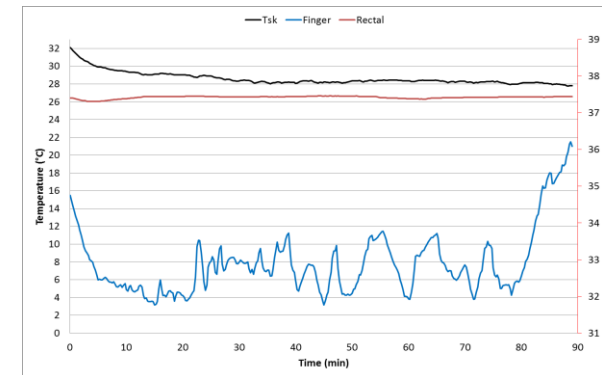


Figure 5. Finger, mean skin and rectal temperatures, S4

*Corresponding author

Email: Chuansi.Gao@design.lth.se



References

- [1] Daanen H.A.M., 2003. Finger cold-induced vasodilation: a review. *Eur J Appl Physiol*, 89:411-426.
- [2] Flours A.D., Westwood D.A., Mekjavic I.B., Cheung S.S., 2008. Effect of body temperature on cold induced vasodilation. *Eur J Appl Physiol*, 104:491-499.
- [3] Daanen H.A.M., Wammes L.J.A., Lotens W.A. (1992) The threshold in esophageal temperature for hand blood flow. In: Proceedings of the fifth international conference Environmental Ergonomics, Maastricht, pp 222-225.
- [4] Cheung S.S., Mekjavic I.B., 2007. Cold-induced vasodilation is not homogenous or generalizable across the hand and feet. *Eur J Appl Physiol*, 99:701-705.
- [5] Gao, C., Lin, L., Halder, A., Kuklane, K., Holmér, I., 2015. Validation of ASTM standard F2732 and comparison with ISO 11079 with respect to temperature ratings for cold weather protective clothing. *Applied Ergonomics*, 46, 44-53.