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

Gao, Chuansi; Lin, Li-Yen; Halder, Amitava; Kuklane, Kalev

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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 (Tclo = 1.89 clo) and walked at 4 MET (232.8 W/m²) on a treadmill in a climatic chamber (Tair = −30.6 °C, W = 0.4 m/s) for 90 min (Fig. 1).

The rectal and little finger temperatures were measured. The mean skin temperature (Tsk) was calculated below:

\[ T_{sk} = 0.07 (T_{footskin} + T_{armskin}) + 0.175 (T_{tongue} + T_{scapula}) + 0.05 T_{hand} + 0.19 T_{shirt} + 0.20 T_{calf} \]

Results
CIVD in the little finger occurred when the subjects’ rectal temperatures (Tre) were relatively stable in the range of 37.1 – 38.1 °C and the Tsk in the range of 32.0 – 25.3 °C.

Within these ranges, periodical responses of the finger CIVD were not dependent on the Tre and Tsk changes (Table 1 and Fig. 2-5).

Conclusions
The finger CIVD varies from individual to individual. Its occurrence is not dependent on the Tre, and Tsk changes within the Tre and Tsk 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).

Table 1. Finger CIVD

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset time (min)</td>
<td>14.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Tre (°C)</td>
<td>3.8</td>
<td>3.4</td>
</tr>
<tr>
<td>Tsk (°C)</td>
<td>16.5</td>
<td>3.6</td>
</tr>
<tr>
<td>Tre_mean (°C)</td>
<td>7.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Amplitude (Tre - Tsk)</td>
<td>12.7</td>
<td>4.4</td>
</tr>
<tr>
<td>Frequency (number of waves)</td>
<td>7.5</td>
<td>4.7</td>
</tr>
</tbody>
</table>

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

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

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

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

References

*Corresponding author
Email: Chuansi.Gao@design.lth.se