Agreement between Chest and Mean Skin Temperature: Influence of Clothing Ensemble and Measurement Device

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AIM

Physiological monitoring devices commonly employ a single skin temperature measurement location on the chest.

This study aimed to measure the agreement between whole-body mean skin temperature and chest skin temperature measured by a conductive or infra-red sensor, wearing two types of clothing ensemble, during exercise in the heat.

METHOD

Participants
Twelve males volunteered to participate in two trials.

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<th>Age (y)</th>
<th>Height (cm)</th>
<th>Mass (kg)</th>
<th>Body Fat (%)</th>
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<tbody>
<tr>
<td>24.2 ±3.7</td>
<td>180 ±6.5</td>
<td>82.9 ±9.5</td>
<td>16.0 ±6.5</td>
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Trial conditions
1. Wearing an athletic clothing ensemble (ATH) of t-shirt, shorts, shoes.
2. Wearing a chemical protective ensemble (CPE) of ATH plus a coverall and respirator.

Thirty minutes of seated rest (environment 24 °C and 50%) followed by 60 minutes of treadmill walking at 4.5 km·h⁻¹ and 1% grade (environment 35°C and 40%).

Measurements
Rectal temperature
Mean skin temperature (Tsk, 8-site),
Chest skin temperature by
1. Conductive sensor (iButton) (Tsk-C)
2. Infrared sensor (EQ-02) (Tsk-I)

Analysis
Repeated measures ANOVA assessed the difference in rectal temperature and Tsk between ATH and CPE. Systematic bias and 95% limits of agreement (LoA), accounting for repeated measures, were calculated between Tsk, Tsk-C, and Tsk-I.

RESULTS

Rectal temperature rose significantly from rest (ATH: 37.40±0.27°C; CPE: 37.32±0.30°C) to end of exercise (ATH: 37.96±0.21°C; CPE: 38.38±0.43°C), demonstrating significant interaction effects for clothing ensemble and time (p<0.001).

The elevation in Tsk from rest (ATH: 33.01±1.18°C; CPE: 33.53±0.74°C) to end of exercise (ATH: 35.90±0.76°C; CPE: 36.46±0.38°C), also showed a significant interaction (p=0.010).

ATH ensemble
Tsk differed from Tsk-C by 1.53 ±0.57 °C (±1.13 °C LoA), and from Tsk-I by 2.23 ±0.84 °C (±1.66 °C LoA).

CPE ensemble
Wearing the CPE ensemble, Tsk differed from Tsk-C by 1.11 ±0.70 °C (±1.44 °C LoA), and from Tsk-I by 1.76 ±0.68 °C (±1.33 °C LoA).

CONCLUSIONS

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Skin temperature measured on the chest overestimates whole-body mean skin temperature. The overestimate was greater for an infrared compared to a conductive temperature sensor, and in the ATH ensemble. These findings should be considered when monitoring skin temperature on the chest and using the data to calculate real-time indices of physiological strain.