THE EFFECT OF FORMULA USE ON MEAN SKIN TEMPERATURE ESTIMATES DURING PROLONGED AND INCREMENTAL UPPER BODY EXERCISE

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A range of formulae have been employed to estimate mean skin temperature (MST). Goss *et al.* (1980) examined a range of MST formulae to determine the most appropriate estimate of MST during cycle exercise, however, no such comparison has been reported in the literature for upper body exercise. This is of particular importance in light of decreases in calf skin temperature (T_{calf}) during prolonged upper body exercise in cool conditions (Price & Campbell, 1997). Consequently, the use of formulae incorporating such a parameter in their calculation may bias estimates of MST. Therefore, the aim of this study was to examine the effect of formula use on estimates of MST during upper body exercise. Subjects undertook either an incremental arm crank ergometry (ACE) protocol (Study 1; n=8, mean±SD age, 23.1±4.1 yrs; height, 179.3±9.4 cm and weight, 78.1±9.7 kg) or prolonged ACE at 60% VO_2peak in cool (21.5±1.3°C) and warm (31.3±0.4°C) conditions (Study 2; n=7; age, 29.0±4.5 yrs; height, 176.3±8.4cm and weight, 64.2±11.8 kg). The incremental exercise test involved four, four-minute workloads (30, 50, 70 and 90W) at a cadence of 70 rev.min^{-1} and 6 minutes recovery between stages. After the fourth rest period subjects exercised continuously at 20W.2min^{-1} from an initial load of 110W until volitional exhaustion. Skin temperatures were measured via a Grant meter logger (Squirrel 1200 Series, UK) from thermistors attached to the forehead, forearm, upperarm, back, chest, abdomen, thigh and calf. Aural temperature was measured from a thermistor inserted into the auditory canal and insulated with cotton wool. Data was recorded at rest, at the end of each exercise stage and volitional exhaustion in study 1 and every 5 minutes after resting measures during study 2. Estimates of mean skin temperature were obtained from the formulae of Nadel, Burton, Ayling, Ramanathan, Newburgh-Spealman and weighted and unweighted formulae of Goss *et al.*, (1980) as outlined by Goss *et al.*, (1980). All data were analysed by two-way repeated measures Analysis of Variance. Main effects were observed for workload/time and formulae ($P<0.05$) for both studies. No interactions were observed ($P>0.05$). Post hoc analysis revealed the formula of Burton (T_{calf} weighting 0.36) to estimate the lowest MST values in all trials whereas the formula of Ayling (no T_{calf} employed in calculation) produced the warmest estimates of MST. The differences between warmest and coolest estimates of MST increased over time during prolonged ACE in cool conditions (T_{calf} decreasing), was greatest during incremental exercise as workload increased (T_{calf} decreasing), but remained constant during prolonged ACE in warm conditions (T_{calf} increasing). The results of this study suggest that the formula choice biases MST estimates where calf temperature is involved in the MST calculation (or the weighting is large), exercise intensity increases or where cool conditions are employed.

Goss, A., Herbert, W.G. & Kelso, T.B. (1980) A comparison of mean skin temperatures during prolonged cycle exercise. *Res. Quart. Exerc. Sport* 60:292-296.

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