The self regulation of exercise performance in the heat

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INTRODUCTION:

Self-paced exercise intensity is thought to be regulated in anticipation of homeostatic catastrophe through the feedforward calculation of heat storage rate (HSR). However, estimations of mean body temperature (T_{body}) using a weighted average of rectal (T_{re}) and mean skin (T_{sk}) produces erroneous HSR. Since esophageal temperature (T_{es}) is a more sensitive index of core temperature, its inclusion in an estimate T_{body} may better reflect changes in HSR.

Purpose: To compare estimates of HSR using a two-compartment thermometry model (CTM) with two different core temperatures and weighting coefficients in thermoneutral (TN) and hot (HOT) conditions.

METHODS:

Participants: five males (23.4±3.82 y, 73.68±7.27 kg, BSA 1.9 ±0.1 m^2) cycled at a fixed RPE on cycle ergometer until power output declined to 70% of the initial 3-min average.

Conditions: The ambient conditions were TN (25.2±0.7°C; RH 31.0±4.0%) and HOT (35.1±0.8°C; RH 23.7±4.7%).

Instrumentation: Esophageal, rectal and skin (7 sites) temperatures were measure continuously. Indirect calorimetry was measured continuously to determine metabolic heat production.

Rate of Heat Storage: calculated using partitional calorimetry (HSR_c)and from four CTM equations with typical weighted coefficients using thermometry (HSR_t).

The Borg Scale	
6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Figure 1. *The Borg RPE scale*

RESULTS:

Despite no difference in HSR_c between HOT and TN in the first 5 min of exercise **(Figure 2)**, power output was significantly lower in HOT vs TN by 15 min ($p<0.01$). In TN, estimates of HSR_t using core/shell weighting, but not T_{es} alone, showed negative HSR values between 0-3 min **(Figure 3A,B, C)**. In contrast, HSR using T_{es} for CTM **(Figure 3B,D)** show higher HSR from 3-6 min of exercise. A significant difference was observed in HSR for T_{body} calculations with core defined by T_{re} **(Figure 3A,C)** compared to core defined by T_{es} **(Figure 3B,D)** during 3-4 min of exercise in HOT ($p<0.05$) and 3-6 min for TN ($p<0.05$).

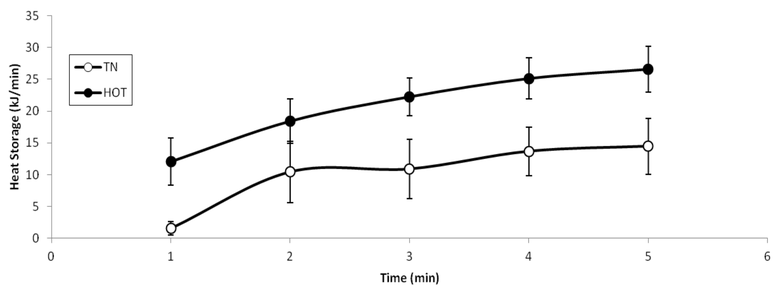

Figure 2. *Average rate of heat storage (kJ/min) during initial 5 minutes of exercise for TN and HOT*

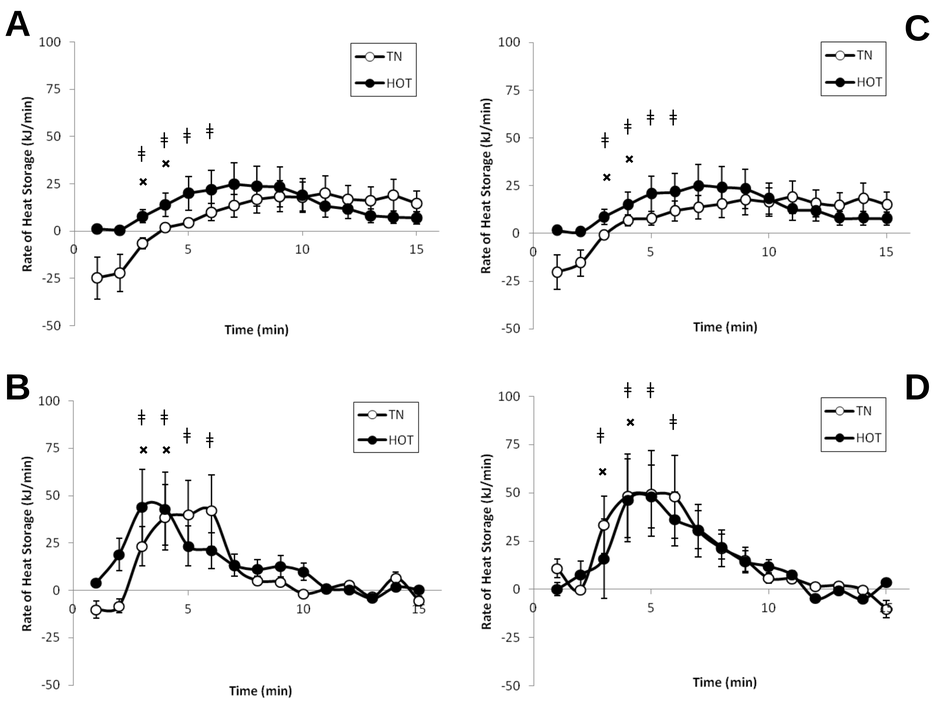

Figure 3. *Estimates of heat storage rate using T_{body} calculations with weighted coefficients of* ***A)*** *$0.79*T_{re}+0.21*T_{sk}$* ***B)*** *$0.9*T_{es}+0.1*T_{sk}$* ***C)*** *$0.9*T_{re}+0.1*T_{sk}$* ***D)*** *T_{es}. x = $p < 0.05$ for HOT; ǂ = $p < 0.05$ for TN.*

CONCLUSIONS:

1) CTM are poor indicators of HSR with significant underestimation of HSR during TN which has been shown in previous studies

2) Theses results question the validity of a feedforward mechanism of exercise intensity regulation to prevent homeostatic catastrophe

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