Extreme Physiology & Medicine

MEETING ABSTRACT Open Access

Aerobic fitness and body fatness describe minimal variability in the thermoregulatory responses to exercise after accounting for heat production and body size

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From 15th International Conference on Environmental Ergonomics (ICEE XV)
Portsmouth, UK. 28 June - 3 July 2015

Introduction

Aerobic fitness (VO_{2max}) and body fatness have been regularly suggested as important determinants of core temperature and sweating responses to exercise [3,5], but recent studies suggest that biophysical factors related to heat production (H_{prod}), total body mass (TBM), and body surface area (BSA), predominantly influence rectal temperature changes (ΔT_{re}) and sweating [1,2,4]. The present study tested the hypotheses that (i) individual variation in ΔT_{re}, whole-body sweat loss (WBSL), and steady-state local sweat rate (LSR_{ss}) is determined primarily by H_{prod} ($W.kg^{-1}$ TBM), evaporation required for heat balance (E_{req}, W), and E_{req} ($W.m^{-2}$), respectively, and (ii) factors related to VO_{2max} and body fat percentage (BF%) contribute minimally to the residual variance in these responses.

Methods

Twenty-eight male subjects [TBM: 78.2(11.3) kg, BSA: 1.96(0.15) m^2, VO_{2max}: 3.86(0.68) $L.min^{-1}$)] performed exercise at external workloads corresponding to a wide range of $\%VO_{2max}$ (32.2-80.0%), H_{prod} (5.2-12.1 $W.kg^{-1}$ TBM), and E_{req} (256-672 W) in 24.8(0.7) °C, 33.4(12.2) % RH, and 1.2(0.1) $m.s^{-1}$ air velocity. T_{re} and forearm LSR were measured continuously; WBSL was estimated from changes in body mass. Forward stepwise multiple regression analysis was subsequently performed and partial contributions of each independent variable were determined using standardized regression coefficients.

Results

H_{prod} ($W.kg^{-1}$ TBM) alone described ~50% of the variance in ΔT_{re} (adjusted R^2 = 0.496, $P < 0.001$), while BSA-to-mass ratio and BF% added 4.3% and 2.3%, respectively, to the explained variance. For WBSL, E_{req} (W) alone explained ~71% of the variance (adjusted R^2 = 0.713, $P < 0.001$), and the inclusion of BF% explained an additional 2% of the variance in WBSL. Similarly, E_{req} ($W.m^{-2}$) correlated significantly with LSR_{ss} (adjusted R^2 = 0.603, $P < 0.001$), while $\%VO_{2max}$ contributed an additional ~4% to the total variance.

Discussion

Previous findings that identified VO_{2max} and body fatness as important modulators of core temperature and sweating may be confounded by collinearity between independent variables, since fitter individuals tend to be lighter and leaner and thus generate more heat (in $W.kg^{-1}$ TBM) and have a higher E_{req} (in W and $W.m^{-2}$) at a fixed $\%VO_{2max}$, resulting in expectedly higher T_{re} and sweating rates. The relatively minor independent contribution of BF% and $\%VO_{2max}$ to these responses warrants consideration.

Conclusion

Biophysical factors related to heat production and body size explained ~54-71% of the total variability in the core temperature and thermoregulatory sweating responses to exercise in a compensable environment, with only a minor contribution (<4%) to the explained variance in ΔT_{re} and WBSL by BF%, and LSR_{ss} by $\%VO_{2max}$.

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Published: 14 September 2015

References

1. Cramer MN, Jay O: *J Appl Physiol* 2014, **116**:1123-1132.
2. Gagnon D, Jay O, Kenny GP: *J Physiol* 2013, **591**:2925-35.
3. Greenhaff PL, Clough PJ: *Eur J Appl Physiol Occup Physiol* 1989, **58**:348-52.
4. Jay O, Bain AR, Deren TM, Sacheli M, Cramer MN: *Am J Physiol Regul Integr Comp Physiol* 2011, **301**:R832-41.
5. Mora-Rodriguez R: *Exerc Sport Sci Rev* 2012, **40**:79-87.

doi:10.1186/2046-7648-4-S1-A11
Cite this article as: Cramer and Jay: **Aerobic fitness and body fatness describe minimal variability in the thermoregulatory responses to exercise after accounting for heat production and body size.** *Extreme Physiology & Medicine* 2015 **4**(Suppl 1):A11.