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1-1-2015

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Recommended Citation

Notley, Sean; Park, Joonhee; Tagami, Kyoko; Ohnishi, Norikazu; and Taylor, Nigel A.S., "Can variations in body morphology explain gender-related differences in heat loss?" (2015). *Faculty of Science, Medicine and Health - Papers: part A*. 3302.

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Abstract

Abstract of a presentation at the Annual Meeting of the Australian Physiological Society, Hobart, 29 Nov-2 Dec, 2015.

Disciplines

Medicine and Health Sciences | Social and Behavioral Sciences

Publication Details

Notley, S. R., Park, J., Tagami, K., Ohnishi, N. & Taylor, N. A.S.. Can variations in body morphology explain gender-related differences in heat loss?. Proceeding of the Annual Meeting of the Australian Physiological Society; Australia: A U P S Inc.; 2015. 57P-57P.

Can variations in body morphology explain gender-related differences in heat loss?

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Human thermoeffector responses are widely variable, with some of that variability explained by phenotypic or genotypic differences. For example, between-gender differences are often described as if they were of a genotypic nature, yet the possibility exists that such variations might merely be gender-related, and not gender-dependent. Since the mass-specific surface area available for heat exchange increases as body size decreases, smaller individuals possess a morphological configuration that is better suited to dry heat dissipation under compensable thermal conditions. Therefore, smaller individuals, and particularly females, may be more reliant on cutaneous blood flow, and less on the sweating mechanism, to meet their heat loss requirements. Accordingly, this experiment was designed to examine this possibility during exercise eliciting equal heat loss requirements for individuals of widely varying size.

Thermoeffector responses were examined in 36 males and 24 females with pronounced differences in their surface area-to-mass ratio (range: 232.3-292.7 and 241.2-303.1 cm².kg⁻¹, respectively). Subjects completed two trials under temperate-dry conditions (28°C; 30% relative humidity). On separate days, participants completed 20 min of seated rest, then performed 45 min of steady-state, semi-recumbent cycling at a matched internal heat production rate (metabolic heat - external work) for each subject equal to ~135 W.m⁻² (trial one [light work]) or ~200 W.m⁻² (trial two [moderate work]). Deep-body and skin temperatures, whole-body sweat rate (change in body mass), local sweat secretion (hand, forearm, upper back and forehead; ventilated capsules) and cutaneous blood flow (forearm; plethysmography) were measured over the final 5 min of exercise. Between-gender differences in physiological responses were assessed using unpaired *t*-tests. Hierarchical, multiple regression analyses were performed to evaluate the independent relationships between specific surface area and gender on sweating and skin blood flow. Three predictive models were developed. Firstly, each participant's mean body temperature change, peak oxygen consumption and whole-body adiposity were used as controlled variables (model 1). To these three variables, each person's specific surface area was added (model 2). Finally, gender was added to the three controlled variables and specific surface area (model 3). Changes in the coefficients of determination between models one and two represented the proportion of the thermoeffector variance explained by differences in specific surface area, after accounting for individual variations in the controlled variables. The coefficient of determination change between the second and third models corresponded to the additional percentage of individual variance that could be explained by gender-related differences that existed independently of variations in the surface-area-to-mass ratio.

Mean body temperature and its change were similar among individuals, and did not differ significantly between males and females (*P*>0.05). The specific surface area alone was a significant predictor of sweating and skin blood flow responses during both light and moderate work (*P*<0.05), accounting for 27-46% of the variation in whole-body sweat rate, 10-20% in local-sweat rates, and between 18-49% of the skin blood flow responses. Gender, however, additionally explained a significant, albeit small, percentage of the variance in whole-body sweating and cutaneous blood flow (3-5%; *P*<0.05), but did not significantly increase the explained variance in local sweating (*P*>0.05).

These observations have revealed that, when the independent influences of mean body temperature change, aerobic fitness, adiposity and specific surface area were statistically controlled, gender alone could explain less than 5% of the inter-individual variation in these thermoeffector responses under compensable conditions. Thus, gender *per se* provides an inadequate way to differentiate thermoregulatory function among individuals. Instead, such variations can largely be assigned to gender-independent morphological differences. However, it is not yet clear whether one's morphological configuration can assist in explaining gender-related differences in heat loss within uncompensable thermal conditions.