Phenotypic heat adaptation: staged reductions in physiological strain

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The sudden exposure to unfamiliar thermal stress (both hot and cold) will disturb homoeostasis, particularly when one is required to work or exercise at high intensities. In these circumstances, the simultaneous demands for oxygen delivery and heat removal can place the body under significant physiological strain. These combined challenges often result in impaired physical performance, sometimes leading to cardiovascular insufficiency (systemic hypotension) and even collapse. These states can occur in lightly clad athletes, due to their high rates of metabolic heat production, and in individuals wearing protective clothing, due to the trapping and storage of metabolic heat. However, repeated and staged exposures to these stressful conditions can improve one’s capacity to withstand such adverse outcomes. This is brought about through a series of integrated physiological (phenotypic) adaptations, the ultimate result of which is a more effective defence of both mean arterial pressure and mean body temperature when confronted by thermal challenges, although not all heat adaptation strategies will elicit equivalent levels of adaptation. And do all athletes and worker benefit from heat adaptation (acclimation)? In this presentation, this question will be answered by modelling heat production and dissipation rates during elite athletic performances. Adaptation theory will also be described, highlighting characteristics such as exposure frequency, duration, intensity and variability. Outcomes from the traditional heat adaptation model will be compared with adaptations that accompany the controlled hyperthermia model. In addition, thermal adaptation will be discussed for individuals of varying genetic, phenotypic and physiological dispositions. Finally, adaptations to the body fluid compartments and sweating responses will described, with an emphasis upon morphological changes (e.g. sweat gland hypertrophy), neural adaptation (e.g. changes in effector thresholds) and process adaptations (e.g. altered vasomotor or sudomotor sensitivities).