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Assessing physical work capacity and performance loss during heat stress using a cardiovascular strain limit model

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INTRODUCTION: Heat stress reduces physical work capacity (PWC), which in turn can incur major economic deficit. Although several prediction models of PWC (as a %) are currently available with different underpinning philosophies, their validity in the real-world may be limited, due to the paucity of the underlying data. A primary issue is that current models assume a fixed workload, and thus do not represent scenarios where workers can self-pace. Given that work at self-selected intensities tends to be characterised by working heart rate (HR), and heat stress can increase HR independently of workload, we developed a new laboratory-based method to quantify heat-induced reductions in PWC at a fixed cardiovascular strain.

METHODS: Sixteen young adult male participants performed ten trials each, consisting of 1-hour of treadmill walking exercise at a fixed target HR of 130 beats·min⁻¹. The first trial was conducted in a reference environment with no heat stress (WBGT = 11.5°C). Remaining trials were conducted at the same fixed HR in WBGT ranges of 21 to 35°C. The physical work capacity was defined as the total energy expended during 1-hour of treadmill walking. This was expressed as a percentage of that achieved in the reference condition, enabling quantification of the relative PWC (%).

RESULTS: The results demonstrate that clamping heart rate during physical work in the heat produced individualised predictions of PWC which were sensitive to biophysical parameters and individual characteristics. Preliminary data suggest that PWC decreases as a function of WBGT and can vary by up to 30% depending on the aerobic fitness level.

CONCLUSION: Our ongoing research aims to produce a new, comprehensive PWC prediction model which incorporates air temperature, humidity, clothing insulation, and solar radiation.

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