Project HeatSafe: Occupational heat stress faced by construction workers in Singapore

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Introduction

Construction workers regularly labour in hot and/or humid indoor and outdoor environments, which can compromise their health and safety [1,2]. With global warming expected to exacerbate workers' heat exposure [3], we described the environmental heat stress and heat strain of construction workers in indoor (underground tunnel) and outdoor (high-rise building) settings, using both physiological and ethnographic methods.

Methods

Seventy-nine indoor and 76 outdoor male construction workers [age (mean ±SD): 33±7 and 31±7 years] were profiled over a single work shift (~9 hours). Environmental heat stress [wet-bulb globe temperature (WBGT)] and heat strain [body core temperature (T_c), skin temperature (T_{sk}) and heart rate] data were captured continuously. Adaptive Physiological Strain Index (aPSI) was calculated as an index of overall physiological strain. Six managers and 55 workers were interviewed to understand their perceptions and management of heat stress.

Results

Mean WBGT across the work shift at the indoor and outdoor sites were 27.2±0.7°C and 29.2±2.9°C respectively. Wet-bulb globe temperature at the indoor sites was relatively stable (min-max = 25.7°C–28.9°C) across the work shift, whereas it fluctuated considerably (min-max = 23.3°C–36.0°C) at the outdoor site (Figure 1). Mean T_c of the indoor and outdoor workers across the shift were 37.5±0.2°C and 37.4±0.3°C, respectively. Peak T_c was maintained below 38°C for 67% of indoor and 72% of outdoor workers. Mean T_{sk} and heart rate of indoor and outdoor workers were: 36.2±0.8°C and 95±9 bpm; 35.9±0.8°C and 92±9 bpm respectively. Mean aPSI of indoor and outdoor workers were 2.6±0.6 and 2.6±0.6 respectively, ranging between 2–3 throughout majority of their shift. However, there were wide variations in physiological strain experienced between workers (Figure 2). Interviews revealed long working hours (10−12 hours per day, 6−7 days per week), with a significant proportion of individuals (27/55, 49%) reported ever experiencing heat-related symptoms at work. Furthermore, there was insufficient heat stress education provided for workers and managers.

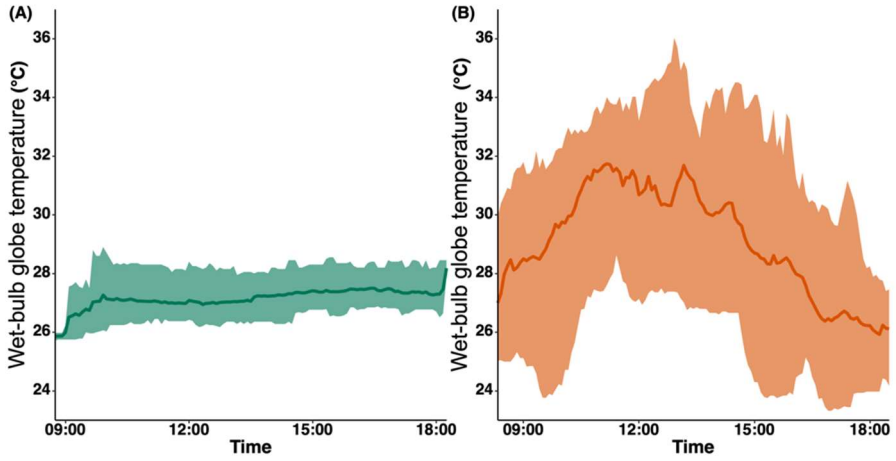

Figure 1. Wet-bulb globe temperature across the work shift at the indoor (A) and outdoor (B) sites. Data are presented as mean ± range (min to max).

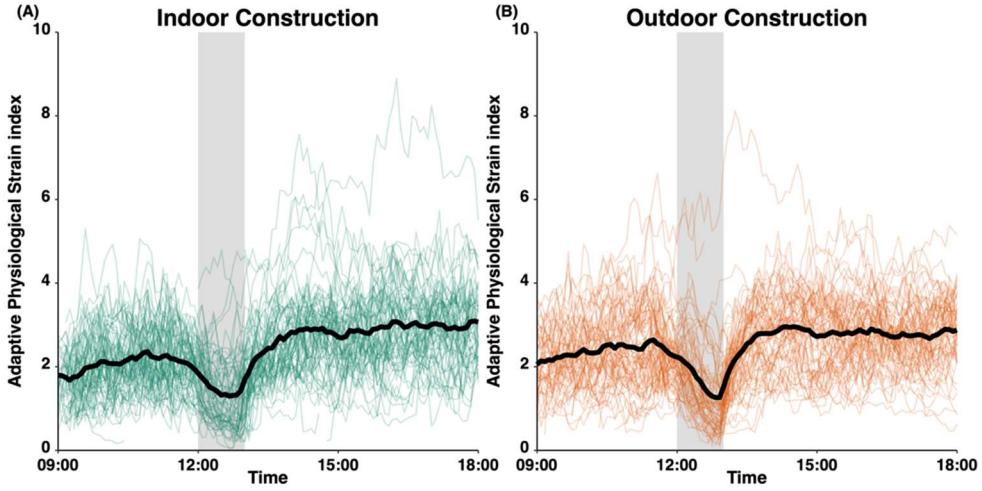

Figure 2. Construction workers' adaptive physiological strain index across a typical work shift at the indoor (A) (n=79) and outdoor (B) (n=76) sites. The black line represents the average while coloured lines represent individual construction worker's adaptive physiological strain index. The grey shaded area represents the lunch break.

Conclusion

Overall, most indoor and outdoor construction workers in Singapore exhibited low physiological strain, which may be due to self-pacing. However, there were still individuals who experienced a high physiological strain during their shift. Many workers reported experiencing heat-related symptoms at some point at work, yet they received limited heat stress education. Workplace education on the risks and management of heat stress is needed to protect workers against the threats of global warming.

References

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