Identification of the threshold ambient temperature above which pre-cooling has a performance benefit for time trials in the heat.

Steve H. Faulkner,[1,2] Iris Broekhuijzen,[1] Margherita Raccuglia,[1] Maarten Hupperets,[3] Simon G. Hodder,[1] George Havenith[1]

[1] Environmental Ergonomics Research Centre, Loughborough Design School, Loughborough University, LE11 3TU, UK.
[2] Department of Engineering, School of Science and Technology, Nottingham Trent University, NG11 8NS, UK
[3] Future Sport Science Laboratory, adidas AG, 91074 Herzogenaurach, Germany

Introduction. Endurance exercise performance progressively deteriorates as the surrounding ambient temperature increases,[1] which is exacerbated when combined with increasing humidity[2] and solar radiation.[3] It is clear that there is a strong link between increases in thermoregulatory strain, due to elevations in both metabolic and ambient heat, and impaired endurance performance.[4]

It has become commonplace to implement pre-cooling prior to competition to alleviate this performance decline, with ~50% of athletes having a defined strategy prior to competing in the heat.[5] Such strategies include the use of ice-vests, which have been suggested to improve time trial performance in the heat by approximately 5%.[6] However, little is known about the ambient temperature threshold above which pre-cooling becomes an effective strategy for enhancing endurance performance. With most studies focusing on a single ambient temperature, typically above 30˚C or a Wet Globe Bulb Temperature (WGBT) of 26˚C.[7] Therefore, it was the aim of this study to investigate the effect of pre-cooling in different environmental temperatures on time trial performance.

It was hypothesized that pre-cooling would improve time trial performance in all environmental temperatures, with the magnitude of effect dependent on environmental temperature.

Methods. In an independent groups design, 24 trained male cyclists (age 24.3 ± 5.1 years; VO_{2max} 61.3 ± 3.7 $mL{\cdot}kg{\cdot}min^{-1}$; training frequency ≥3 times per week) completed two time trials with (COLD) and without (CON) of pre-cooling using an ice-vest and sleeves ensemble. Pre-cooling was implemented for 30 minutes at rest and during a 9 minute progressive warm up, in ambient temperatures of 24.0 ± 0.1°C & 49.5 ± 1.4% *rh* (WBGT 19.2°C); 27.2 ± 0.3°C & 50.7 ± 5.3% *rh* (WBGT 22.1°C); or 35.0 ± 0.4°C & 50.6% ± 1.3% *rh* (29.2°C). Participants removed the cooling vest (if warn) on completion of the warm up, prior to completing a self-paced time trial designed to last ~60 minutes when ridden at ~75% W_{max}.

Results. Time trial performance was 6.2% and 2.6% faster following COLD in both 35˚C and 27˚C (figure 1A) but not 24˚C (1.2%). Magnitude based inferential statistics indicate that COLD was *very likely beneficial* to performance in 35˚C and *likely beneficial* in 27˚C and *possibly beneficial* in 24°C. Mean power was 2.4% 2.5% and 5.6% higher following COLD (figure 1B,C) and considered to be *likely beneficial* in 24°C and *very likely beneficial* in 27˚C and 35˚C. There was no effect of COLD on gastrointestinal temperature at any point.

Conclusions. Pre-cooling with an ice-vest and sleeves is likely to have a positive effect on time trial performance at temperatures above 24˚C, with a clear relationship between ambient temperature and the magnitude of effect of pre-cooling. These results indicate that cyclists should start to consider implementing a pre-cooling procedure prior to racing a time-trial in environmental temperatures of 24˚C and above. Importantly, utilising pre-cooling in lower ambient temperatures is unlikely to have a detrimental effect on performance at the cooling intensities used here. To the authors' knowledge, this is the first time that a lower ambient temperature threshold has been identified above which pre-cooling has a significant ergogenic impact on performance.

Keywords

Cycling, ice-vest, time-trial, performance, ergogenic

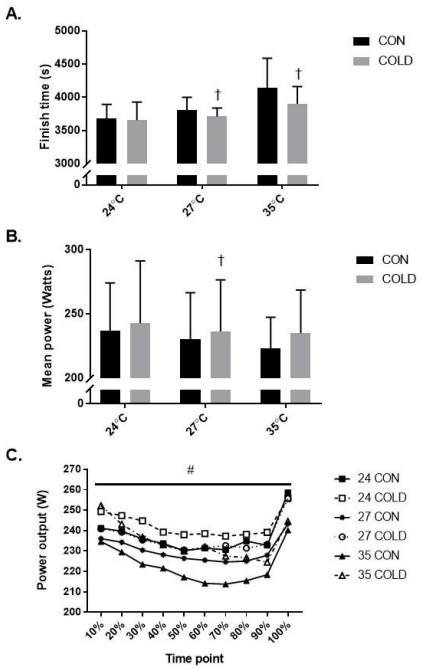

Figure 1: Performance data showing A) time trial completion times; B) mean power output and C) pacing profile. † denotes a significant difference from CON (P<0.05). # denote a significant effect of time (P<0.05). Data presented as mean ± SD.

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