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Effect of competition-compatible precooling on distance running in humid heat

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Theoretical Background:

The next two major competitions in athletics will be held in Doha, Qatar (World Championships 2019) and in Tokyo, Japan (Olympic Games 2020). On both occasions, extreme environmental conditions are expected: A wet bulb globe temperature (WBGT) of ~28°C in Doha and of ~30°C in Tokyo (Murata et al., 2016), indicating “high” and “excessive” temperatures, respectively (Racinais et al., 2015). High WBGT cause a fast increase of body core temperature (CT) during exercise and therefore impair endurance performance (Nybo et al., 2014).

One commonly used means against the reduction of endurance performance induced by the rise of CT is “precooling”. It aims to delay the point where critically high CT is reached by lowering CT before the onset of exercise (Ross et al., 2013). Positive effects of precooling on endurance performance have been found, especially where different cooling modalities such as cold water immersion, cooling vests and ice slurries were combined (Racinais et al., 2015).

However, most of the existing studies on precooling have executed precooling directly before exercise-onset. They are thus hardly compatible with the regulatory restrictions before major athletics competitions. For example, long distance runners competing in track events (most importantly the 5000 m event) are obliged to arrive in the “call-room” ~30 min before the start of their race. In the call-room, no personal precooling instruments like cooling vests or baths are allowed. Before entering the call room, athletes typically are transferred from their hotel to the competition stadium. Also during transfer and subsequent warm-up, precooling is not possible without practical and regulatory restrictions. In order to implement precooling into the predetermined schedule, it would be necessary to extend the duration between precooling and the start of the race. This would likely reduce the chance of a performance benefit, as the effect of precooling could be “washed out” before the start. However, no study has investigated the effects of best-practice precooling compatible with the schedule before major athletics competitions on physiological parameters and on distance running performance so far.

Research Question:

What are the effects of competition-compatible precooling on A) body core temperature, B) heart rate, oxygen consumption and thermal perception as well as C) performance during distance running in humid heat?

Methods:

Subjects and design

Eighteen trained men (age: 29.9 ± 4.7 years, height: 179 ± 6 cm, weight: 72.3 ± 5.3 kg, V̇O2max: 61.0 ± 4.7 ml·kg-1·min-1) gave written informed consent to participate in the study, which was approved by the institutional review board of the Swiss Federal Institute of Sports Magglingen.

After familiarisation with heat conditions and assessment of V̇O2max by an incremental running test, ten subjects completed two maximal running trials in randomized order: one with preceding precooling (COOL) and a control trial without precooling (CONT). Both trials were conducted in a heat chamber set to a WBGT of ~29°C, representing the environmental conditions in Qatar and Tokyo, respectively. Eight subjects completed a submaximal running trial after the precooling phase (Results reported elsewhere). Therefore, only CT data of these subjects was included in the present study.

Experimental procedures

The precooling protocol in COOL was designed such, that it could be directly implemented into major athletics competitions: First, 30 min cold-water immersion (22°C) starting ~2.5 h before the performance trial (possible in the hotel room before the transfer to the stadium). Then, 30 min (corresponding to the time during the transfer) in a cooling vest, followed by a 30 min warm-up and another 30 min (corresponding to the time in the call-room) during which a bottle of ice slurry (7 g per kg body mass) was consumed. In CONT, no precooling was undertaken.

The performance trial was a 20 min run on a motorised treadmill designed to represent the physiological load of a 5000 m track-race and to make possible the comparison of physiological parameters between conditions. The first 10 min of the trial were run with constant speed corresponding to 75% of the maximal velocity reached in the preceding V̇O2max test. The second 10 min of the trial were a standard time trial, during which subjects selected their own running speed. The measure of running performance was the total distance covered in 20 min. During the performance trial, a large fan set up in front of the treadmill simulated wind speed equivalent to the current running speed.

CT at the start of the performance trial was measured by an intestinal sensor. Heart rate (HR), relative-to-bodyweight oxygen consumption (VO2) and subjective rating of thermal perception (RTP) were measured during the fixed-speed 10 min of the performance trial.

Differences between COOL and CONT were tested using two-sided Wilcoxon signed rank tests with Bonferroni correction.

Results:

A) CT at the start of the performance trial was lower in COOL compared to CONT (37.0 ± 0.4°C in COOL and 37.3 ± 0.5°C in CONT, 95% confidence interval (CI) of difference = [-0.5°C, -0.1°C], $p = 0.02$).

B) HR and VO2 were not different between COOL and CONT (95% CI of difference in HR = [-6 bpm, 4 bpm], $p > 0.9$; 95% CI of difference in VO2 = [-2.2 ml·kg-1·min-1, 0.7 ml·kg-1·min-1], $p > 0.9$). RTP was lower in COOL compared to CONT (95% CI of difference ≈ [-1.0, -0.1], $p = 0.04$).

C) Distance covered in the 20 min performance trial did not differ between COOL and CONT (5362 ± 533 m in COOL and 5363 ± 544 m in CONT, 95% CI of difference = [-39 m, 35 m], $p > 0.9$).

Discussion:

The main finding of the present study was that a precooling protocol, which is compatible with major athletics competitions, can reduce CT before and RTP during exercise but does not improve running performance in a trial representative of 5000 m running competitions. This differs from the Results of previous precooling studies, which suggested that precooling could improve endurance performance in the heat (Ross et al., 2013). Regarding this contrast, two important aspects must be noted:

First, the duration between the cold-water immersion and the start of the performance trial was longer in our study than in previous studies. Accordingly, we observed a smaller difference in CT at the start of exercise (0.3°C) than for example the study of Booth et al. (1997), where runners started exercising immediately after cold-water immersion and where a TC-difference of 0.7°C was measured at the start of exercise. This presumed negative relationship between the duration from precooling to exercise-onset and the effect of precooling on CT at exercise-onset could partially explain the lack of a positive effect of precooling on performance in the present study.

Second, the duration of our performance trial was shorter than in other studies. Since the performance-enhancing effect of precooling is thought to be dependent on exercise duration (Quod et al., 2006), the "too short" performance trial in our study could also be responsible for the absence of a beneficial effect of precooling on performance.

However, both the duration from cold-water immersion to exercise and the duration of the performance trial used in the present study closely represent reality in major athletics competitions.

We conclude that athletes competing in track events lasting no longer than ~20 min (i.e. 5000 m or shorter) cannot expect a performance-improvement by the investigated precooling intervention. The observed physiological and psychological effects (i.e. lower CT and RTP) are likely too small to trigger a relevant benefit in a 5000 m race, but could have more impact on longer races as 10000 m or the marathon. Importantly, 5000 m runners should still personally try out the different competition-compatible precooling modalities, as individual differences in the response to precooling can be expected. Like this, athletes can optimise their precooling strategies and thus their performance in the heat.

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