Comparison of internal and external precooling on the determinants of endurance running performance in hot and humid conditions

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Aim: Precooling techniques are acute interventions that ameliorate exertional heat stress and mediate a decline in endurance running performance in the heat. This study compared two prominent approaches to precooling on the determinants of endurance performance under heat stress. **Methods:** Twelve males (age 38.6±11.1 years, body mass 77.3±7.1 kg) completed three incremental, discontinuous treadmill tests in the heat (31.9±1°C, 61.9±8.9% relative humidity) to determine speed at lactate threshold at two fixed blood lactate concentrations (2 & 3.5 mmol. L^{-1}), running economy and VO_{2max}. Trials involved 20 minutes of either internal cooling (INT, 7.5 $g.kg^{-1}$ ice slurry ingestion) or mixed-methods external cooling (EXT, cold towels, forearm immersion, ice vest and cooling shorts), alongside no intervention (CON). **Results:** An effect on running speed was observed at fixed lactate concentrations ($F=3.78$, $p=0.04$, partial $\eta 2 = 0.27$). Mean values at 2 $mmol.L^{-1}$ were INT 12.3±1.1 $km.h^{-1}$, EXT 12.3±1.1 $km.h^{-1}$, CON 12±1.1 $km.h^{-1}$ and at 3.5 $mmol.L^{-1}$ INT 13.8±1 $km.h^{-1}$, EXT 13.8±1 $km.h^{-1}$, CON 13.6±1 $km.h^{-1}$. Bonferroni pairwise comparisons identified a difference between INT and CON ($p=0.03$), but not for EXT ($p=0.12$). There was no effect of cooling on running economy across six exercise stages (INT 269.5±36.5 $ml.km^{-1}.min^{-1}$, EXT 269.7±37.9 $ml.km^{-1}.min^{-1}$, CON 266.5±35.2 $ml.km^{-1}.min^{-1}$, $p=0.82$), nor on VO_{2max} (INT 57.5±5.6 $ml.kg^{-1}.min^{-1}$, EXT 58.4±4.7 $ml.kg^{-1}.min^{-1}$, CON 57.3±4.9 $ml.kg^{-1}.min^{-1}$, $p=0.69$). An effect for cooling on physiological strain index was observed ($F=4.85$, $p=0.02$, partial $\eta 2 = 0.38$), with differences between EXT and CON (CON 4.8±1.6 vs. EXT 4.3±1.5, $p=0.02$), but not for INT (4.2±1.8, $p=0.15$). Precooling reduced thermal sensation ($F=20.98$, $p<0.01$, partial $\eta 2 = 0.66$) with differences in both cooling methods (INT 5.7±0.9, EXT 5.4±0.8, CON 6.2±0.8, $p<0.01$). **Conclusions:** Beneficial effects of precooling on endurance performance have been widely evidenced during free-paced and open-ended trials. Results from this study may indicate that modest changes in lactate threshold or physiological strain, alongside a diminished perceptual strain, could help explain the better maintenance of endurance running performance in the heat from precooling.