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TEMPERATURE RISING

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Considering all factors that contribute to performance, triathletes have plenty to think about. The interpretation of the co-existing physical, physiological, psychological, environmental, mechanical and technical aspects can be somewhat overwhelming. As a primarily summer sport, triathletes are innately mindful of preparing for, and dealing with, the demands of training and competing in hot weather. Vast amounts of scientific literature support the concept that an excessive rise in core body temperature disrupts physiological functions that are not only important for athletic performance but also for health and life. That said, humans are hard-wired with highly robust regulatory mechanisms to avert catastrophic levels of hyperthermia – most of the time. However, without adopting requisite knowledge and practice, mitigating the rise in core temperature during competition will be challenging.

HEAT PRODUCTION DURING EXERCISE

When humans exercise only a small proportion (approx. 25%) of energy produced is converted to movement or mechanical work – the majority of energy is released as heat. If the metabolic demand is low/modest, and the surrounding environmental conditions are favourable then the majority of heat production will be effectively released from the body. However, large metabolic demands that co-exist with a higher intensity effort will contribute to a greater production of heat, and subsequent rise in core temperature – even in friendly environmental conditions (Bongers et al., 2017).

To give you some perspective, normal body core temperature at rest is 37.2 C. Mild to moderate exercise intensity typically induces a rise in core temperature to 37.5-38 C. When affected by viral fever, core temperature at rest may rise to 38.2-38.5 C. Scientific evidence supports the notion of a 40-40.5 C "threshold" - or the point where exercise-induced heat production contributes significantly to fatigue (Bongers et al., 2017). Furthermore, a rise in core temperature >40.5 C may significantly increase the risk of developing substantial heat illnesses. Additionally, prolonged exercise also increases skin temperature. The combined effect of elevated core and skin temperature contributes to a lower core-skin temperature gradient, which will further exacerbate fatigue and the decline in performance (Bongers et al., 2017).

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Many athletes are led to believe that being dehydrated, coupled with reduced sweat rates, increases core body temperature and subsequent risk of heat injury or a more catastrophic event. However, research during the past decade has demonstrated that this is not entirely true. Indeed, research conducted in the 'real, outdoor world' - as opposed to a controlled laboratory - has demonstrated that the fastest iron-distance triathlon times are associated with greater levels of hypo-hydration, with no relationship with post-race core temperature (cited in Laursen et al., 2006).

THERMAL TRENDS DURING TRIATHLON EVENTS

A study by Laursen and colleagues (2006) was a significant breakthrough in understanding the thermal demands encountered by athletes during an iron-distance triathlon. Ten well-trained triathletes were monitored during an iron-distance event in Western Australia. Among a number of physiological metrics, core body temperature was monitored via ingestible thermometer capsules, with data transmitted at various checkpoints via Bluetooth telemetry. Interestingly, the highest recorded core temperature was observed during the swim – one of the athletes who accomplished the eighth fastest swim time overall (49 minutes) had core temperature recorded at 40.5 C. Given that the swim is the first stage of the competition, it is highly unlikely that a loss of total body fluid contributed to this rather substantial rise in core temperature. Rather, this response is most likely due to a high muscle metabolic demand, coupled with the insulator effect of 3mm thick wetsuit, thus limiting heat dissipation from the skin. The water temperature during the swim was mild, at 19.5 C.

Following the swim, core body temperature tended to decline throughout the cycle and run sectors, despite prevailing warm environmental conditions (~25 C/50%RH). The primary reason for the decline in core temperature during the cycle and run leg is most likely attributed to a reduced relative metabolic intensity compared to swimming, plus the additional effect of a breeze to assist with sweat evaporation from the skin, not to mention the systemic effects of fatigue and subsequent slowing down.

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Perhaps the most significant finding of this classic observational study, is that despite an average 3% loss of body mass (2.3 ffl 1.2kg), at 83% (ffl6%) heart rate maximum, these well-trained triathletes recorded only a modest and very well tolerated ~1 C average increase in core body temperature during the ~10 hour journey. These findings are consistent with those of Noakes (2003), in that only a small proportion of body mass change during endurance events are attributed to loss of body fluid, and most change in core temperature is in response to metabolic heat production.

MIXED-METHOD COOLING STRATEGIES

It goes without saying that preparing for the worst is an athlete's best insurance policy, which includes adequate prior heat acclimation training. As race day arrives, engaging with strategies to reduce

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>
> — Laursen and colleagues (2006)

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STAYING COOL: Make sure you have your holistic cooling strategy in place before race day.

thermal strain is advantageous. For example, pre-cooling induces body heat removal, thus increasing heat storage capacity during the event. Effective pre-cooling methods include whole-body cold-water immersion, cold air exposure, cooling vests or anatomical cool packs and ingestion of ice cold drinks (Bongers et al., 2017). The duration of water immersion should vary in accordance with the available water temperature. For example, 15-30 minutes in mild water temperatures (20-24 C), 10-12 minutes in cool water (16-19 C), 5-10 minutes in cold water (11-15 C). The most effective pre-cooling strategy appears to be whole-body water immersion, followed by the consumption of 0-4 C ice-cold fluids.

Effective cooling strategies during exercise (pre-cooling) include ice-vests, cold drinks, facial wind, water spray, menthol sprayed onto clothing, and/or mouth rinse. The most effective combination of pre-cooling strategies appears to be ice-vest with cold fluid ingestion – although the former is obviously not practical during triathlon competition. With the advent of insulated drink bottles, cold-fluid ingestion is the obvious choice for triathletes.

Timely re-establishment of pre-event homeostasis is important for recovery. The same pre-cooling methods previously described are similarly effective. If available, cold-water (11-15 C) immersion for 5-10 minutes is ideal. The next best option is cooling exposed skin, with the objective to increase the core to skin temperature gradient and subsequently promote greater heat loss, while sipping ice-cold fluids.

PRACTICAL PERSPECTIVES

The nanotechnology boffins have some work to do, as current wearable cooling garments or devices for use during triathlon competition are neither practical nor effective. In principle, maintaining a larger core-to-skin temperature gradient, via skin cooling, could have a greater bearing on performance than the critical core temperature threshold that scientists are typically focussed and familiar with.

Heat stress during endurance training or competition contributes to increased thermal, metabolic and cardiovascular strain. Therefore, it's imperative that athletes carefully plan for a realistic pace strategy based on 'feel' and anticipation, rather than relying too much on environmentally affected physiological metrics (e.g. heart rate and power output).

Consuming an ice-slurry has been documented numerous times in the peer-reviewed literature as an effective ergogenic performance aid during endurance events (Jones et al., 2012; Yeo et al., 2012; Tan and Lee, 2015), including triathlon (Stevens et al, 2013). The ice-slurry mechanisms are numerous and include reduced perceived thermal sensations, and reduced intra-gastric temperature.

Therefore, at the present time, consumption of an ice-slurry, or at least very cold fluids, appears to be the most practical, and possible, pre-competition cooling strategy. Furthermore, current trends are leaning more towards the temperature of fluids rather than volume of fluids consumed. AT

"Consumption of an ice-slurry, or at least very cold fluids, appears to be the most practical, and possible, pre-competition cooling strategy." — Lepers et al., 2013

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