

PEARLS FOR BEST ENDURANCE RUNNING PERFORMANCE IN THE HEAT

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10 PEARLS FOR ATHLETES TO BEAT THE HEAT

1. *You should heat acclimatise by training in the heat for 2 weeks*
2. *If you cannot acclimatise for 2 weeks, try at least one week!*
3. *Implement your hydration plan from the days preceding the event*
4. *Use pre-cooling strategies during the warm-up (e.g. ice-vest)*
5. *Try your specific cooling strategies for the event/race during training*
6. *Do not use clothing that limits sweat evaporation*
7. *Discuss your medication with your sports physician as many medications can impair your ability to tolerate heat*
8. *Diarrhoea and vomiting impair hydration status and will require the use of Oral Rehydration Solutions (ORS)*
9. *Use a non-greasy sunscreen*
10. *Use a hat and grade 3 sunglasses*

INTRODUCTION

The 17th IAAF World Championships, Doha 2019 (27/09-06/10) and The Games of the XXXII Olympiad, Tokyo 2020 (24/07-09/08) will take place under hot and potentially humid environmental conditions. The environmental conditions during sporting events are generally estimated using the Wet-Bulb-Globe-Temperature (WBGT) index. The WBGT is calculated using a combination of the dry temperature (standard thermometer), the wet-bulb temperature (indicative of the true capacity of the air to evaporate water according to its relative humidity and air velocity) and the globe temperature (indicative of solar radiation).

Human core body temperature is around 37°C, while muscle- and skin temperatures are ~35°C and ~31°C respectively when resting in temperate environmental

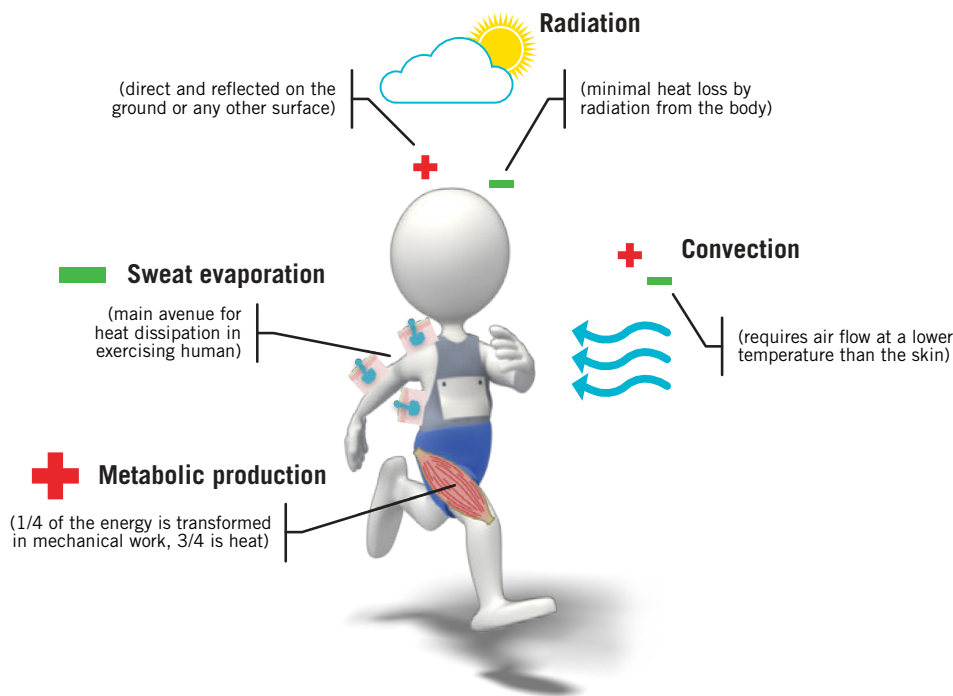


Figure 1: The thermal environment of the athlete.

conditions. When running or race-walking, muscle contractions produce a considerable amount of heat, resulting in a large increase in muscle temperature¹, which drives an increase in core body temperature². The heat produced is dissipated to the environment via the skin through sensible (i.e. convection and radiation) and insensible evaporation heat loss pathways (Figure 1)³. However, in hot ambient conditions, the gradient between skin and environmental temperature is minimal, possibly even negative, such that heat dissipation occurs mainly through sweat evaporation. As hot and humid ambient conditions limit heat dissipation capacity during exercise, body core temperature increases toward higher values than in cooler environments for a given exercise.

An increase in muscle temperature (e.g. through warm-up) has several performance benefits for explosive athletic events such as sprints, jumps or throws⁴. However, preventing an excessive rise in core body temperature during prolonged exercise, requires transferring metabolic heat from the working muscles and core to the skin and then to the environment. This necessitates an increase in skin blood flow⁵ and sweating⁶. These increases are larger in hot and humid conditions due to the lower skin capacity to dissipate metabolic heat in the surrounding environment. This increases cardiovascular strain^{7,8}, which in

turn leads to a reduction in absolute work rate (e.g. speed) in order for relative exercise intensity to be maintained⁹. In summary, hot ambient conditions may benefit explosive events, but progressively impairs performance in longer duration events¹⁰.

On the positive side, the detrimental effects of heat stress during endurance events can be reduced with the adoption of countermeasures such as heat acclimation. Here are some pearls to optimize performance and reduce the risk of heat illness during athletic events under heat stress.

THE WEEKS PRECEDING

Key message: In the weeks, or even the months preceding an endurance race in the heat, the focus should be on heat acclimatization. This is achieved by performing repeated exercise-heat exposures that increase body core and skin temperatures, as well as inducing significant sweating¹¹.

Methods

There are a wide variety of methods that can increase core and skin temperature and stimulate sweating (Figure 2). The natural methods based on a training camp in hot ambient conditions are called heat acclimatization; heat acclimation refers to the artificial methods, either active (e.g. hot room) or passive (e.g. hot bath). The

first choice should be to train in the same environment as the upcoming competition. However, this is not always possible. If an athlete cannot train in the heat before a competition in the heat, he/she can use artificial heat exposure methods such as training in a hot room, sauna bathing, or a hot bath post thermoneutral training.

The principle to trigger acclimation is to increase both core and skin temperature, induce profuse sweating and elevate skin blood flow. The most specific adaptations are obtained by training in the heat while daily heat exposure provides the fastest adaptations. Each training session in the heat should last for 60-90 min. The other training sessions can be done in temperate environments. Sleep and recovery should always be in a cool environment. During the training sessions in the heat, relative training intensity can be controlled by heart-rate and maintained constant throughout acclimation. Absolute training intensity will be reduced during the first days and progressively be increased over 2 weeks. Athletes should consider to train at times of lower heat stress at the beginning of the acclimation period. If the training sessions in the heat includes high-intensity work with a neuromuscular focus, this should be done at the beginning of the training, before athletes reach elevated temperatures.

Timeline

Athletes have some degree of heat acclimatization due to regular training, even in cool conditions. However, they will still benefit from a dedicated period of heat acclimatization. The number of days required to achieve optimal acclimatization varies but most adaptations develop within 7-10 days, with 14 days being optimal. Athletes should therefore train in a similar environment 2 weeks prior to competing in hot and/or humid conditions.

It is important to note that most adaptations are lost after 1-2 weeks but some benefits can be maintained for up to 1 month. The rate of losing heat adaptations may likely be slowed by training and regular heat exposures post-acclimation. Importantly, re-acclimation during this period is faster than the initial rate of acclimation. Thus, conducting an initial heat acclimatization camp several weeks before

HEAT

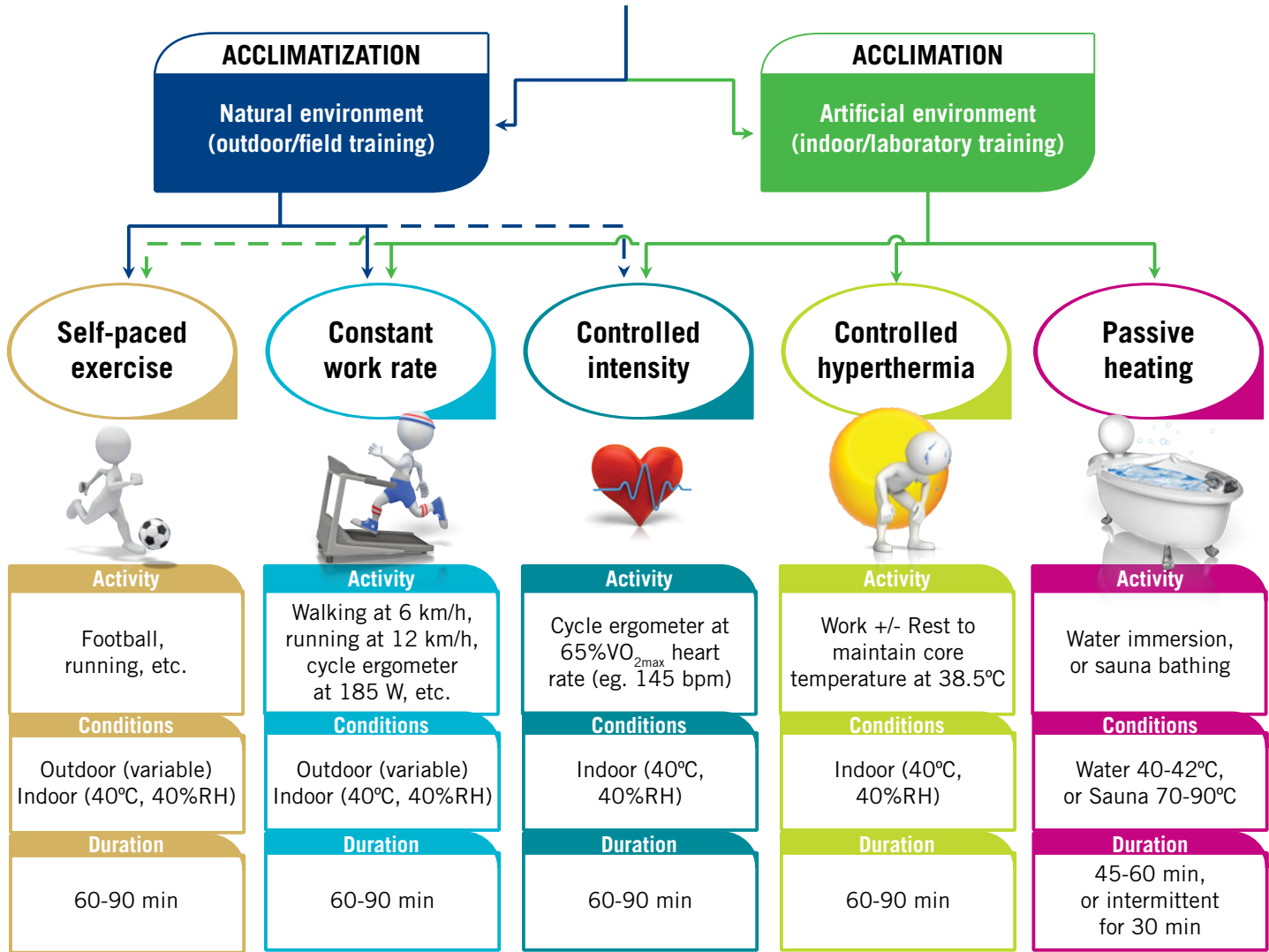


Figure 2: Various methods for heat acclimatization.

the target event may increase the speed at which adaptations occurs in a follow-up pre-competition camp¹².

Therefore, depending on the travel plan, athletes can acclimatize partially or totally before arriving at the competition venue. For example, the main acclimatization block can be performed 2 weeks before traveling, with 4 to 5 days of re-acclimation after arrival at the competition venue.

Adaptations

Heat stress can dramatically decrease endurance performance, but this decrement can be progressively reverted with appropriate heat acclimatization¹³. In fact, the benefit of heat acclimatization is larger than any other strategy (e.g. altitude camp) when competing in the heat. Heat acclimatization may also reduce

the risk of heat-related illnesses. Thus, heat acclimatization should be a priority before any event where the conditions may be hot and/or humid, even if the level of heat stress is uncertain. Indeed, heat acclimatization does not impair performance in cooler environments and may even increase it under certain circumstances^{14,15}.

The most visible adaptations of the body to repeated training in the heat include an increased sweat rate, a decreased heart rate at a given intensity, a better retention of electrolytes, and a decreased body core temperature.

THE DAYS PRECEDING

Key message: The two important words in the days preceding an endurance race in the heat are taper and hydration.

Taper

Preparing for an event in the heat follows the same logic as for any other event, with the additional requirement for heat acclimatization. As an athlete generally tapers before a competition, the heat-acclimatization plan needs to integrate this constraint. It is therefore impractical to plan for 2 weeks of heat-acclimatization just before the event. As explained above, the timeline can integrate a first acclimatization block a couple of weeks before and then the adaptation can be maintained throughout the taper. To do so, it is also possible to use passive heat acclimation techniques such as hot water immersion or sauna bathing for 30-40 minutes pre- or post-training. This approach takes advantage of a raised training-induced core temperature; the combination of extra clothing during

training will further increase the stimulus. Water temperature should be around 40°C to induce adaptation while remaining tolerable (easily measured with a floating pool thermometer). Although not as specific as exercise heat acclimatization, heat acclimation can be used to accommodate taper and travel requirements¹⁶.

Hydration

Heat dissipation relies on sweat evaporation. However, profuse sweating may lead to progressive dehydration if fluids are not sufficiently replaced¹⁷⁻¹⁹. Severe dehydration might intensify the rise in whole-body temperature and impair prolonged exercise performance. This occurs as dehydration negatively impacts the function of the heart by making it more difficult to maintain blood pressure and blood flow to the working muscles and skin (to lose heat). Therefore, hydration prior to and during exercise, and in recovery is important for athletes to perform well and ensure their safety in the heat; especially during the heat acclimatization period due to the increase in sweat rate. It should also be acknowledged that an acute increase in fluid absorption will result in an increase in urine excretion, and that the body will need a few days to adapt.

Sodium (salt) supplementation during exercise lasting longer than 1 h is

recommended for heavy and 'salty' sweaters. Sodium intake may be increased prior to and following hot-weather training and racing. During events, electrolyte tablets or a pinch of salt may be used by athletes tolerating it. It is also advisable to add 30–60 g/h of carbohydrates to drinks for training lasting longer than 1 h and up to 90 g/h for events lasting over 2.5 h. This can be achieved through a combination of fluids and solid foods. During the acclimatization period, recovery drinks should include sodium, carbohydrates and protein to optimize recovery. Milk is a very good recovery drink. The preferred method of rehydration is through the consumption of fluids with food, including salty food.

THE HOURS PRECEDING

Key message: athletes should adapt their warm-up and hydration routines before an endurance event in the heat.

Warm-up and Pre-cooling

Athletes should minimize unnecessary heat exposure and heat gain prior the start of the event. Athletes should therefore warm-up in the shade if possible. They might also consider a mixture of external (ice-vests, cold towels, or fanning) and internal (cold fluid or ice slurry ingestion) pre-cooling methods. A practical approach might be the use of commercially available ice-cooling

vests during warm-up, which can provide effective cooling without affecting optimal muscle temperature and function. During the event, athletes should also protect their eyes by wearing UV ray blocking sun-glasses in a dark tint (i.e. grade 3) and their skin by using non-greasy sunscreen (water-based sunscreen is preferred to oil-based sunscreen that may affect sweating). Lightly colored clothing can also minimize the effect of the sun's radiation, but clothing should not impair sweat evaporation. Self-dousing water or other cooling techniques that are commonly adopted, rely mostly on individual's beneficial perception rather than scientifically evident approaches. Any cooling method should be tested and individualized during training and not in competition, to minimize disruption to the athlete.

Hydration

Drinking to thirst is adequate for exercise lasting less than 1-2h in cool environments. However, a planned drinking strategy may optimize performance during activities >90min, particularly in the heat, during high-intensity exercises with high sweat rates (and when carbohydrate intake of 1 g/min is desired)²⁰. Individuals with high sweat rates (and/or those concerned with exercise performance) should determine sweat rates under conditions (exercise



It is essential for event and team medical staff and the local ambulance/hospital services to agree on (and practice) the concept of cool-first and transport second before any sporting event in the heat.



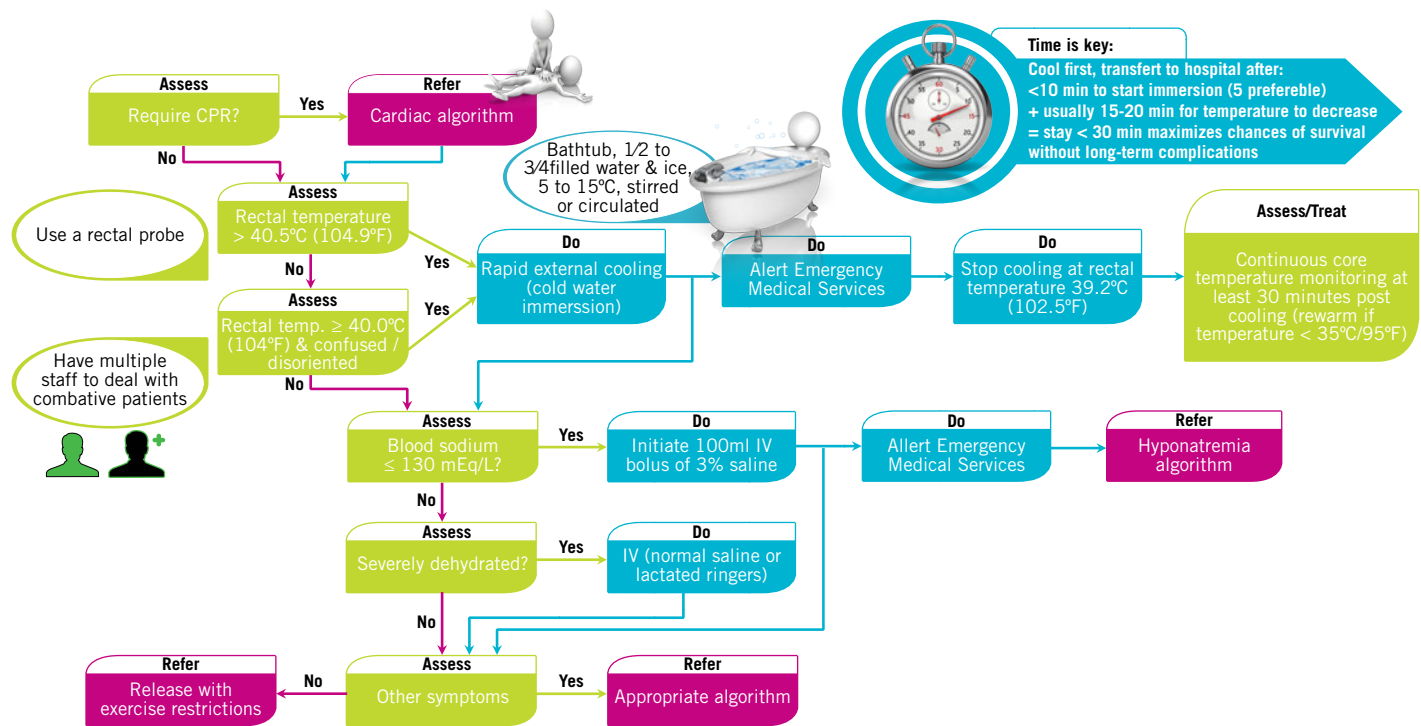


Figure 3: How to manage Exertional Heat Illness / Stroke. Source: Racinais S, O'Connor F, Nye N, Casa D. www.ephysiol.com

intensity, pace) and environments similar to that anticipated when competing. They should consider to tailor drinking to prevent significant body mass losses (e.g., exceeding 2-3%).

This individual prescription must remain within the limits of how much fluid can be absorbed by the body (~1.2 L/h). It is also important to recognize that hydration regimens should never result in over-hydration, as this can have serious health consequences (so called “hyponatremia” that can be more severe than dehydration and even lead to death). Simple techniques such as measuring body weight before and after exercise or evaluating urine color in the morning (first void) can help athletes assess fluid losses through sweating and estimate hydration needs and status.

FROM PREVENTION TO REACTION

Key message: Athletes with exertional heat stroke will likely recover without any consequences if their extreme hyperthermia is reversed in less than 30 minutes to a core body temperature of < 40°C (104°F).

Athletes may however suffer permanent disability beyond this point and even death if recommended treatment is postponed by more than an hour. The following

four exertional heat stroke (EHS) clinical management principles will improve patient outcomes:

Principle 1- Early recognition

Skilled medical staff will immediately recognize EHS in a collapsed athlete (or an athlete struggling during intense exercise in the heat), minimizing the total hyperthermal time. They will also consider and rule out other medical conditions presenting with mental compromise during intense exercise in the heat, including cardiac conditions, asthma, exertional hyponatremia, other head-related illnesses, exertional sickling, and diabetes.

Principle 2- Early diagnosis

Assess core body temperature using a valid device to quickly diagnose possible EHS. When athletes have been doing intense exercise in the heat it is crucial that rectal temperature is utilized to determine if the athlete is severely hyperthermic²¹. Central Nervous System (CNS) dysfunction (confusion, altered consciousness, coma, convulsions, agitation, combativeness, disorientation, etc.) and a rectal temperature greater than 40.5°C (>105°F) indicate an EHS episode that needs to be addressed immediately.

Principle 3- Rapid cooling

It is essential for patients with EHS to be cooled as fast as possible; the key factor that determines EHS outcome is the number of minutes the individual’s core temp is greater than 40.5°C. (Figure 3). It is therefore critical that EHS is rapidly considered (recognized) and verified (diagnoses with rectal temperature) for rapid cooling to commence. Cold water immersion (CWI) has the fastest cooling rates and should be the cooling mode of choice^{21,22}. CWI equipment should be available at convenient locations in controlled athletic venues such as training venues-, endurance sports events, and competitions conducted in warm/hot environments. A few practical tips to optimize rapid cooling strategies:

- consistently stir the water during cooling
- cover as much skin surface area as possible
- drape a sheet under armpits to stabilize the patient in the tub
- use rectal thermistor to monitor core temperature during cooling
- water temperatures should be kept at 10 to 15°C (although a wide range of water temperatures will provide effective cooling rates).

- remove the patient from the CWI when his/her core temperature is 39°C.

Principle 4- On-site cooling – cool first and transport second

A key concept of effective EHS care is cool-first and transport second²³. This maximizes the opportunity for a successful outcome. An EHS patient waiting for ambulance transport to a hospital will potentially lose valuable aggressive cooling management time (often more than the recommended 30 minutes to reduce hyperthermia). It is essential for event and team medical staff and the local ambulance/hospital services to agree on (and practice) the concept of cool-first and transport second before any sporting event in the heat.

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