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ASPETAR سبيتار

Beat the heat

IAAF World Athletics Championships Doha 2019 and the Olympic Games Tokyo 2020.

Are you ready?
Give me five!

Are you prepared to compete in 10,000m or longer events in the heat?

2 weeks of heat acclimatisation/acclimation	+ 4 points
1 week of heat acclimatisation/acclimation	+ 3 points
Coming from a warm country	+ 3 points
Hydration plan	+ 2 points
Pre-cooling	+ 1 points
Per (during)-cooling	+ 1 points
Clothing limiting sweat evaporation	– 1 points
Previous history of heat illness	– 1 points

Score at least **5 points** on the above list!

Beat the heat

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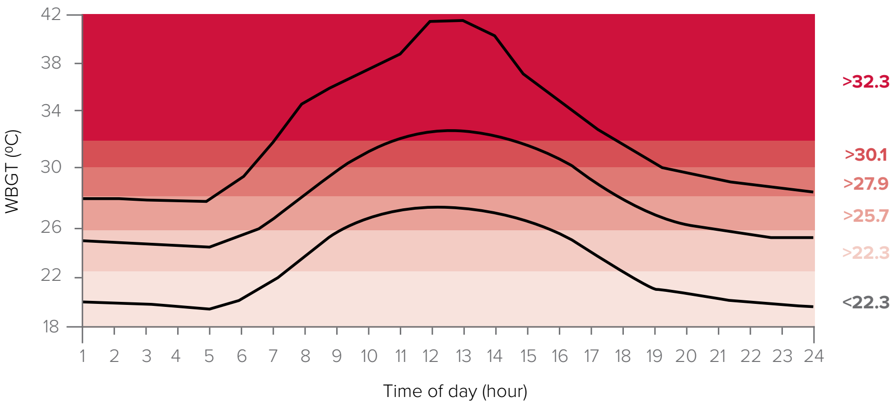
ASPETAR (Qatar) / UCRISE (Australia) / IAAF (Monaco)

The 17th IAAF World Championships Doha, Qatar 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.

These hot and humid ambient conditions limit heat dissipation capacity during exercise, thus impairing endurance performance and increasing the risk of exertional heat. The detrimental effects of these illnesses can be reduced with the adoption of counter measures such as heat acclimation. This document addresses some Frequently Asked Questions regarding athletic events under heat stress and provides recommendations to optimise performance and reduce the risk of heat illness.

Doha 2019 estimated environmental conditions

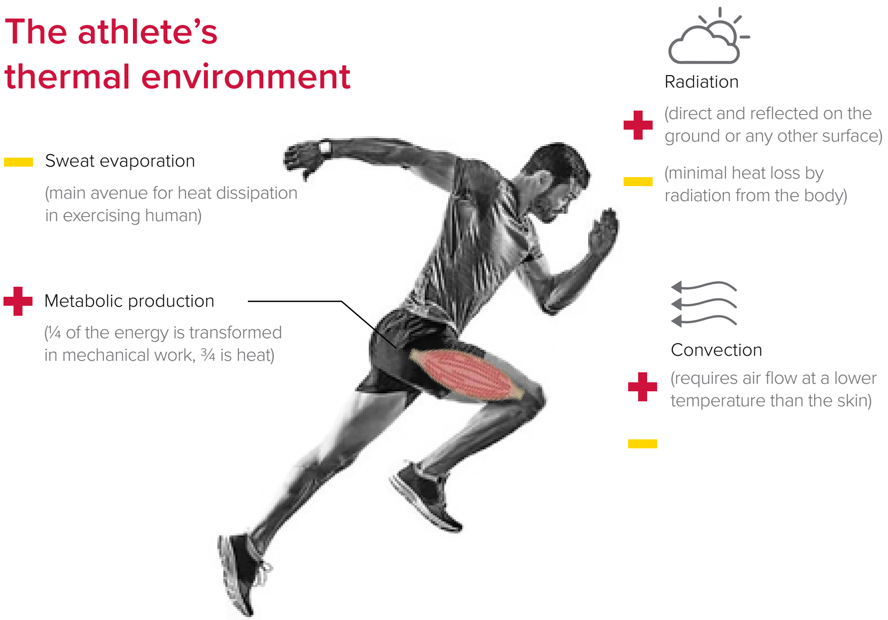


How do we maintain our temperature?

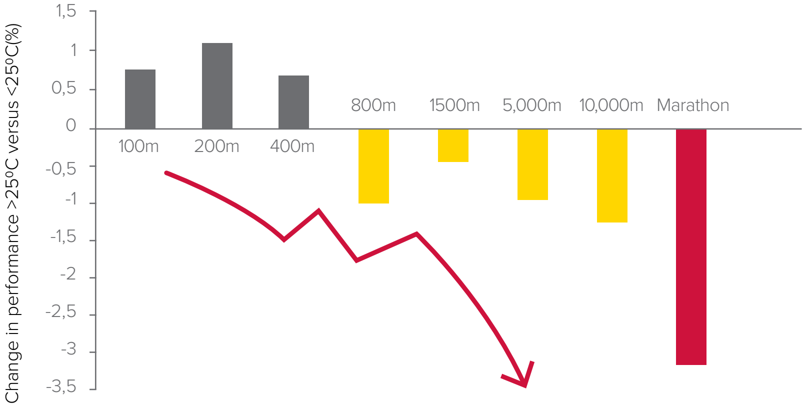
The environmental conditions during sporting events are generally estimated with the Wet-Bulb-Globe-Temperature (WBGT) index. The WBGT is calculated from the dry (standard thermometer) temperature, the wet-bulb temperature (indicative of the true capacity of the air to evaporate water according to its relative humidity and air velocity) and the solar radiation (globe temperature). Core body temperature in humans hovers around 37°C, while muscle temperature sits at ~35°C and skin temperature at ~31°C when resting in temperate environmental conditions. **When running or race-walking, muscle contractions produce a considerable amount of heat, inducing a large increase in muscle temperature,[1] which drives an increase in core body temperature.[2]**

The heat produced is dissipated to the environment via the skin through sensible (i.e. convection and radiation) and insensible evaporation heat loss pathways[3]. However, in hot ambient condition, the gradient between skin and environmental temperature is minimal, possibly even negative, such that heat dissipation occurs mainly through sweat evaporation.

The athlete's thermal environment



How does that affect performance?



The effect of temperature on running performance[10]

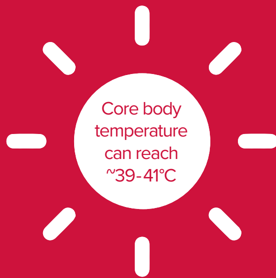
An increase in muscle temperature (e.g. through warm-up) has several benefits for explosive athletic performance such as sprints, jumps or throws[4]. However, preventing an excessive rise in core body temperature during prolonged exercise requires transferring metabolic heat from the working muscles and core, to the skin and then onto the environment.

This necessitates an increase in skin blood flow[5] and sweating[6]. These increases are larger in hot and humid conditions due to the lower capacity of the skin to dissipate metabolic heat in the surrounding environment.

This causes a rise in 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 maintained[9].

In summary, hot ambient conditions may benefit explosive events, but progressively impairs longer duration events[10].

What temperature does our body reach?



Body temperature increases after a few minutes of exercise[2]. If the heat dissipation capacities of the thermal environment (air temperature, radiant temperature, humidity, air velocity) and the athlete's heat loss pathways (acclimation, sweat rate, clothing) can compensate for the metabolic heat generated (intensity), core temperature will plateau.

However, if the heat stress is not compensable for a given work rate, core temperature will keep rising and an equilibrium may only be attained by decreasing heat production (e.g. speed).

Depending on intensity and duration, a plateau may occur anywhere around ~38.5-39°C when exercising in temperate environments. However, some athletes may reach core body temperatures above 41°C when competing in hot ambient conditions.[11]

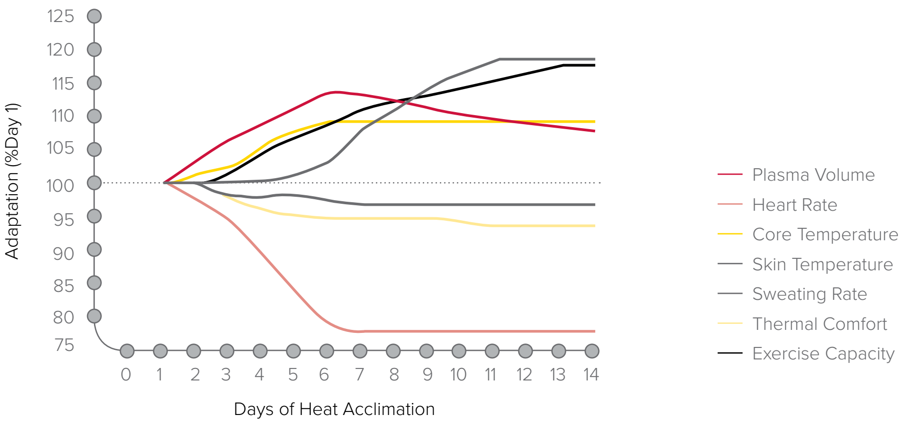
Maximal body core temperature when competing in the heat

How to best prepare to compete in the heat?

The best way to prepare for competing in the heat is to train in the heat (heat acclimatise). This is achieved via repeated exercise-heat exposures that increase body core and skin temperatures, as well as inducing significant sweating.[12]

The number of days required to achieve optimal acclimatisation varies but most adaptations develop within 7-10 days, with 14 days being optimal. It is thus recommended to train in a similar environment to the one in which competition will occur 2 weeks prior to competing in hot and/or humid conditions. Conducting an initial heat acclimatisation camp several weeks before the target event may increase the speed at which adaptations occurs in a follow-up pre-competition camp.[13] 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.

Adaptations to repeated training in the heat for un-acclimatised athletes[13]

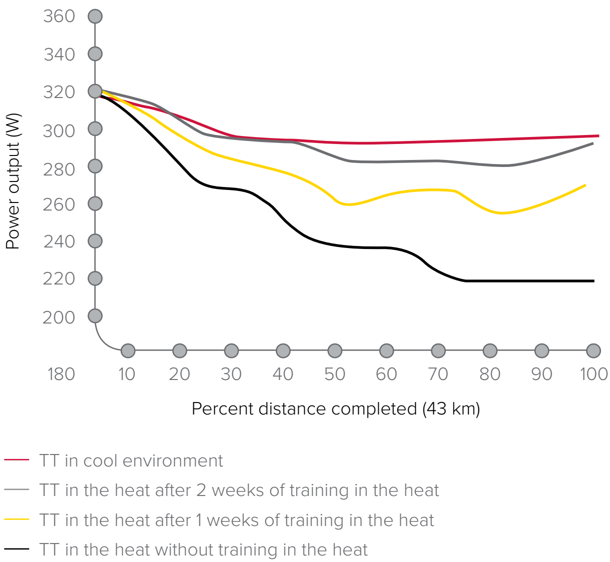


How and how much will I benefit from heat acclimatisation?

Heat stress can dramatically decrease endurance performance, but this decrement can be progressively reverted with heat acclimatisation[14]. The magnitude of decrease due to heat stress and the benefit of heat acclimatisation are larger than any other strategies (e.g. altitude camp) when competing in the heat.

Heat acclimatisation may also reduce the risk of heat illness. Thus, heat acclimatisation 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 acclimatisation does not impair performance in cooler environment and may even increase it under some circumstances[15,16].

The impact of heat acclimatisation on cycling time trial (TT) performance in the heat[14]



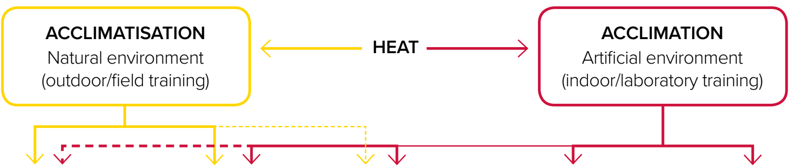
Heat acclimatisation may also reduce the risk of heat illness.

How to heat acclimatise in a cold country?

There are a wide variety of approaches that can increase core and skin temperature and stimulate sweating. If it is not possible to train in the same environment as the upcoming competition, some adaptations can be partly acquired by artificially simulating heat during indoor training (environmental chamber if available, or even some heaters and no fan).

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 core temperature being elevated from training and can therefore be combined with extra clothing during training to increase the stimulus. Water temperature should be around 40ºC to induce adaptation while remaining tolerable (this can be easily measured with a floating pool thermometer). Artificial techniques are called heat acclimation. Although not as specific as exercise heat acclimatisation, heat acclimation can be used before travelling to a hot environment to reduce the time required for acclimatisation upon arrival.[17]

The different heat acclimatisation methods[17]



Self-paced exercise	Constant work rate	Controlled intensity	Controlled hyperthermia	Passive heating
Activity Football, running etc.	**Activity** Walking at 6 km/h running at 12 km/h cycle ergometer at 185 W, etc.	**Activity** Cycle ergometer at 65% Vo2max, heart rate (eg. 145 bpm)	**Activity** Work+/- Rest to maintain core temperature at 38.5ºC	**Activity** Water immersion, or sauna bathing
Conditions Outdoor (variable) Indoor (40ºC,40%RH)	**Conditions** Outdoor (variable) Indoor (40ºC,40%RH)	**Conditions** Indoor (40ºC,40%RH)	**Conditions** Indoor (40ºC,40%RH)	**Conditions** Water 40-42ºC, or Sauna 70-90ºC
Duration 60-90 min	**Duration** 60-90 min	**Duration** 60-90 min	**Duration** 60-90 min	**Duration** 45-60 min, or intermittent for 30 min

When to heat acclimatise?

Despite the benefits of heat acclimatisation, only 15% of the athletes participating in the 2015 IAAF World Championships (Beijing), which were held in a hot and humid environment, prepared by specifically training in the heat ahead of time[18]. Some degree of heat acclimatisation is obtained by regular training, even in cool conditions, but the most efficient method for obtaining all benefits is to train in conditions similar to the upcoming competition. Depending on the travel plan, this can be achieved partially or totally before arriving at the competition venue.

Example of heat acclimatisation strategies depending on travel requirements

How does hydration impact on performance?

Heat dissipation relies on sweat evaporation. However, profuse sweating may lead to progressive dehydration if fluids are not sufficiently replaced.[19-21] Severe dehydration intensifies the rise in whole-body temperature and impairs 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, enough (see below) hydration prior to and during exercise and in recovery is important for athletes to perform well and ensure their safety in the heat.

Dehydration level when competing in the heat

How much to drink?

Drinking to thirst is adequate for exercise lasting less than 1-2h in cool environments. However, a planned drinking may optimise 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).[22] Individuals with high sweat rates and/or those concerned with exercise performance should determine sweat rates under conditions (exercise intensity, pace) and environments similar to that anticipated when competing and tailor drinking to **prevent body mass losses exceeding 2-3%**.

This individual prescription must remain within the limits of the how much fluid can be absorbed by the body (~1.2 L/h). It is also important to recognise that hydration regimens should never result in over-hydration, as this can have serious health consequences (so called “hyponatremia”, an imbalance of the salts in the body) 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 colour in the morning (first void) can help athletes assess fluid losses through sweating and estimate hydration needs and status.

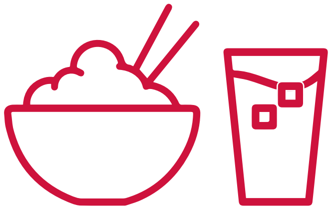
What colour is your urine?

It is also important to recognise that hydration regimens should never result in over-hydration.

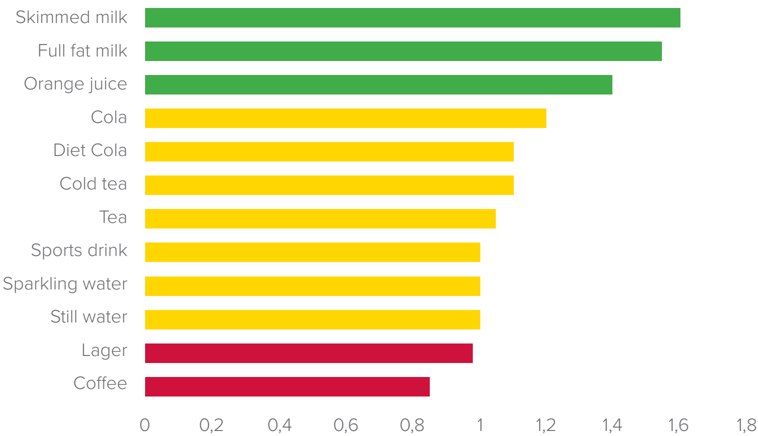
What to drink?

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 include 30–60 g/h of carbohydrates to drinks for exercise 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.

Following training or competing in the heat, recovery drinks should include sodium, carbohydrates and protein to optimise recovery. The preferred method of rehydration is through the consumption of fluids with foods, including salty food.



Hydration index (i.e. amount of water retained as compared to still water) of common beverages[23]



What about pre and per-cooling?

Before the start of the event, it is advisable to minimise unnecessary heat exposure and heat gain. Athletes should therefore warm-up in the shade if possible.

They might also consider external (ice-vests, cold towels, or fanning) and internal (cold fluid or ice slurry ingestion) precooling methods, or a mix of both.

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 sun-screen (water-based sun screen should be preferred to oil-based sun-screen that may affect sweating). Lightly coloured 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 individualised during training and not in competition, to minimise disruption to the athlete.

During warm-up, consider using:

ICE SLURRY

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