

BEAT THE HEAT

in World Athletics Road Races



CONTENTS

Are you prepared? Calculator.	pg.4
How is body temperature maintained?	pg.5
How does heat affect performance?	pg.6
What temperature does our body reach?	pg.7
How to best prepare to compete in the heat?	pg.8
How much can performance be improved by heat acclimatization?	pg.10
How does hydration impact performance?	pg.11
How much to drink?	pg.12
What to drink?	pg.13
What about pre and per-cooling?	pg.15

PREPARED TO COMPETE IN THE HEAT? GIVE ME FIVE!

ARE YOU PREPARED TO COMPETE IN THE HEAT?

2 weeks of heat acclimatization/acclimation	+ 4 points
1 week of heat acclimatization/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
I am taking approved medication that can reduce my heat tolerance	- 1 points

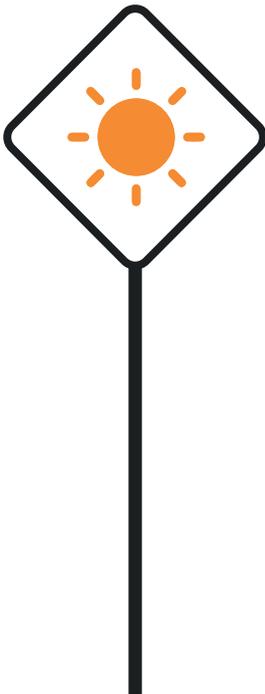
SCORE AT LEAST **5 POINTS** ON THE ABOVE LIST!

BEAT THE HEAT

Out of the several thousands of road races that take place every year, many of them are held in hot and humid environmental conditions.

Hot and humid ambient conditions limit heat dissipation capacity during exercise, thus impairing endurance performance and increasing the risk of exertional heat illness such as heat cramps, heat exhaustion, and heat stroke.

The risk of heat illness can be reduced by adopting countermeasures such as heat acclimation/acclimatization. This document addresses some Frequently Asked Questions about performing at athletic events in hot and humid ambient conditions and provides recommendations to optimise performance and reduce the risk of heat illness.



HOW IS BODY TEMPERATURE MAINTAINED?

When resting in temperate environmental conditions:

- core body temperature in humans is around 37°C
- muscle temperature is approximately 35°C
- skin temperature is approximately 31°C

During physical exertions such as running, muscle contractions produce a considerable amount of heat, inducing a large increase in muscle temperature, which drives an increase in core body temperature.



The heat produced by the body is dissipated to the environment via the skin primarily in the form of sweating.

THE ATHLETE'S THERMAL ENVIRONMENT

 Sweat evaporation
(main avenue for heat dissipation in exercising human)

 Metabolic production
($\frac{1}{4}$ of the energy is transformed in mechanical work, $\frac{3}{4}$ is heat)



Radiation

 (direct and reflected on the ground or any other surface)

 (minimal heat loss by radiation from the body)

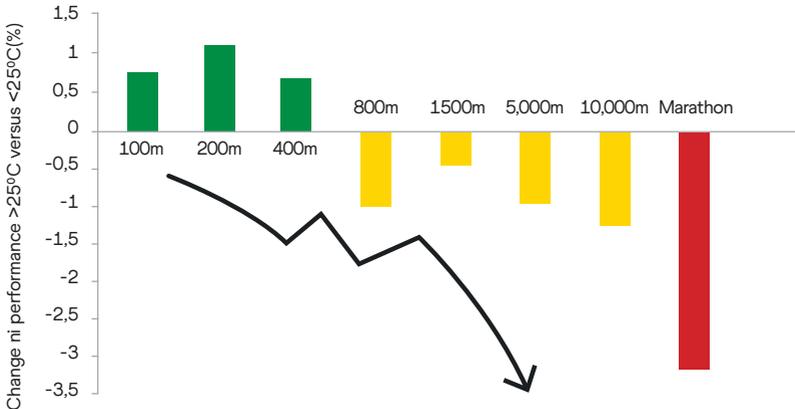


Convection

 (requires air flow at a lower temperature than the skin)



HOW DOES HEAT AFFECT PERFORMANCE?



THE EFFECT OF TEMPERATURE ON RUNNING PERFORMANCE

An increase in muscle temperature (e.g. through warm-up) has several benefits for explosive athletic performance such as sprints, jumps or throws. However, endurance events in the heat can be negatively affected by high body core temperature. The increase in body core temperature has a direct impact on the cardiovascular strain that, when significant, increases perception of effort and this will inevitably impact the exercise capacity (e.g. reduce speed).

In summary, hot ambient conditions may benefit performance during short duration explosive events, but progressively impairs performance during longer duration events.

WHAT IS THE BODY TEMPERATURE RESPONSE DURING EXERCISE?



Body temperature increases after a few minutes of exercise. If the heat stress is not effectively compensated, core temperature will keep rising unless heat production is reduced (e.g. reduce speed).

Depending on the intensity and duration of the exercise, a stabilization in body temperature may occur anywhere around 38.5-39°C when exercising in temperate environments. However, athletes can achieve a core body temperature above 41°C when competing intensely in hot ambient conditions.

Maximal body core temperature when competing in the heat

Core body temperature can reach ~39-41°C

VISIBLE BODY ADAPTATIONS TO REPEATED HEAT TRAINING:

- Increased sweat rate
- Decreased heart rate at a given intensity
- Better retention of electrolytes
- Decreased body core temperature



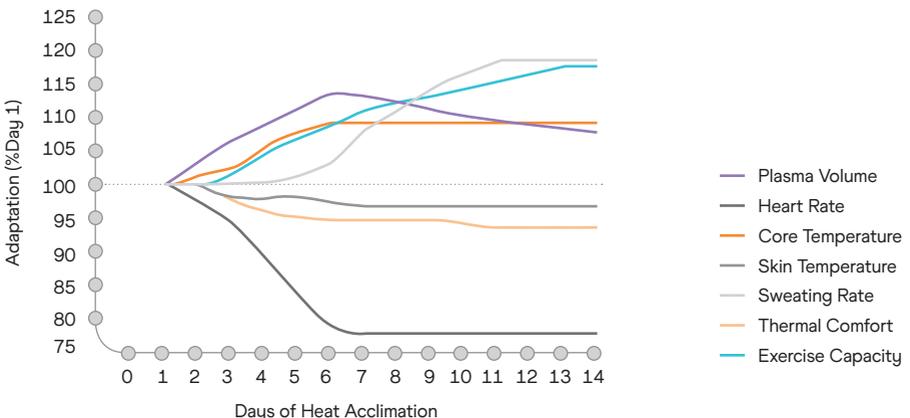
HOW TO BEST PREPARE TO COMPETE IN THE HEAT?

Train in the heat. Heat adaptation is achieved via repeated exercise-heat exposure that increases body core and skin temperatures as well as induces significant sweating. This can be achieved using hot ambient conditions (acclimatization) or by simulating hot ambient conditions by using environmental chambers or improvised “hot rooms” (acclimation).

14 days is the preferred adaptation period. Most adaptation tends to occur within 7-10 days, but 14 days is optimal for most. It is therefore recommended that athletes train in a similar environment to the one in which competition will occur for two weeks prior to competition.

Initial heat acclimatization camp can enhance rate of adaptation. Conducting an initial acclimatization camp several weeks before the target event may also enhance the rate of adaptation in a follow-up pre-competition camp.

ADAPTATIONS TO REPEATED TRAINING IN THE HEAT FOR UN-ACCLIMATISED ATHLETES



HOW MUCH CAN PERFORMANCE BE IMPROVED BY HEAT ACCLIMATIZATION?

Heat acclimation is far more important than other performance enhancing strategies such as altitude training when competing in the heat. Heat acclimatization will also reduce the risk of heat illness. Therefore, heat acclimatization should be a priority before any event where hot and/or humid conditions are likely or expected. Indeed, heat acclimatization does not impair performance in cooler environment and may even enhance performance under certain conditions.

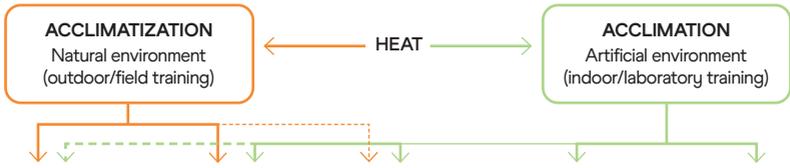
HOW TO HEAT ACCLIMATISE IN A COLD COUNTRY?

There are a wide variety of approaches that can increase core and skin temperature and stimulate sweating. These are:

- **Train for 60-90 minutes a day in the same ambient conditions as the upcoming competition for 2 weeks.** However, if not possible, most adaptations can be acquired by artificially simulating heat during indoor training (i.e. use of a purpose-built environmental chamber if available, or even using heaters and boiling water to artificially create hot and humid ambient conditions). If not possible, other alternatives should be considered like using passive heat acclimation techniques such as hot water immersion or sauna bathing for 30-40 minutes pre- or post-training but overall benefits of passive heat acclimation will be less than training in hot ambient conditions. Water temperature should be around 40°C in order to cause adaptation while remaining tolerable (this can be easily measured with a floating pool thermometer).

Collectively, artificial techniques aimed at inducing heat adaptation are called heat acclimation. Although not as specific as exercise heat acclimatization, heat acclimation can be used before travelling to a hot environment to reduce the time required for acclimatization upon arrival.

THE DIFFERENT HEAT ACCLIMATIZATION METHODS



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% Vo^{2max} , heart rate (e.g. 145 bpm)	Activity Work +/- Rest to maintain core temperature at 38.5°C	Activity Water immersion, or sauna bathing
Conditions Outdoor (variable) Indoor (40°C,40%RH)	Conditions Outdoor (variable) Indoor (40°C,40%RH)	Conditions Indoor (40°C,40%RH)	Conditions Indoor (40°C,40%RH)	Conditions Water 40-42°C, or Sauna 70-90°C
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

EXAMPLE OF HEAT ACCLIMATIZATION STRATEGIES DEPENDING ON TRAVEL REQUIREMENTS

2 weeks acclimatization before travelling



Acclimatization in advance + maintenance 1 session/week



Pre acclimation + 1 week acclimatization upon arrival



2 weeks acclimatization upon arrival

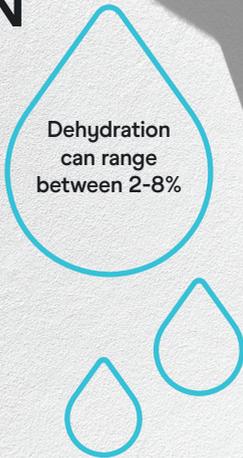


-7 -6 -5 -4 -3 -2 -1 Competition
Weeks

HOW DOES HYDRATION IMPACT PERFORMANCE?

Heat dissipation relies on sweat evaporation. However, profuse sweating may lead to progressive dehydration if fluids are not sufficiently replaced. Severe dehydration accelerates the rise in body temperature and impairs prolonged exercise performance. Therefore, a sufficient intake of fluids before, during and after exercise is necessary for athletes to perform well and stay safe when competing in hot and humid ambient conditions.

DEHYDRATION LEVEL WHEN COMPETING IN THE HEAT



Dehydration can range between 2-8%

HOW MUCH TO DRINK?

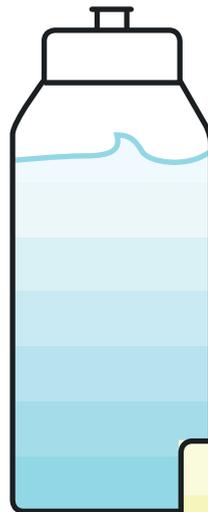
Drinking to thirst is adequate for exercise lasting less than 1-2 h in cool environments.

Planned drinking may enhance sporting performance during activities lasting more than 90 minutes, particularly during high-intensity exercise in the heat that elicits high sweat rates.

Beware of overhydration. It is also important to recognise that hydration regimens should never result in significant 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 result in death.

Simple techniques such as measuring body mass 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.

Prepare in advance. It is of paramount importance that athletes establish their optimal personal drinking strategies during training and well before arriving at the competition.



WHAT COLOUR IS YOUR URINE?



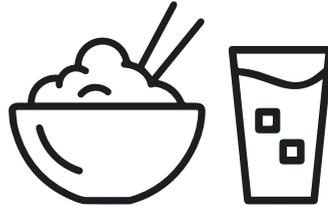
○ **It is also important to recognise that hydration regimens should never result in over-hydration.**

DO NOT OVERDRINK

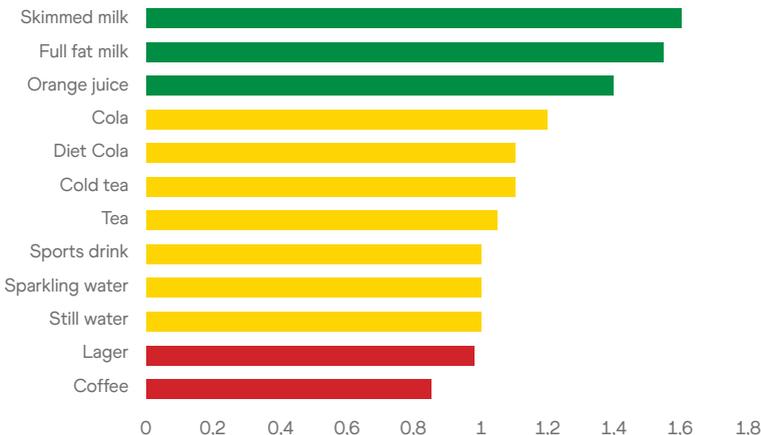
WHAT TO DRINK?

Sodium (salt) supplementation during exercise lasting longer than 1 h is recommended for heavy and “salty” sweaters. Sodium intake may be increased before and after hot-weather training and racing. Electrolyte tablets or some salt (a pinch of salt at a time) may be used by athletes during training and competition by those who tolerate it. It is also advisable to include 30–60 g/h of carbohydrates to drinks for sporting performances lasting about 1 h and up to 90 g/h for longer events. These recommendations can be achieved through a combination of fluids and solid foods. After training or competition in the heat, recovery drinks should include sodium, carbohydrates and, if necessary, 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



WHAT ABOUT PRE AND PER-COOLING?

Before the start of the event, it is advisable to:

- **Minimise unnecessary heat exposure**, athletes should therefore warm-up in the shade if possible;
- **Consider external (ice-vests, cold towels, or fanning) and internal (cold fluid or ice slurry ingestion) pre-cooling methods**, or a combination of both. One option is the use of commercially available ice-cooling vests during warm-up, which can provide effective cooling without affecting optimal muscle temperature and function.

During competition, athletes should:

- **Protect their eyes**, by wearing UV ray blocking sunglasses in a dark tint (i.e. grade 3)
- **Protect their skin** by using non-greasy sun-screen (water-based sun screen should be preferred to oil-based sun-screen that may affect sweating).
- **Wear lightly coloured clothing** that 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 are less evidence-based but may offer some psychological benefit.
- 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:



DO MEDICATIONS HAVE AN IMPACT ON HEAT STRESS DURING EXERCISE?

The use of prescribed or over-the-counter medication can have a significant impact on the body capacities of dissipating heat. The following medications have been demonstrated to have a direct effect on central temperature control and heat dissipation:

- Diuretics (such as furosemide, acetazolamide, amiloride, bumetanide, torsemide, hydrochlorothiazide, spironolactone and metolazone);
- Non-steroidal anti-inflammatory drugs (NSAIDs, such as aspirin, ibuprofen, naproxen and ketoprofen);
- ADHD medications (such as methylphenidate and dextroamphetamine-AMP);
- Selective serotonin reuptake inhibitors (SSRIs, such as fluoxetine, sertraline, paroxetine and citalopram);
- Ephedrine containing medications.

Individuals taking these medications should be aware of their potential increased risk of heat-related illnesses during exercise and should consult their physician prior to conducting any form of exercise. Especially when exercise will be conducted in an extreme environment such as heat.



WORLD
ATHLETICS™

healthandscience@worldathletics.org

www.worldathletics.org



@worldathletics

IN COLLABORATION WITH

