Advice Hyperthermia May 2023

This advice has been written by the medical committee of the International Korfball Federation based on documents available in the literature and from other sport associations as a advice towards players, staff, referees, volunteers and IKF employees.

In hyperthermia, a distinction is made between heat exhaustion and a heat stroke, in which the temperature has risen above 41.5 degrees.

An athlete benefits from good temperature regulation of the body. Due to good temperature regulation, the core temperature can remain low during exercise (eg 38.5 degrees), which improves the athlete's performance. This temperature can already be reached at 'normal' outside temperatures but is reached more quickly in a warm environment (high outside temperature and high humidity). Every person has their own maximum 'critical' core temperature. The body has several measures to ensure that this temperature is not exceeded or reached too quickly. One of the measures is to reduce the effort, so that the body temperature rises less quickly. This has a direct negative effect on performance. In addition, the body responds to the rise in temperature by increasing the blood flow in the skin and by stimulating sweat production. This allows the body to release the heat to the environment. Because the skin blood flow increases, the muscle blood flow decreases, with the logical consequence that the oxygen supply of the muscles will decrease. As a result, performance also decreases. In addition to the loss of performance due to reduced muscle blood flow, performance loss can also occur due to losing too much fluid through sweating (dehydration). After all, 1% water loss from the body causes a decrease in performance of about 4%, a water loss of 2% even leads to about 8% reduction in performance. It should be clear that this can win games… or lose!
Optimal temperature regulation can lead to a 15% performance improvement. Much research is being done into the temperature management of the body during exercise under different conditions, such as the outside temperature and humidity and the performance that can be delivered under those conditions. Good cooling strategies are then of great importance to find the optimum temperature for maximum performance. In addition to optimizing the body temperature, it also happens that our core temperature rises to values above 40 degrees Celsius. There is an exercise-related hyperthermia if the core temperature of the body rises above 40 degrees Celsius due to the effort. Healthy athletes, including military personnel, can become hyperthermic during intensive exercise.

However, if other factors are involved, such as a high outside temperature and poor moisture balance or other so-called intrinsic or extrinsic factors, then heat-related conditions can arise:

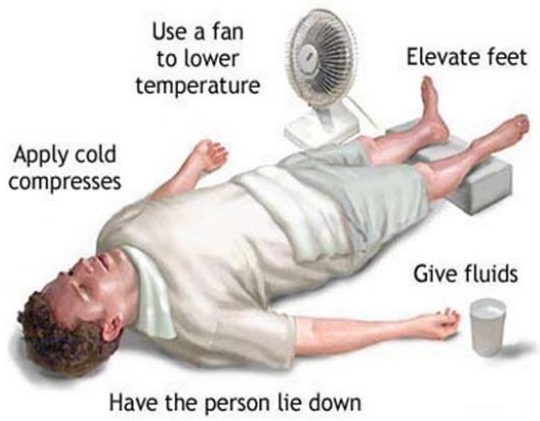
We then distinguish:

Heat cramp:
A common heat ailment is cramping. These are painful contractions of the muscles, usually the calf muscle. This is the result of extreme fluid loss and insufficient drinking, which disrupts the balance between the salts in the body cells (sodium, potassium, calcium).
Therapy:

The cramp disappears when there is a correct balance again. Drinking is often the best remedy. If necessary, a muscle can be stretched and cooled.

Heat Exhaustion:
A form of exhaustion due to fluid and/or salt loss, in which the body retains more heat than it loses. This is possible if the humidity level of the air is high and good ventilating clothing is not worn. Heat exhaustion gives a flu-like picture. The victim has a headache and is nauseous and has cool skin due to heavy sweating. The athlete often stumbles over the track as a sign of starting consciousness problems. Heat exhaustion can progress to heat stroke.

Therapy:



:

Place the athlete on the ground in a cool area in the shade. Legs slightly up, clothes off or open, hydrate and cool. Measure the temperature of the stretch and keep a close eye on the athlete. (ABCDE). If the person loses consciousness, call 112 immediately
Heat stroke:
An exercise-related heat stroke (also called heat stroke) is a severe form of heat exhaustion, which causes tissue damage. Heat stroke is often accompanied by convulsions and loss of consciousness.
Heat stroke is a very serious heat injury, which can lead to death in a short time if no action is taken or if it is treated too late. Early recognition and treatment by rapid and aggressive cooling is of great importance.
Recognize heat stroke
How do you recognize heat stroke? Recognizing yourself, as a runner, that is quite difficult. There can be several symptoms that can be a precursor to heat stroke. These symptoms are sometimes physical, such as cramping, pale skin, tingling fingers, cessation of sweating. You can reasonably recognize these symptoms, but sometimes they do not occur, or you are not sensitive to them in the heat of battle. The other symptoms are of a neurological nature, such as staggering, high heart rate, no longer being able to speak properly, dizziness, tunnel vision, nausea, convulsions, hallucinations and finally coma. As an athlete you often no longer realize that these symptoms occur, and it is then important that fellow runners or the public or caregivers observe these symptoms and make the diagnosis. But sometimes it goes so fast and none of these symptoms come on first and suddenly it's over and out and you lose consciousness. If the temperature is above 40 degrees and there is neurological dysfunction, then you are dealing with an exercise-related (exercise-induced) heat stroke or heatstroke.

Treatment of heat stroke
If an athlete goes into heat stroke due to the exertion, it is necessary to aggressively cool this person as soon as possible to stop the tissue damage caused by the overheating. In this case, always call 112 and use the ABCDE method, and if you find that the temperature measured rectally is above 40 degrees and the heart is still functioning, cooling with the available resources is the order. Place the athlete in a cool shaded area and then begin treatment. The different cooling options have their different cooling coefficients expressed in degrees per minute. The best method to cool an overheated person is the cooling bath. The cooling coefficient here is 0.2 to 0.3 degrees Celsius drop per minute. Other cooling methods, such as cold packs, have a very low cooling

coefficient and are therefore not very effective. Cold running water from the tap or garden hose or water from the ditch then has a better effect. But know that every little bit helps and starting cooling quickly is crucial. Stacking of the cooling methods is allowed.
Do you doubt whether the temperature is above 40 degrees because, for example, you initially quickly measure a lower value with an ear thermometer, then cool anyway, it never hurts to cool a person if they have made a considerable effort and show neurological dysfunction and it's not freezing cold.
Just make sure that you can measure stretch language when cooling down and that you stop the cooling down as soon as the athlete's temperature has dropped below 38.9 degrees. (A rule of thumb is 1 degree drop in core temperature per 5 minutes). Good clinical observation is of course always required.
An investigation into the cooling coefficients of the different cooling methods yields the following overview, which shows that the best cooling coefficient is achieved by immersion in an ice-cold cooling bath. An ice bath will not be available everywhere and then mobile cooling methods are second best, such as towels soaked in ice water, a tarp in which the athlete is placed, and over which water is poured (Tarp method) or cold water via a garden hose from the tap or cold water from the ditch. Cold packs or a fan can also be used but have a very small cooling coefficient.

Cooling by immersion or Cold-Water Immersion is the best cooling method.
The chance of survival is inversely related to the time it takes to cool an overheated athlete back to 38.9 degrees Celsius.

Cooling in the cooling bath. Cold Water Immersion
This method consists of immersing the athlete in a bath with a temperature of 5-10 degrees Celsius, until the athlete's temperature (measured rectally) is below 38.9 degrees). In this way the heat stroke is stopped the fastest and the damage in the body is minimized and the athlete's recovery from the heat stroke is often prosperous compared to the other cooling methods, where the process of cell denaturation and rhabdomyolysis takes longer. can go. The use of a cooling bath can only take place under the medical supervision of a responsible doctor and also requires 2 first aiders and 2 nurses for proper implementation. In addition to the (inflatable) cooling bath and ice-cold water, a water-permeable lifting sheet and a long watertight rectal thermometer are also required, so that the temperature can be measured during the immersion.
The Red Cross has made an instructional film about the treatment of the heat stroke by aggressive cooling and the use of cooling baths
A national protocol has been developed by the Running and Hyperthermia working group that is used to treat heat stroke in a responsible manner using the cooling bath (Cold Water Immersion). This protocol is now part of the guidelines for endurance sports, part of the field standard for event management.
The clinical distinction between the various heat-related illnesses is well illustrated by the 2015 National Athletic Trainers' Association position statement on Exertional Heat Illnesses in the Journal of Athletic Training in the following overview:

Table 3. Clinical Distinctions of Exertional Heat Illnesses

	Heat Illness			
Characteristic	Exercise-Associated Muscle (Heat) Cramps	Heat Syncope	Heat Exhaustion	Exertional Heat Stroke
Description	Acute, painful, involuntary muscle contractions presenting during or after exercise	Collapsing in the heat, resulting in loss of consciousness	Inability to continue exercise due to cardiovascular insufficiency	Severe hyperthermia leading to overwhelming of the thermoregulatory system
Physiologic cause	Dehydration, electrolyte imbalances, and/or neuromuscular fatigue	Standing erect in a hot environment, causing postural pooling of blood in the legs	High skin blood flow, heavy sweating, and/or dehydration, causing reduced venous return	High metabolic heat production and/or reduced heat dissipation
Primary treatment factors	Stop exercising, provide sodium-containing beverages	Lay patient supine and elevate legs to restore central blood volume	Cease exercise, remove from hot environment, elevate legs, provide fluids	Immediate whole-body cold-water immersion to quickly reduce core body temperature
Recovery	Often occurs within minutes to hours	Often occurs within hours	Often occurs within 24 h; same-day return to play not advised	Highly dependent on initial care and treatment; further medical testing and physician clearance required before return to activity

Factors that can influence the temperature regulation of the body fall into 2 categories, the extrinsic factors, factors from outside the body and intrinsic factors, factors that influence temperature regulation from within the body. The following table from the 2015 National Athletic Trainers' Association position statement on Exertional Heat Illnesses article in the Journal of Athletic Training summarizes the most well-known factors:

Table 6. Risk Factors for Exertional Heat Stroke[69,90]

Extrinsic Risk Factors	Intrinsic Risk Factors
High ambient temperature, solar radiation, and high humidity	High intensity of exercise and/or poor physical conditioning
Athletic gear or uniforms	Sleep loss
Peer or organizational pressure	Dehydration or inadequate water intake
Inappropriate work-to-rest ratios based on intensity, wet-bulb globe temperature, clothing, equipment, fitness, and athlete's medical condition	Use of diuretics or certain medications (ie, antihistamines, diuretics, antihypertensives, attention-deficit hyperactive disorder drugs)
Predisposing medical conditions	Overzealousness or reluctance to report problems, issues, or illnesses
Lack of education and awareness of heat illnesses among coaches, athletes, and medical staff	Inadequate heat acclimatization
No emergency plan to identify and treat exertional heat illnesses	High muscle mass-to-body fat ratio
Minimal access to fluids before and during practice and rest breaks	Presence of a fever
Delay in recognition of early warning signs	Skin disorder

- The Extrinsic factors (factors that influence the individual from the outside to develop a heatstroke) are:
- • Ambient temperature: Heat strokes can occur from a wind chill (Wet Bulb Globe Temperature) above 15 degrees Celsius, the number of heat strokes increases exponentially above 18 degrees, especially in 10 mile runs and half marathons.
- • Clothing: dressed too warmly, so that heat emission is hindered.
- • Peer pressure: encouragement from teammates or the public, as a result of which signals are not properly listened to.
- • Give little rest: or be granted and keep going.
- • No access to moisture: If no moisture/water is available before and during race.
- • Lack of knowledge: about the phenomenon of heatstroke among runners, coaches, organizers and care providers, as a result of which a heatstroke is not recognized in time and treated correctly.
- • Not recognizing symptoms in time and lack of treatment plan : Recognizing in time and having the resources available to take someone out of the race and cool down is crucial to nip a heatstroke in the bud. Cool first and then transport!
- The Intrinsic factors (factors that influence the development of a heat stroke from within the individual) are:
- • Making a great effort Especially when performing at peak power for 1 hour to 2 hours. Most heat strokes occur in the 10 km, 15 km, 10 miles or half marathons. These distances are run at high power and with little time/attention to the fluid balance.
- • Dehydration If not enough is drunk before or during the run, the fluid balance will be disturbed and cooling of the body will be endangered. (Like an empty radiator in a car..)
- • Higher heart rate At the same effort (eg when running at the same pace), which may indicate an underlying flu or inflammation or just not quite 100 percent, which unnoticed requires an increase in the body's ability to perform at the same level, which ultimately increases the risk of a heat stroke.
- • Age (inversely correlated), Young athletes are often victims of a heat stroke. They are motivated to deliver top performance, and therefore run at maximum power. If they cannot dissipate the heat properly, this increases the risk of heat stroke.
- • Insufficient acclimatization. Acclimatization ensures that our vascular system adjusts to the weather conditions where the performance must be delivered. One can be acclimatized after a few days to a few weeks.
- Sleep Deprivation, Stress. Too little sleep and stress at work are factors that can contribute to a heat stroke.
- Use medication, skin problems. Certain medications such as antihistamines, diuretics, antihypertensives and ADHD drugs etc can contribute to the development of a heat stroke. If you have skin problems that make it impossible to perspire properly, this also increases the risk of a heat stroke.
- Suppress signals. Signs that may indicate the development of a heat stroke, such as cramps, swaying, excessive sweating (followed by no longer sweating if the fluid balance is completely disturbed), inability to think, hear or speak properly (the feeling that you are walking in a tunnel ..), pale skin etc, should be taken seriously, they are all indicators of an upcoming heat stroke

- Body Mass Index/Obesity An athlete with a high BMI will in most cases have to deliver more power to deliver the same performance as someone with a lower BMI, so that the core temperature will be higher for the athlete with a high BMI, all other things being equal. BMI.
- Poor/moderate physical fitness If you have not trained well, or if you have poor physical fitness for other reasons, the chance of a heat stroke is greater if the same performance is required.
- Recent/current illness/fever If you have had the flu in the last 2 weeks or if you have a fever or throat infection, you run a higher risk of a heat stroke. In those cases, do not exercise
- Strong Rise Tcore during warm-up If the core temperature rises sharply during the warm-up, then the chance of a high core temperature, above 40 degrees after a 15 km run, is greater than for an athlete whose core temperature during the warm-up not rising as much.
- Previously measured maximum T core If you have previously developed a high core temperature (eg 40 degrees after a 15 km run), you will probably also get that the next time.
- Genetic factors (this is the subject of research) Not much is known about this at the moment.

The core temperature is a result of all these factors. Being able to measure and monitor the core temperature is therefore very important in order to signal in good time that a critical limit has been reached above which heat stroke is lurking and the effort must be stopped.

Measuring Body Temperature
There are many methods to measure body temperature:

- Esophageal is the gold standard (the core temperature measured at the bottom of the esophagus). This method is not practically applicable in the field.
- Rectal, the well-known method, lags slightly behind core temperature, but is a reliable way to measure an athlete's core temperature to assess whether heat stroke is present.
- Intestinal, with a sensor that is swallowed and that can continuously measure the core temperature in the intestines (not in the stomach). This is often not applicable to the field.
- Tympanometry: Ear thermometer, with which a first impression of the core temperature can be obtained quickly, but this is unreliable when measuring an athlete outside, there can sometimes be a difference of 2 degrees between core temperature and the measured ear temperature. If you have nothing else, measure both ears and quickly add 2 degrees to the measured value. So if you measure 39 degrees, the core temperature may be 41 degrees. If you measure 35 degrees, the core temperature will probably not be above 40 degrees. However, if the runner shows signs of overheating (loss of consciousness, etc.) then go ahead and measure the rectal temperature.
- Oral: Measuring the temperature in the mouth is influenced by breathing and outside air and is also not reliable for estimating core temperature.

Acclimatization

In order to be able to perform optimally (and medically responsible!) in a warm and humid environment, athletes must be sufficiently acclimatized to the weather conditions. In the event of an acute increase in the outside temperature, there is therefore no real acclimatization and certain athletes may experience more problems than others. At the beginning of the stay in a warm environment, the body undergoes some changes. Because the body wants to lose heat, the skin blood flow increases. As a result, less fluid remains in the 'big' blood vessels, which the body initially wants to compensate for by a higher heart rate (particularly during exercise). The body then takes measures to increase the amount of fluid in the large blood vessels (so drink more!). As a result, the heart rate slowly decreases again for a few days. Acclimatization therefore means that after the acute I ncrease in heart rate and temperature, there is a slow decrease in heart rate, an increase in sweat secretion and a decrease in body temperature. Research shows that acclimatization to warm environments, with or without high humidity, takes about 7 to 14 days. The body has already largely adapted in the first 4 to 6 days (especially the heart rate), in the 2nd week there are still adjustments in the sweat mechanism. It also appears that well-trained people adapt faster to a warmer climate than less well-trained people. Well-trained people can also handle the transition from a warm to a cool climate better.

Hydration

Drinking is very important to prevent overheating and loss of performance. Sufficient fluid intake should be done before, during and after exercise. See enclosed box for amounts of fluid intake. It is important that no water (hypotonic) but isotonic drink is drunk. Isotonic drink is water with a quantity of dissolved particles (salt and sugar) that corresponds to someone's 'body water'. Ordinary water contains hardly any dissolved particles. The advantage of an isotonic drink is that it is quickly absorbed (together with the ingested food!).
In addition, a hypertonic drink is available. Hypertonic means that it contains a higher concentration of dissolved particles than in body water. The disadvantage of this drink is that the moisture and dissolved particles are slowly absorbed from the intestines.
In addition to the rapid absorption from the intestines, isotonic drink has the advantage that the salt expelled is replenished. Low salt levels (hyponatremia) can be dangerous. Hyponatremia can cause cerebral edema (swelling of the brain), which can have disastrous consequences (starting with a headache).
The salt (sodium) in the blood also has a function to retain water. This means you urinate less and therefore lose less fluid. In a warm environment you can choose to adjust the ratio of salt and sugar in the bottle. After all, you lose more salt in warm weather. So: lower the amount of sugar in the bottle and add more salt.

Drinking tips

- Weigh yourself before and after competitions to chart how much fluid you are losing. The difference in weight is almost equal to the sweat loss
- Drink about 1.5 times as much fluid as you lose in sweat (about 1 liter per hour)
- Always drink large sips at a time. Frequent small sips stimulate the stomach less well, so that gastric emptying is slower
- Body weight may have decreased by a maximum of 1-2% after exercise
- General: your urine output must be sufficient (at least 1.5 liters per day)
- Drinking is not necessary during an effort shorter than 45 minutes. It goes without saying that sufficient should be taken in the hours before the effort

Clothing

In order to properly lose excess body heat, the right choice of clothing is crucial. Therefore, make sure that you do not cut back on clothing, but use high-quality clothing. The following tips will come in handy:

- Do not dress too warmly and choose clothing that limits the evaporation of sweat as little as possible. So use "breathable" clothing
- White clothing has the best reflection of heat from the environment, in contrast to black clothing. White clothing is therefore preferred
- Protect your head and neck when exposure to direct sunlight is unavoidable (eg a headscarf).

Return to play

After an exercise heatstroke episode has occurred, physiological changes, such as heat tolerance, can be temporarily and sometimes permanently impaired. Long-term complications and morbidity are directly related to the time the core body temperature remained above the critical threshold. To safely return an athlete to full participation after a heatstroke, a specific return-to-play (RTP) strategy must be implemented.

The following guidelines are recommended for RTP:

- Physician approval prior to return to physical activity. The athlete must be asymptomatic and laboratory tests must be normal.
- The length of the recovery time is mainly determined by the severity of the incident.
- The athlete should avoid physical activity for at least one (1) week after the incident.
- The athlete should begin a gradual RTP protocol under the direct supervision of an appropriate health care professional, such as an athletic trainer or physician.
- The type and length of the RTP program may vary from person to person, but a general program may include:
    - Easy to moderate exercise in a climate-controlled environment for several days, followed by vigorous exercise in an air-conditioned environment for several days
    - Easy to moderate exercise in the heat for several days, followed by vigorous exercise for several days in the heat
    - If applicable to the individual sport: several days of light to moderate exercise in the heat with equipment, followed by several days of heavy exercise in the heat with equipment

References:

- Ned Tijdschr Geneeskd. 1994;138:910-3
- https://www.sportzorg.nl/sport-bewegen/bibliotheek-archief/warmte-en-inspanning
- https://nocnsf.nl/nieuws/2023/06/tien-tips-voor-sporten-bij-extreem-warm-weer
- https://www.topsporttopics.nl/sportwetenschap/factsheet/factsheet-presteren-in-de-hitte/
- 2015 National Athletic Trainers' Association position statement on Exertional Heat Illnesses in the Journal of Athletic Training