EHF
BEACH HANDBALL

ASPETAR
سبيتار

REFEREEING IN BEACH HANDBALL

Physical demands and preparation strategies to cope with the heat

PHYSICAL DEMANDS OF REFEREEING BEACH HANDBALL

Beach handball is a sport played in different environmental conditions. While mostly a summer sport, it is not unusual for games to be played in challenging weather conditions with rain and cold weather. Referees are on court for the whole duration of the match as well as during the one-against-the-goalkeeper activity that decides match winners, and must move to be in the best position to officiate the game. During a tournament, it is not unusual for referees to officiate three to five matches per day and therefore, a better understanding of the physical demands is important to put in place training strategies aimed at improving fitness and refereeing performances.

The function of the beach handball referees is fundamental, since they make decisions based on and enforce the Rules of the Game. To do this correctly, referees must position themselves properly, as their word is final and influences the outcome of a given match. Moving on sand combined with the environmental challenges typical of most beach handball tournaments (heat and humidity) require good levels of fitness for referees to perform at their best. In this document, we present the latest data on beach handball referee performance and provide some guidance to improve physical fitness as well as put in place strategies for referees to perform at their best in different environmental conditions.

PHYSICAL DEMANDS OF BEACH HANDBALL REFEREES

To our knowledge, at the time of preparing this report, only one study analysing the time-motion characteristics of beach handball referees has been published. The study by Martínez-Rodríguez et al. (2024) was conducted on 12 Spanish referees officiating junior and senior matches. Their study reported an average distance covered of 514.62 + 80.54 m per set (>1,030 m covered in total per match) with a relative distance of 46 m/min.

The European Handball Federation, through the European Beach Handball Commission in partnership with Aspetar Hospital, conducted a comprehensive research project in Lacanau (France) during the European Beach Tour Finals 2024 to determine the physical demands of refereeing in a beach handball tournament as well as gain insights into the hydration status and body temperatures of referees during the tournament. Time-motion data indicated that in a match (which includes the start of the match routines and eventual shootouts), referees cover an average distance of 1,368 m [maximum distance covered by a referee was 2,055 m]. This distance is covered by performing movements of different intensity.

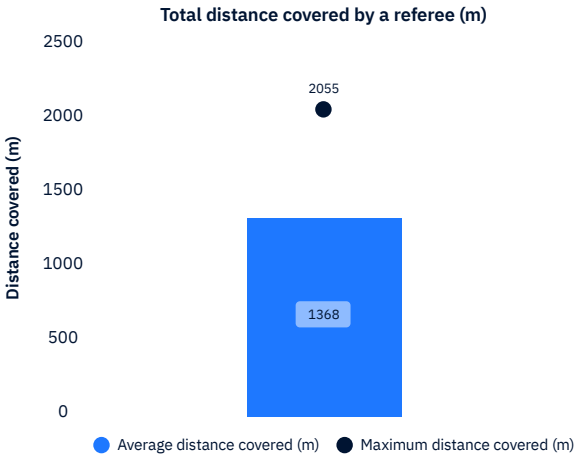


Figure 1:
Distance covered (in meters) by referees in the tournament in Lacanau (average value and maximum value)

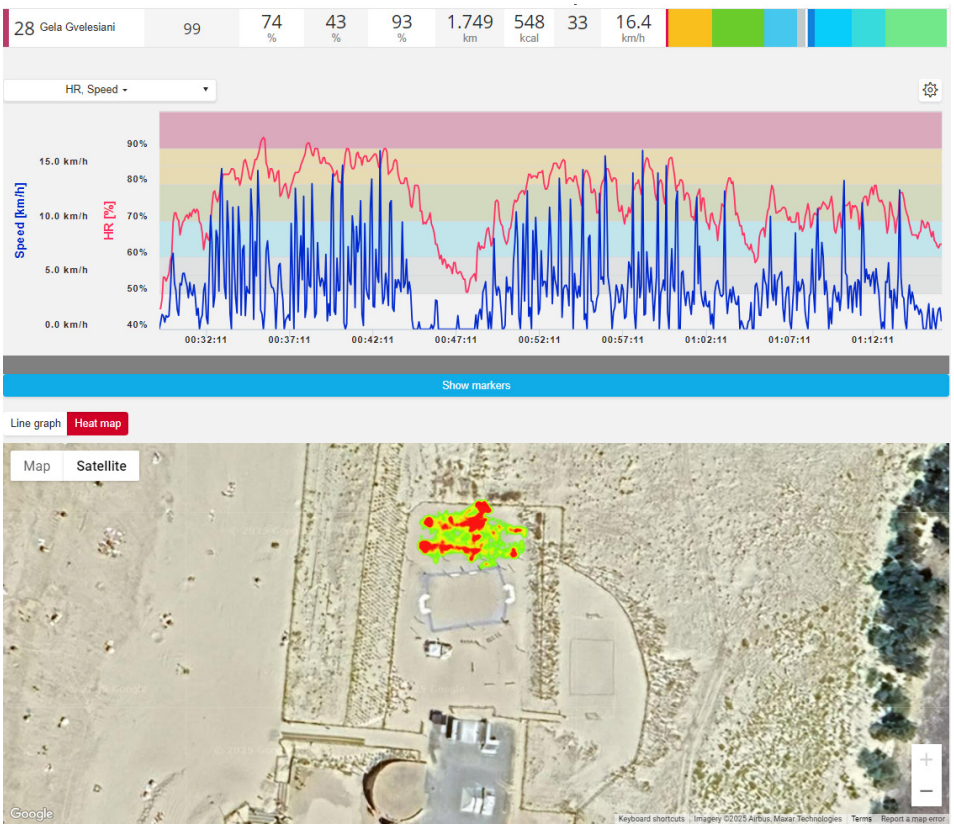


Figure 2: Speed profile, heart rate and displacement heat map of one referee officiating a match in Lacanau (2024)

On average, only **1.13** sprints per match were performed by the referees, where a sprint was coded as every activity faster than 13 km/h. Most of the distance was covered by performing movements with relatively low acceleration and speed. As expected, referees rarely performed high-intensity activities, and the intermittent pattern of movements indicated an overall pace of <40 m/min.

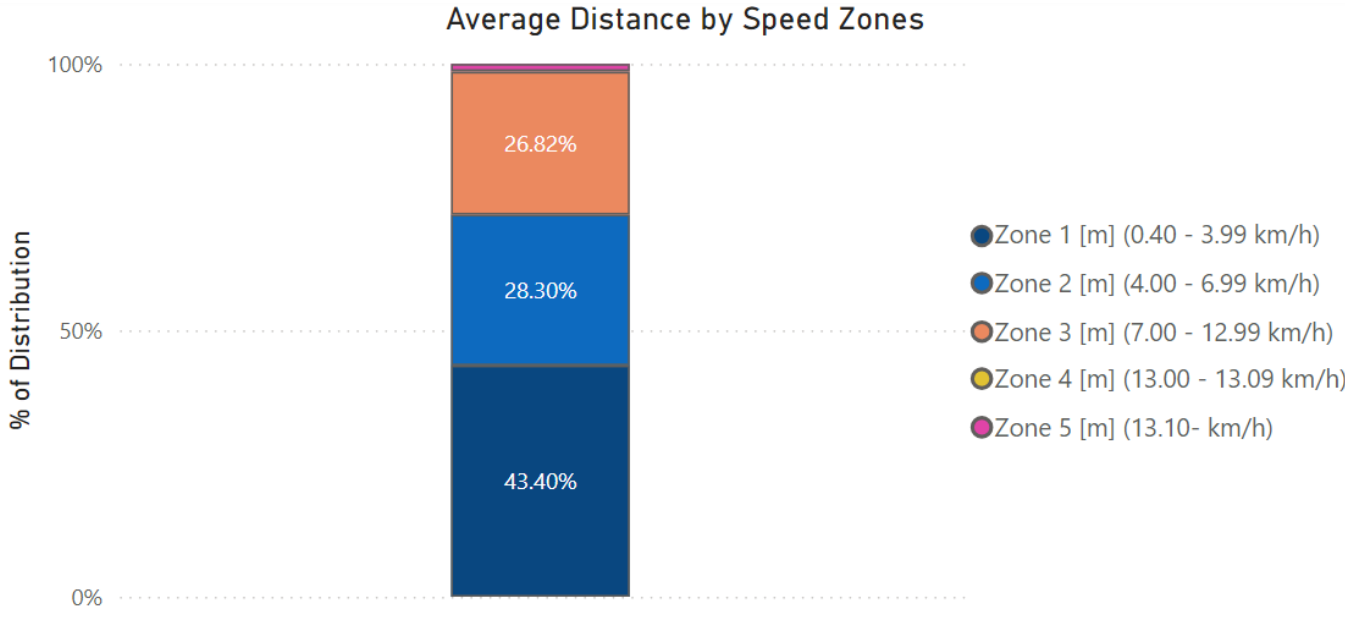


Figure 3: Average distance covered expressed as a percentage of the total distance in the different speed zones by the referees at the tournament in Lacanau (2024)

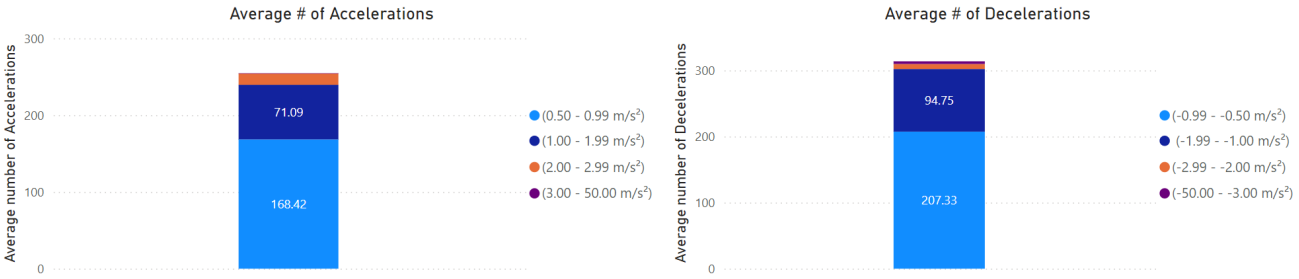
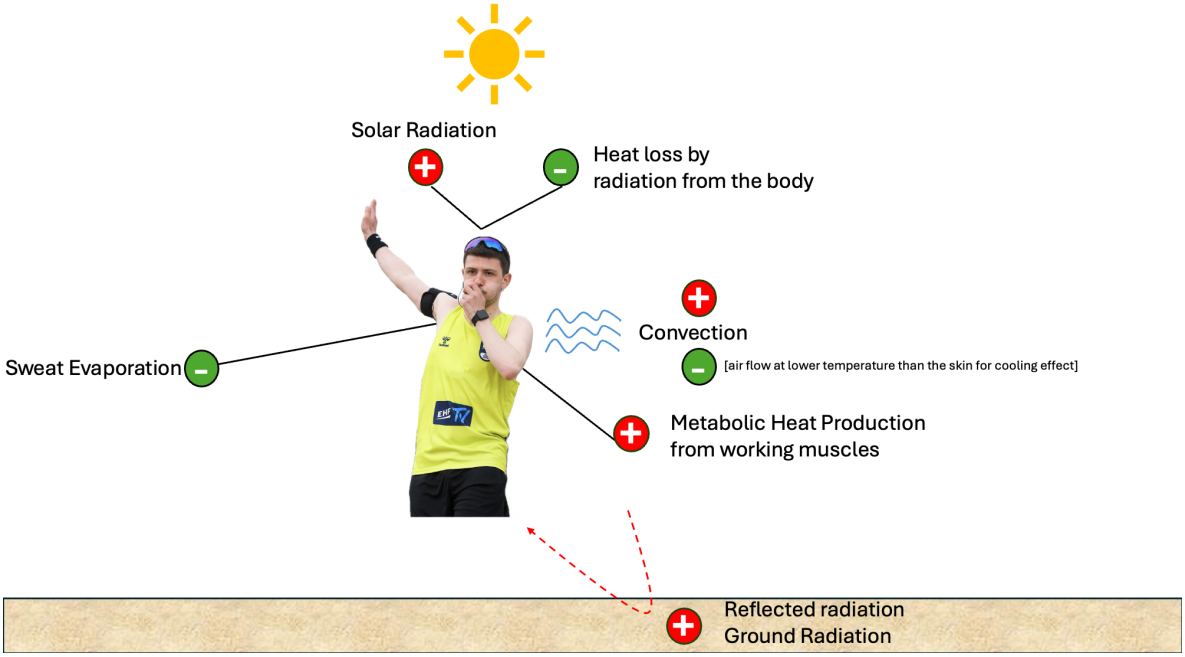


Figure 4: Average number of acceleration and decelerations performed by referees per game in Lacanau

Despite the relatively low intensity of movements, some referees reached a maximum heart rate of >180 bpm during their matches (average maximum heart rate during matches was 167 bpm). This was indicative of increased cardiovascular stress when game situations became challenging and was also determined by the referees' fitness levels and/or weather conditions. Preparation should therefore focus on having acceptable levels of endurance capacity as well as the ability to perform accelerations in different directions (including running backwards) to be able to be placed in the right position to judge the game and not be affected by fatigue.

ENVIRONMENTAL CONDITIONS CAN AFFECT REFEREES' PERFORMANCES

It is well established that environmental conditions affect human performance. Numerous studies have been conducted in a variety of sports. When moving or exercising, muscle contractions produce heat, increasing muscle temperature and core body temperature. The heat is normally dissipated to the environment. However, hot environmental conditions limit heat loss (convection and radiation) and humid environments limit sweat evaporation from the skin (the human body's greatest heat loss mechanism when exercising in the heat).



Environmental conditions such as high air temperature, high humidity, low air movement and/or high radiant heat can be strenuous for athletes and referees. Heat stress occurs when the body's ability to dissipate heat generated by metabolism is compromised. It can reduce cognitive (e.g., ability to track multiple stimuli – ball and player movements) and physical (e.g., exercise capacity – ability to optimise on-court positioning) performance and increase the risk of exertional heat illness (EHI) and/or the potentially fatal exertional heat stroke (EHS). Symptoms of EHI range from muscle cramps to collapse due to heat exhaustion. EHS is a medical emergency and is characterised by high core temperatures (typically ≥40.5°C) and central nervous system dysfunction, including symptoms like confusion, ataxia, loss of balance, apathy, and irritability. EHS is the 3rd leading cause of death in sport (Bouchama et al., 2022).

Considering that most beach handball tournaments are played in hot and humid conditions, it is important to realise the potential for heat stress to affect player and referee performances.

Heat stress can be quantified using the Wet Bulb Globe Temperature (WBGT) index — an index that considers temperature, humidity and solar radiation. The WBGT temperature is a measure of environmental heat as it affects humans, and clear recommendations have been developed to ascertain risk. The following table provides guidelines to officials and tournament organisers to reduce the risk of EHI.

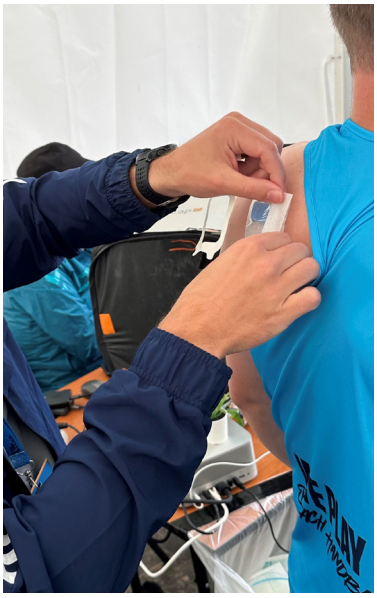
WBGT Temperature	Risk	Recommendations	Colour Code
>28°C	Extreme	Be on high alert. Make sure there are shaded areas and cooling stations, and that consumption of fluids is frequent. You might need to create shaded areas courtside for players. Frequent water breaks are required. It is fundamental to have medical procedures in place. WBGT >30°C is not recommended for sports practice (Roberts et al., 2023).	
23°C–28°C	High	Athletes and officials need to be on constant monitoring for symptoms of heat illness. Make sure athletes and referees/officials are well hydrated, have access to cooling and shaded areas and have access to fluids. Have a cold or ice immersion pool on site.	
18°C–23°C	Moderate	Cautious monitoring for symptoms of heat illness. Make sure athletes and referees/officials are well hydrated and have access to cooling and shaded areas as well as fluids. Have a cold or ice immersion pool on site.	
<18°C	Low	Closely monitor new or unconditioned athletes and referees, and all athletes during extreme exertion.	
<10°C	Hypothermia risk	Make sure you have enough layers of clothing and get warm immediately after refereeing.	

Given the impact challenging environmental conditions can have on health (EHI/EHS) and performance (reduced cognitive/physical function) it is important to recognise the risks and optimise preparation for performing in the heat.

Very limited research has been conducted on beach handball. The only study conducted on players (n = 16) reported core temperatures to reach 39°C in a tournament played in Costa Rica at WBGT 36.1°C (Gutiérrez-Vargas et al., 2019). However, virtually no data exists on referees and there is very limited data on players beyond that Costa Rica study. In the study conducted in Lacanau in 2024, the environmental conditions did not exacerbate risk of heat stress (low risk on the WBGT scale), however, some referees reached a core temperature of 39°C and above.

Core and Skin Temperature Measurements

Core temperature is the temperature of the body's internal organs. A normal body temperature ranges from 36.5°C to 37.4°C, but temperature readings vary depending on where on the body it is measured. Thanks to recent advancements in technology, core temperature can be measured and recorded by ingesting a telemetric pill. In the study conducted in Lacanau in 2024, the referees ingested a telemetric pill each morning (Ecelsius performance, Bodycap, France) before reaching the tournament venue. The telemetric pill measures core temperature with an accuracy of +0.1°C. Additionally, skin temperature sensors (E-Flex, Bodycap, France) were attached to the upper torso, on the scapula, and on the upper leg using a medical grade plaster (Tegaderm, 3M).



Hydration Status Is Important To Combat the Heat

Excessive sweating during exercise/physical activity can cause progressive dehydration, leading to an increase in body temperature and reduced performance over time. Referees may be exposed to challenging environmental conditions for a long time when refereeing numerous matches in a tournament and should therefore always make sure they are hydrated and ready to perform in the heat. Hydration is very important. For exercise lasting less than one or two hours in cool conditions, drinking to quench thirst is usually sufficient. However, for prolonged and repeated activities in hot and humid conditions, planned hydration strategies (which may include fluids containing sodium and carbohydrates) are very effective in reducing the risks of heat stress and maintaining performance.

For the first time, at the tournament in Lacanau in 2024, the hydration status of referees was assessed, via saliva samples, using a point-of-care testing device (MX3 Diagnostics, Australia). Hydration categories based on saliva osmolarity were determined for each measurement as follows: hydrated (<65 mOsm); mildly dehydrated (66–100 mOsm); moderately dehydrated (101–150 mOsm); and severely dehydrated (>151 mOsm).

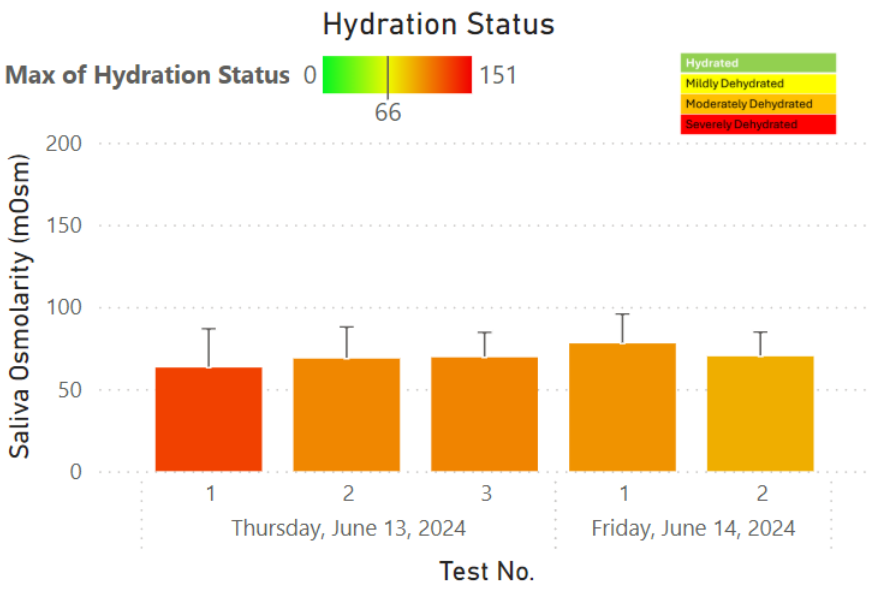


Figure 5: Average values of saliva osmolarity (mOsm) of the beach handball referees in Lacanau in 2024. The average values in the sample showed severely or moderately dehydrated values with large variability

Despite low-risk environmental conditions in Lacanau 2024, with some days also being relatively cold, the average value of the group of referees showed that there was some level of dehydration. Some referees were found to be dehydrated in the afternoon before their last match. This indicates the need for re-enforcing the importance of being hydrated and having access to fluids over the course of tournaments, to avoid the risk of dehydration and the consequent impairment in performance as well as the potential risk of heat stress.

PREPARING FOR THE ENVIRONMENTAL CHALLENGE

Beach handball tournaments can be played in different environmental conditions. Referees need to be ready to perform in varying conditions. Here we will present a few strategies to prepare for and perform in different conditions.

Refereeing in the Heat

If you know you are going to referee a tournament in the heat, there are a few strategies you can implement to prepare yourself for the task and reduce the risks of heat stress / heat illness.

1. Improve your general fitness: If you are unfit, you are more at risk of struggling to referee in a hot and humid environment. Therefore, you need to make sure that you can run on the sand and sustain the activities for four to five matches per day. A good level of aerobic capacity is recommended, and this can be improved and/or maintained by performing running activities (alternating with other forms of prolonged exercise such as cycling), alternating long runs with intermittent exercise sessions. Your ability to move on the sand and be in the right position to judge the match will depend on your running abilities.

2. Heat acclimatisation is a well-known physiological adaptation that occurs with repeated exposure to exercise and/or passive heat stress. If you can exercise in the heat to prepare for the tournament, you should do so for a period of one to two weeks, which will induce most physiological adaptations that optimise performance and reduce the risk of EHI.
You can induce the necessary adaptations by gradually increasing the intensity and duration of exercise during daily heat exposure.

If you live in a cold country or are in the winter season with no access to outdoor opportunities to exercise in the heat, you can also acclimatise using passive exposure to heat stress, like saunas. This method has been proven to be effective for athletes. A study involving middle-distance runners investigated the effects of using a sauna (90°C) for about 30 minutes post-training three times a week over three weeks. The results showed that, compared to a period without sauna use, the runners improved performance (Scoon et al., 2007). Another study found that three weeks of sauna use (100–108°C for 30 minutes three times a week) post-training reduced body temperature and heart rate during a heat tolerance test (30 minutes running at 40°C), while also enhancing performance in tests at “regular” temperatures (18°C) (Kirby et al., 2021). Therefore, going to a sauna (90–108 °C) after training can effectively aid in heat acclimation, even offering benefits in cooler conditions.

If you do not have access to saunas, alternative methods like hot water immersion/baths are a viable option. Recent studies have demonstrated that just six days of hot baths — 40°C water for 40 minutes after typical training — can induce heat acclimation, lowering body temperature and sweat thresholds, reducing perceived exertion, and improving running performance in tests performed at high temperatures (33°C) (Zurawlew et al., 2016, 2018). Importantly, tolerance to sauna/hot water immersion exposure should be built up progressively and safely and it is important to ensure hydration is maintained to avoid adverse effects (e.g., heat-related illness)

3. Hydration and cooling strategies during the tournament: Dehydration contributes to heat exhaustion and can indirectly increase physiological strain during an activity like refereeing. Hydration strategies are important for athletes to safely perform physical activities in warm to hot conditions and are very important for referees too. Hydration supports vascular volume and sweating, both of which are essential to temperature regulation. Physical activity in hot environments causes heavy sweat losses and may determine substantial body water deficits if fluids are not replaced. Being well hydrated at the beginning of each match is key to performing well and reducing the risks of fatigue and cramps. Hydration during match breaks and in between matches is key to being able to perform your referee duties at tournaments. Signs and symptoms of dehydration (i.e., dizziness, rapid heat rate, fatigue, and headache) should prompt immediate ingestion of fluids and electrolytes as well as accessing of cooled/ shaded areas with good ventilation to reduce body temperature.

RECOGNISE HEAT STRESS SYMPTOMS

Exertional Heat Illness

High body temperature
(without CNS dysfunction)
Exhaustion
Excessive sweating/dehydration
Skin temperature
Cool to hot/pale to flushed
Rapid/weak heart rate
Nausea or vomiting
Muscle cramps

Actions

Get to a cooler place
Sip water if conscious
Cool the body *(cold shower, cold towel, cold water hand immersion)*

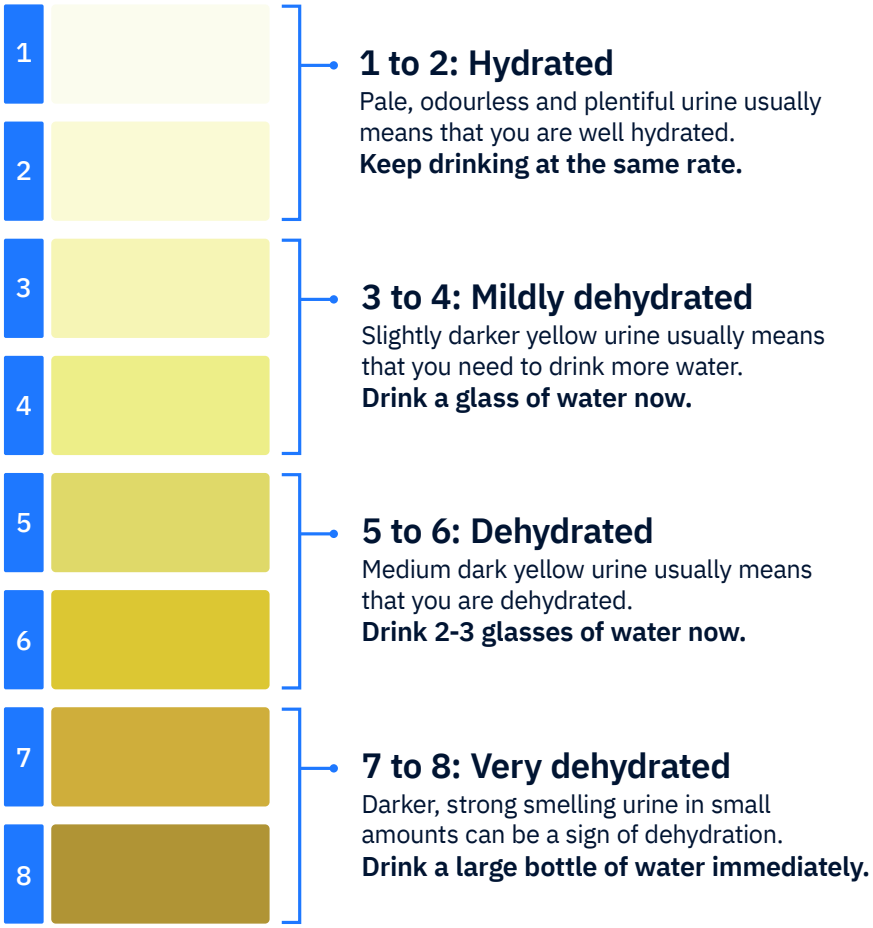
Exertional Heat Stroke

High body temperature
Vigorous exercise
Obvious CNS dysfunction, presenting as:
Severe confusion/ disorientation
Loss of consciousness/coma
Seizures

Actions

IMMEDIATE COOLING
(within 30 min)
Engage the medical team
Hospital transport
(only after sufficient cooling)

You can self-assess dehydration by monitoring body weight changes, thirst, and urine volume or concentration. A urine colour chart like the one in this guide can give you some guidance. Remember that over drinking is also not good — your hydration strategy should never result in overhydration.



Cooling strategies are very important to control your body temperature and make sure you do not overheat. Simple strategies can help avoid overheating. Before a match, you can use cold towels, drink ice slurry or immerse your hands and arms in cold water to reduce your body temperature. Staying in the shade and avoiding unnecessary exposure to the heat and humidity will also help in preparation for a match. Additionally, in extreme heat, you need to minimise warm-up routines to avoid unnecessary increases in core body temperature and focus on mobilisation exercises to prepare your muscles to avoid injuries. Post-match routines for rapid cooldown can include cold water immersion and cold showers as well as hand and forearm cooling through immersion in buckets of cold water. It is recommended that these strategies are tried and tested outside of competition to ensure tolerance (the ingestion of ice-cold and/or new fluid solutions can cause gastrointestinal distress). Cooling strategies should not evoke a shivering response, doing so utilises the body's fuel sources that will be required during matches.

Refereeing in the Cold/Inclement Weather

Some tournaments may be performed in cooler conditions and/or in the rain. In such cases, layering clothing is important to maintain the body temperature and be able to perform. Longer and progressive warm-ups are necessary to increase your core body temperature as well as ensure your muscles are ready and reduce the risks of injuries. Socks and gloves can be used to cover hands and feet and maintain temperature. Post-match access to warm areas, warm showers, additional clothing layers and warm drinks are important. Additionally, you should change out of wet clothes, hydrate and refuel. Dehydration can also happen in the cold, so constantly check your hydration status and make sure you are well hydrated.

REFERENCES

Bouchama, A., Abuyassin, B., Lehe, C., Laitano, O., Jay, O., O'Connor, F. G., & Leon, L. R. (2022). Classic and exertional heatstroke. *Nature Reviews Disease Primers*, 8(1), 8. https://doi.org/10.1038/s41572-021-00334-6

Gutiérrez-Vargas, R., Gutiérrez-Vargas, J. C., Ugalde-Ramírez, J. A., & Rojas-Valverde, D. (2019). Kinematics and thermal sex-related responses during an official beach handball game in Costa Rica: A pilot study. *Archivos de Medicina Del Deporte*, 36(1), 13–18.

Kirby, N. V., Lucas, S. J. E., Armstrong, O. J., Weaver, S. R., & Lucas, R. A. I. (2021). Intermittent post-exercise sauna bathing improves markers of exercise capacity in hot and temperate conditions in trained middle-distance runners. *European Journal of Applied Physiology*, 121(2), 621–635. https://doi.org/10.1007/s00421-020-04541-z

Martínez-Rodríguez, A., Sánchez-Sánchez, J., López-Fernández, J., Lara-Cobos, D., & Sánchez-Sáez, J. A. (2024). A Global Positioning System Used to Monitor the Physical Performance of Elite Beach Handball Referees in a Spanish Championship. *Sensors*, 24(3). https://doi.org/10.3390/s24030827

Roberts, W. O., Armstrong, L. E., Sawka, M. N., Yeargin, S. W., Heled, Y., & O'Connor, F. G. (2023). ACSM Expert Consensus Statement on Exertional Heat Illness: Recognition, Management, and Return to Activity. *Current Sports Medicine Reports*, 22(4), 134–149. https://doi.org/10.1249/JSR.0000000000001058

Scoon, G. S. M., Hopkins, W. G., Mayhew, S., & Cotter, J. D. (2007). Effect of post-exercise sauna bathing on the endurance performance of competitive male runners. *Journal of Science and Medicine in Sport*, 10(4), 259–262. https://doi.org/10.1016/j.jsams.2006.06.009

Zurawlew, M. J., Mee, J. A., & Walsh, N. P. (2018). Post-exercise Hot Water Immersion Elicits Heat Acclimation Adaptations in Endurance Trained and Recreationally Active Individuals. *Frontiers in Physiology*, 9. https://doi.org/10.3389/fphys.2018.01824

Zurawlew, M. J., Walsh, N. P., Fortes, M. B., & Potter, C. (2016). Post-exercise hot water immersion induces heat acclimation and improves endurance exercise performance in the heat. *Scandinavian Journal of Medicine & Science in Sports*, 26(7), 745–754. https://doi.org/10.1111/sms.12638

Aspetar Executive Director of Research and Scientific Support – **Prof. Marco Cardinale, PhD**

Aspetar Post Doc researcher – **Dr. Christopher John Esh, PhD**

Project Lead Beach Handball Commission Member – **Marco Trespidi**

Project Lead EHF office – **Alexandra Horvath**

Booklet layout – **Richard Turner**