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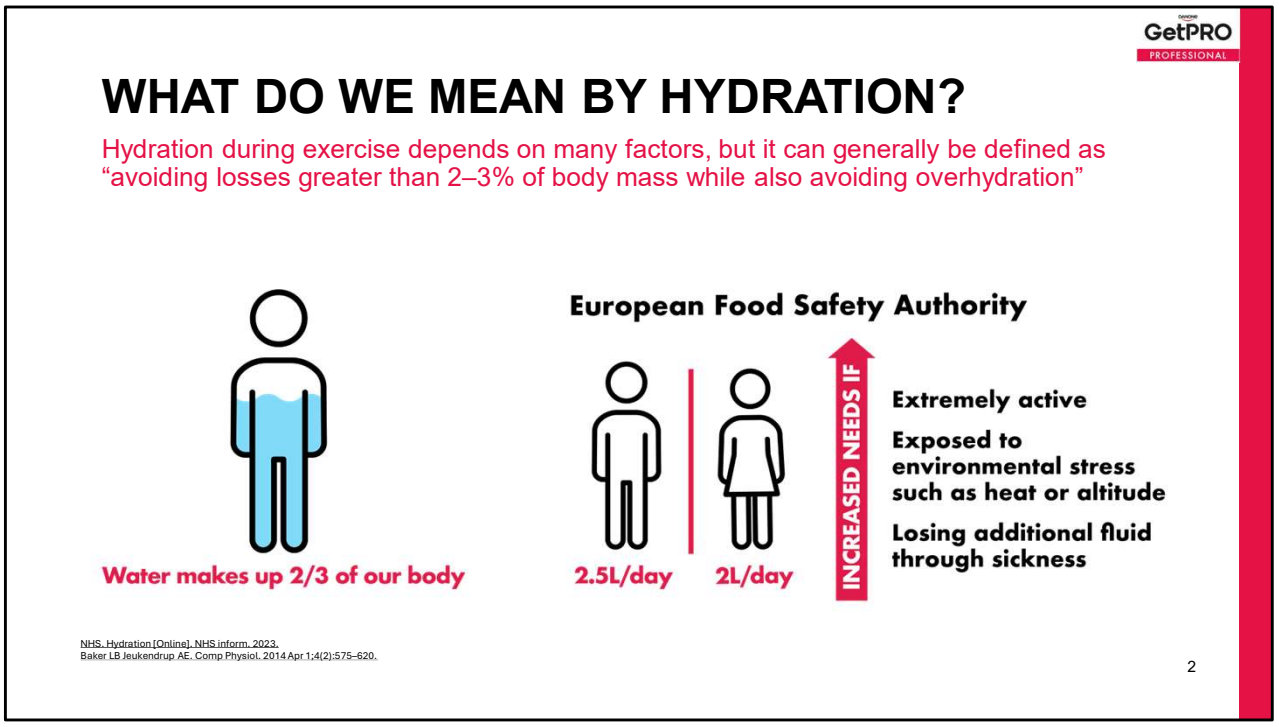
HYDRATION FOR ATHLETES

This resource was created by Michael Naylor, Head of Performance Nutrition, UK Sports Institute in collaboration with the GetPRO Professional nutrition team

This resource is for use under professional supervision

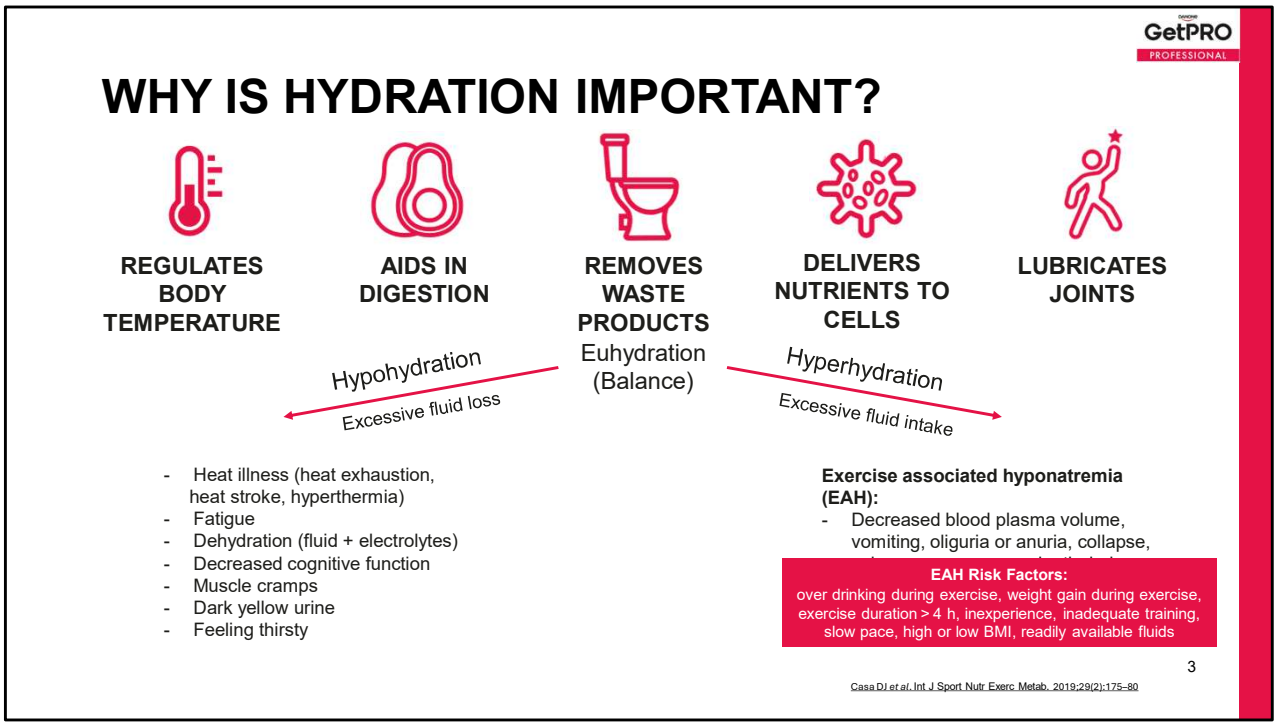


Water makes up 2/3 of our body, and so it is vital we drink enough fluid to maintain heathy balance. This healthy balance is otherwise known as 'euhydration'. When either side of this are off balance, so if we drink too much without sufficient electrolytes or we drink too little, we can affect our performance and our health, something I will come on to later in this presentation.

Daily fluid requirements are determined by total body water loss, with the goal of intake approximating daily water losses. The European Food Safety Authority defines adequate intake for total water as 2.5L/day for men and 2L/day for women, with higher amounts needed for individuals who are extremely active, exposed to environmental stress from heat or altitude, or are losing additional fluid through vomiting or diarrhea.

You can live without water for about 3 days, whereas food you can live without for around 3 weeks!

https://www.nhsinform.scot/campaigns/hydration/
https://www.researchgate.net/profile/Asker-Jeukendrup/publication/261517517_Optimal_Composition_of_Fluid-Replacement_Beverages/links/5a717a11aca272e425ed9a82/Optimal-Composition-of-Fluid-Replacement-Beverages.pdf



Hydration is crucial for health and performance because water is involved in almost every bodily function. It helps regulate body temperature, lubricates joints, aids in digestion, delivers nutrients to cells, and removes waste products.

When we lose an excessive amount of fluid (research suggests <2% body weight), we can end up in a state of hypohydration. Hypohydration can lead to dehydration (loss of fluid and electrolytes), fatigue, decreased cognitive function, muscle cramps, and even heat-related illnesses during exercise, all of which can majorly impact our performance and if severe, our health.
Hydration is vital to remain our core body temperature

However, although rare, it is important not to over hydrate, otherwise known as hyperhydration. Hyperhydration can lead to exercise associated hyponatremia (EAH), which typically occurs when athletes consume water far in excess of their losses or without concomitant electrolyte replenishment. Risk factors for EAH include: over drinking during exercise, weight gain during exercise, exercise duration > 4 h, inexperience, inadequate training, slow pace, high or low BMI, and readily available fluids.

This brings us back to our definition of hydration as “avoiding losses greater than 2–3% of body mass while also avoiding overhydration”

Oliguria = low urine output
Anuria = lack of urine production

https://journals.humankinetics.com/downloadpdf/view/journals/ijsnem/29/2/article-p175.pdf

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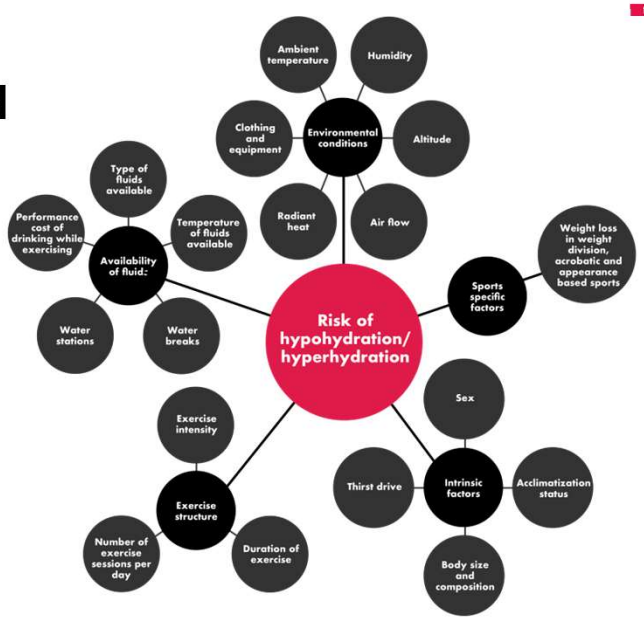
WHAT FACTORS IMPACT OPTIMUM HYDRATION?

- Environmental Conditions
- Sport Specific Factors
- Intrinsic Factors
- Exercise Structure
- Availability of Fluids



Belval LN *et al.* Nutrients. 2019 Jul 9;11(7):1550.

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There are a number of factors that impact our ability to maintain a hydrated state. It is important to note that these factors will impact how much or how little fluid our body needs – but it is also important to note that when faced with the same factors, your sweat rate should remain a similar rate.

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https://www.mdpi.com/2072-6643/11/7/1550

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WHAT DOES THIS MEAN FOR THE ATHLETE?

Sweat rates are highly individual and can vary from 0.5 L/hr to 3 L/hr.

Sweating is accompanied by a loss of electrolytes and sodium is the predominate electrolyte lost in sweat.

Average sweat sodium concentrations have been seen to vary from 15 mmol/L to 90 mmol/L, with the average reported to be ~40 mmol/L. Standard sport electrolytes contain between 20-30 mmol/L, helping promote the absorption and retention of water.

Even athletes with low or average sweat sodium concentrations can accrue a substantial sodium deficit due to high sweat rates (>2L/h) or extended periods of strenuous exercise

Factors influencing our sweat rate and sweat sodium concentration include:

- Duration / intensity of exercise
- Genetics
- Diet
- Heat / heat acclimatization status
- Hydration status
- Clothing

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Casa DJ *et al.* Int J Sport Nutr Exerc Metab. 2019;29(2):175–80

We know that dehydration can impair performance in most events, and so it is recommended athletes begin exercise euhydrated. Athletes tend to have higher sweat rates than that of the general population, particularly if training for long durations or in the heat.
Sweating is accompanied by a loss of electrolytes and sodium is the predominate electrolyte lost in sweat. The total amount of sodium lost depends on:
sweat rate, duration of exercise, sweat sodium concentration, as well as genetics, diet, heat acclimatization status, the clothes we're wearing + our hydration status.
Average sweat sodium concentrations measured using the 'gold standard' whole-body washdown procedure have been reported to be around 40 mmol/L, but from as low as 15 mmol/L to as much as 90 mmol/L. This range is due to myriad of factors influencing our sweat rate and sweat sodium concentration. Standard sport electrolytes contain 20-30mmol/L sodium, helping promote the absorption and retention of the fluid you consume.

Importantly, even athletes with low or average sweat sodium concentrations can accrue a substantial sodium deficit or large sweat losses due to high sweating rates (>2L/h) or extended periods of strenuous exercise (training twice per day or ultra endurance events).

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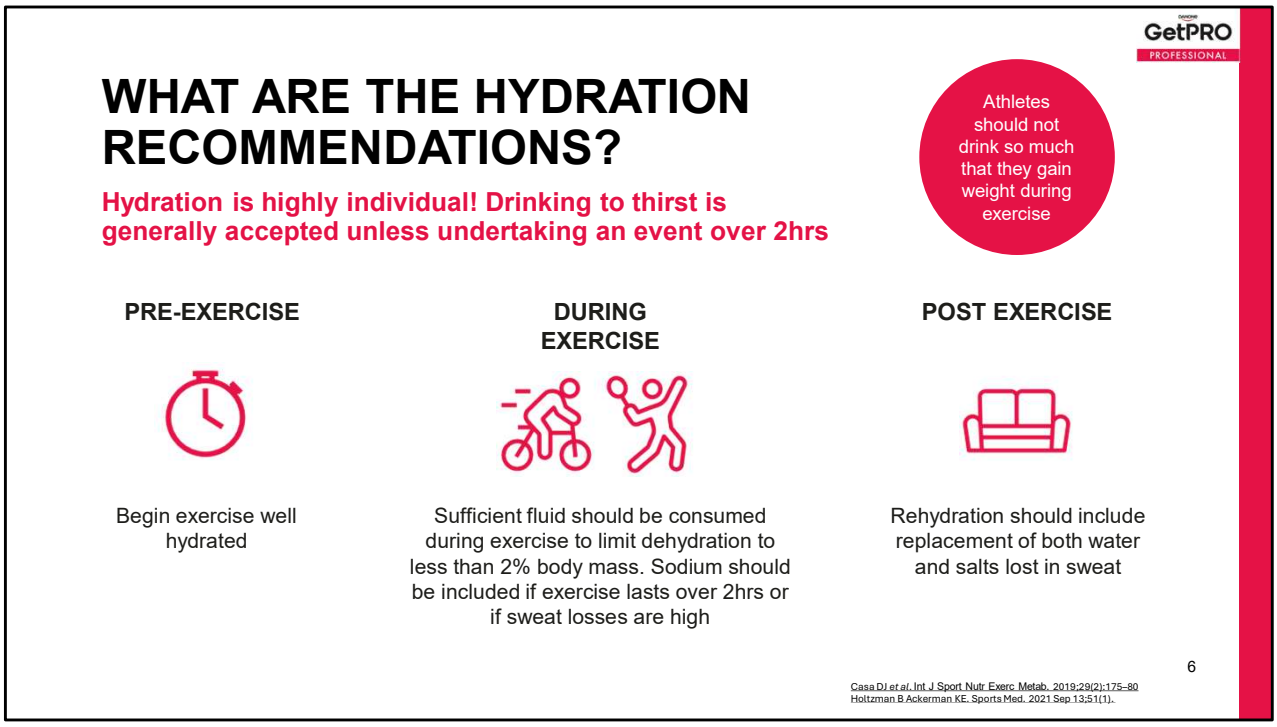


Drinking to thirst is generally recommended to avoid over or under hydrating, however if athletes feel they are at risk of either over and underhydrating, they should work with a qualified nutritionist to make a hydration plan.

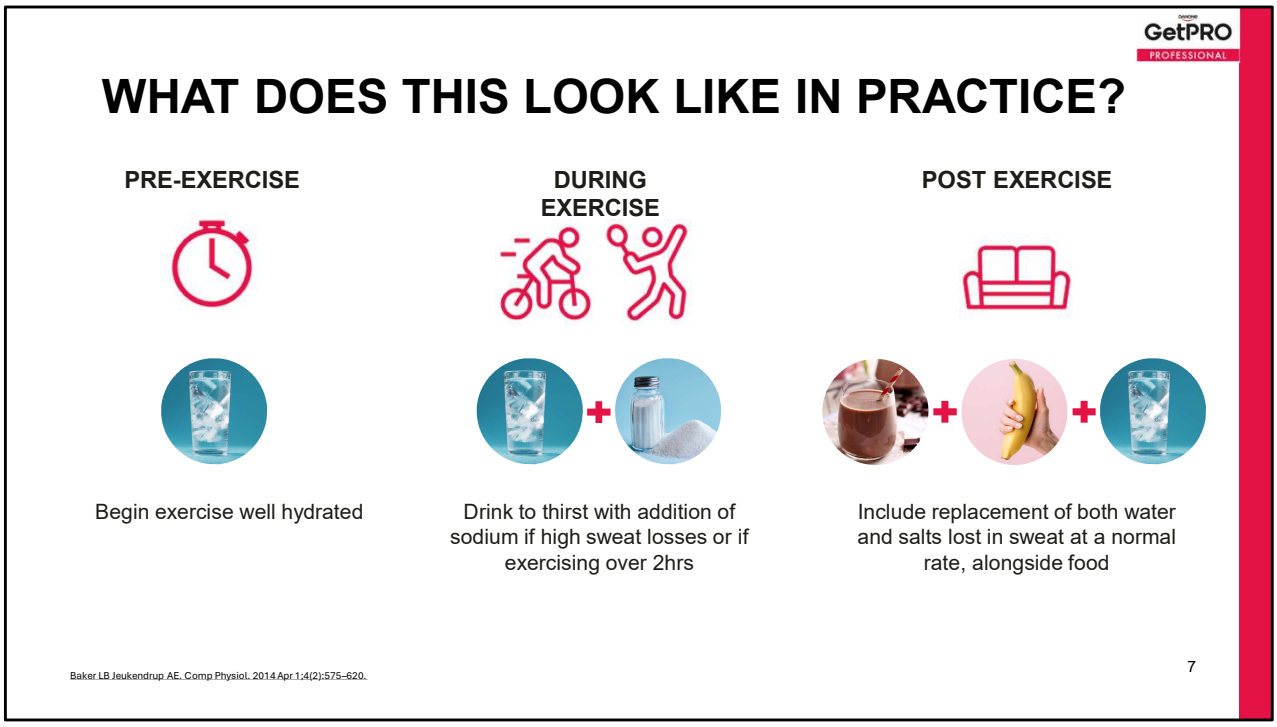
Pre hydration:
Athletes should be well hydrated before exercise (IOC, 2011, from Casa et al, 2019)
If dehydrated pre-exercise. A slow rehydration process is preferred to rapid.
5-10ml per kg bw, 2 – 4hrs pre-exercise.

During exercise:
Sufficient fluid should be consumed during exercise to limit dehydration to less than 2% body mass. Sodium should be included if exercise lasts over 2hrs or if sweat losses are high. (IOC, 2011, from Casa et al, 2019)
For most athletes in most situation's, consuming 0.4 to 0.8 litres per hour, is sufficient, and this can be achieved via drinking to thirst, without impacting performance.

Post exercise:
During recovery from exercise, rehydration should include replacement of both water and salts lost in sweat. (IOC, 2011, from Casa et al, 2019)
Practically, athletes should try to consume 20–30 mmol L−1 sodium and 2–5 mmol L−1 potassium; this can be achieved by drinking water and supplementing with snacks or by

drinking a sports beverage. Again, consuming fluids at a modest rate in conjunction with sodium + potassium to make up any fluid deficit is recommended.

Links:
https://link.springer.com/article/10.1007/s40279-021-01508-8
https://journals.humankinetics.com/downloadpdf/view/journals/ijsnem/29/2/article-p175.pdf



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Adding sodium to your water in a measure of 20-30mmol/L helps to stimulate physiological thirst, improve the drinks palatability and voluntary fluid intake. In addition, 20-30mmol/L sodium from a fluid replacement drink helps to replace the electrolytes lost in sweat.

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https://www.researchgate.net/publication/261517517_Optimal_Composition_of_Fluid-Replacement_Beverages

FLUID PLAN (ROUGH GUIDE) – extracted from – Thomas & Burke (2016)
Athletes may achieve euhydration before exercise by consuming a fluid volume equivalent to 5 to 10 mL/kg BW in the 2 to 4 hours before exercise to achieve urine that is pale yellow in colour while allowing for sufficient time for excess fluid to be voided

The fluid plan that suits most athletes and athletic events will typically achieve an intake of 0.4 to 0.8 L/h, although this needs to be customized to the athlete's tolerance and experience, their opportunities for drinking fluids and the benefits of consuming other nutrients (eg, carbohydrate) in drink form. Ingestion of cold beverages (0.5C) may help reduce core temperature and, thus, improve performance in the heat. The presence of flavour in a beverage may increase palatability and voluntary fluid intake.

Most athletes finish exercising with a fluid deficit and may need to restore euhydration during the recovery period. Rehydration strategies should primarily involve the consumption of water and sodium at a modest rate that minimizes diuresis/ urinary losses.

The presence of dietary sodium/sodium chloride (from foods or fluids) helps to retain ingested fluids, especially extracellular fluids, including plasma volume. Therefore, athletes should not be advised to restrict sodium in their postexercise nutrition particularly when large sodium losses have been incurred. Because sweat losses and obligatory urine losses continue during the postexercise phase, effective rehydration requires the intake of a greater volume of fluid (eg, 125% to 150%) than the final fluid deficit (eg, 1.25 to 1.5 L fluid for every 1 kg BW lost).

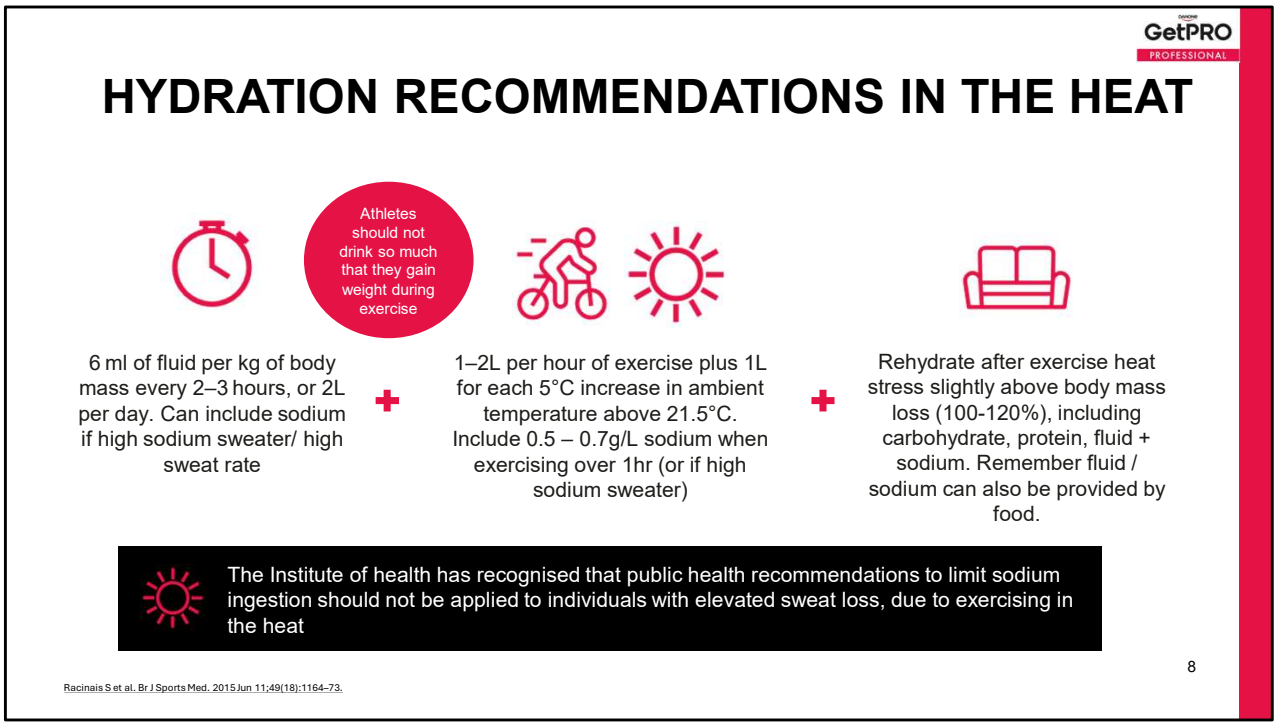
Links:
Ackerman & Holtzman (2021)
https://link.springer.com/article/10.1007/s40279-021-01508-8

Casa et al, 2019
https://journals.humankinetics.com/downloadpdf/view/journals/ijsnem/29/2/article-p175.pdf

Thomas & Burke, 2016
https://www.researchgate.net/publication/295847724_Position_of_the_Academy_of_Nutrition_and_Dietetics_Dietitians_of_Canada_and_the_American_College_of_Sports_Medicine_Nutrition_and_Athletic_Performance/link/5a8c4857458515a4068ace88/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19

Water image:

https://stock.adobe.com/uk/search/free?filters%5Bcontent_type%3Aphoto%5D=1&filters%5Bcontent_type%3Aillustration%5D=1&filters%5Bcontent_type%3Azip_vector%5D=1&filters%5Bfree_collection%5D=1&filters%5Bcontent_type%3Aimage%5D=1&order=relevance&safe_search=1&k=chocolate+milk&search_page=1&search_type=autosuggest&acp=0&aco=chocolate+milk&get_facets=1&asset_id=327746844



Before training and competition in the heat, athletes should drink 6 mL of fluid per kg of body mass every 2–3 h, in order to start exercise euhydrated.

During intense prolonged exercise in the heat, body water mass losses should be minimised (without increasing body weight) to reduce physiological strain and help to preserve optimal performance. This rise in water intake, should be accompanied with electrolytes, particularly sodium, if exercising in the heat over 1hr (or if high sodium sweater)– in a ratio of 20-30mmol per litre.

Adequately rehydrating after exercise-heat stress by providing plenty of fluids with meals is essential. If aggressive and rapid replenishment is needed, then consuming fluids and electrolytes to offset 100–150% of body mass losses will allow for adequate rehydration.

Recovery hydration should include sodium, carbohydrates and protein. Remember food sources also contain sodium and so a physical electrolyte may not be needed – assess to your individual needs.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4602249/

0.5g /L to mmol/ L sodium = 20-30 mmol per litre. (Lucozade sport = around 20 mmol per litre) sis electrolyte (30mmol / litre) sis electrolyte Go = 30 mmol/litre

ENVIRONMENTAL FACTORS AND INFLUENCES

High temperature/humidity and clothing can limit heat dissipation. If this thermal strain continues, it can result in reduced exercise intensity, impacting performance and potentially health.

→ This includes wetsuits + water temperature!

Altitudes above 4900-7600m can increase water and electrolyte losses, decreasing plasma volume and total body water content. In both cold air and high altitude, respiratory water losses, may increase and require additional water consumption due to low air water pressures.

Exercising in the cold can produce large sweat rates, particularly if wearing lots of clothes. Additionally, the cold can decrease thirst sensitivity, thus increasing risk of hypohydration.

Question: When might you sweat but not notice?

Racinais S et al. Br J Sports Med. 2022 Sep 23;57(1):bjsports-2022-105942.

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Training in the heat can increase sweat rate, as can training at altitude due to the increase in respiratory losses. It is also important to be mindful of the conditions you may not notice thirst (e.g. in the cold) or notice sweat (e.g. when swimming).

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9811094/

Answer to Question:
When swimming. We still sweat while swimming!

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FACTORS THAT INFLUENCE HYPOHYDRATION IN TEAM SPORTS

Sport	Availability of fluid		Environment		Intensity		Hypohydration risk	
	Training	Competition	Training	Competition	Training	Competition	Training	Competition
Basketball	High	High	Low	Low	Mod	Mod	Low	Low
Ice hockey	High	High	Low	Low	Mod	High	Mod	Mod
Football	High	High	Mod	Mod	Mod	High	Mod	Mod
Baseball	High	High	Mod	Mod	Low	Low	Low	Low
Softball	High	High	Mod	Mod	Low	Low	Low	Low
Volleyball	High	High	Low	Low	Low	Low	Low	Low
Soccer	Mod	Low	Mod	Mod	Mod	High	Mod	High
Lacrosse	High	High	Mod	Mod	Mod	Mod	Mod	Mod
Rugby	High	Low	Mod	Mod	Mod	High	Mod	High

Belval LN *et al*. Nutrients. 2019 Jul 9;11(7):1550.

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Link to Image:
https://www.mdpi.com/2072-6643/11/7/1550

Availability of Fluid: High, the dynamics of the sport allow for multiple opportunities to consume fluid; Moderate (Mod), Fluid is only available during breaks in training, competition, or carried by the athlete; Low, Fluid is limited or not available due to time restrictions, rules or dynamics of the sport, and ability to carry. Environment: High, environmental conditions that are of great risk for hypohydration; Mod, the environment is variable ranging from cool to hot conditions that may pose risk for hypohydration; Low, the environmental conditions are not a threat to hypohydration. Intensity: High, exercise intensity in the sport is increased and likely to result in large sweat losses and hypohydration; Mod, exercise intensity in the sport varies from moderate to high and may result in large sweat losses and hypohydration; Low, exercise intensity in the sport is low and less likely to result in large sweat losses and hypohydration. Hypohydration Risk: High, the risk for hypohydration in the sport is high based on reported sweat losses, the availability of fluid, environmental conditions, and the intensity of exercise; Mod, the risk for hypohydration in the sport is moderate based on reported sweat losses, the availability of fluid, environmental conditions, and the intensity of exercise; Low, the risk for hypohydration in the sport is low based on reported sweat losses, the availability of fluid, environmental conditions, and the intensity of exercise. Note: These assessments are representative of typical situations encountered in these sports. Site-specific factors may differ from those presented here.

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FACTORS THAT INFLUENCE HYPOHYDRATION IN TEAM SPORTS

Sport	Availability of fluid		Environment		Intensity		Hypohydration risk	
	Training	Competition	Training	Competition	Training	Competition	Training	Competition
Tennis	High	Mod	Mod	Mod	High	High	Mod	Mod
Wrestling	High	High	Mod	Mod	High	High	High	Low
Gymnastics	High	High	Low	Low	Mod	Low	Low	Low
Running (<1 h)	Low	High	Mod	Mod	High	High	Low	Low
Running (1-2 h)	Low	High	Mod	Mod	Mod	Mod	Mod	Mod
Running (>2 h)	Low	High	Mod	Mod	Low	Mod	Mod	Mod
Cycling (<1 h)	High	High	Mod	Mod	High	High	Low	Low
Cycling (>2 h)	Mod	Mod	Mod	Mod	Mod	Mod	Low	High
Swimming	High	High	Low	Low	High	High	Low	Low
Triathlon (<2 h)								
Swim	Low	Low	Low	Low	Mod	Mod	Low	Low
Bike	Mod	High	Mod	Mod	Mod	Mod	Low	Low
Run	Low	High	Mod	Mod	Mod	Mod	Low	Low
Triathlon (2-5 h)								
Swim	Low	Low	Low	Low	Mod	Mod	Low	Low
Bike	Mod	High	Mod	Mod	Mod	Mod	Low	Low
Run	Low	High	Mod	Mod	Mod	Mod	Low	Low
Triathlon (5-9 h)								
Swim	Low	Low	Low	Low	Mod	Mod	Low	Low
Bike	Mod	High	Mod	Mod	Mod	Mod	Mod	Mod
Run	Low	High	Mod	Mod	Mod	Mod	Mod	Mod
Triathlon (>9 h)								
Swim	Low	Low	Low	Low	Mod	Mod	Low	Low
Bike	Mod	High	Mod	Mod	Mod	Mod	Mod	Mod
Run	Low	High	Mod	Mod	Mod	Mod	Mod	Mod

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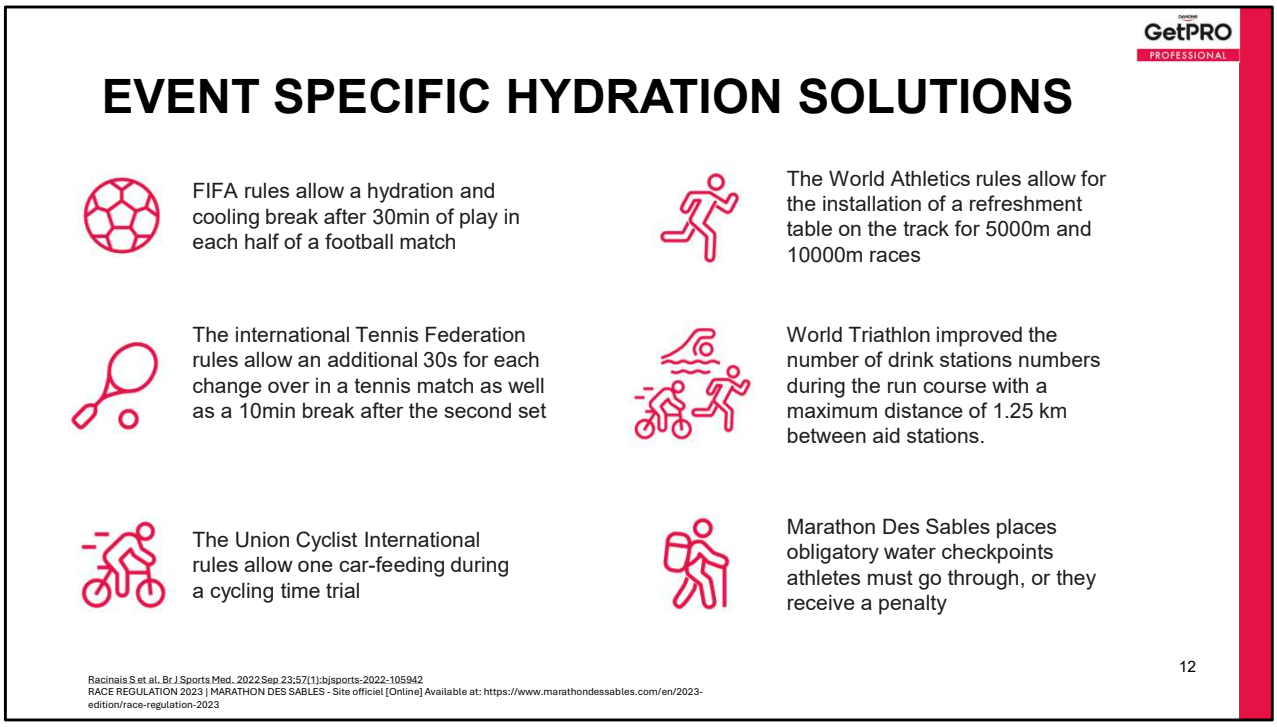


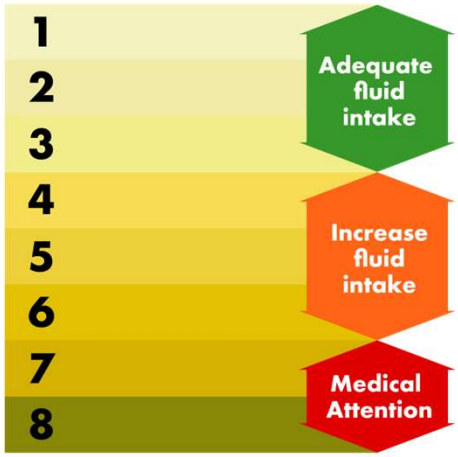
As you can, sports at the elite levels have made changes in order to allow for appropriate hydration / cooling in the heat. This shows that we can't ignore these changes at the elite level, and procedures must be reflected at grass roots, to ensure the health and safety of young athletes.

- FIFA rules allow a hydration and cooling break after 30min of play in each half of a football match
- The International Tennis Federation rules allow an additional 30s for each change over in a tennis match as well as a 10min break after the second set
- The Union Cyclist International rules allow one car-feeding during a cycling time trial
- The World Athletics rules allow for the installation of a refreshment table on the track for 5000m and 10000m races
- World Triathlon improved the number of aid/drink stations numbers during the run course with a maximum distance of 1.25 km between aid stations.
- Marathon des sables -

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9811094/#:~:text=Rehydrate%20after%20exercise%2Dheat%20stress,includes%20sodium%2C%20carbohydrates%20and%20protein
https://www.marathondessables.com/en/2023-edition/race-regulation-2023

MONITORING HYDRATION

Actions



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SUMMARY

Good hydration practices include:

1) Begin exercise in a euhydrated state
2) Prevent excessive hypohydration during exercise
3) Replace remaining losses following exercise prior to the next exercise bout

Fluid intake varies depending on:

- Individual sweat rate
- Exercise mode
- Exercise intensity
- Environmental conditions
- Exercise duration

Characteristics and rules of each sport may influence optimal hydration strategies:

- Clothing or event uniform
- Availability of fluid during and training and competition

TAKE HOME MESSAGES

Good hydration practices include beginning exercise in a euhydrated state; preventing excessive hypohydration during exercise; and replacing remaining losses following exercise prior to the next exercise bout

Drinking to thirst is generally accepted, with addition of sodium if high sweat losses or if exercising over 2 hours

Hypohydration is influenced by individual sweat rate, exercise mode, intensity, duration, and environmental factors such as heat

Characteristics and rules of each sport, such as the use of particular uniforms or the availability of fluid during training and competition, may influence optimal hydration strategies

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