

# FLUIDS

## FACTS & FADS

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If we judge nutrients by the length of time it takes for a lack of intake to cause problems, or by the seriousness of the symptoms caused by a deficiency, then water is a clear ‘Number One’. It makes up half our body mass and enables many body functions to occur. In contrast, dehydration interferes with physiological functions and when extreme or coupled with other issues it can lead to death.

Humans have evolved with systems in place to maintain remarkably good fluid balance over the long-term, with thirst being the principal driver of fluid intake and urine production being the principle regulator of fluid loss. Of course, there are exceptions to the rule in terms of populations (e.g. children and the elderly), individuals (there is a genetic predisposition to be a good or a reluctant drinker) and situations (sudden changes in fluid loss/need to which it can take several days to adjust). This review will cover the myths and furious debates between sports scientists/physicians surrounding the fluid needs of athletes.

### MYTH No. 1 *8 Glasses a day*

Over the past decades, the world has undergone some major cultural changes. Even in regions where tap water is clean and pleasant tasting, the market for bottled water is lucrative. Not only are we willing to pay above the odds for water, but many of us appear to have a water bottle welded to our hands as we go about our daily activities. This is not intrinsically good or bad, but reflects a shift from times when we drank mostly at meals and scheduled snacks. At least one of the drivers is the mantra that we should drink eight glasses of water each day for our health. It’s hard to trace the origins of this ‘wise-sounding’ advice, but scientific scrutiny shows that it is neither evidence-based nor necessary<sup>1</sup>.

A major criticism of the ‘8 glasses rule’ is that it overlooks the substantial amount of fluid provided by food or prepared dishes (milk, yoghurt, soup, fruit, vegetables etc). For some people, these sources may be perfectly adequate to meet daily fluid needs

without constant need for the tap or water bottle. The best advice is: each of us should develop everyday drinking patterns that suit our level of fluid loss and be able to scale it up or down as fluid losses change. Athletes are a special group with wide-ranging fluid losses. They may benefit from special attention to address the acute needs of exercise as well as daily rehydration.

### MYTH No. 2 *Coffee dehydrates you*

The ‘8 glasses rule’ is often appended with the advice that for every cup of coffee, we should add another glass of water to our day. The good news is that the bad publicity about caffeine has also recently been refuted<sup>2</sup>. Contrary to popular belief and the warnings included in in-flight magazines on airplanes, caffeine has a marginal effect as a diuretic, particularly in people who regularly consume it. In fact, tea, coffee and cola drinks contribute a substantial source of fluid in the diet of the average adult. Although there are other aspects of these



caffeine-containing fluids to be enjoyed (e.g. polyphenol content, social ambience) or cautioned against (e.g. effect on sleep, accompanying sugar content), they needn't be harshly judged on the basis of hydration. It's possible that suddenly cutting people off from their habitual intake of caffeine-containing drinks might actually impair hydration rather than improve it, since many people will not replace fluids they like with an equal volume of something that doesn't appeal to them.

#### *Why drink during exercise?*

Evaporation of sweat provides the major opportunity to dissipate the body heat generated as a by-product of exercise or absorbed from a hot environment. Sweat rates during exercise vary according to factors such as the intensity of exercise, environmental conditions (heat, humidity, airflow) and the athlete's size, clothing and state of fitness/acclimatisation. Typical sweat rates during sport vary from 0.5 to 2.0 l/hour and can cause substantial losses of fluid and electrolytes. In events lasting

longer than 30 minutes, there may be advantages to drinking fluids during the session to offset these losses.

Opportunities to drink during sport vary according to rules, environment and culture.

- In team games and racket sports, competitors can consume fluids during breaks in play such as substitutions, half-time or changes of end.
- In continuous events such as marathons, cycling races and triathlon, the athlete must drink 'on the move'.
- Intake is also determined by access to fluids. Limiting characteristics include rules that forbid drinks on the arena during play (e.g. football) or require the athlete to carry their own supplies (e.g. adventure races), while supportive situations include those in which drinks can be provided by trainers/handlers or from a network of aid stations/feed zones.
- Even if drinks are available, athletes may need to factor in the time lost in slowing down to obtain and consume the drink as well as the risk of gastrointestinal discomfort.

Some degree of dehydration is inevitable in most sports because of the mismatch between the athlete's sweat losses and his or her capacity to replace fluids during the event. This is particularly the case in most high-level sports where exercise intensities ensure high sweat rates and the athlete may be reluctant to sacrifice the costs of drinking. Studies across a range of sports find that athletes typically drink at a rate that is around 50 to 70% of their sweat losses. A more recent phenomenon, however, is the observation that some athletes or exercisers actually drink more than they sweat.

Fluid mismatches during exercise can be aided or impaired by the athlete's hydration status at the start of the session. Some athletes begin the workout or event with a pre-existing fluid deficit, due to chronic dehydration in a hot environment or to inadequate opportunity to restore fluid balance following an earlier bout of exercise. Some athletes may even deliberately dehydrate to 'make weight' for competition in a weigh-division sport. On the other hand, some athletes deliberately over-hydrate in

the hours or days before a challenging event and may be in a positive fluid balance as they approach the starting line or start of play.

### DEBATE No. 1

*How well hydrated should athletes aim to be?*

Guidelines for fluid intake during a session of exercise are based on the goal of avoiding a fluid deficit that could impair performance or health. However, defining this fluid deficit has become a major source of disagreement between scientists. There are many studies on the effects of different levels of fluid loss on exercise capacity (how long someone can keep exercising at a given pace or output) or performance (how well or how quickly an athlete can complete an exercise task). The outcomes vary according to characteristics of the research design including the type of exercise, the environment in which it is undertaken and whether the fluid deficit is incurred over the course of the session or was present at the start of exercise.

The majority view is that:

- Impairments of aerobic and intermittent high-intensity exercise can typically be detected in both physical outcomes (power outputs, work rates etc) and mental characteristics (skills/concentration etc) when dehydration reaches ~2% of body mass.
- Dehydration also increases the perception of effort of an exercise task meaning that performance might be sustained, but at a greater mental and physical cost.
- Effects of dehydration seem clear when exercise is carried out in warm to hot conditions and increase with the size of the fluid deficit. Effects are smaller in cooler conditions and may be harder to detect.
- It's unclear whether mild dehydration affects single efforts involving power or strength, although strength endurance is impaired.
- Dehydration adds to the thermal strain of exercise and may exacerbate problems with body temperature control in hot weather.
- Dehydration also increases the risk of gastrointestinal upsets during exercise, which can directly impair performance

as well as interfere with the effectiveness of hydration strategies.

Critics of this view argue that it is almost entirely based on laboratory studies which can't incorporate the cooling effects of wind and air resistance or the motivating effects of the competition atmosphere. As such, the presently available studies might overestimate the true effect of dehydration on performance in real life conditions. But a counter-argument is that the statistical interpretation of most studies is weighted against finding small but potentially important effects of dehydration on performance. Combining probability statistics with small sample sizes generally means that sports research is only capable of detecting substantial reductions or differences in performance. Such analyses may fail to recognise performance changes that would affect the outcomes of real-life sport, where events are decided by milliseconds and millimetres. Indeed, in studies where the same exercise is undertaken in a hot environment with incrementally increasing fluid deficits from 0 to 4% body mass, there is a parallel increase in thermoregulatory strain, cardiovascular drift and perception of effort. Intuitively, a similar subtle decrease in performance and/or increase in the effort required to perform is also happening, but we find it hard to draw the line in the sand where we consider it important. Some newer studies report impairment of performance in field conditions with mild fluid deficits.

### DEBATE No. 2

*How should we educate athletes to drink during sport?*

Hydration guidelines have evolved since the 1970s thanks to increasing knowledge but also some justifiable criticisms of previous ideas and education messages. The first guidelines focussed on distance running with recommendations that were prescriptive and impractical to apply to other sports. In addition, they failed to recognise and incorporate the additional benefits of consuming carbohydrate during exercise of >1 hour duration. Although many athletes like the simplicity of prescriptive advice, even apparently simple guidelines often fail the test of scrutiny.

- **Example 1:** Early guidelines encouraged

**our ability to sweat and subsequent evaporation of that sweat, which cools down the surface of the skin and creates a heat gradient across the skin, further encouraging heat loss.**

distance runners to drink 100 to 200 ml of water at aid stations provided every 2 to 3 km in a race. This might sound reasonable but, if taken literally, could mean an intake of 330 ml/hour by a slow runner through to 2 l/hour by a fast runner. Whether this would be inadequate or suitable for slower runners depends on their actual sweat rates. However, the high rate would be impossible to achieve when running at fast speeds and any runner who tried it would be likely to develop gastrointestinal discomfort and to lose a substantial amount of time at aid stations.

- **Example 2:** The same guideline of drinking 100 to 200 ml of fluid every 10 to 15 minutes in a football match can't be achieved because the rules prevent drinks from being taken onto the pitch during each 45 minute half.

Current guidelines by groups such as the American College of Sports Medicine<sup>3</sup> have tried to accommodate the different hydration characteristics of a range of sports, as well as the unique needs of each participant. They recommend that each athlete develop an individualised fluid plan based on an appreciation of his or her likely sweat rates and knowledge of opportunities to drink during the exercise session. Such personalised fluid plans should aim to keep fluid deficit below 2%



of body mass, especially if the activities are undertaken in a hot environment, but also prevent over-drinking.

There is a strong criticism of these recommendations from some sports scientists on the basis that they are unnecessary or complicated. Instead, it has been argued that athletes should simply drink according to their thirst<sup>4</sup>.

#### DEBATE No. 3

#### *Are we doing enough to prevent over-hydration?*

Observations from some sporting events over the past decade show that some individuals are overzealous with hydration tactics and drink at a rate that substantially exceeds their sweat losses and their ability to excrete fluid via urine. Excessive fluid intake, recognised by a substantial

gain in body mass over the session, leads to hyponatremia: low plasma sodium concentrations. Among the risk factors are:

- **Being female:** due to smaller body size (lower sweat rates) and willingness to adhere to advice (which may have emphasised the importance of drinking during exercise).
- **Being a slow competitor in an endurance or ultra-endurance race:** combining a low rate of sweat loss with opportunities to drink multiple servings of the fluids provided at aid stations.
- **Inappropriate secretion of vasopressin:** leading to a failure to excrete urine according to plasma osmolarity.

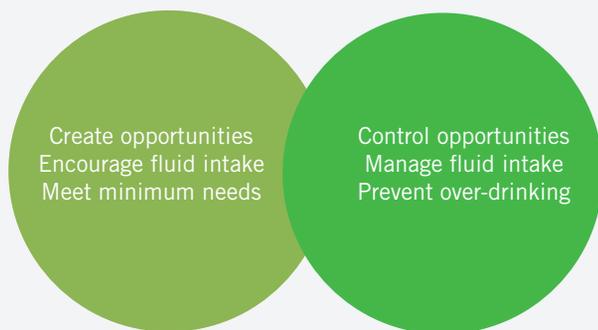
Mild hyponatremia may also occur as a result of large salt losses in individuals who excrete sweat that is salty or simply high in volume. However, overdrinking underpins

the development of severe hyponatremia and ensuing encephalopathies which have caused several unfortunate and preventable deaths among athletes and military personnel. As a result, although it is recognised that it occurs in a minority of athletes especially during high-intensity sports with substantial sweat rates, new fluid guidelines are clear in their warnings against over-drinking during exercise. Nevertheless, there are claims that such guidelines are not strong enough and even that they have been hijacked by commercial interests in sports beverages<sup>4</sup>.

#### *Finding some common ground*

The discourse on fluid intake during sport has become heated and emotive<sup>4,5</sup> and there is a need to find common ground. The opinion of this author comes from more

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**Figure 1:** In most sports, there are both individuals/situations in which guidance is needed to limit fluid intake as well as those which might benefit from assistance to increase drinking practices. Factors that underpin this continuum are summarised (adapted from Burke and Cox, Complete Guide to Food for Sports Performance, 3rd edition, Allen and Unwin: Sydney, 2011).

than 30 years of working with elite athletes and a lifelong commitment to recreational sporting pursuits:

1. Thirst or ad libitum intake of fluid provides a reasonable starting point for developing a fluid plan for exercise.
2. There are several types of athletes or situations, however, where there may be benefits from building a more calculated approach than just drinking if you are thirsty.
  - In sports where opportunities for fluid intake are limited. The athlete may need to drink at the available opportunities early in an event (i.e. 'ahead of their thirst') to better pace total fluid intake over the session.
  - In sports where performance can benefit from the intakes of other nutrients that can be delivered in

fluids, in particular, carbohydrate. Targets are regular tastes of carbohydrate for high-intensity events of 45 to 75 minutes, intakes of 30 to 60 g/hour for activities of >60 minutes of moderate or intermittent high-intensity exercise, and intakes of up to ~80 g/hour for ultra-endurance events of >3 to 4 hours. As long as it doesn't require an excessive fluid intake, athletes may develop a plan to consume beverages such as sports drinks to contribute to refuelling targets.

- For individuals who are unable to respond appropriately to thirst or hunger. Most of us live in a food environment with continually upsized food portions which has clouded our ability to judge what a suitable amount to consume is.

Upper and lower limits to fluid intake can be useful for some athletes (Figure 1).

These factors justify the benefits of developing a more sophisticated plan for intake during some sporting scenarios, particularly for competition. Such plans might include fluid, carbohydrate and other factors such as caffeine and beverage temperature. Athletes should do a periodic assessment of their hydration and fuelling practices during exercise, using a cost-benefit analysis to identify practical strategies that optimise performance with minimal risk of gastrointestinal discomfort or time lost in drinking. Updating and fine-tuning will allow the athlete to accommodate changing circumstances such as environmental conditions or the activity requirements of their sport.



#### References

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