

*What follows is a summary of the Position Stand on Exercise and Fluid Replacement as updated and published by the American College of Sports Medicine (ACSM) in 2007<sup>1</sup>.*

Adequate fluid and electrolyte (the “salts” contained with the body’s fluid stores) replacement is essential to both endurance training (to enhance fitness gains) and racing (to maximise performance). There are four key themes to be appreciated in relation to fluid replacement associated with exercise:

1. There is considerable variability amongst athletes, different activities and environmental conditions.
2. Adequate fluid replenishment before exercise is vital.
3. Appropriate fluid replacement during exercise will assist physical performance.
4. Fluid replacement after exercise promotes recovery.

## **Variability in fluid and electrolyte requirements.**

These requirements differ, and are dependent upon:

- The individual and their clothing.
- The nature, intensity and duration of the physical activity.
- Environmental conditions.

Individual variation exists because of differences in body weight and size, acclimatisation to the environment in which the activity is taking place as well as their genetic make-up and state of fitness. The fact that the nature of the physical activity and the climate in which it is conducted influences sweat rates seems intuitive, but it must also be noted that the total sweat losses may also change during the course of a single bout of exercise, as both the intensity and weather conditions are likely to change if this exercise is of a prolonged duration.

The upshot of this is that there are no hard-and-fast rules that apply to all athletes, not even to the one athlete who trains or races in different conditions or type of activity. Despite this, the ACSM do state that the minimal sweating rate required by someone exercising at a high intensity in “hot weather” is 1200ml per hour. This must be replaced to allow for optimal performance. Therefore, this statement suggests that the absolute minimum amount of fluid replacement must therefore be greater than 1200ml per hour.

## **Assessment of adequate hydration.**

There are a number of laboratory measures of blood and urine that can be used to assess whether someone is adequately hydrated (euvoalaemic) or dehydrated (hypovolemic). These, however, are not practical on a day-to-day basis for most athletes.

The most practical means of assessing adequacy of hydration is by body weight. Total body mass can change over prolonged periods (as the body’s composition of muscle, fat and other tissues change), but short-term changes (hour-to-hour and day-to-day) are due to changes in total body water.

Body weight is ideally measured first thing in the morning, without any clothing, after emptying your bladder and before any food ingestion. The average of three measurements made upon three consecutive mornings should be used as a baseline (on the assumption that adequate fluid intake has occurred on those three days). Total body mass should not fluctuate by more than 1% on any given day. Weight loss of more than 1% represents a dehydrated, or “hypovolaemic state”, and demonstrates that fluid ingestion for the previous 24 hours has been inadequate.

With regards to athletes, estimation of fluid losses will take time and experience, and monitoring body weight after a range of different training (or racing) scenarios (of varied type, intensity, duration and ambient weather conditions) will allow for more appropriate fluid replacement strategies in the future.

## Fluid intake prior to exercise.

Prior to exercise, the goal is to be adequately hydrated (euvolaemic) without being “hyper-hydrated”.

The concept of hyper-hydration has been tested and proven to offer no advantages over being in the euvolaemic state, whilst having the added inconvenience of excessive urine production and the risk of hyponatraemia (low sodium concentration within blood).

The guidelines for achieving an adequate hydration state prior to a training session or event are:

- No concerted effort is required if the following conditions are met:
  1. There is recovery period of at least 8 hours following the previous exercise session;
  2. Fluid intake with meals has been sufficient
  3. Urine is of a pale colour
- Fluid intake should commence at least 4 hours before exercise, with the amount totalling approximately 6 mls per kilogram of body weight
- If urine output is low, or its colour dark, this amount should be closer to 10mls per kilogram of body weight
- The fluid ingested should have some sodium content.

## Fluid replacement during exercise.

Specific fluid and electrolyte replacement guidelines are challenging to make, and they should be tailored to the individual and the other influencing factors that have been mentioned above. It is well documented that a loss of greater than 2% of total body weight during exercise represents an degree of fluid depletion that brings about a definitive decline in performance. The goal during training or racing, therefore, is to avoid this. Individual recommendations can be made based upon pre- and post-exercise body weight measurements made during various training sessions.

The table below (adapted from Noakes et al<sup>2</sup>) gives a starting point from which to work. It provides an estimate of sweating rates (and therefore the minimum amount of fluid replenishment required) of marathon runners of different body weight, running at different speeds and in different ambient environmental conditions.

Estimated sweating rates of marathon runners at various intensities and in differing ambient temperatures.					
Body Weight (kg)	Climate	Running speed (running pace)			
		8.5 km/h	10 km/h	12.5 km/h	15 km/h
		7:00 per km	6:00 per km	4:48 per km	4:00 per km
50	Cool (18°C)	430 ml/hour	530 ml/hour	690 ml/hour	860 ml/hour
	Warm (28°C)	520 ml/hour	620 ml/hour	790 ml/hour	960 ml/hour
70	Cool (18°C)	650 ml/hour	790 ml/hour	1020 ml/hour	1250 ml/hour
	Warm (28°C)	750 ml/hour	890 ml/hour	1120 ml/hour	1360 ml/hour
90	Cool (18°C)	860 ml/hour	1040 ml/hour	1340 ml/hour	1640 ml/hour
	Warm (28°C)	970 ml/hour	1150 ml/hour	1460 ml/hour	1760 ml/hour

## Composition of Consumed Fluids.

This article focuses upon the water and electrolyte intake that is required during physical activity, and therefore does not serve to provide a guide for energy intake (usually measured in terms of carbohydrate content).

Fluids consumed during exercise should contain:

- Sodium (at a concentration of 20-30 mmol/litre)
- Potassium (2-5 mmol/L).

To maximise fluid absorption through the gastro-intestinal tract, it is recommended that carbohydrate content should not exceed 8%.

In other words, and as often displayed for the consumer under *Nutrition Information* on the label of commercially available products, the ideal content should be:

- Sodium: 2-3 mmol (per 100ml serving)
- Potassium: 0.2-0.5 mmol (per 100ml)
- Carbohydrate: less than 8 g per 100ml

## Fluid Replenishment following strenuous exercise.

Following exercise, one must aim to replace any fluid and electrolytes. The rate at which this must occur is dictated by the particular circumstances, considering the following:

- The magnitude of the exercise-related losses
- The anticipated recovery period before the next bout of exercise

The consumption of plain water accompanying normal meals and snacks will usually suffice. The use of commercially available sports drinks may be of assistance, but a normal healthy selection of foods and meals will usually provide sufficient electrolytes. For those requiring or desiring a more rapid recovery from volume depletion, the ingestion of 1500ml of fluid for every kilogram of body weight lost should suffice.

The use of intravenous fluids does not provide any benefit over simple oral intake other than in the most extreme of circumstances.

## Concluding Points.

- Physical activity results in high sweat rates, leading to both fluid and electrolyte depletion
- This loss of greater in warm-to-hot weather
- Excessive volume depletion (“dehydration”) will impede performance
- All individuals should aim to be adequately hydrated prior to commencing any exercise or racing session
- Fluid requirements during exercise vary amongst individuals with other factors also playing a role, and hence, estimates of the amount of fluid required during exercise can only be made based upon a particular individual’s past experience
- There are clearly defined guidelines for the ideal composition of “sports drinks”
- Fluid replenishment following exercise allows for more complete recovery

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## References.

- <sup>1</sup> Sawka, M. N et al (2007) Exercise and Fluid Replacement. *Medicine and Science in Sports and Exercise*. 39(2): 377-390.
- <sup>2</sup> Noakes, T. D et al (1985) Water intoxication: a possible complication during endurance exercise. *Medicine and Science in Sports and Exercise*. 17:370-375.