



AIS SPORTS SUPPLEMENT FRAMEWORK

ELECTROLYTE REPLACEMENT SUPPLEMENTS

What is it?

- > Electrolyte replacement supplements are powders, tablets or ready to drink products designed for replacement of fluid and electrolytes (in particular, sodium and potassium) lost through sweat or other body fluids. Typical uses include:
 - As a method of increasing total body water and plasma volume prior to exercise in hot environments, when opportunities for fluid replacement are inadequate to prevent significant fluid losses (pre-exercise hyperhydration).
 - As an alternative to standard sports drinks when it is deemed of value to replace large electrolyte losses during and after exercise with a more aggressive approach, or where electrolyte replacement is desired with limited or no carbohydrate intake.
 - To restore fluid/electrolyte deficits caused by other factors such as the dehydration techniques undertaken to “make weight” for competition or gastrointestinal upsets (vomiting/diarrhea etc.).
- > Guidelines around the need, or optimal plan, for sodium intake during endurance (i.e. > 1 hour) and ultra-endurance exercise (i.e. >4 h) are unclear.
 - General recommendations include 0.5–0.7 g per litre of fluid [21–30 mmol/L]¹ with this target being set as a balance between preserving thirst drive and preserving the palatability of fluids.
 - There are suggestions that in situations of large sweat sodium losses (e.g. ultra-endurance exercise, individuals who have “salty” sweat or combination of these factors) a more proactive approach to sodium intake during exercise may be needed. However, the best method for assessing these needs, and planning for sodium replacement, are yet to be determined.
- > Two contentious issues around electrolyte/sodium replacement during exercise concern the prevention of cramps and hyponatremia.
- > Exercise associated muscle cramps may be caused by multiple factors, with primary risk factors including fatigue due to unaccustomed volume/intensity of exercise and previous history of cramps. There is some evidence, although controversial² that whole body sodium depletion may be a cause of specific types of cramps in some individuals. Electrolyte supplementation may be beneficial in these athletes.³ There is also some suggestion that a sudden drop in plasma sodium concentration (e.g. dilution due to large, sudden intake of plain water) may increase susceptibility to muscle cramps, although the exact mechanism underlying this effect has not yet been determined.⁴
- > Typically, plasma sodium concentrations are typically tightly regulated at ~ 135–145 mmol/L and athletes become mildly hypernatremic (high blood sodium concentrations) during exercise because sweat losses deplete fluid stores at a higher rate than sodium/electrolyte losses (sweat is hypotonic compared with blood).
 - **Mild hyponatremia** (<135 mmol/L) can occur in some sports, often without overt symptoms, due to the strategies used to replace sweat fluid and sodium losses. An athlete can dilute blood sodium concentrations during exercise by drinking fluids at a rate that is slightly greater than their sweat losses, or by replacing large sweat losses (and the accompanying large electrolyte loss) with low sodium fluids (e.g. water or soft drinks). Sodium replacement during exercise can address this issue provided the total fluid consumed remains less than sweat losses. Whilst mild hyponatremia is usually asymptomatic, a large and sudden drop in blood sodium concentration, even when the final value remains > 130 mmol/L, can result in symptoms of severe hyponatremia (below), due to the rapid shift of water into the intracellular space (Hew Butler et al. 2015).
 - **Severe hyponatremia** (plasma sodium < 130 mmol/L) can be associated with confusion, nausea, headaches, and the potentially fatal outcome of cerebral oedema. It is comparatively rare in sport and occurs when an athlete consumes fluid at a rate that is substantially higher than actual sweat losses, and the rate of urine production. This condition may be exacerbated in individuals/scenarios involving inappropriate secretion of the renal hormone ADH (also known as vasopressin) which reduce urine production (vasopressin or ADH). Although sodium replacement in concert with “over drinking” behaviour may slightly reduce the degree to which hyponatremia develops, the underpinning cause of severe hyponatremia is excessive fluid intake and should be tackled directly.⁵
 - Rehydration after exercise (or other dehydrating events) requires the replacement of electrolyte losses before fluid balance can be fully restored. In the absence of electrolyte replacement, fluid replacement will restore blood osmolarity (concentration) before it has replaced its volume, leading to a reduction in thirst and increased urination. Such signs can be confused with adequate or overhydration. Rehydration after the development of moderate-severe dehydration (e.g. fluid loss > loss of 2% BM) is more efficient when there is a considered replacement of electrolytes. Although sodium can be replaced by eating salty foods (e.g. bread, breakfast cereal, cheese & crackers, Vegemite™) or adding salt to meals, electrolyte supplements or sports drinks with higher sodium content can be useful for rapidly restoring fluids and electrolytes with a more targeted approach, especially if food intake is likely to be minimal or delayed after exercise. See Table 1 for details on higher sodium foods.



What does it look like?

- > Pharmaceutical Oral Rehydration Solutions (ORS) and sports-related Electrolyte Replacement Supplements are available in ready to drink, tablet, ice block and powdered forms in a wide variety of flavours.
 - In general, ORS are manufactured according to the World Health Organisation guidelines for the treatment and prevention of dehydration associated with diarrhoea and gastroenteritis. Typical sodium content is in the range of 50–60mmol/L which is ideal for electrolyte and fluid replacement following large losses. Note that sweat sodium concentrations are often less than this value, and therefore exclusive reliance on high sodium ORS products with no plain water intake during ultra-endurance exercise could result in increased blood sodium concentration, due to replacing proportionally more sodium than fluid.
 - Since ORS are focused on electrolyte/fluid replacement; the low-moderate carbohydrate content (1.5–2% or 1.5–2 g/100 ml) is present to contribute to intestinal sodium/fluid absorption rather than achieve typical fuelling goals for exercise.
- > Sports-related electrolyte supplements which are marketed to athletes include:
 - Electrolyte-only powders and tablets which can be added to fluids varying in carbohydrate content according to the athlete's needs.
 - Sport drinks with high electrolyte concentrations (often marketed as an "endurance formula" which provide higher amounts of both carbohydrates and electrolytes. The sodium content of these drinks is typically within the range of 30–50 mmol/L (in contrast to typical ranges of 10–30 mmol/L in standard sports drinks)

Note that the characteristics of sports drinks are discussed in a separate Sports Drinks (Carbohydrate-Electrolyte drinks) fact sheet)

Table 1: A sodium ready reckoner of common high sodium foods

Food Item	Sodium [mg/100g]	Amount of food needed to replace 60mmol of Sodium
Air popped popcorn	300	4 ½ cups
Tinned tuna	350	1 large tin
Baked beans	360	1 x 220g tin
Salted mixed nuts	393	3 cups
White bread	400	3 slices
Rice crackers	404	3 ½ packets
Cornflakes	485	8 ½ cups
Salted butter	550	11 tablespoons
Potato chips	556	1 ½ large packets
Peanut butter	580	11 tablespoons
Pickle spread	690	7 tablespoons
Cheddar cheese	696	10 slices of pre-sliced cheese
White wrap	790	2 ½ wraps
Salted peanuts	790	1 ½ cups
Ham	967	10 slices
Pretzels	1245	2 cups
Olives	1410	20 olives
Smoked salmon	1880	1 ¼ slices
Vegemite	3300	8 ½ teaspoons

- > Food First approach - The following meals provide ~60mmol of sodium (the equivalent to 1litre of an ORS) as well as other important nutrients.
 - Vegemite and cheese on toast ^{CP}_{Ca}: 2 slices white bread + 2 slices cheese + 1 teaspoon vegemite
 - Baked beans on toast ^{CP}: 2 slices white bread + ½ 220g tin
 - Ham, cheese & pickle sandwiches ^{CP}_{Ca}: 2 slices white bread + 1 slice cheese + 1 tablespoon pickle spread
 - Smoked salmon & olive salad ^{CP}: 1 slice smoked salmon + 5 olives
 - Cheese, crackers & pretzels ^{CP}_{Ca}: 1 cup pretzels + 3 slices cheese + 2 rows of rice crackers

- Cereal & toast ^{C^PCa}: 1 ½ cups cornflakes + 1 ½ cups milk + 2 x toast + 1 Tablespoon peanut butter
- Tuna, cheese & salad wrap + nuts ^{C^PCa}: 1 wrap + 1 x 90g tin tuna + 1 slice cheese + salad + 1 teaspoon butter + 1/3 cup peanuts

^C provides valuable amounts of carbohydrate to support post-exercise refuelling

^P provides valuable amounts of protein to support post-exercise repair

^I provides valuable amounts of iron to support overall athlete health and performance

^{Ca} provides valuable amounts of calcium to support overall athlete health and performance

How and when do I use it?

- > **Before exercise in hot environments, where large sweat losses cannot be practically replaced:** Pre-exercise hyperhydration can be achieved by consuming up to 10mL/kg body weight of fluid with a very high sodium concentration, ideally as close to plasma sodium concentration (i.e. 135mmol/L) as tolerated, within 1-2 hours prior to exercise. This concentration, as much as double that of typical ORS products, can be achieved by manipulating the ratio of product to water, or using commercially available products designed specifically for this purpose. Note that other strategies (i.e. glycerol supplementation) can also be used for pre-exercise hyperhydration.
- > **During exercise and sporting activities:** Electrolyte replacement supplements may be useful in the following situations:
 - When targeted replacement of large sodium losses is desired. This may occur in events or individuals where there is a high rate of sweat loss, prolonged duration of sweating, or evidence of "salty sweat" (high sweat content of electrolytes). A personalised fluid plan should be made with the help of a Sports Dietitian; it is also noted that during ultra-endurance events, sodium replacement may also be achieved via food choices.
 - When electrolyte replacement is desired without an accompanying carbohydrate intake (e.g. undertaking training with 'low carbohydrate availability' or exercise undertaken during a period of reduced energy intake).
- > **For the prevention and treatment of dehydration during diarrhoea and gastro-enteritis,** particularly as guided by a Sports Physician. Note that ORS are recommended for these purposes since the priority is to rehydrate rather than consume energy/carbohydrate.
- > **In the restoration of moderate-large fluid deficits** incurred during exercise or other dehydrating activities (e.g. "making weight"), where a targeted replacement of fluid and electrolyte losses will assist with more rapid and effective rehydration. Scenarios in which this might be useful include a short period of recovery until an exercise session, or after an exercise session late in the day where the athlete wants to rehydrate with minimal risk of sleep disturbances due to the need for a toilet break.

The athlete with a moderate-large fluid deficit should follow a rehydration plan tailored to meet their estimated fluid loss. Specifically:

- The athlete should consume a volume of fluid equal to ~ 1.2-1.5 times their estimated fluid deficit within 2-4 hours following the dehydrating activity, or as much of this volume as can be comfortably tolerated.
- Fluid intake should be accompanied by electrolyte replacement (particularly sodium) to optimise fluid retention. This may be achieved through food sources, via the salting of meals, or through the use of higher sodium sports drinks or electrolyte supplements, according to what is most practical. While intake of food sources can target other nutrition goals, it is noted that electrolyte supplements provide a known sodium content that may be more precisely achieved.
- Since the carbohydrate content of ORS and some sports electrolyte supplements is negligible, refuelling goals may need to be addressed separately.

Are there any concerns or considerations?

Unnecessary expense and unclear guidelines

There is currently no consensus regarding the value of sodium replacement during exercise for either performance or health reasons.

Disruption to hydration plan if used incorrectly

- > Increasing the sodium content of a drink generally reduces the drink palatability and may interfere with the voluntary consumption of fluid.
- > Excessive intake of salt supplementation during exercise may cause gastrointestinal problems or further impairment of fluid balance.

Failure to address major risk for hyponatremia during exercise

Excessive fluid intake during exercise (substantially greater than sweat losses) is the major cause of serious cases of hyponatremia in susceptible people. Sodium replacement during exercise does not address this problem and may provide a false sense of security.

Consideration of larger messages about salt and health

The Dietary Guidelines for Australians promote a reduction in sodium/salt intake by the community, due to the link between salt intake and hypertension in susceptible people. Electrolyte replacement during and after sport may be considered as a special situation for a specific sub-group of the population, however, general guidelines for healthy eating should not be overlooked.



Where can I find more information?

Sports Dietitians Australia

www.sportsdietitians.com.au/factsheets

Gatorade Sports Science Institute

secure.footprint.net/gatorade/prd/gssiweb/sf_libraries/sse-docs/122_nina_stachendfeld.pdf?sfvrsn=4

Supplement safety information

www.sportintegrity.gov.au/what-we-do/anti-doping/supplements-sport

References

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4. McCubbin A, Allanson B, Caldwell Odgers J, Cort M, Costa R, Cox G, Crawshaw S, Desbrow B, Freney E, Gaskell S, Hughes D, Irwin C, Jay O, Lalor B, Ross M, Shaw G, Périard J, Burke L. (2020). Sports Dietitians Australia Position Statement: Nutrition for Exercise in Hot Environments. Int J Sport Nutr Exer Metab, 30, 83-98.
5. Hew-Butler T, Rosner MH, Fowkes-Godek S, Dugas JP, Hoffman MD, Lewis DP, et al. (2015). Statement of the 3rd International Exercise-Associated Hyponatremia Consensus Development Conference, B J Sports Med, 49 (22), 1432-46.

The Australian Institute of Sport (AIS) Supplement Framework is an initiative of the Australian High Performance Sport System. The AIS acknowledges the support of members of the National Institute Network (NIN) and National Sporting Organisations (NSO) and their staff in delivering content expertise. This information is intended to help athletes, coaches and scientists make evidence-based decisions about the use of supplements and sports foods. Before engaging in supplement use, we recommend that each individual refer to the specific supplement policies of their sporting organisation, sports institute or parent body, and seek appropriate professional advice from an accredited sports dietitian (www.sportsdietitians.com.au).

Athletes should be aware that the use of supplements may have doping implications. Athletes are reminded that they are responsible for all substances that enter their body under the 'strict liability' rules of the World Anti-Doping Code. Some supplements are riskier than others. The Sport Integrity Australia (SIA) app is a useful resource to help mitigate the risk of inadvertent doping by helping to identify supplements that have been batch-tested. The SIA App provides a list of more than 11,000 batch-tested products. We recommend that all athletes consult the educational resources of SIA regarding the risks associated with supplements and sports foods.. While batch-tested products have the lowest risk of a product containing prohibited substances, they cannot offer you a guarantee that they are not contaminated (www.sportintegrity.gov.au/what-we-do/supplements-sport).

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