CURRENT ISSUES
THE INSIDE STORY

Sports Drinks: Their Role in Hydration for Athletic Performance

Athletes are particularly at risk for dehydration and adequate hydration is key for both health and performance (1,2, 7-9). In fact, the health consequences of severe dehydration can be life threatening for the athlete, particularly if they continue to exercise in such a state. Consequences of dehydration include (1-7):

- Increased core body temperature and heart rate (0.15-0.2°C and 3-5 beats per minute (bpm) for every 1% body mass loss)
- Decreased plasma volume, stroke volume and cardiac output
- Reduced mean arterial pressure
- Compromised skin blood flow
- Impaired physical and mental performance (with as little as 2% dehydration)
- Increased rating of perceived exertion and decreased motivation.

Some of the noticeable symptoms of dehydration include: flushed skin, thirst, dizziness, headache, irritability, fatigue, disorientation, vomiting, nausea, hot and cold sensations, chills, cramps and apathy (1). The above symptoms and cardiovascular and thermoregulatory effects can begin with as little as 1-3 % dehydration. For a 150 pound (68 kg) athlete, 2% dehydration would translate into a loss of 3 lbs of fluid or 1.36 L. This is not an uncommon level of dehydration in athletes (1).

Typical sweat rates can range from 0.5 to 2.0 L/h (1). Sweat rates vary within and between individuals and will depend in part on the duration and intensity of the exercise, environmental conditions and the athlete's degree of acclimatization (1). Hence, athletes should know their sweat rates for the conditions in which they regularly train and compete. Weighing oneself before and after exercise will provide an indication of how much fluid was lost during exercise. Any fluid consumed or lost through urine (between weighing) would need to be factored into the equation. The American College of Sports Medicine (ACSM) along with the American Dietetic Association (ADA) and Dietitians of Canada (DC) recommend drinking during exercise to replace sweat losses and avoiding dehydration greater than 2% body mass.

How to Calculate Sweat Rate in L/h

$$\frac{\text{(Pre-exercise body weight kg - Post-exercise body weight kg)} + \text{Fluid intake (L)} - \text{Urine volume (L)}}{\text{Exercise time (h)}}$$

Hydration Guidelines:

- At least 4 hours before exercise, slowly drink about 5-7 mL per kg of body mass. For a 165 pound (75 kg) athlete this is 375-525 mL of fluid (1,2).
- If over the next 2 hours no urine is produced or it is dark and concentrated, slowly drink another 3-5 mL per kg of body mass (1).
- *During* exercise - drink to closely match sweat losses (1,2).
- *After* exercise - replace any remaining fluid deficit (1,2). For rapid and complete recovery (such as when training or competing more than once per day) athletes should drink 450-675 mL (16-24 oz) for every 0.5 kg (pound) of weight (sweat) lost. However, if time permits, regular meals, snacks and beverages help restore euhydration. Sodium containing food and beverages assist with fluid retention and rehydration (1,2).

Gastric emptying and intestinal absorption are limiting factors for fluid entry into the blood stream and are slowed during high-intensity exercise (10-12). Gastrointestinal distress is not an uncommon complaint among athletes and is aggravated by psychological stress and severe hypohydration (12-15). Additionally, research has demonstrated that athletes often do not adequately replace sweat losses (16-18). Therefore, sports drinks need to be formulated with the above in mind.

The Role of Sports Drink Ingredients

- **Water**
  - Most sports drinks are approximately 90-96% water to replace sweat losses.
  - Carbonation should be avoided. This can inhibit voluntary fluid consumption due to the accompanying feelings of fullness and gas (19).
- **Flavour**
  - Light flavour increases palatability and voluntary drinking, thereby improving hydration (6,20-21).
- **Electrolytes**
  - Electrolytes are important for proper muscle and nerve conduction and ensuring proper fluid distribution throughout body tissues (1-2,9,22).
  - ***Sodium***
    - Sodium is the primary electrolyte lost in sweat. Sweat sodium concentrations range from 20 to 80 mmol/L (460 to 1840 mg/L) (22).
    - Sodium in a sports drink can help:
      - replace sweat losses (23);
      - prevent muscle cramping (24);
      - stimulate voluntary fluid consumption via flavour enhancement and the osmotic stimulation of thirst (6,16,25-26);
      - restore fluid distribution in the extracellular fluid space (1);
      - decrease urinary losses (27-29);
      - prevent declines in serum sodium (23).
    - Water has been found to dampen the sensation of thirst before body fluid balance has been adequately restored (30).
    - Sports drinks should contain sodium in concentrations of at least 0.3 to 0.7 g/L (1-2). Athletes prone to cramping or ultra-endurance athletes may require more sodium to prevent muscle cramps and hyponatremia* (1-2,9,24,31-32).

**Hyponatremia is an extremely rare but potentially fatal condition characterized by a drop in serum sodium below 135 mmol/L. Athletes need to understand that they should not exceed fluid intake guidelines and should understand their sweat rates and drink to match their fluid losses. Over hydrating will not benefit and can harm the athlete (32).*

  - ***Potassium***
    - Potassium is also lost in sweat, at an average concentration of 5 mmol/L (195 mg/L) and is added to sports drinks to help replace sweat losses (22).
  - ***Other Electrolytes***
    - Magnesium, chloride and calcium are also lost in sweat and have been added to many sports drinks help replace sweat losses. However, more research is required to determine if the addition of these minerals helps to support physiological functioning during exercise.
- **Carbohydrate (CHO)**
  - The addition of carbohydrate to a sports beverage serves a number of important functions:
    - Increases voluntary fluid consumption due to increased palatability of sweetened beverages (6,20);

- Helps maintain blood glucose for muscle uptake and central nervous system support (33-46);
- Helps maintain carbohydrate oxidation rates (40-41,43-45);
- Improves athletic performance (detailed discussion follows)
  - Consumption of 30-60 grams of carbohydrate per hour is therefore recommended (1-2,22,47).

- The aforementioned benefits will only occur if the carbohydrate containing beverage rapidly leaves the gastrointestinal tract and enters the blood stream. To do so, the sports drink should contain:

  - **A 4-8 % carbohydrate concentration.** During exercise carbohydrate solutions greater than 8% slow gastric emptying and intestinal absorption compared to beverages with lower concentrations (48-54). Solutions within the 4-8 % range can empty and absorb as quickly as water (10,55-56).
    - To determine the concentration of carbohydrate in a beverage divide the grams of CHO by the mL fluid.
      Example:
      $$\frac{15\text{ g of CHO}}{250\text{ mL}} \times 100 = 6.0\%$$

  - **Multiple types of carbohydrate.** The speed of intestinal absorption is enhanced when multiple types of carbohydrate are included in a sports beverage formula (51,53). Examples include: glucose, sucrose, fructose, glucose polymers and maltodextrin. Additionally, the maximal exogenous carbohydrate oxidation rate of 1 g/min has been found to be exceeded by up to 25% with the ingestion of multiple carbohydrate substrates during exercise. This is likely due to the activation of various carbohydrate transporters in the intestine (57-60).

  - **Low fructose concentration.** Sports drinks should contain no more than 2-3% fructose to prevent gastrointestinal distress from the osmotic effect of high fructose levels in the intestine (2,61). However, when multiple types of carbohydrate are present in a sports drink, intestinal absorption and exogenous carbohydrate oxidation appear to be enhanced above that when only one type of carbohydrate is ingested (57-60,62-63). Hence, small amounts of fructose may be beneficial in a sports drink when used in combination with other types of carbohydrate.

Carbohydrate and Performance

The effects of carbohydrate supplementation during exercise have been studied for decades (22,47). Fortunately many of these studies have utilized sports drinks as the vehicle for the carbohydrate delivery, allowing us to draw many conclusions regarding the efficacy of sports drinks on exercise performance. Specifically, carbohydrate supplementation during exercise has been found to exhibit the following training and performance benefits:

- During prolonged endurance exercise:
  - Decreased rating of perceived exertion (64-65)
  - Prolonged time to exhaustion (11,40-43,66-68)
  - Faster time trials (33,44-45).

- During high intensity and high-intensity intermittent exercise:
  - Decreased rating of perceived exertion and perception of fatigue (39,69-70)
  - Prolonged time to exhaustion (36-37,39,69,71)
  - Faster sprint times and time trials (35,38-39,69,72)
  - Enhanced fine motor skills (69)
  - Improved power output (73-74).

Some of the above performance improvements were seen in events lasting under 60 minutes (35,69,72,74). Benefits such as increased time to exhaustion may not often mimic competition, but will allow the athlete to be able to train longer and more intensely which could translate into improved performance in competition due to enhanced training responses. Additionally, athletes who have less than a day between competitions may particularly benefit from sports drinks over water due to the carbohydrate replenishment and improved fluid retention from the electrolyte content (75).

It should also be noted that not all reports of carbohydrate supplementation in the literature have reported ergogenic effects. Many factors influence sport performance making such studies difficult to control and performance protocols have varying degrees of sensitivity (47). However, the majority of studies do support an ergogenic effect of carbohydrate supplementation on exercise performance (11,33,35-45,64-74).

Summary Points

Sports drink consumption can benefit exercise that is:

- 45-50 minutes or longer;
- Very intense;
- Done in hot and/or humid climates;
- Done in protective sports equipment;
- Either prolonged endurance or high intensity (including intermittent).

Sports drinks should contain:

- At least 0.3-0.7 g of sodium per litre;
- A 4-8 % carbohydrate concentration;
- Multiple carbohydrate types.

Athletes should know their sweat rates, replace lost fluid and electrolytes and select sports drinks when appropriate.

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