3.1 Sports Drinks

There currently exists a large number of drinks that we can define as “sports drinks”. As the term suggests, it would seem that any type of liquid that can be used in a sports event can be called a sports drink.

In this module, we will explore the advantages and disadvantages of using different drinks in order to classify them according to their adequacy, or lack thereof, for use coupled with physical effort.

Currently, water is presented as a universal liquid and is the most readily available for consumption. Although we have previously seen that it is a useful tool for day-to-day needs, for certain efforts requiring elevated volume and intensity, we must recognize that water does not supply energy and electrolytes "to the cause". Because of this, it can cause “water intoxication” in an athlete. It is here that certain other drinks come onto the scene, supplying carbohydrates and electrolytes, which are fundamental at particular points during physical effort.

Starting with a brief overview of the history of beverages today known as “sports” drinks, timing and forms of preparation, we will try to understand how and why athletes should use them.

3.1.1 Historical Overview

In the summer of 1965, an assistant trainer at the University of Florida, obsessed with getting maximum performance from his team, the "Florida Gators", met with a group of scientists to understand why most of his players suffered so much from the heat. Here Doctor Robert Cade and his prestigious group of researchers (Dr. Dana Shires, Dr. H. James Free and Dr. Alejandro De Quesada) come into the story in search of a solution to the problem.

Firstly, they established that, by sweating, the players were affected by the loss of fluids and electrolytes. Concurrently, they lost large amounts of carbohydrates and were unable to restore them.

These discoveries were taken into the laboratory to guide the formulation of a drink that could balance the losses (water, carbohydrates and electrolytes) and help the players to recover after physical exertion.

Thus, other teams began to call this drink "Gator's aid", never knowing that in the future the nickname would become one of the top brands in today’s market (Gatorade). The team’s results were excellent and their physical performance was vastly improved. They became known as the

"second-half team" because that was when they defeated their opponents. The trainer had discovered that his players gained physical advantages from the drink, proving to be less dehydrated and performing better. In 1966, their crowning achievement occurred; for the first time in history, they won the *Orange Bowl* (retrieved from goo.gl/5HHRAS)

In a few years, the product became commercialized and was the first of many glucose-electrolyte solutions (GES). Years later on the market, the improved versions of the product, such as those with glucose polymer solutions (GPS) and varying amounts of electrolytes, declared themselves to be "sports drinks".

The glucose-electrolyte solutions were originally designed to replace lost liquids and carbohydrates. In addition to water, the main ingredients in these solutions are carbohydrates, usually with different combinations of glucose, glucose polymers, sucrose or fructose and some of the main electrolytes lost via perspiration (sodium, chloride, potassium and phosphorous). Levels of sugar vary from 5 to 8% depending on the brand, as do the calories, which fluctuate between 80 and 350 kcal/L (varying in relation to the amount of carbohydrates).
Some brands also include a variety of other substances, such as vitamins (usually B and C), minerals (calcium and magnesium), drugs (caffeine) and herbal products (ginseng).

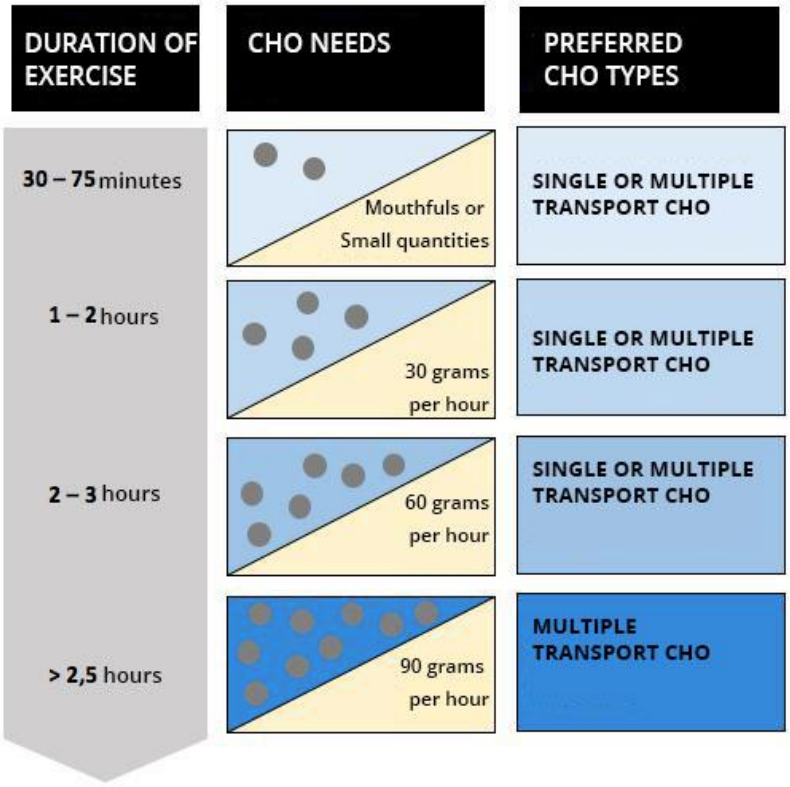
The glucose polymer solutions are designed to deliver carbohydrates, and at the same time diminish the osmotic concentration of the solution. Osmolarity ranges from 200 to 400 mOsm/L, helping to minimize the effect of gastric emptying on the athlete (Coombes & Hamilton, 2000).

3.1.2 The Role of Sports Drinks

In previous modules, we have gone into detail regarding the importance of ingesting carbohydrates (CHO) while exercising as a tool to delay the onset of fatigue in athletes. Let's remember that CHs are the main fuel source during exercise. If we add to this the research – sustaining that high temperatures can accelerate muscle glycogen – we find that the fusion of "hydration and sports drinks" becomes indispensable to improving physical performance.

Just as Jeukendrup (2014) proposes in the following review, numerous studies have indicated that the need for CHO is incremental in relation to the duration of the exercise (see table 1).

Table 1: CHO Intake while Exercising



Source: Adapted from Jeukendrup, 2014.

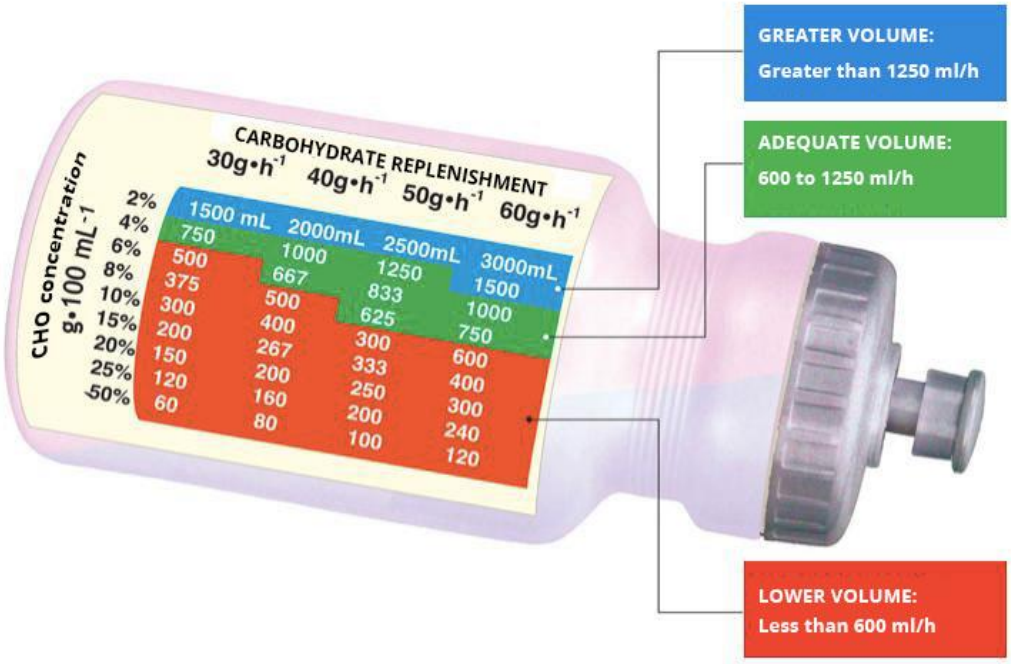
Likewise, research indicates that an adequate quantity of CHO in the solution can help maintain body temperature just as effectively as water, and thanks to the delivery of "sugars", can improve prolonged performance.

We must pause here because, although CHO delivery in different combinations and concentrations can be beneficial, we must also keep in mind that solutions delivering more than 15-20% of CHO can significantly delay gastric emptying, diminish intestinal absorption and cause gastrointestinal irritation.

In general, CHO solutions that vary from 5 to 8% empty the stomach just as effectively as water during exercise. Compared to water, no significant adverse effects have been observed in these solutions in terms of plasma volume, sweat production, or body temperature regulation. In fact, they can help maintain plasma volume, hepatic glycogen and blood glucose levels during prolonged exercise (Maughan, 2000).

The following figure shows the quantity of liquid we can ingest at a specific concentration, so that the grams of CHO needed for an event can be accessed.

Figure 1: Concentration of CHO According to Liquid Volume



Source: Adapted from McArdle, 2015.

Another role of sports drinks is related to the replenishment of electrolytes in prolonged activities. Here they must mainly compensate for elevated losses of sodium and potassium through sweat.

If electrolytes are not replaced in activities where physical effort lasts over 4 hours (cycling, triathlons, marathons, tennis, etc.), there is a risk of hyponatremia, a condition where blood sodium levels are depleted; a problem we will cover in detail further ahead. During this type of effort, consuming large quantities of water can cause sodium displacement from the extracellular medium to the intestine, generating an accelerated reduction in plasma sodium (Mountain, Cheuvront & Sawka, 2006).

Sodium is the "electrolyte superstar" that delivers physiological benefits when added to drinks consumed during exercise. Concentrations may vary from 20 to 50 mmol/L (460-1150 mg/L) can stimulate maximum delivery of water and carbohydrates to the small intestine and help maintain the volume of extracellular fluid.

On the other hand, while still important, loss of potassium is lower (4-8 mmol/L) so its replacement is less necessary than that of sodium, at least while exercising. Generally, it is best included in post-exercise drinks which help to replenish losses, as it favors intercellular water retention and helps achieve adequate rehydration.

3.1.3 Designing Homemade Sports Drinks

In their review of the effectiveness of drinks on the market, Coombes and Hamilton (2000) propose a series of guidelines for the optimum sports drink formula, details of which include:

An optimum sports drinks must provide:

- 50 to 80 g of CHO/L;
- 80 to 350 kcal/L;
- more than one type of carbohydrate in the composition (not just glucose);
- osmolarity between 200 and 400 mOsm/L;
- between 20 and 60 mmol/L of sodium (460 to 1380 mg/L).

Stemming from this original proposal and reviewing the nutrients on offer in the current market (see table 2), we can emulate industrial preparation with a homemade version, which is a cost-effective alternative; especially when the implementation costs of an industrial sports drinks are not viable.

Table 2: Composition of Different Types of Sports Drinks on the Market (each 1000 cm^3)

Drink	Kcal	CHO (%)	CHO (Gr/l)	Sodium (mg/l)	Potassium (mg/l)
Gatorade	222	5,83%	58,3	444,4	125
Powerade	222	5,83%	58,3	416	97,2
SIS Go	292	7,2%	72	1000	120
GU Drink Mix	195	5,0%	50	694	83,3
Isostar Fast Hydration	288	6,7%	67	700	190

Source: Prepared by the author.

Traditional preparation of homemade sports drinks requires water (bottled or drinkable tap water), orange/grapefruit juice, sugar and table salt. The ingredients that create variability in the composition are the use of tap water, because its sodium content is not always the same. Similarly, not using a precision balance for table salt can create issues with the total quantity that can be added with a teaspoon. The same thing happens with the chemical composition of the citrus fruit CHO, but keep in mind that, as a "homemade concoction", perfectly standardizing this drink is very complex.

Another variable to consider when preparing a homemade sports drink is the quantity of sodium contained in bottled water, if used instead of tap water (approximately 50 mg Na/L). According to industry standards,

these are classified as low sodium content (up to 20 mg Na/L), moderate sodium content (up to 100 mg Na/L) and high sodium content (over 100 mg Na/L).

Although preparation can have variations that modify the chemical composition of the final product (with the addition of maltodextrin, glucose, or even commercial juices in powdered form), the basic ingredients and quantities for the homemade format are shown in the following table.

Table 3: Conventional Preparation of Homemade Sports Drinks

Ingredients	Quantity	CHO (gr/L)	Sodium (mg/L)
Tap water	1000 ml	--	50 mg (*)
And (*) a coffee spoon of table salt (*)	1 gr Salt	--	400 mg
3 tablespoons of sugar	60 gr	60 gr	--
2 Lemons (juiced)	150 gr	8 cc	--
Total	288	68 gr	150 mg
(*) Can be replaced by 1 tablet of 1 gr of salt. Which provides the same. (*) May vary close to the area in question or if it is replaced by bottled water.			

Source: Prepared by the author.

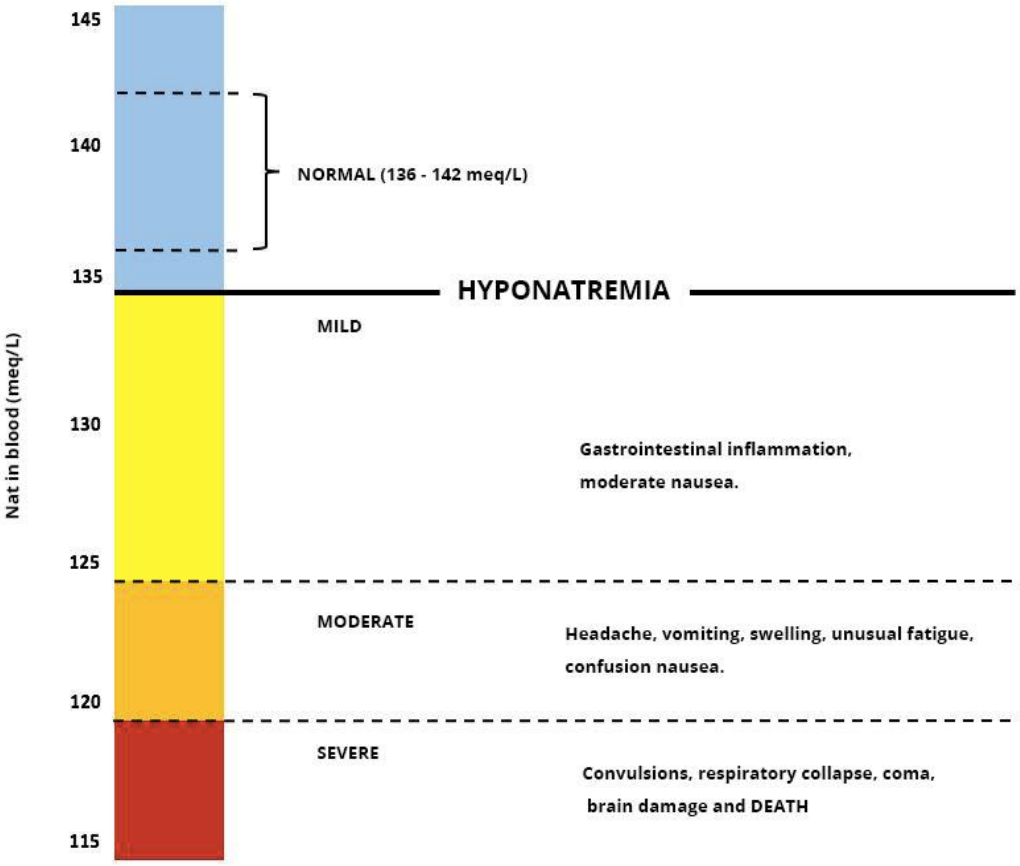
We can see that if we respect the suggested quantities, the critical elements of a sports drink – like sodium and CHO – generally contain the same values as those proposed for an ideal sports drink by Coombes & Hamilton (2000).

3.1.4 Exercise-Associated Hyponatremia

We have covered the entire module and we have seen the importance of ingesting liquids before, during and after exercise. We have seen the importance of adequate hypotonic water consumption in some cases, but we have realized that in other cases, said consumption can be counterproductive and could cause a complication known as hyponatremia or "water intoxication".

A decrease in the concentration of plasma sodium causes an osmotic imbalance in the blood-brain barrier, which enables quick entry of water into the brain. This inflammation of cerebral tissue produces a cascade of light to severe symptoms in relation to the amounts of sodium concentration in the blood, and can be seen in figure 2 (Rosner & Kinver, 2007).

Figure 2: Symptoms of Exercise-Associated Hyponatremia (EAH)



Source: Adapted from McGraw Hill, 2011.

Hyponatremia during exercise often appears together with two enabling factors:

1) Activity lasting more than 4 or 5 hours.
2) Excessive intake of large quantities of plain water during that time.

This is a rather common complication in triathletes, marathon runners and ultra-endurance athletes. It is less common in tennis, for example, where exposure to heat, game duration and excessive simple water hydration combine in a different way.

As well as sodium serum concentration, which we have recently seen, sustained physical activity also magnifies the problem. Urine production diminishes due to the limited blood flow capacity in the kidneys, which diminishes the ability to excrete excess water.

Recommendations for Preventing Hyponatremia

Here is a list of some recommendations to prevent hyponatremia:

1) You can prepare a hydration plan to replace liquids in accordance with foreseeable loss and avoid over-hydration.

2) You can use sports drinks in those sports where physical exertion lasts more than 3 hours, especially for athletes who "sweat profusely". In addition to electrolytes, glucose facilitates intestinal water absorption via the glucose-sodium transport mechanism.
3) Prior to activities that last a long time and to exposure to high temperatures, it is best to salt food "a bit more".
4) Athletes should be educated so that they can identify "warning signs", and then suspend their efforts, stop drinking and seek medical attention when appropriate.