Module 4. Integration

Being adequately hydrated is an essential requirement for our bodies in order to execute vital physiological functions. As losses through sweat increase considerably during physical exercise – added to normal liquids losses via respiration, fecal matter and urine – athletes need a greater quantity of liquids to compensate for the imbalance that can occur.

Increased muscular work and certain environmental conditions promote increased perspiration, which dissipates heat and helps keep body temperature within an acceptable range. Through a chain of events, metabolic heat generated by muscle contractions during exercise can eventually lead to diminished blood volume resulting in cardiovascular tension, increased glycogen use, as well as altered metabolic and central nervous system function.

Along with water, sweat also contains substantial quantities of sodium and lower quantities of potassium, calcium and magnesium. Although the athlete's response to dehydration is complex and personal, it is clear that a 2% decrease in body weight due to perspiration during physical exercise can compromise cognitive function and, above all, aerobic performance. Let's keep in mind that acute changes in body weight generally reflect changes in body fluid (daily states of hydration can be estimated by tracking weight in the morning and its variability throughout the day in order to approximate losses).

In previous modules, we saw the importance of hydration for an athlete in terms of physiological functions, which justifies the consumption of liquids when playing sports (before, during and post-exercise). Although scientific advances allow us to observe ever-greater information with respect to a given athlete, individualization of liquid consumption is one of the challenges that Exercise Science professionals must work on. Scientific evidence has provided us with enough information for us to work on this point.

Let's review some key points on the road to understanding this area.

1) The sweat rate (SR) enables us to approximate a specific athlete's losses under certain environmental conditions. Let's suppose that, replicating certain conditions, we can predict the athlete's "future loss" if he or she does not properly hydrate. Therefore, it should be clear to us that SR is a term linked to quantity and not quality.

2) The ACSM's latest position (2007) regarding fluid replenishment determined an average sodium loss of approximately 35 mEq/L of sweat (ranging from 10-70), which gives us an idea of what needs to be replaced, even if numbers vary based on genetic disposition, nutrition, acclimatization and so on. This indicates an average of

805 mg of sodium lost per liter of sweat during exercise.

3) A 2016 review by the American College of Sports Medicine suggested replenishing different types of CHO at 45 or 60 minutes, depending on the intensity and/or type of activity. Here is where sports drinks can become our principle ally. First of all, because they deliver sufficient amount of electrolytes to replenish certain losses (re: item 2); secondly, because the combination and concentrations of carbohydrates in these drinks allow us to adequately restore them without diminishing gastric emptying and/or causing gastrointestinal irritation.

Thus, based on what we have seen previously, let's review a practical case to help us better interpret the proposal as well as how to implement it.

Example

The scenario is for an individual who plays elite soccer (central midfielder), whose basic anthropometric stats are:

- Average weight 70 kg (154 lbs).
- Height 174 cm (5 ft 7 in).

We need to determine SR during 3 periods of the year with different temperatures and relative humidity levels. The test is done under conditions comparable to the competition in which the subject will participate (a moderate-to-high intensity game lasting approximately 90 minutes).

Previously in the course we saw how to determine the SR. Based on those calculations, we can reach the following conclusion:

Summer: 31°C and 40% HR.
Sweat rate: 1.2 L/hr.

Autumn: 20°C and 58% HR.
Sweat rate: 0.6 L/hr.

Winter: 9°C and 95% HR.
Sweat rate: 0.3 L/hr.

As we said, the SR is useful when we replicate conditions similar to those that require fluid replacement. We know that if we find ourselves in summer with temperatures and humidity similar to those present during the test, the subject could lose approximately 1.8 liters in a 90-minute game.

With these values, we can also approximate the sodium loss, at 805 mg/L, which gives us a total loss of 1449 mg during the game (1.5 g).

We can say that for a moderately-highly intense activity, we can compensate for the loss of glycogen during the exercise by consuming CHO at 45 minutes into the game (30-60 g up to 90 minutes).

So, let's review the athlete's needs for the game:

- Fluids to cover: 1.8 liters.
- Approximate sodium: 1.5 g.
- CHO 30 to 60 g (simple or complex).

These can be compensated for during the game with:

- 1 liter of water.
- 750 cm3 of a sports drink while playing (approximately 340 mg of sodium and 44 g of CHO).

It is also important to complete sodium replenishment with liquids having a higher concentration of sodium after the game (sports drinks with added sodium or electrolyte tablets). Salting foods more heavily before the game is also a good choice.

Clearly, in this example we address three different environmental conditions because we need to use them as our basis to for arriving at an exact calculation of sweat loss. In order to adequately hydrate the same subject in winter, replenishment needs will be different. This and many other variables are involved in an athlete's hydration, as a field test is needed to precisely determine his or her needs. However, starting to individualize the plan is recommended in order to more accurately approximate hydration, energy and electrolyte needs, and thus assist the athlete at both a quantitative and qualitative level.

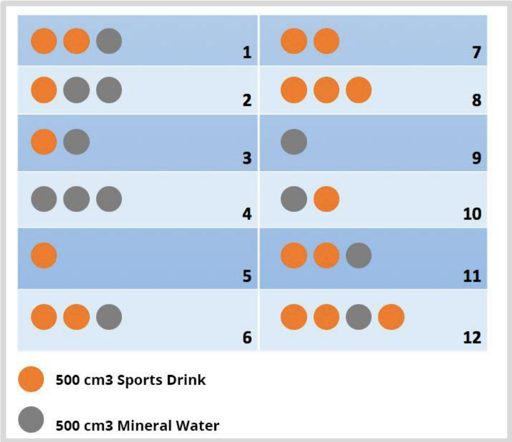
To individualize and accomplish a plan for every athlete, we may sometimes run into barriers that have nothing to do with science. Individual sports make educating the athlete and implementing a model to apply the information in practice more feasible, but the situation can become complicated when we have to work with each one of the subjects in the context of group sports. Here is where certain educational strategies or certain *tips* can help us implement a plan that can be adjusted to each athlete's needs.

Hydration Strategies in Team Sports

Once we have identified the quantity and type of liquids that each player needs, we can display intake as a "grid model".

This requires a table located where the exercise takes place. As shown in figure 1, the type and quantity of liquid that each player/athlete should ingest during exercise are indicated for each athlete's shirt number.

Figure 1: Drink Distribution as Grid Model

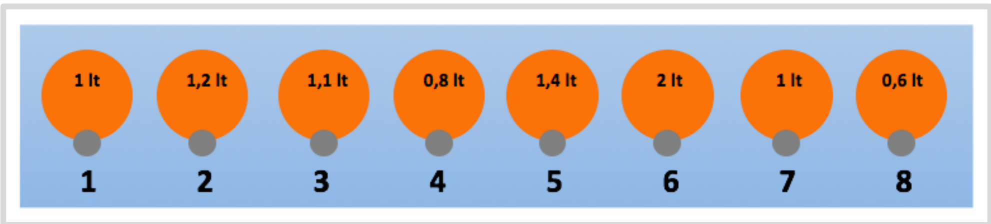


Source: Prepared by the author.

This model "obliges" the players to consume the minimum amount of corresponding liquids to compensate for losses during training/competition. This will vary based on environmental conditions and the duration of the proposed training – thus, these factors that must be known beforehand. According to the figure, the player with the shirt number 2 should drink a total of 1500 cm^3, divided into 500 cm^3 of sports drink and 1000 cm^3 of mineral water during the exertion.

Another tool we can use to individualize the liquids of the group is "cooler distribution"; so each player has his or her drink in individual coolers for the exercise period. This model requires each player's drink to be stored in containers, generally with the sports drink in powdered form so the CHO and electrolytes can be concentrated or diluted according to each subject's needs. Figure 2 is an example of how this can be presented using a table.

Figure 2: Distribution of Individualized Coolers



Source: Prepared by the author.

These are some tools that we can use to distribute liquids according to each athlete's needs. Many times sports drinks are consumed randomly when neither the intensity nor the duration of the activity calls for them. So minimum consumption can be established with these plans so that hydration does not become a factor that negatively impacts performance.

Finalizing the Sports Event

A serious athlete's goal is to be able to finish physical effort without any liquid deficit. Unfortunately, experience has shown us that this is not often the case. It's more common for athletes to try to return to their state of euhydration during recovery periods.

Generally, the liquid that athletes drink to get through a physical task is left to their discretion. A sign of low intake at the end of an exercise is indicative of better pre- and intra-exercise hydration. Contrarily, when an athlete drinks abundant liquids at the end of the activity, it is usually a sign of insufficient liquid intake earlier on.

In any case, obligatory losses of sweat and urine continue after the end of the activity, and that is why effective approximate rehydration requires an intake of around 150% of the body weight lost.

It is clear that rehydration strategies must involve not only the consumption of water – and future debates may stem from this point.

Beverage Hydration Index (BHI)

Historically, sports drinks and water are presented as drinks with excellent hydration properties, while drinks containing caffeine or alcohol have been associated with increased dehydration of the athlete.

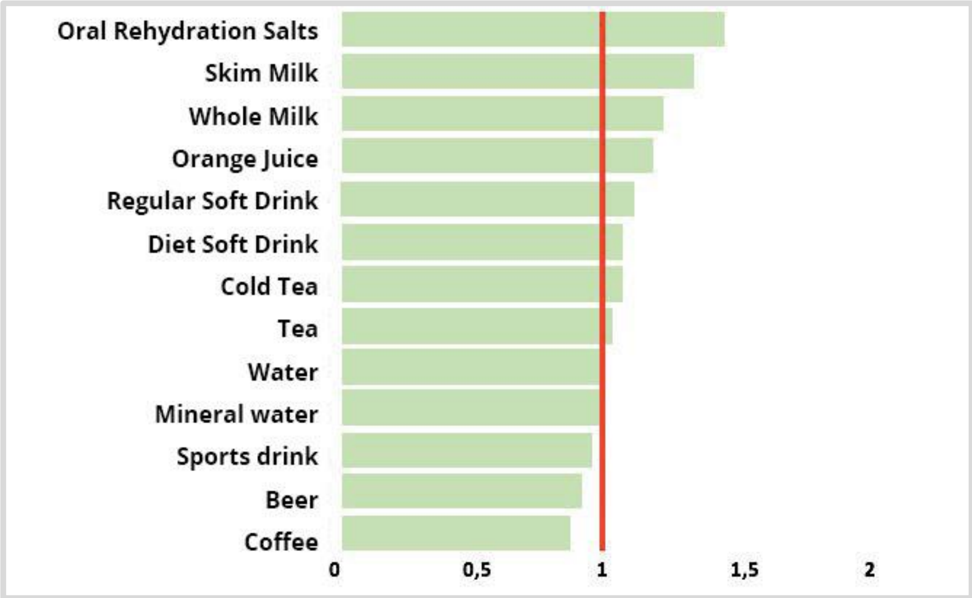
Current studies, therefore, are concentrating on questions regarding drink composition and capacity for retention within the body. The hydration properties of certain liquids, according to their capacity for retention within the body, shall dominate the future of this science.

Ron Maughan and his collaborators are investigating this field, working on the beverage hydration index (BHI). The BHI compares how long the body retains a beverage 2 hours after consumption as compared to the same amount of water.

Of course, the faster the stomach empties and the faster fluids are absorbed, the faster the fluids will enter the body. However, this concerns not only the speed that fluids enter the body, because if the same quantity of urine were to occur, the net effect would not be liquid retention. The contents of the beverage modify its absorption and as well as its excretion.

The first studies demonstrated that some beverages have greater hydration properties than water. As we can see in the following figure, it is not surprising that oral rehydration solutions (ORS) have a higher value, as their high electrolyte content is responsible for liquid retention. However, skim milk, whole milk and orange juice also achieved strong results. Those drinks are higher in calories and have more ingredients which can slow gastric emptying and absorption.

Figure 3: Beverage Hydration Index



Source: Prepared by the author.

The higher the BHI value, the better the liquid is retained in the body. Surprisingly, beer, coffee and tea have values similar to that of water, as no significant differences were observed (i.e., they did not present the supposed dehydration properties that are usually attributed to them). It is likely that the dehydration properties of alcohol and caffeine are compensated for by the fluid retention properties of the other ingredients. In turn, as we have seen during the course, alcohol and caffeine in very small quantities did not present any diuretic effects.

Thus, although some beverages are better than others in terms of fluid retention, the determining factor continues to be the quantity of beverages consumed in order to satisfy daily needs. The issues related to intake quantity, and the question of helping athletes modify their hydration habits during their daily activities – including convincing athletes of the scientific value of said practices – continue to be the main challenges.

References

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