

Preventing Dehydration: Sports Drinks or Water **Bob Murray, PhD, FACSM**

Introduction

The 2000 National Athletic Trainers' Association (NATA) position stand on *Fluid Replacement for Athletes* states that "the onset of significant dehydration is preventable, or at least modifiable, when hydration protocols are followed to ensure all athletes the most productive and safest athletic experience."¹ Minimizing dehydration is the simplest, yet the most effective step athletes can take to protect both health and performance.

Athletes regularly encounter dehydration and hyperthermia, and some fall victim to the consequences. Whenever vigorous physical activity occurs – and especially when it occurs in a warm environment – cardiovascular and thermoregulatory functions are placed under severe stress. In fact, there is little doubt that vigorous physical activity in a warm environment is one of the greatest physiological stresses the human body can encounter. The competition between muscle and skin for a limited blood supply can quickly overwhelm the body's cardiovascular capacity to cope and can create the negative physiological circumstances that have tragically claimed the lives of athletes.

During vigorous exercise, plasma volume decreases and, along with a concomitant increase in plasma osmolality, provokes a cascade of physiological events designed to maintain cardiovascular function (e.g., central venous pressure, skin blood flow, muscle blood flow) and allow for continued exercise.² There is, however, a limit to the body's ability to maintain physiological homeostasis during exercise in a warm environment when the body is no longer capable of coping with the demands placed upon it. When this limit is reached, fatigue occurs and exercise ceases or is at least curtailed. If physical activity is continued, symptoms of impaired cardiovascular function often develop (e.g., syncope, heat exhaustion), and, in severe cases, neurological failure and severe hyperthermia ensue (e.g., heat stroke).

Effects of Dehydration on Physiology and Performance

Hydration status is a critical determinant of the athlete's physiological capacity to train, compete, and recover successfully. Even slight dehydration (e.g., a 1-2% loss in body weight) has a negative effect on physiological function and performance. An athlete who fails to replace body fluids lost as sweat typically experiences many adverse functional changes, including a higher exercise heart rate, a higher plasma osmolality, a lower blood flow to the skin, and a higher core temperature. As dehydration becomes greater, so does the negative impact on performance. The fact that athletes regularly encounter dehydration during training and competition makes adequate fluid intake the number one nutrition intervention for all athletes. The performance benefits of drinking ample fluid during exercise have been clearly established by decades of scientific investigation. The simple truth is that no other nutritional intervention comes close to providing the performance-enhancing effects of staying well hydrated.

Athletes Usually Do Not Drink Enough

Even though the benefits of hydration are well established, most athletes still experience dehydration during training and competition. Even the most well-intentioned, well-educated athlete, with fluid easily available, may become dehydrated because athletes

generally underestimate their sweat loss and therefore do not voluntarily consume enough fluid, and because the human thirst mechanism is an inaccurate short-term indicator of fluid needs. For these reasons, significant dehydration can quickly occur in highly fit athletes.³ Unfortunately, there is no clear physiological signal that dehydration is occurring, and most athletes are oblivious to the subtle effects of dehydration (thirst, growing fatigue, irritability, inability to mentally focus, hyperthermia), in large part because they are so accustomed to experiencing these symptoms.

Hydration Guidelines

Consuming adequate fluid at regular intervals during exercise easily prevents dehydration. All athletes can train themselves to become better drinkers and can learn from experience just how much fluid they need under varying circumstances of exercise and environment. Athletes who are profuse sweaters (> 2 liters/hour) may not be able to ingest enough fluid to remain completely hydrated. However, all athletes can learn to become better drinkers, and procedures should be put in place to assure that they do.

Current fluid replacement guidelines recommend that the goal of fluid replacement is to replace 100% of sweat loss during exercise. For instance, if an athlete loses sweat at a modest rate of one liter per hour, ingesting 8 oz every 15 minutes would fully replace sweat loss. Of course, it is important that athletes have a good idea of just how much sweat they lose during a typical practice or game so that they can judge how much fluid to ingest. This is most easily accomplished by having athletes record a nude body weight before and after practice. Any weight deficit represents a failure to drink adequately. For example, if an athlete weighs 178 lb before practice and 176 lb after practice, the 2-lb difference reflects the need to drink an additional 32 oz of fluid in future practices.

Fluid balance, electrolyte homeostasis, cardiovascular function, and thermoregulatory control are intimately linked and each has a major impact on health and performance. For this reason, it is important for coaches, athletic trainers, fitness leaders, exercise scientists, and sports medicine physicians to understand the fundamental physiological mechanisms that allow the human body to cope with the stress imposed by exercise.

Science of Sports Drinks

One of the most effective ways to prevent dehydration is to have athletes consume adequate amounts of a properly formulated sports drink. The four primary benefits to consuming a properly formulated sports drink are:

- Encourage voluntary fluid intake
- Stimulate fast absorption
- Promote rapid and complete rehydration
- Improve performance

Encourage voluntary fluid intake. Athletes typically don't drink enough to keep pace with sweat loss.³ That is, they voluntarily dehydrate, a fairly common physiological occurrence during physical activity. An effective sports drink then, must not only have the taste characteristics to maximize overall acceptance during physical activity. In addition, because the thirst mechanism in the brain is stimulated by the osmotic effects

of electrolytes in body fluids, an effective sports drink must also contain the correct electrolyte profile to maintain the osmotic drive for drinking.

A sports drink can best stimulate drinking by making sure that the sports drink formula strikes the proper balance between palatability and function. A sports drink must taste best when athletes are hot, sweaty and thirsty, and it must also have the proper electrolyte profile to maintain the physiological drive to drink. Many athletes rely on thirst alone to stimulate them to drink, but thirst is an inaccurate gauge of fluid needs when we're physically active. Thirst is driven by two key physiological changes: a rise in the concentration of sodium level and a drop in blood volume. Whenever we sweat, part of that sweat comes from blood. And by virtue of the fact that we lose more water molecules from the blood than we do electrolytes, plasma-sodium concentration – the saltiness of the blood – rises, which stimulates thirst. But if sweat is replaced by plain water, the plasma sodium concentration falls, which reduces thirst.

Plain water then, although a good thirst quencher, is a poor rehydrator. As opposed to a sports drink that helps maintain the physiological drive to drink, water shuts off thirst before an athlete can properly rehydrate.³ Unfortunately, when athletes drink only water, the osmotic drive to drink is removed because plasma blood sodium level – the primary determinant of plasma osmolality – is quickly lowered below the thirst threshold. Ingesting water can alleviate thirst when hydration status is not even close to normal.

Stimulate fast absorption. To stay well-hydrated during exercise, the fluid, carbohydrates and electrolytes in a sports drink have to be rapidly absorbed to offset the loss of fluid and electrolytes in the sweat and the rapid oxidation of carbohydrate by muscle.

In order to stimulate absorption, a sports drink must be formulated to maximize gastric emptying and to speed the absorption of solutes (carbohydrates, electrolytes) and fluids into the bloodstream. Beverages that are carbonated or have high levels of carbohydrates generally empty slowly from the stomach and should be avoided during athletic activities because such drinks may cause bloating or a feeling of fullness, upset stomach, burping, and nausea.

Although the primary factors affecting the gastric emptying rate are the energy content and volume of the food or fluid that is ingested, dehydration and intense exercise can also slow gastric emptying.^{4,5}

Once fluid is emptied from the stomach, it enters the small intestine, where the characteristics of the sports drink become extremely important. The surface of the jejunum of the proximal small intestine is rich in receptors—special proteins that transport nutrients into the bloodstream. These transport proteins work in a manner very much like a revolving door, allowing sodium and glucose, two common and absolutely necessary ingredients in a sports drink, into the cell. As a result of this solute transport, water molecules quickly follow to maintain osmotic equilibrium. In other words, water absorption from the intestine is accelerated by the presence of sodium and glucose in the intestine.

Fluid absorption will be retarded if the osmolality of the beverage being consumed is too high. Too much carbohydrate, the wrong types of carbohydrate, or too high an osmolality will slow fluid absorption.

The NATA position statement echoes this finding by indicating that “during events when a high rate of fluid intake is necessary to sustain hydration, the carbohydrate composition should be kept low (e.g., <7%) to optimize gastric emptying and fluid absorption.”¹

Promote rapid rehydration. The key to rapid and complete rehydration is to provide enough electrolytes in the rehydration beverage to serve as an osmotic impetus to restore and maintain extra-cellular fluid volume, including blood volume. And this depends upon ingesting both the fluid as well as the electrolytes that are lost in sweat.

A study conducted in New Zealand helps to prove this point. During the experiment, subjects were asked to cycle in a warm room for three hours, ingesting on one occasion water and the other, a properly formulated sports drink. Results showed that plasma sodium levels were better maintained and less urine was produced when the sports drink was consumed.⁶ Why? The electrolytes in the sports drink maintained plasma sodium and served as an osmotic impetus to retain the ingested fluid by reducing urine production by the kidneys.

The NATA position stand also addresses this issue, stating that “consuming water alone decreases osmolality, which limits the drive to drink and slightly increases urine output. Including sodium in the rehydration beverage or in the diet allows fluid volume to be better conserved and increases the drive to drink.”¹

Improve athletic performance. Decades of research confirm that sports drinks are superior to water at improving performance during both intense and prolonged exercise.⁷⁻⁹ The primary reason is that the carbohydrates in a sports drink provide fuel to both muscles and brain.

Ingesting a sports drink during exercise maintains blood glucose levels and promotes the uptake of carbohydrate into muscle cells. This in turn increases the use of carbohydrates as fuel by muscle and brain. Sustaining carbohydrate oxidation benefits performance in a wide variety of tasks, including maintaining motor skills in the latter portions of practice and games.

The NATA position stand is very clear in this regard, stating that “including carbohydrates and electrolytes in the rehydration drink can maintain blood glucose, carbohydrate oxidation and electrolyte balance and can maintain performance when the exercise session exceeds 50 minutes in duration or is extremely intense.”¹

Conclusion

Dehydration is a common condition that can affect the health and performance of athletes. Having athletes follow an individualized hydration program, which includes the consumption of a properly formulated sports drink, is one of the most effective ways to prevent dehydration to help keep athletes safe and performing at their best.

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