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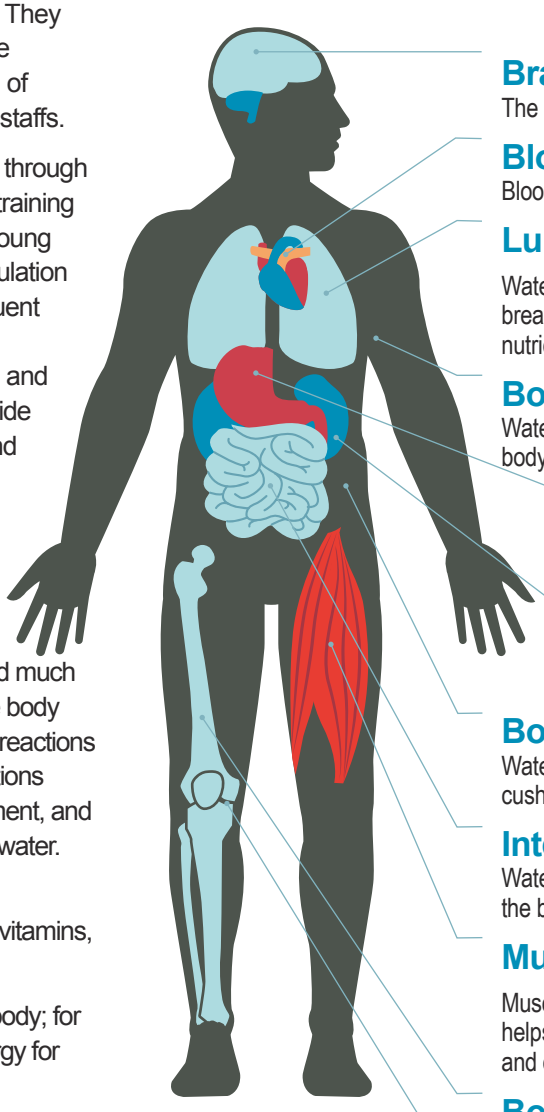
Eat to Compete:
Sports Nutrition for Young Adults—Hydration

► Young athletes must drink enough fluid to perform at their best and reduce the dangerous risks of dehydration during prolonged physical activity.

Proper nutrition is fundamental to fitness and performance. Although many athletes carefully regulate their diet, they may pay little attention to their body's water needs. They often misunderstand and, as a result, underplay the importance of water to good nutrition. Water needs of athletes should be a primary concern for coaching staffs.

The body can lose up to half a gallon of water a day through normal sweating, breathing, and urination, Actively training athletes can lose even more. In addition, because young athletes are not as efficient at body temperature regulation as adults are, they risk overheating and the consequent onset of heat-related illnesses. Young athletes must balance drinking enough water to avoid dehydration and drinking too much water, which can have negative side effects. Understanding water balance in the body and the factors that impact it can help young athletes perform at their best.



Importance of Water in the Body

The body is comprised of about 60 percent water, and much of that water is located inside lean muscle tissue. The body needs water to regulate the processes and chemical reactions of every living cell. If each cell is to complete the reactions demanded for performance at optimal speed, movement, and endurance, the body must have adequate access to water. Some of the functions of water are as follows:

- transporting protein, amino acids, carbohydrates, vitamins, minerals, and oxygen to cells
- being part of the many chemical reactions in the body; for example, the reactions that change food into energy for use in the body
- aiding in the digestion and absorption of nutrients
- aiding in the repair and replacement of old tissues
- helping flush the body of toxic wastes
- helping maintain constant body temperatures by providing sweat for cooling and blood circulation for warming
- lubricating and cushioning the joints and tissues of the body

Water Balance

Water Input. Water needed by the body comes from various sources: food, drink, and metabolism. In addition to water itself, beverages such as milk, sports drinks, and juices contain large amounts of water. Other foods are also rich supplies of water. Fresh fruit and vegetables generally contain a lot of water (some have as much as 95 percent water), while protein foods such as beef and eggs can contain up to 50 percent water. Water is also released in the body as foods are broken down and metabolized for energy.

Water Output. To ensure proper hydration, water lost must not exceed water consumed. The body can lose up to half a gallon of water a day through normal sweating, breathing, and excretion processes.

During prolonged physical activity, water losses increase due to increased breathing and sweating. In fact, during heavy exercise, an athlete can lose between 4 and 16 cups of sweat (6 to 8 pounds of body weight) in just 1 hour! The body's digestive system can only absorb about 4 cups of fluid per hour, so an athlete must consume water before, during, and after exercise to replace what is lost and minimize dehydration.

Water Losses on Hot, Humid Days

High temperatures increase the rate of water loss through sweating. During physical activity, body heat rises quickly due to the working muscles. One of the major functions of water is to maintain core body temperature. So, as body heat rises, the body compensates by sweating. As the sweat evaporates, the skin and the blood, which is traveling through vessels near the skin's surface, are cooled. This cooled blood then flows back to the body's core, decreasing the internal body temperature.

Exercising in hot, humid climates presents yet another concern: the body's ability to sweat efficiently is reduced because the air is filled with moisture, making it difficult for sweat to evaporate. As a result, the body cannot cool itself properly, and internal body temperature can rise to dangerous levels.

Other factors can increase the rate of water loss. These must be avoided or minimized to stop the onset of rapid dehydration:

- excessive clothing, padding, and taping
- competition in environmental conditions in which the athlete is unaccustomed
- intense levels of sunshine
- increased intensity of exercise
- increased duration of exercise
- failure to drink water-containing fluids every 15 to 20 minutes during exercise (An athlete needs to drink even if he or she does not feel thirsty.)

Athletes must consider these factors that increase the rate of water loss and use extreme caution when training on sunny, hot, and humid days. These combined factors present the most dangerous environmental conditions for athletes. They encourage the rapid onset of dehydration and quickly raise internal body temperature.

Certain strategies can help minimize some of these factors. Wearing athletic clothing that is light in color and made with fabrics that wick moisture away from the skin can help with cooling. Training in an environment that is similar to what will be experienced during competition can also help the body adapt its temperature regulation to some extent. It is important to consult athletic trainers and registered dietitians certified in sports nutrition for personalized training and hydration practices so that safe and appropriate strategies are used for minimizing dehydration.

Effects of Dehydration

Dehydration occurs when more water is lost from the body than consumed. The first symptom of dehydration is fatigue. Other early symptoms include the following:

- thirst
- headache
- dry or "cotton" mouth
- dizziness or lightheadedness
- weakness
- rapid heartbeat
- dry, flushed skin

The body cannot properly cool itself when dehydration occurs. Serious heat-related injuries or illnesses, such as heat exhaustion and heat stroke, can result when excessive water is lost and not replaced during exercise and the body temperature increases. Symptoms of heat exhaustion include dizziness, weakness, rapid

pulse, low blood pressure, headache, and elevated body temperature. Symptoms of heat stroke can include sudden cessation of sweating, clumsiness or stumbling, disorientation, vomiting, and loss of consciousness. Death can occur with heat stroke.

Dehydration also reduces endurance and athletic performance. Generally, a water loss equal to about 2 percent of body weight during exercise can reduce cognitive and aerobic performance. As water loss increases, performance becomes more impaired, and the risk of heat-related illnesses increases (table 1).

Table 1. How Your Body Reacts When You Lose Water During Exercise

Percent Weight Loss	Effects on the Body
1 to 2	Increase in core body temperature, decline in aerobic and cognitive performance in warm or hot environments
3	Significant increase in body temperature with aerobic exercise
>5*	Significant increase in body temperature with definite decrease in aerobic ability, muscular endurance, and sport-specific skill Possible 20 to 30 percent decrease in strength and anaerobic power Susceptibility to heat exhaustion
10 or more	Excessively high core body temperature Susceptibility to heat stroke Heat injury and circulatory collapse with aerobic performance

*With a 5 percent body weight loss, an athlete will need at least 5 hours to rehydrate.

Sweating and Electrolyte Loss

In addition to water, sweat contains electrolytes and waste products from metabolism. Electrolytes are minerals important to muscle contraction and relaxation, nerve impulses, and heartbeat. The primary electrolytes in sweat are sodium and chloride, with minor amounts of other minerals such as potassium, calcium, and magnesium. The amount of electrolytes lost in sweat can vary significantly from one athlete to another, but, in general, electrolyte loss that results from light sweating or exercise lasting less than 2 hours can be replaced with post-exercise snacks and meals.

As exercise and sweating increase in intensity and duration (2 hours or more), the loss of electrolytes goes up. While sweat glands can reabsorb some electrolytes, there are limits to their rate of reabsorbing them. The sweat glands cannot reabsorb enough electrolytes to keep up with losses when exercise is intense and sweat production is high. As electrolyte loss increases, water loss increases proportionately, thus accelerating dehydration. Athletes who participate in long-duration events of 2 hours or more should plan to replace water and electrolytes during the event using a beverage that contains both water and electrolytes.

Monitoring Hydration

Thirst during exercise may not be the best indicator of the need for water intake because exercise blunts thirst. At the point of thirst, the body has already lost up to 2 percent of its weight in water, a loss that has been shown to impair body temperature and reduce exercise capacity by 10 to 15 percent. Likewise, depending on thirst to indicate when rehydration has been reached may not be reliable. Some studies have shown that the feeling of thirst is blunted when liquid is initially consumed after exercise despite the athlete still being in a 1 to 3 percent dehydrated state. Athletes need to be able to use other means of monitoring their body's water balance to promote health and the best athletic

performance. Two practical ways of monitoring hydration at home are urine color and amount and body weight change during exercise.

The color and amount of urine excreted are good signs of the body's state of hydration. When hydration balance is normal (called *euhydration*), the urine should be very pale yellow and in large quantities, and urination should frequently occur throughout the day. Highly concentrated, dark urine is usually a sign of dehydration. If using this method, keep in mind that some foods (beets, for example), nutrition supplements such as vitamins C and riboflavin, and some medications will affect the color of urine, making it appear darker even in euhydration.

The change in body weight from pre- to post-exercise is another excellent way to monitor the amount of water lost. Every pound of body weight lost during exercise represents about 2 cups (16 ounces) of water. However, it takes about one and a half times as much water to replace what is lost because urination will increase with increased water intake after exercise. Coaches, athletic trainers, and sports dietitians can help athletes monitor their hydration status by encouraging them to pay attention to the color of their urine and to weigh before and after exercise to monitor water loss. When these two hydration measures are used consistently, a plan can be made for drinking enough water to limit body weight loss to 2 percent or less.

Hydration Before, During, and After Exercise

While each athlete needs to develop an individual plan for hydration, general guidelines based on scientific evidence can serve as a starting point (table 2).

Cold water is a good fluid replacer for most athletes when exercise lasts less than 1 hour. Drinking cool or cold water is best because it enters the bloodstream and tissues rapidly and helps cool the interior of the body.

In events that last 60 minutes or more, diluted fruit juices (one part juice to one part water) or sports drinks are preferred because they supply glucose, the body's main energy source. Glucose stores in the body are usually depleted within 60 to 90 minutes of moderate to vigorous exercise. Diluted juice or sports drinks will also supply sodium. Sodium has been shown to possibly increase the rate of water and glucose absorption from the digestive tract and help retain that water in the body after exercise. The taste of sports drinks compared to plain water can help increase water intake during exercise.

Athletes should not drink full-strength fruit juices and other highly concentrated drinks. These create feelings of fullness and can cause cramping and stomach upset during exercise.

Alcoholic beverages and energy drinks should not be used for hydration. Alcohol not only impairs cognitive abilities, but it also impairs athletic performance and recovery from exercise. Alcohol is also a diuretic; that is, it causes the body to lose water in a greater amount than the water it provides. Energy drinks contain the diuretic caffeine in amounts that vary significantly from about 80 to 340 milligrams per serving. Experts agree that caffeine consumed in small amounts in the daily diet (less than 180 milligrams per day or about 2 cups of coffee) is not likely to cause dehydration. However, energy drinks are not regulated by the US Food and Drug Administration (FDA) and may contain caffeine and other ingredients in amounts that are different from those listed on the label. Energy drinks may also cause feelings of overstimulation, irregular heartbeat, and inability to sleep, especially in athletes who rarely consume caffeine. The American Academy of Pediatrics recommends that children and adolescents not consume energy drinks.

Table 2. How Much to Drink When You Are Exercising*	
Time	**Amount to Drink**
1 to 2 hours and 30 minutes before exercise	2 to 2½ cups (16 to 20 ounces) cool water
10 to 15 minutes before exercise	1 to 1½ cups (8 to 12 ounces) cool water
Every 15 to 20 minutes during exercise	3 to 8 ounces cool water for exercise less than 60 minutes 3 to 8 ounces cool sports drink or diluted juice for exercise longer than 60 minutes
Immediately following exercise	2 cups (16 ounces) cool liquid Sports drinks are preferred if exercise lasts longer than 60 minutes.
After exercise and over the next day	Liberal intake of liquids (It takes one and a half times the liquid to replace weight lost, and complete rehydration may take up to 36 hours.)

* Sweat rates and water loss vary by the individual athlete's size, length of exercise, environmental temperature, humidity, and the exercise intensity. This table presents an accepted model that can serve as a starting point to establish an individual hydration plan. A registered dietitian certified in sports nutrition can provide guidance to individualize a hydration plan.

A Word of Caution—Water Intoxication

Understanding and monitoring hydration status to prevent excessive dehydration and associated heat-related injury can also help athletes, their coaches, and training staff avoid the opposite danger: exercise-associated hyponatremia, commonly called *water intoxication*. Hyponatremia, which means low blood sodium, is a serious condition that occurs when an athlete drinks too much fluid too quickly, overwhelming the kidney's ability to excrete it. This leads to a drop in sodium levels in the blood as the excess water dilutes the sodium. If fluid intake continues to exceed what the kidneys can handle, water begins to move inside the body's cells at higher amounts than normal, including brain and central nervous system cells. This can have serious consequences if not treated.

The major risk factor for developing water intoxication is overdrinking water, sports drinks, and other diluted beverages. Other risk factors can go along with overdrinking and contribute to water intoxication. The common ones are long-duration exercise (more than 4 hours) and inadequate training or event inexperience. Deaths from water intoxication have been reported across numerous sports, including football, marathon running, hiking, and military training. One of the major signs that water intoxication should be suspected is weight gain or weight maintenance during an event or practice session.

Symptoms of water intoxication can be mistaken for dehydration and have been the cause of death among some athletes who tried to correct the mistaken dehydration symptoms, such as muscle cramping, by increasing their consumption of water and sports beverages. For example, muscle cramps are often mistaken as a sign of dehydration, leading athletes to increase their fluid intake, but experts now suggest that muscle cramps are actually related to fatigue and muscle overuse. Mild symptoms of water intoxication include light-headedness, nausea, weight gain during the event or practice, dizziness, and puffiness. Without treatment, symptoms can progress to severe problems such as vomiting, confusion, delirium, seizures, coma, and death. Because of the seriousness of this condition, athletes and coaching staffs should develop an individualized hydration plan to prevent significant dehydration while avoiding water intoxication.

Summary

Water is the single most important nutrient needed by young athletes. Many factors influence individual water needs during exercise. If athletes exercise when they are dehydrated, they will not perform at an optimal level and will risk the onset of dangerous heat-related illness. However, overconsumption of fluids can also lead to serious injuries and even death. Understanding the factors associated with water balance, working with young athletes to develop an individualized hydration plan, and monitoring hydration status should be of primary concern to the performing athlete and the coaching staff.

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