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Fluids for Optimal Physical Activity

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By Dan Benardot, PhD, DHC, RD, LD, FACSM
Professor and Division Head, Division of Nutrition, Georgia State University

Introduction

Any physical activity creates heat, and this heat must somehow be dissipated (removed) to continue performing the activity. Failure to dissipate heat at the same pace that it is being created causes body temperature to rise and eventually will lead to heatstroke and, in extreme cases, death.

One of the main mechanisms for dissipating heat is sweat production. Sweat cools the body down when it evaporates off the skin by evaporating the body heat away. Therefore, the inability to produce sufficient levels of sweat is a primary cause of overheating. Since physically active people have a finite storage capacity for body water, but a tremendous ability to produce sweat, the right kinds of fluids must be consumed in the right amounts before and during physical activity to maintain the sweat rate.

Temperature regulation represents the balance between heat produced or received (heat-in) and heat removed (heat-out). When the temperature regulatory system is working correctly, heat-in and heat-out are in perfect balance, and body temperature is maintained. Both internal and external factors can contribute to body heat. Radiant heat from the sun, as well as the heat created from burning the fuel (carbohydrate, protein, or fat) that is required for muscular work, contribute to the heating. Physically active people must find a way to dissipate from the body the same amount of heat that has been added to the body to maintain a constant body temperature.

Understanding Heat Dissipation

The two primary systems for dissipating heat involve the following:

1. Moving more blood to the skin to allow heat dissipation through radiation.
2. Increasing the rate of sweat production.

These two systems account for about 85 percent of heat removal when a person is at rest. Heat losses through conduction (the natural transmission of heat from a hotter body to the cooler air environment) and

convection (heat transfer from tissue to the blood and through the skin) account for the remaining 15 percent of heat-out. During exercise, however, virtually all heat loss occurs via the evaporation of sweat.

Both systems rely on maintenance of an adequate blood volume. A lower blood volume results in a reduced movement of blood to the skin and, therefore, also a reduced production of sweat. Working muscles demand more blood flow to deliver nutrients and to remove the by-products of burned fuel.

At the same time, however, there is also a need to shift blood away from the muscles and toward the skin to increase the sweat rate. In essence, the blood does 'double-duty' when a person is exercising. With low blood volume, one or both of these systems fail, with a resultant decrease in athletic performance. In fact, the maintenance of blood volume is rightly considered by many sports scientists to be the primary indicator of whether an athlete's performance can be maintained at a high rate.

Sweat loss rates volumes

Athletes working intensely in the heat can lose 2.5 liters (over 2.5 quarts) of sweat per hour. Sweat contains mainly sodium chloride (salt) but also has much smaller amounts of potassium, calcium, and magnesium. Physically active people who have become better acclimatized to exercise in hot environments undergo an important adaptation that results in a lower sweat sodium concentration. Less well-conditioned people have higher sweat sodium concentrations.

Losing less sodium through sweat enables people to better sustain blood volume and to exercise longer and at higher intensities. Typically, the loss of a single liter of sweat results in loss of nearly three grams (3,000 mg) of sodium chloride. Athletes who lose 2.5 liters of sweat per hour will lose almost 15 grams (15,000 mg) of sodium in two hours – a level that could easily exceed normal daily sodium intakes.

Losing sodium that is not replaced causes blood volume to drop and lowers sweat production. As a means of normalizing the blood sodium concentration and blood volume, the body tries to preserve body water volume by producing less but more highly concentrated urine. This urine is darker in color than the urine of someone who is well hydrated, and is such a good indicator of hydration state (light urine = good hydration, dark urine = bad hydration) that the U.S. Olympic Committee has produced wallet cards with color gradations so athletes can easily understand the degree to which they are well hydrated or poorly hydrated.

Fluid-Related Problems

Dehydration

Dehydration occurs when more fluids are lost than are consumed. By definition, dehydration means that the amount of body water is below optimal. As little as a two percent drop in body water results in a measurable reduction in athletic performance. Common risks for dehydration include the following:

- Vomiting
- Diarrhea
- Inadequate fluid replacement
- Induced high sweat rates (saunas, steam rooms etc.)
- Laxatives
- Diuretics (substances with a diuretic effect, such as caffeine and alcohol)
- Dieting
- Febrile illness

Heat Cramps

Heat cramps—painful spasms in the legs and abdomen—are typically the result of a fluid and electrolyte imbalance caused by severe dehydration. They are most likely to occur in people who sweat heavily and who fail to replace the sodium they lose in sweat. Consuming a sports beverage that contains between 100mg to 200mg/cup of sodium is an important strategy to avoid cramping. Higher sodium concentrations (i.e. 150 to 200mg/cup) are recommended for longer endurance activities and/or hot and humid days when the sweat rate is high.

Heat Exhaustion

The symptoms of heat exhaustion include weakness, cold and clammy skin, a feeling of faintness, fatigue, nausea, and a weak pulse. It is also possible, when the individual has a severe body water depletion that sweating has stopped and the skin feels dry. The likely cause of these symptoms is an inadequate blood flow to the brain, with the sufferer typically on the ground but semiconscious. Symptoms usually respond well to rapid cooling, so heat-exhaustion victims should be cooled through whatever means are available. Caution: Under no circumstances should anyone who has stopped sweating continue exercising because this may cause a rapid and dangerous rise in core temperature.

Heatstroke (sunstroke)

Heatstroke is an extremely dangerous condition, characterized by high body temperature (usually above 105 degrees Fahrenheit, or 40.5 degrees Celsius), hot and dry skin, and a rapid pulse. It is also possible for the athlete to be coming in and out of consciousness. Call 911 and then do whatever possible to cool the athlete (fanning, cold water, sponge bath, loosening clothing, cold-water bath).

Low Blood Sodium (hyponatremia)

Exercising for long periods may cause low blood sodium (hyponatremia), a potentially fatal condition. Low blood sodium can occur if you drink excessive amounts of water (i.e., beverage with no sodium) and dilute the sodium content of your blood. This may lead to rapid and dangerous swelling of the brain. In general, unless it is contraindicated because of a medical condition and the exerciser is under the careful supervision of a physician, adding salt to meals and beverages is a desirable strategy for avoiding low blood electrolytes and reducing hyponatremia risk.

Signs and symptoms of low blood sodium include the following:

- **Headache**
- **Swollen fingers and ankles**
- **Confusion**
- **Nausea**
- **Seizures**
- **Cramping**
- **Coma**
- **Bloated Stomach**

4 Steps to perfect hydration

Since it is nearly impossible for any athlete to consume sufficient fluids during physical activity to maintain the body water level, waiting for the “thirst sensation” before drinking fluids *guarantees* that the athlete will be exercising in a progressively worsening state of under-hydration, with higher risk of poor performance and heat stress.

Step 1: Knowing How Much To Drink

Without regular fluid intake, blood volume and sweat rates will quickly drop and body heat will rise quickly and dangerously. Because it is so difficult to consume sufficient fluids during exercise, physically active people should develop a fixed drinking schedule.

Of course, it’s difficult to know precisely how much water is being lost during activity, but a simple technique can help to estimate how much is lost. One pint of water weighs approximately 1 pound. By knowing this relationship, an estimate can be made of how much fluid should be consumed during physical activity by doing the following:

1. Write down what time it is just before the exercise session.
2. Write down your body weight in pounds.
3. Do the normal exercise, and monitor how much fluid is consumed during the exercise period.
4. Immediately after exercise, take off the sweaty clothing and towel dry. Once dry, write down body weight in pounds. (Again, this should be nude weight.)
5. Write down the current time.
6. Calculate the amount of fluid lost by subtracting end weight from beginning weight.
7. Calculate exercise time by subtracting ending time from beginning time.
8. The amount of extra fluid that should be consumed during the activity is equivalent to 1 pint (16 ounces) of additional fluid for each pound lost, provided in 10- to 20-minute increments.

Example: If John weighs 4 pounds less after a 2-hour football practice, he should consume an additional 4 pints (8 cups) of fluid during that practice. He was already consuming 2 cups of fluid, so John’s total fluid consumption should be 10 cups of fluid per 2-hour practice. In 2 hours there are 12 10-minute time increments, so John has 12 opportunities to consume 10 cups of fluid. Therefore, John should consume 6.5 ounces of fluid, or a bit more than 3/4 of a cup ($10 \div 12 = 0.8$), every 10 minutes or 13 ounces of fluid (about 1.5 cups) every 20 minutes.

Step 2: Pre-exercise hydration

Athletes should be in a state of optimal hydration before the initiation of exercise or competition. Even a minor level of under-hydration (as little as two percent of body weight) can cause a measurable difference in performance, and the greater the under-hydration, the greater the negative impact. Furthermore, it can take 24 hours or longer to bring a dehydrated athlete back to a well-hydrated state.

Therefore, waiting until just before practice or competition to return to a well-hydrated state, or simply failing to take any steps to make certain the exerciser is in an optimally hydrated state, will doom that person to having a poor practice or competition outcome. Consume plenty of fluids with food (water with food is excellent), and have a sipping protocol for between meals (1 mouthful every 15 minutes) of a sports beverage that contains a 6-7% carbohydrate solution and some sodium.

Step 3: Hydration during exercise

Drink a sports beverage that contains 100mg to 200mg sodium per cup and has carbohydrate at a level of

six – seven percent solution. Never miss an opportunity to drink, and try to emulate ‘game time’ drinking patterns during practice so you are well adapted to your frequent drinking routine and it becomes second-nature.

Step 4: Hydrating after exercise

Do whatever you can to reduce the state of dehydration caused by the physical activity. This will require the consumption of plenty of fluids. This is also a good opportunity to replace the glycogen (stored carbohydrate) that your muscles used during activity, so plan several small meals that contain carbohydrate. These should start immediately after completion of the exercise. There is increasing evidence that having a combination of fluid-protein-carbohydrate following intense activity may reduce muscle soreness. If muscle soreness is an issue for you then this should be consumed following exercise (chocolate milk is a good choice, as it has all three!)

Summary

The single most important thing you can do to get the most out of your exercise session is to start in a well-hydrated state and remain in a well-hydrated state. Poorly hydrated muscles do not benefit from exercise training...they just get worn out. Find a carbohydrate and sodium containing beverage you enjoy drinking, and always have it with you before, during, and after exercise.

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