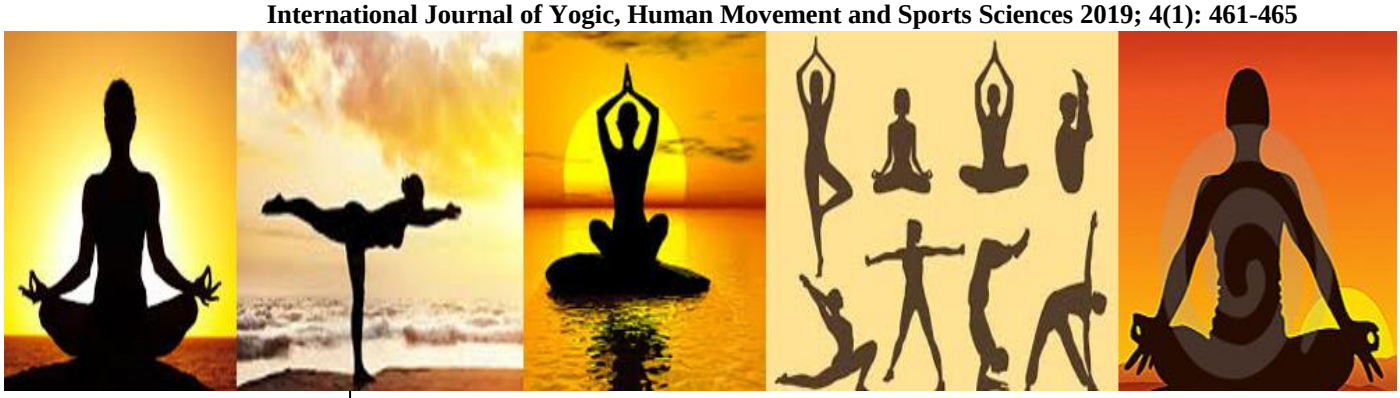
International Journal of Yogic, Human Movement and Sports Sciences 2019; 4(1): 461-465



ISSN: 2456-4419
Impact Factor: (RJIF): 5.18
Yoga 2019; 4(1): 461-465

www.theyogicjournal.com
Received: 13-11-2018
Accepted: 18-12-2018

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Dehydration in Sports

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Abstract
Our bodies are made up of about two-thirds water. We only need the total water level to drop by as little as a few percent for us to become dehydrated – that is, lacking in water. This can eventually lead to problems, such as kidney stones, damage to the liver, muscles and joints, and seizures. Having Crohn's Disease or Ulcerative Colitis – the two main forms of Inflammatory Bowel Disease (IBD) - can sometimes increase the risk of becoming dehydrated. This information sheet looks at why this may happen and some ways to prevent and treat it.
Dehydration is a loss of too much fluid from the body. The body needs water in order to maintain normal functioning. If your body loses too much fluid - more than you are getting from your food and liquids - your body loses electrolytes. Electrolytes include important nutrients like sodium and potassium which your body needs to work normally. A person can be at risk for dehydration in any season, not just the summer months. It is also important to know that elderly individuals are at heightened risk for dehydration because their bodies have a lower water content than younger people. The human body is roughly 75 percent water. Without this water, it cannot survive. Water is found inside cells, within blood vessels, and between cells.
A sophisticated water management system keeps our water levels balanced, and our thirst mechanism tells us when we need to increase fluid intake. Dehydration must be treated by replenishing the fluid level in the body. When your body becomes dehydrated, drastic changes can immediately occur. Research has shown that dehydration decreases brain tissue fluid, which can result in changes in brain volume. Your blood becomes thicker as well, straining your cardiovascular system by making your heart work harder. To make matters worse, dehydration compromises your body's ability to regulate its temperature.

Keywords: Yoga, pranayama, aged women, breath holding capacity, vital capacity

Introduction
Hydration status, water consumption, and the effects of hypohydration on exercise performance, work performance, health, and well-being have been the topic of much public and scientific debate in recent years. The effect of body water balance on aspects of exercise performance has been extensively researched and, in recent years, reviewed comprehensively.1-3 The majority of research in this area has been undertaken with regard to endurance exercise performance, but the effects on power, strength, and skills have also been investigated. These areas form the focus of the current review. The electrolytes lost in sweat are mainly sodium and chloride, but smaller quantities of potassium, calcium, magnesium, and other minerals are also present. Their amounts are related to the volume and rate of sweat produced and, therefore, vary according to individual factors already presented in Endurance training and/or heat acclimatization appear to lower sweat sodium and chloride concentrations.
If you are starting to feel inspired to participate in sporting activities, it is important to remember to keep well hydrated. This is especially the case during the summer months and in warm environments, for example in hotter climates, poorly ventilated gyms or sports halls. Drinking water before, during and after exercise helps us to work out more efficiently and for longer, and while sports drinks have a role to play, particularly for elite level endurance athletes, they are often used inappropriately by the rest of us as recreational drinks, which adds unnecessary calorific intake to our diet. This factsheet explains why staying well hydrated is important for active individuals and how this can be best achieved.
The adequacy of body fluids is important for athletes in supporting performance. Nutrition is the study of foods and nutrients and their effect on health, growth, and development of the

individual. Sports Nutrition applies nutrition principles to sport with the intent of maximizing performance. Maintaining optimal hydration is essential during exercise, as both dehydration and over hydration can be detrimental to performance and, if extreme, can have severe health consequences.

Dehydration

Dehydration is the term that is used when the body loses too much water. The body requires a certain amount of water to work normally. Our bodies are made up of about two thirds water. Water forms the basis for all body fluids, including blood and digestive juices. It helps to transport and absorb nutrients.

Body water is lost daily through our lungs as water vapor, through skin as sweat, and through tears, urine, and stool. During an average day, about 10 cups of water is lost. During heavy exercise in hot weather, the body can lose that much in an hour.

Water losses are normally replaced with drinking fluids and eating food that contains water. When someone becomes sick or is exposed to excessive heat, the body cannot keep up with the losses and dehydration occurs. Severe dehydration is a medical emergency and can be life-threatening. Death from dehydration can occur in three days or less. No one normally lives for more than 5 to 6 days without water.

Functions of water in the human body

The body is composed of 50-75% of water, depending on age and body fatness. Water is essential for living, significantly more so than food. Death will usually occur after one week without any liquids (2 to 3 days in the heat) but humans have been known to survive some months without food. The common rate of sweat loss is about 275ml in the heat. Prolonged exercise performance can be impaired by depletion of the body's energy stores and by disturbances of water and electrolyte balance. Exercise can exceed two liters per hour in highly fit and well-acclimatized athletes. Even more modest and common rates of sweat loss (e.g., 1 - 1.5 l/h) sustained for 30 to 60 minutes can result in dehydration that is of sufficient magnitude to negatively affect cardiovascular, thermoregulatory, and performance responses. 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.

Note: The blood-flow demands of exercising skeletal muscle during exercise are further increased by the need to pump large volumes of blood to the skin for convective and evaporative heat loss.

The relationship of water and exercise

In Exercise Physiology, Water plays an important role in two aspects:

"Heat Dissipation" and "Physiological Homeostasis

1. **Heat Dissipation:** Regulates body temperature through perspiration.
2. **Physiological Homeostasis:** Water helps to maintain the physical equilibrium, to regulate its internal environment to maintain a stable, constant condition for adapting the physical activity.
    - Normal body water turnover in an adult is from 1.7 to 2.3 L/day
    - Respiration: vigorous exercise can dissipate1-5ml water per minute
    - Sweat: about 500ml per day (depending upon temperature and humidity)
    - Urine excretion: about 1000-1500ml per day
    - Stool excretion: about 100-200mg per day

Effects of dehydration on physiology and performance

Inadequate drinking during strenuous activity can result in dehydration and impaired athletic performance. During intense physical activity, athletes often do not drink enough fluids to replace what they lose in exercise, resulting in what's called "voluntary dehydration". The followings are the physiological consequences between difference dehydration levels:

- Fluid losses of as little as 1% of body weight (about 600ml), cause heart rate to be elevated, cardiac output to be declined, and core temperature to be raised. - Fluid losses of 2% of body weight (less than 4 pounds in a 200-pound athlete), due to the dysfunction of homeostatic, it can impair performance by raising the body temperature and increasing fatigue who fails to replace body fluids. - Fluid losses of 4-6% of body weight (about 2400-3600ml) will decrease muscle strength and muscle endurance. And heat spasm often develops. The performance ability may lower by 20-30% and also affected the anaerobic capacity. Besides, there are progressive increases in the concentrations of sodium and other dissolved substances in the blood plasma, a lower blood flow to the skin, and a higher core temperature which will increase the chance of heat stroke.

- Fluid losses over 6% of body weight (> 3600ml). Dehydration compromises symptoms of impaired cardiovascular function often develop (e.g., syncope, heat exhaustion, heat spasm), and, in severe cases, neurological failure and severe hyperthermia ensue (e.g., heat stroke).

Causes of excessive body water losses:

A. Illness

- Vomiting and diarrhea
- Increase in urination (infection, diabetes)
- Fever
- Lung problems
- Kidney problems
- Burns (lose water through damaged skin)

B. Activities and environment

- Excessive sweating and exercise, especially in hot weather
- Rapid breathing during exercise
- Hot, dry windy days can cause more water loss than cool days
- Inadequate water intake
- Alcohol consumption which can cause excessive

urination and perspiration
- Diets: some diets include the use of laxatives and diuretics which emphasize shedding "water weight" as a quick weight loss method

C. Medications
- Diuretics which are used to treat high blood pressure
- Antihistamines
- Anti-inflammatory medications such as ibuprofen
- Some psychiatric medications have side effects that cause water loss through diarrhea, vomiting, loss of appetite, etc. (Lithium, Depakote, antipsychotics)

Risks for dehydration

A. Older Age
- As the body ages it has less ability to conserve water
- The sense of thirst is less acute
- The body responds less to changes in temperature

B. CHRONIC ILLNESS
- Poorly controlled diabetes mellitus
- Kidney disease
- Alcoholism
- C. Athletes, especially endurance athletes
- The longer someone exercises, the harder it is to stay hydrated. For those that exercise daily, the water losses accumulate and can lead to dehydration

D. High altitudes (especially over 8,000 feet)
- At high altitudes, the body attempts to adjust by rapid breathing and increased urination which can lead to dehydration

Table 1: Symptoms of dehydration

Mild	Moderate	Severe
Thirst*	Very dry, sticky mouth	Extreme thirst
Dry lips	Thirst	Irritability
Slightly dry mouth	Sleepiness or tiredness	Confusion
	Less frequent urination	Little or no urination
	Lack of tears with crying	Dark, concentrated urine
	Headache	Lack of sweating
	Muscle weakness and cramps	Low blood pressure
	Dizziness or lightheadedness	Rapid heart rate and breathing
	Sunken eyes	Cold hands, blue lips
some individuals are not able to feel or report thirst	Skin that lacks elasticity (doesn't bounce back when pinched into a fold)	Fever

In very serious cases, delirium, unconsciousness, or coma can occur.

Complications

Heat injury
- Heat cramps occur commonly in people who work hard in the heat. The muscles being used during work are usually the ones that cramp.
- Heat exhaustion is seen when the body temperature is above 102 degrees Fahrenheit. Symptoms include headache nausea, dizziness, weakness, and thirst.
- Heat stroke is a medical emergency and can cause confusion, headache, irritability, and lead to loss of consciousness, seizures and coma. The body temperature is generally over 104 degrees Fahrenheit.

Brain swelling (cerebral edema)
- This can occur if electrolytes such as sodium are unbalanced and the cells respond by pulling more water inside them. This causes swelling of the cells.

Seizures
- With dehydration, the normal electrical activity of the brain can become disorganized and cause or increase seizures.

D. Shock
- With dehydration the blood pressure can drop and the resultant reduced blood flow means that less oxygen reaches tissues.

E. Kidney failure
- The kidneys no longer work well when there is not enough fluid circulating through the body.

Diagnosis

A. Diagnosis is usually based on physical signs and symptoms

B. Blood tests
- Electrolytes such as sodium
- Kidney function tests

C. The urine can show dehydration by its color as well as a measure of concentration called the specific gravity.

Treatment

a. Drinking more fluids especially water or drinks containing electrolytes.
b. Fluids should be taken in frequent, small amounts as drinking too much, too fast can cause vomiting.
c. Fluids containing caffeine can stimulate further water loss by increased urination.
d. Fluids that contain a lot of sugar can cause or worsen diarrhea.
e. Intravenous (given through the veins) fluids may be needed for severe dehydration.

Prevention

a. Consume plenty of fluids and foods that contain a lot of water (fruits and vegetables) on a regular basis.
b. Drink extra fluids during hot weather
c. Drink extra fluids when ill.
d. When strenuous exercise is planned, start hydrating the day prior and replenish fluids at regular intervals during and after exercise.
e. Schedule physical outdoor activities during the cooler parts of the day.
   - Monitor your urine color. Clear to pale yellow

(lemonade color) is indicative of optimal hydration status.
- Fruits and vegetables are made mostly of water and are a great way to add fluids to help meet your hydration needs. Plus, they have lots of vitamins and minerals!
- Weigh in before practice and after to determine your amount of water loss.
- If you are a salty sweater, eat salty foods before activity and don't be afraid to use the salt shaker. Replace losses post-workout with watery foods that contain salt, such as broth-based soups or vegetable juice.
- Other sources of water include smoothies, juice, sports drinks and tea. However, be wary of the extra calories these liquids may contain.
- Carry a water bottle with you so you can drink water throughout the day.

Note: Good indicator of dehydration – urine color
- The darker the color of urine, the more dehydrated the person is.
- Normal colored urine is pale yellow.
- The urine of a person who is a bit dehydrated is bright yellow. The person should drink at least a cup of water or two.
- The urine of a person who is very dehydrated is orange. The person should drink at least a liter of water or more.

Suggestions for fluid intake
- Voluntary drinking before the thirst signals. Initially, one experiences thirst and discomfort when they lose 1% of body fluid. If you feel thirsty, you are already dehydrated.
- Try to avoid caffeinated and alcoholic beverages, while they do supply water to the body initially, contain diuretics that cause the body to lose water.
- Cold beverages are more palatable during and after exercise, and this greater palatability will increase fluid consumption by athletes. Drinking cold beverages (8-12 °C) causes a slight transient cooling of the upper digestive tract.
- Sports drink consists with minerals, Sports drinks are intended to replenish electrolytes, sugar, water, and other nutrients, and are usually isotonic (containing the same proportions as found in the human body). Non-athletes who use sports drinks should also be aware that sports drinks for athletes typically contain high levels of carbohydrates which will result in weight gain if consumed without a corresponding increase in exercise activity.
- Try to avoid concentrated juice, sweetened drinks, chocolate milk and soda. These sugared beverages will lower the rehydration rate.
- The choice of drink will depend on whether you need a drink to replace fluid losses or to provide moreenergy / carbohydrate or both. Either plain water or sports drink which contain 4 to 8% carbohydrate are suitable.

Fluid intake before exercise

Prehydrating
- Drink approximately 600ml of fluids up to two hours before an endurance exercise session.
- Drink 200ml of fluids 15 minutes before exercise

Fluid intake during exercise
- During intense and prolonged exercise sessions, or exercising in a hot/humid environment, drink 150-350ml. every 15 to 20 minutes. (depending on individual sweating rate, exercise duration)
- Splash some water onto the skin surface can help to reduce the sweat evaporation during exercise.
- Plain water is useful in non-endurance events of low intensity, where carbohydrate replacement is not the priority. Since it is much faster to be absorbed into the body.
- If exercise duration is longer than one hour, consuming sports drinks can sustain fluid-electrolyte balance and exercise performance. Ingestion of approximately 30-60 g of carbohydrate during each hour of exercise will generally be sufficient to maintain high rates of oxidation of blood glucose late in exercise and to delay fatigue.

Fluid intake after exercise
- After exercise drink enough fluids to replace quench your thirst plus extra.
- Use body weight after exercise as a guideline. Drink 480ml of fluids for every pounds lose.

Note: Avoid excessive fluid consumption after exercise
- Over-drinking 1-2L will increase the blood circulation, so as to increase the workload for the cardiovascular system.
- The potential danger of excessive fluid consumption which may, in the extreme, result in a low blood sodium concentration or hyponatremia, while the sodium concentration in the plasma falls below 135 mmol/L. Hyponatremia is a rare occurrence, it is a dangerous condition that may arise when athletes drink too much water, diluting the body's sodium.

Overhydration

Just as deficits in body water can be detrimental to health and performance, over hydration can also have severe consequences. As outlined in the *Statement of the 3rd International Exercise-Associated Hyponatremia Consensus Development Conference*, excess fluid intake may lead to a condition known as exercise-associated hyponatremia (EAH), which is defined as a plasma sodium concentration below 135 mmol/L.30 Although the incidence is rare, EAH can occur when (1) water clearance by the kidneys is insufficient or (2) water ingestion exceeds sweat losses.31–34 Less likely in acclimatized individuals, the loss of salt-concentrated sweat, as occurs in "salty sweaters," may also lead to extracellular sodium dilution and increase the risk of EAH.32 EAH is observed most commonly in slower-paced participants who consume fluids frequently throughout the course of long-duration events (>4 hours).35,36 With excess fluid intake, the solute concentration of the extracellular space decreases, causing water to move into the cells and, ultimately, intracellular swelling. This intracellular swelling can lead to severe edema, particularly in the cerebral and pulmonary circulations. Whether the cause of EAH relates solely to the volume of fluid ingested, or whether the type of fluid can play a role, has been debated by researchers. The bulk of the evidence indicates that the volume, but not the fluid composition, is associated with hyponatremia and is likely the primary factor leading to EAH.35

Symptoms of EAH begin to appear when plasma sodium concentration drops below 130 mmol/L and include dizziness, nausea and puffiness. 35, 36 When plasma sodium

concentrations fall below 125 mmol/L, symptoms become increasingly severe and include swelling in the hands and feet, confusion, vomiting, delirium and disorientation. If plasma sodium drops below 120 mmol/L, the chances of cerebral edema, brainstem herniation and death increase significantly. Many symptoms of EAH (vomiting, headache and fatigue) are non-specific and mimic those of under hydration. Therefore, plasma sodium or body-weight measurements may be required to determine if an individual is suffering from EAH or dehydration.30 EAH is typically treated by ingestion of hypertonic fluids, or, in severe cases, sodium replacement through IV infusion to redistribute fluid from the intracellular to the extracellular space and reduce swelling.

Note: With excess fluid intake, the solute concentration of the extracellular space decreases, causing water to move into the cells and, ultimately, intracellular swelling.

What about sports Drinks

Sports drinks are designed to rehydrate, provide energy and replenish the body's electrolytes, especially sodium, which is lost through sweating. Sports drinks also contain carbohydrates – the body's main source of energy. During prolonged, intense exercise, it is important to replace the fluid and minerals lost in sweat. The appropriate amount for rehydration will depend on factors such as the level and duration of exertion. Reduce the risk of fluid-electrolyte imbalances such as hyponatremia (dangerously low blood sodium level), which can occur after long and intense exercise when a high level of sweating has also occurred and large volumes of plain water are consumed. Athletes that will benefit most from a sports drink are those intensely exercising for longer than 60 minutes and salty sweaters. Sports drinks are designed to help replenish sodium lost from sweat. If exercising longer than 60 minutes, consuming a few gulps of a sports drink every 15 to 20 minutes can help to maintain energy and electrolyte levels, and sustain performance. (For more information, refer to the Fueling during Exercise fact sheet.)

Summary

Deviations from normal total body water can have significant physiological consequences that have the potential to contribute to performance decrements, as well as health consequences. During exercise, individuals should strive to maintain normal hydration (<2 percent body mass loss), while avoiding weight gain. The addition of electrolytes and carbohydrates to ingested fluids may provide additional benefits, particularly for "salty sweaters" or those competing in long-duration events. For competitive athletes focused on performance, reliable and inexpensive hydration-assessment methods, such as monitoring changes in body weight, can be used to implement optimal hydration strategies. Water makes up nearly two-thirds of the human body. It plays a large part in many bodily functions, such as lubricating your joints and eyes, keeping your skin healthy by eliminating toxins and facilitating proper digestion. Once your body loses water, it needs to be replaced to maintain balance between the salts, glucose and other minerals in your system that keep your biological processes working optimally. Dehydration happens when you've lost too much water without replacing it, preventing your body from performing its normal functions. Mild dehydration can easily be treated but if it reaches extreme levels, it can be life-threatening and will require immediate medical attention. Blood tests are often employed to test kidney function and to check sodium, potassium, and other electrolyte levels. Electrolytes are chemicals that regulate hydration in the body and are crucial for nerve and muscle function. A urine analysis will provide very useful information to help diagnose dehydration. Prevention is really the most important treatment for dehydration. Consuming plenty of fluids and foods that have high water content (such as fruits and vegetables) should be enough for most people to prevent dehydration.

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