11.6: Consequences of Deficiency or Excess

Skills to Develop

- Summarize the following fluid and electrolyte imbalance disorders: dehydration, water intoxication, heat stroke, and hypertension.
- Describe the DASH diet and state its benefits.

As with all nutrients, having too much or too little water has health consequences. Excessive water intake can dilute the levels of critical electrolytes in the blood. Water intoxication is rare, however, when it does happen, it can be deadly. On the other hand, having too little water in the body is common. In fact, diarrhea-induced dehydration is the number-one cause of early-childhood death worldwide. In this section, we will discuss subtle changes in electrolytes that compromise health on a chronic basis.

High-Hydration Status: Water Intoxication/Hyponatremia

Water intoxication mainly affects athletes who over hydrate. Water intoxication is extremely rare, primarily because healthy kidneys are capable of excreting up to one liter of excess water per hour. Over hydration was unfortunately demonstrated in 2007 by Jennifer Strange, who drank six liters of water in three hours while competing in a “Hold Your Wee for a Wii” radio contest. Afterward, she complained of a headache, vomited, and died.

Low-Hydration Status: Dehydration

Dehydration refers to water loss from the body without adequate replacement. It can result from either water loss or electrolyte imbalance, or, most commonly, both. Dehydration can be caused by prolonged physical activity without adequate water intake, heat exposure, excessive weight loss, vomiting, diarrhea, blood loss, infectious diseases,
malnutrition, electrolyte imbalances, and very high glucose levels. Physiologically, dehydration decreases blood volume. The water in cells moves into the blood to compensate for the low blood volume, and cells shrink. Signs and symptoms of dehydration include thirst, dizziness, fainting, headaches, lack of concentration, low blood pressure, fatigue, low (dark color urine) to no urine output, inability to regulate body temperature, weakness and lethargy, and, in extreme cases, loss of consciousness and death. Signs and symptoms are usually noticeable after about 2 percent of total body water is lost.

Caffeine and alcohol consumption can increase urinary output. If the output is not matched by input, then the person can become dehydrated.

Chronic dehydration is linked to higher incidences of some diseases. There is strong evidence that low-hydration status increases the risk for kidney stones and exercise-induced asthma. There is also some scientific evidence that chronic dehydration increases the risk for kidney disease, heart disease, and the development of hyperglycemia in people with diabetes. Older people often suffer from chronic dehydration as their thirst mechanism is no longer as sensitive as it used to be.

![Figure 11.6.1: Older people need to guard against dehydration by taking steps to drink more, especially when exercising. © Shutterstock](https://med.libretexts.org/Courses/American_Public_University/APUS%3A_An_Introduction_to_Nutrition_(Byerley)/Text/11%3A_Nutrients_Important_to_Fluid_and_Electrolyte_Balance/11.06%3A_Consequences_of_Deficiency_or_Excess)

**Heat Stroke**

Heat stroke is a life-threatening condition that occurs when the body temperature is greater than 105.1°F (40.6°C). It is the result of the body being unable to sufficiently cool itself by thermoregulatory mechanisms. Dehydration is a primary cause of heat stroke as there are not enough fluids in the body to maintain adequate sweat production, and cooling of the body is impaired. Signs and symptoms are dry skin (absence of sweating), dizziness, trouble breathing, rapid pulse, confusion, agitation, seizures, coma, and possibly death. Dehydration may be preceded by heat exhaustion, which is characterized by heavy sweating, rapid breathing, and fast pulse. The elderly, infants, and athletes are the most at risk for heat stroke.

**Hypertension**

Blood pressure is the force of moving blood against arterial walls. It is reported as the systolic pressure over the diastolic pressure, which is the greatest and least pressure on an artery that occurs with each heartbeat. The force of blood...
against an artery is measured with a device called a sphygmomanometer. The results are recorded in millimeters of mercury, or mmHg. A desirable blood pressure ranges between 90/60 and 120/80 mmHg. Hypertension is the scientific term for high blood pressure and defined as a sustained blood pressure of 140/90 mmHg or greater. Hypertension is a risk factor for cardiovascular disease, and reducing blood pressure has been found to decrease the risk of dying from a heart attack or stroke. The Centers for Disease Control and Prevention (CDC) reported that in 2007–2008 approximately 33 percent of Americans were hypertensive. Centers for Disease Control and Prevention. “FastStats—Hypertension.” Accessed October 2, 2011. http://www.cdc.gov/nchs/fastats/hyprtens.htm. The percentage of people with hypertension increases to over 60 percent in people over the age of sixty.

Risk factors for hypertension include obesity, cardiovascular disease, age, heredity or genetics, race, BMI over 30, type 2 diabetes, and salt sensitivity. About 30-50% of people with hypertension are sensitive to salt.

Figure 11.6.2: Blood pressure is measured with a cuff, also known as a sphygmomanometer, that measures blood pressure in millimeters of mercury, or mmHg. © Shutterstock

There has been much debate about the role sodium plays in hypertension. In the latter 1980s and early 1990s the largest epidemiological study evaluating the relationship of dietary sodium intake with blood pressure, called INTERSALT, was
completed and then went through further analyses.Intersalt Cooperative Research Group. “Intersalt: An International Study of Electrolyte Excretion and Blood Pressure. Results for 24 Hour Urinary Sodium and Potassium Excretion.” BMJ 297, no. 6644 (1988): 319–28. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1834069/. Elliott, P. et al. “Intersalt Revisited: Further Analyses of 24 Hour Sodium Excretion and Blood Pressure within and across Populations.” BMJ 312, no. 7041 (1996): 1249–53. http://www.ncbi.nlm.nih.gov/pubmed/8634612. More than ten thousand men and women from thirty-two countries participated in the study. The study concluded that a higher sodium intake is linked to an increase in blood pressure. A more recent study, involving over twelve thousand US citizens, concluded that a higher sodium-to-potassium intake is linked to higher cardiovascular mortality and all-causes mortality.Yang Q. et al. “Sodium and Potassium Intake and Mortality among US Adults: Prospective Data from the Third National Health and Nutrition Examination Survey.” Arch Intern Med 171, no. 13 (2011): 1183–91. doi: 10.1001/archinternmed.2011.257. The DASH-Sodium trial was a clinical trial which evaluated the effects of a specified eating plan with or without reduced sodium intake. The DASH diet is an eating plan that is low in saturated fat, cholesterol, and total fat. Fruits, vegetables, low-fat dairy foods, whole-grain foods, fish, poultry, and nuts are emphasized while red meats, sweets, and sugar-containing beverages are mostly avoided. (To find out more about the DASH eating plan see "Interactive 11.6.1. In this study, people on the low-sodium (1500 milligrams per day) DASH diet had mean systolic blood pressures that were 7.1 mmHg lower than people without hypertension not on the DASH diet. The effect on blood pressure was greatest in participants with hypertension at the beginning of the study who followed the DASH diet. Their systolic blood pressures were, on average, 11.5 mmHg lower than participants with hypertension on the control diet.Sacks, F. M. et al. “Effects on Blood Pressure of Reduced Dietary Sodium and the Dietary Approaches to Stop Hypertension (DASH) Diet.” N Engl J Med 344, no. 1 (2001): 3–10. http://www.ncbi.nlm.nih.gov/pubmed/11136953. Following the DASH diet not only reduces sodium intake, but also increases potassium, calcium, and magnesium intake. All of these electrolytes have a positive effect on blood pressure, although the mechanisms by which they reduce blood pressure are largely unknown.

While some other large studies have demonstrated little or no significant relationship between sodium intake and blood pressure, the weight of scientific evidence demonstrating low-sodium diets as effective preventative and treatment measures against hypertension led the US government to pass a focus on salt within the Consolidated Appropriations Act of 2008. A part of this act tasked the CDC, under guidance from the IOM, to make recommendations for Americans to reduce dietary sodium intake. This task is ongoing and involves “studying government approaches (regulatory and legislative actions), food supply approaches (new product development, food reformulation), and information/education strategies for the public and professionals.”Jane E. Henney, Christine L. Taylor, and Caitlin S. Boon, eds., Strategies to Reduce Sodium Intake in the United States, by Committee on Strategies to Reduce Sodium Intake, Institute of Medicine (Washington, D.C.: National Academies Press, 2010): 19. http://www.nap.edu/openbook.php?record_id=12818&page=19#p2001b5996019001.

Dietary recommendations to lower blood pressure are as follows. The DASH diet and MyPlate are two diets that meet these recommendations.

- decrease sodium intake
- exercise and lose weight if overweight
- limit consumption of alcohol (one to two drinks per day)
- increase your intake of calcium, potassium, magnesium and vitamin C

Interactive

https://med.libretexts.org/Courses/American_Public_University/APUS%3A_An_Introduction_to_Nutrition_(Byerley)/Text/11%3A_Nutrients_Important_to_Fluid_and_Electrolyte_Balance/11.06%3A_Consequences_of_Deficiency_or_Excess

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The National Heart, Lung, and Blood Institute has prepared an informative fact sheet on the DASH diet.


Use the food group charts to help design a daily menu that follows the DASH eating plan.

Salt Sensitivity

High dietary intake of sodium is one risk factor for hypertension and contributes to high blood pressure in many people. However, studies have shown that not everyone’s blood pressure is affected by lowering sodium intake. About 10 to 20 percent of the population is considered to be salt-sensitive, meaning their blood pressure is affected by salt intake. Genetics, race, gender, weight, and physical activity level are determinants of salt sensitivity. African Americans, women, and overweight individuals are more salt-sensitive than others. Also, if hypertension runs in a person’s family, that person is more likely to be salt-sensitive. Because reducing dietary salt intake will not work for everyone with hypertension or a risk for developing the condition, there are many opponents of reducing dietary salt intake at the national level. Among such opponents is the Salt Institute, a nonprofit trade organization that states, “No evidence demonstrates that current salt intake levels lead to worse health outcomes such as more heart attacks or higher cardiovascular mortality.” The Salt Institute. “Salt and Health.” © 2011 Salt Institute. Accessed October 2, 2011. http://www.saltinstitute.org/Issues-in-focus/Food-salt-health.

Key Takeaways

- Dehydration decreases blood volume. Dehydration is a primary cause of heat stroke.
- Chronic dehydration is linked to higher incidences of some diseases.
- Hypertension is a risk factor for cardiovascular disease and reducing blood pressure has been found to decrease the risk of dying from a heart attack or stroke. Many large studies suggest that high sodium intake is linked to an increase in blood pressure.
- The Dietary Approaches to Stop Hypertension (DASH)-Sodium trial concluded that sodium intake is effective in decreasing blood pressure.
- About 10 to 20 percent of the population is considered to be salt-sensitive. Genetics, race, gender, body weight and physical activity level are determinants of salt sensitivity.

Discussion Starter

1. Does salt restriction need to be a public policy? Compare it to having a public policy on water intake to prevent dehydration in children during school-sponsored sports events.