Subject: Nutrition/2nd Semester (CC3T)/Ch-10

Topic Name: Minerals and Trace elements

(**Sodium**: Biochemical and Physiological role, bioavailability and requirement, Sources,its importance, excess and deficiency disorders)

Salt and Sodium

Salt, also known as sodium chloride, is about 40% sodium and 60% chloride. It flavors food and is used as a binder and stabilizer. It is also a food preservative, as bacteria can't thrive in the presence of a high amount of salt. The human body requires a small amount of sodium to conduct nerve impulses, contract and relax muscles, and maintain the proper balance of water and minerals. It is estimated that we need about 500 mg of sodium daily for these vital functions. But too much sodium in the diet can lead to high blood pressure, heart disease, and stroke. It can also cause calcium losses, some of which may be pulled from bone. Most Americans consume at least 1.5 teaspoons of salt per day, or about 3400 mg of sodium, which contains far more than our bodies need.

Recommended Amounts

The U.S. Dietary Reference Intakes state that there is not enough evidence to establish a Recommended Dietary Allowance or a toxic level for sodium (aside from chronic disease risk). Because of this, a Tolerable Upper intake Level (UL) has not been established; a UL is the maximum daily intake unlikely to cause harmful effects on health.

Guidelines for Adequate Intakes (AI) of sodium were established based on the lowest levels of sodium intake used in randomized controlled trials that did not show a deficiency but that also allowed for an adequate intake of nutritious foods naturally containing sodium. For men and women 14 years of age and older and pregnant women, the AI is 1,500 milligrams a day.

A Chronic Disease Risk Reduction (CDRR) Intake has also been established, based on the evidence of benefit of a reduced sodium intake on the risk of cardiovascular disease and high blood pressure. Reducing sodium intakes below the CDRR is expected to lower the risk of chronic disease in the general healthy population. The CDRR lists 2,300 milligrams a day as the maximum amount to consume for chronic

disease reduction for men and women 14 years of age and older and pregnant women. Most people in the U.S. consume more sodium than the AI or CDRR guidelines.

Food Sources

Sodium isn't generally a nutrient that you need to look for; it finds you. Almost any unprocessed food like fruits, vegetables, whole grains, nuts, meats, and dairy foods is low in sodium. Most of the salt in our diets comes from commercially prepared foods, not from salt added to cooking at home or even from salt added at the table before eating.

According to The Centers for Disease Control and Prevention, the top 10 sources of sodium in our diets include: breads/rolls; pizza; sandwiches; cold cuts/cured meats; soups; burritos, tacos; savory snacks (chips, popcorn, pretzels, crackers); chicken; cheese; eggs, omelets.

Are "natural" salts healthier than table salt?

Salt is harvested from salt mines or by evaporating ocean water. All types of salt are made of sodium chloride, and the nutrient content varies minimally. Although less processed salts contain small amounts of minerals, the amount is not enough to offer substantial nutritional benefit. Different salts are chosen mainly for flavor.

 The most widely used, table salt, is extracted from underground salt deposits. It is heavily processed to remove impurities, which may also remove trace minerals. It is then ground very fine. Iodine, a trace mineral, was added to salt in 1924 to prevent goiter and hypothyroidism, medical conditions caused by iodine deficiency. Table salt also often contains an anticaking agent such as calcium silicate to prevent clumps from forming.

Kosher salt is a coarsely grained salt named for its use in traditional Kosher food preparation. Kosher salt does not typically contain iodine but may have an anti-caking agent.

Sea salt is produced by evaporating ocean or sea water. It is also composed mostly of sodium chloride, but sometimes contains small amounts of minerals like potassium, zinc, and iron depending on where it was harvested. Because it is not highly refined and ground like table salt, it may appear coarser and darker with an uneven color, indicating the remaining impurities and nutrients. Unfortunately, some of these impurities can contain metals found in the ocean, like lead. The coarseness and granule size will vary by brand.

Himalayan pink salt is harvested from mines in Pakistan. Its pink hue comes from small amounts of iron oxide. Similar to sea salt, it is less processed and refined and therefore the crystals appear larger and contain small amounts of minerals including iron, calcium, potassium, and magnesium.

Larger, coarser salt granules do not dissolve as easily or evenly in cooking, but offer a burst of flavor. They are best used sprinkled onto meats and vegetables before cooking or immediately after. They should not be used in baking recipes. Keep in mind that measurements of different salts are not always interchangeable in recipes. Generally, sea salt and table salt can be interchanged if the granule size is similar. However, table salt tends to have more concentrated, saltier flavor than kosher salt, so the substitution is one teaspoon of table salt for about 1.5 to 2 teaspoons of kosher salt depending on the brand.

Importance of Sodium

Sodium and Health

In most people, the kidneys have trouble keeping up with excess sodium in the blood. As sodium accumulates, the body holds onto water to dilute the sodium. This increases both the amount of fluid surrounding cells and the volume of blood in the bloodstream. Increased blood volume means more work for the heart and more pressure on blood vessels. Over time, the extra work and pressure can stiffen blood vessels, leading to high blood pressure, heart attack, and stroke. It can also lead to

heart failure. There is some evidence that too much salt can damage the heart, aorta, and kidneys without increasing blood pressure, and that it may be bad for bones, too. Learn more about the health risks and disease related to salt and sodium:

Cardiovascular disease

After conducting a review on sodium research, the Institute of Medicine concluded that reducing sodium intake lowers blood pressure, but evidence of a decreased risk of cardiovascular diseases (CVD) is inconclusive. It is clear, however, that high blood pressure is a leading cause of CVD. It accounts for two-thirds of all strokes and half of heart disease. In China, high blood pressure is the leading cause of preventable death, responsible for more than one million deaths a year.

There may be a genetic component to salt intake, as people respond differently to lower sodium intakes. Those who are "salt-sensitive" experience the greatest blood pressure reductions after following a reduced sodium diet. Those who are "salt-resistant" do not experience these changes even with significant increases in sodium intake. Studies have found that women more than men, people older than 50 years, African-Americans, and those with a higher starting blood pressure respond the greatest to reduced sodium intake. However, there is not enough evidence to make strong conclusions about specific groups who may be salt-resistant; the overall evidence supports a benefit of limiting sodium intake for everyone, even though the optimal target amount is not clear.

Observational and clinical research has found that higher sodium intakes are associated with cardiovascular diseases and related deaths. The following are key studies:

- *Intersalt:* Researchers measured the amount of sodium excreted over a 24-hour period (a good stand-in for salt intake) among more than 10,000 adults from 32 countries. The average was nearly 4,000 mg of sodium a day. Yet the range was huge, from 200 mg a day among the Yanomamo people of Brazil to 10,300 mg in northern Japan. Populations with higher salt consumption had higher average blood pressures and greater increases of blood pressures with age. Four groups of people —the four countries with salt intakes less than 1,300 mg per day—had low average blood pressures and little or no upward trend of blood pressure with age.

    o   The authors conducted a re-review and update on the Intersalt data. They found: 1) a stronger association than their prior study with higher sodium intakes and higher blood pressure, and 2) a stronger association with higher sodium intakes and higher blood pressure in middle age participants as compared with younger adults.

- *TOHP:* The two Trials of Hypertension Prevention (TOHP) were conducted from 1987-1995. They tested the impact of lifestyle changes on blood pressure, such as weight loss, stress management, nutritional supplements, and consuming

less sodium. In each of the studies, small decreases in blood pressure were seen with sodium reduction over 18-36 months. Years after the trials had ended, the researchers surveyed the participants and found that:

o   After an average of 10-15 years, the TOHP participants in the sodium-reduction groups were 25% less likely to have had a heart attack or stroke, to have needed a procedure to open or bypass a cholesterol-clogged coronary artery, or to have died of cardiovascular disease.

o   The higher the ratio of potassium to sodium in a participant's diet, the lower the chances were of developing cardiovascular trouble. This suggests that a strategy that includes both increasing potassium and lowering sodium may be the most effective way to fight high blood pressure.

- *TOHP Follow-up Study*: A continuation of the two previous TOHP trials in 2000 that looked specifically at CVD or deaths from CVD. [11] When participants with sodium intakes less than 2,300 mg daily were compared with those who had intakes of 3,600-4,800 mg, there was a 32% lower risk of developing CVD. There was also a continuing decrease in CVD-related events (stroke, heart attack) with decreasing sodium intakes as low as 1,500 mg daily.

- **DASH**: The Dietary Approaches to Stop Hypertension (DASH) trials, begun in 1994, were major advances in blood pressure research, demonstrating the links between diet and blood pressure.

o   In the first study, 459 participants were randomly assigned to either

o   1) a standard American diet high in red meat and sugars, and low in fiber,

o   2) a similar diet that was richer in fruits and vegetables, or

o   3) the "DASH diet," which emphasized fruits, vegetables and low-fat dairy foods, and limited red meat, saturated fats, and sweets. After eight weeks, the fruits and vegetables diet and DASH diet reduced systolic (the top number of a blood pressure reading) and diastolic (the bottom number of a blood pressure reading) blood pressure, with the DASH diet producing a stronger effect.

o   The second study found that lowering sodium in either the DASH or standard American diet had an even stronger impact on reducing blood pressure. The DASH study contributed much of the scientific basis for the Dietary Guidelines for Americans 2010, which recommends reducing daily sodium to less than a teaspoon.

- A meta-analysis of clinical trials found that a moderate sodium reduction to about 4,000 mg a day for at least one month caused significant reductions in blood pressure in individuals with both normal and high blood pressure. Further analysis

showed that blood pressure was reduced in both men and women and white and black races, suggesting a benefit for the total population.

Chronic kidney disease

Chronic kidney disease (CKD) shares risk factors with cardiovascular disease, with high blood pressure being a major risk factor for both. Salt sensitivity is reported to be more prevalent in patients with CKD due to a reduced ability to excrete sodium, which may lead to increased blood pressure.

Although there is evidence that links high sodium intake with high blood pressure, there is not adequate evidence that a low sodium restriction protects against or causes better outcomes of CKD than a moderate sodium restriction. One systematic review of patients diagnosed with CKD found that high sodium intakes of greater than 4,600 mg a day were associated with progression of CKD, but low sodium intakes less than 2,300 mg a day had no significant effect when compared with moderate sodium intakes of 2,300-4,600 mg a day.

Guidelines generally advise a moderate rather than low sodium restriction to prevent the development and progression of CKD. A daily sodium intake of less than 4,000 mg is recommended for overall management of CKD, and less than 3,000 mg daily for CKD with symptoms of fluid retention or proteinuria, a condition in which excess protein is excreted in the urine.

Osteoporosis

The amount of calcium that your body loses via urination increases with the amount of salt you eat. If calcium is in short supply in the blood, it can leach out of bones. So a diet high in sodium could have an additional unwanted effect—the bone-thinning disease known as osteoporosis. A study in post-menopausal women showed that the loss of hip bone density over two years was related to the 24-hour urinary sodium excretion at the start of the study, and that the connection with bone loss was as strong as that for calcium intake. Other studies have shown that reducing salt intake causes a positive calcium balance, suggesting that reducing salt intake could slow the loss of calcium from bone that occurs with aging.

Cancer

Research shows that a higher intake of salt, sodium, or salty foods is linked to an increase in stomach cancer. The World Cancer Research Fund and American Institute for Cancer Research concluded that salt, as well as salted and salty foods, are a "probable cause of stomach cancer."

Signs of Sodium Deficiency

A deficiency of sodium in the U.S. is rare because it is so commonly added to a wide variety of foods and occurs naturally in some foods. **Hyponatremia** is the term used to describe abnormally low amounts of sodium in the blood. This occurs mainly in older adults, particularly those living in long-term care facilities or hospitals who take medications or have health conditions that deplete the body of sodium, leading to hyponatremia. Excess vomiting, diarrhea, and sweating can also cause hyponatremia if salt is lost in these fluids that are expelled from the body. Sometimes too much fluid abnormally collecting in the body can lead to hyponatremia, which might stem from diseases such as heart failure or liver cirrhosis. In rare cases, simply drinking too much fluid can lead to hyponatremia if the kidneys can't excrete the excess water. Symptoms of hyponatremia can include: nausea, vomiting, headaches, altered mental state/confusion, lethargy, seizures, coma.

Signs of Sodium Excess/ Toxicity

Too much sodium in the blood is called **hypernatremia**. This acute condition can happen in older adults who are mentally and physically impaired who do not eat or drink enough, or who are sick with a high fever, vomiting, or infection that causes severe dehydration. Excessive sweating or diuretic medications that deplete the body of water are other causes. When sodium accumulates in the blood, water is transferred out of cells and into the blood to dilute it. This fluid shift and a build-up of fluid in the brain can cause seizures, coma, or even death. Extra fluid collecting in the lungs can cause difficulty breathing. Other symptoms of hypernatremia can include: nausea, vomiting, weakness, loss of appetite, intense thirst, confusion, kidney damage.

The interrelationship of sodium and potassium

Sodium and potassium are closely interconnected but have opposite effects in the body. Both are essential nutrients that play key roles in maintaining physiological balance, and both have been linked to the risk of chronic diseases, especially cardiovascular disease. High salt intake increases blood pressure, which can lead to heart disease, while high potassium intake can help relax blood vessels and excrete sodium while decreasing blood pressure. Our bodies need far more potassium than sodium each day, but the typical U.S. diet is just the opposite: Americans average about 3,300 milligrams of sodium per day, about 75% of which comes from processed foods, while only getting about 2,900 milligrams of potassium each day. [19,20]

A study in the *Archives of Internal Medicine* found that:

- People who ate high-sodium, low-potassium diets had a higher risk of dying from a heart attack or any cause. In this study, people with the highest sodium intakes had a 20% higher risk of death from any cause than people with the lowest

sodium intakes. People with the highest potassium intakes had a 20% lower risk of dying than people with the lowest intakes. But what may be even more important for health is the relationship of sodium to potassium in the diet. People with the highest ratio of sodium to potassium in their diets had double the risk of dying of a heart attack than people with the lowest ratio, and they had a 50% higher risk of death from any cause.

- People can make a key dietary change to help lower their risk: Eat more fresh vegetables and fruits, which are naturally high in potassium and low in sodium, but eat less bread, cheese, processed meat, and other processed foods that are high in sodium and low in potassium.