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SODIUM AS ONE OF THE BASIC ELEMENTS IN HUMAN LIFE

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Sodium is one of the most important elements in the internal environment of our body. The importance of the optimal amount of sodium in the body can be assessed simply by the enormous number of functions performed by it in the body. The body cannot produce sodium on its own, it enters the body in ionic form with food, while it is found not only in animal products, but also in plant origin. Sodium ions are mostly concentrated in the extracellular fluids of most modern animals, including humans; potassium ions predominate in the tissues and cells of these organisms. As for any functionally significant element in the human body, for sodium ions there is an optimal concentration in blood plasma, which, according to various sources, is approximately 135-146 mmol/L, while significant fluctuations in this concentration, both upward and downward, can cause a number of pathological processes, the main beginning of which is the imbalance of the acid-base state of the body. We have carried out a brief review of information on the importance of sodium ions for human life, its functional significance and the features of some biochemical processes associated with this element.

Keywords: sodium, sodium ions, hyponatremia, hypernatremia, health, potassium, potassium ions

99% of the elemental composition of the human body is represented by 12 basic chemical elements. Among these elements, sodium accounts for about 2% of the total mineral component of the body.

Although sodium does not belong to organogenic chemical elements, like carbon or oxygen, its importance for the human body is very high. Although most of the mineral is found in intercellular fluids, it can be transported into the extracellular matrix. The sodium-potassium pump, a special transport enzyme adenosine triphosphatase, is responsible for the circulation of sodium from the cytoplasm of the cell to the intercellular space. The movement of ions in the intercellular space is promoted by the hormone of the adrenal cortex aldosterone. Nutrient absorption occurs throughout the gastrointestinal tract. Through the villi of the epithelium, ions penetrate the intercellular space, carrying water with dissolved nutrients. Metal ions are able to penetrate into the blood through the pulmonary epithelium and epidermis [1].

Up to 90% of the excretion of sodium ions falls on the work of the kidneys, the remaining amount leaves the body with feces and sweat gland secretions. The process of sodium metabolism is regulated by the thyroid gland. The hypofunction of this organ leads to the retention of metal ions in the cells, and increased secretion increases the excretion of sodium. The hormone of the hypothalamus vasopressin, which accelerates the excretion of the mineral in the urine, is also responsible for the excretion of the element. The balance between the amount of incoming and outgoing mineral tends to zero.

After absorption, the salts of this element dissociate to sodium cations. The ionic form of the mineral in the human body accounts for 85%, the remaining 15% are various compounds of a protein nature. The ionized form of sodium is active and performs several vital functions, which will be discussed below [2].

Relevance. Sodium is the main component of the intercellular space. In the human body, sodium in the form of soluble salts (chloride, phosphate, bicarbonate) is found mainly in extracellular fluids. Together with potassium, the active ionized form of sodium performs a number of vital functions that ensure the homeostatic state of the body, among which are the creation of conditions for the formation of a membrane potential that ensures signal transmission from nerve and muscle cells to the executive organs (which is especially important for the rhythmic contraction of the myocardium), maintaining osmotic blood concentration (since the volume of circulating blood and its viscosity directly depend on the amount of sodium ions in the blood serum), maintaining the acid-base state, normalizing the water balance, providing membrane transport, transferring carbon dioxide from cells to the lungs, providing hypotensive effects by expanding blood vessels, participation in the synthesis of gastric juice, which protects against pathogenic microorganisms, participation in all types of metabolism, including the activation of many enzymatic systems, while acting as a cofactor in the most important biochemical transformations [1].

Purpose of research. Examine a list of foreign sources describing the role of sodium cations for the normal functioning of all organism systems, trace the peculiarities of the consequences of the lack of sodium ions in the human body.

Materials and methods of research

To study the significance of sodium in the optimal work and activities of the main bodies

and systems, we have been worked out a list of foreign sources containing reliable and officially confirmed information on the significance of this microelement for the normal functioning of the human organism.

Results of the research and discussions

The body of an adult healthy person contains about 100 g of sodium. Slightly more than half of all its ions is in extracellular fluid, approximately 34.5 g in bone tissue as its inorganic component, and about 14.5 g in cells. At the same time, blood plasma normally contains from 310 to 340 mg / dl of sodium.

The degree of absorption of sodium compounds tends to 100%, and since it is not synthesized in the body, a daily supply from outside is necessary. Sodium is contained in the form of ions in animal and plant foods, and there is more of it in animal products than in vegetable ones. Nevertheless, the main sources of sodium for our body are food and sea salt, as well as sodium-containing food additives used in the production of food products (such as sodium nitrate and sodium glutamate). Beetroot, carrot, turnip, artichoke, tomato, seafood, offal, seaweed will help replenish the nutrient supply. The absorption of sodium from plant and animal products is facilitated by vitamins D, K. 20-60% of the nutrient is lost during heat treatment. According to the recommendations of the World Health Organization, it is recommended to limit sodium intake to 2 grams per day for adults, which is approximately equivalent to 5 grams of table salt [3].

Absorption of sodium ions is carried out in the small intestine; this process occurs with the expenditure of energy in the form of ATP molecules. Excess sodium entering the body is normally excreted in the urine and, in small amounts, with sweat.

Sodium is one of the key components of blood plasma, lymphatic fluid, extracellular fluid, and amniotic fluid. Together with potassium, it ensures the maintenance of the body's water balance, affecting osmotic pressure, due to which the necessary volume of extracellular fluid is provided, while potassium ensures the preservation of fluid inside the cell. If the balance of sodium or potassium levels is disturbed, the fluid begins to move out of the cell or into the cell to restore the lost balance of sodium and potassium in intracellular and extracellular fluids [4]. With a significant degree of probability, it can be assumed that the dominance of potassium cation is maintained in animal cells – from unicellular forms to higher multicellular ones. This is of fundamental importance for preserving the physicochemical features of the intracellular environment from the moment of its formation to the present, that is, for billions of years. Rare exceptions (for example, sodium-free erythrocytes of some animal lines) only confirm the regularity of intracellular predominance of potassium ions over sodium ions. The predominance of sodium ions inside erythrocytes is explained by the fact that sodium in the cell replaces potassium when there is no need for protein synthesis at the final stages of the life of this type of cell [5].

The role of sodium cations is not limited to the above. The latter are necessary for the absorption of glucose by the kidneys and in the intestine, as well as for the transport of other nutrients through the cell membrane. Sodium plays an essential role in maintaining the constancy of the acid-base state in the body. As a component of the sodium pump, sodium helps in the transfer of metabolic material between cell membranes. At the same time, its role in the transmission of electrochemical impulses along nerve and muscle membranes and maintaining normal muscle irritability and excitability is also enormous and significant, thereby ensuring muscle function [4].

Hypernatremia, in which the concentration of sodium ions in the blood plasma rises above the reference values (for sodium ions, the reference values are 135-146 mmol/L), is possible with the loss of large volumes of fluid, which is carried out through the kidneys (with diabetes insipidus), the gastrointestinal tract (osmotic diarrhea) or through the skin (through sweat glands). Hypernatremia may be a consequence of the side effect of diuretic drugs, leading to partial dehydration of the body by excreting a significant amount of urine by the urinary system [2, 5].

Hypernatremia usually causes a feeling of thirst. The most serious symptoms of hypernatremia occur due to brain dysfunction. Severe hypernatremia can lead to disorientation, muscle cramps, seizures, coma, and death. A high concentration of sodium in the blood adversely affects the brain [6]. Therefore, the high concentration of sodium in the blood plasma is compensated by fluid replenishment. In all cases, except the lightest, intravenous administration of dilute liquids (containing water and a small amount of sodium in a carefully adjusted concentration) is prescribed. The level of sodium in the blood decreases slowly because its rapid drop can cause irreversible damage to the brain [3].

Excessive sodium intake is associated with an increase in blood pressure, while insufficient sodium intake leads to an increase in re-

nin and aldosterone levels in the body. There is evidence confirming the association of excessive sodium intake with an increased risk of developing cardiovascular diseases. A constant excess of sodium and potassium in food is accompanied by a slight increase in the level of insulin in the blood. The introduction of a large amount of sodium chloride causes protein breakdown and severe emaciation. With parenteral administration of isotonic solution, body temperature may rise, this is especially noted in children [7].

Hyponatremia, which is a lack of sodium in the body, is defined as a decrease in the concentration of sodium in the blood plasma below normal values. Even though the loss of fluid and salts most often accompany each other, you can also find a deficiency of only sodium. The main reason for the decrease in the amount of sodium in the body is dehydration, which is a loss of fluid, because of severe sweating, diarrhea or vomiting. Also, a significant loss of sodium is possible with adrenaline insufficiency when glomerular reabsorption disorders are observed. Diseases such as liver and heart disorders (for example, cirrhosis and heart failure) can lead to sodium and fluid retention. Often the body retains more fluid than sodium, which leads to a decrease in sodium concentration [4].

Certain diseases can lead to too much water consumption (polydipsia), which can contribute to the development of hyponatremia [6].

Thiazide diuretics are a common cause of hyponatremia. These drugs increase the excretion of sodium, which increases the excretion of water. Thiazide diuretics are usually well tolerated but can cause hyponatremia in people prone to low sodium levels, especially in the elderly [5].

Hyponatremia may be the result of salt starvation, and the latter, in turn, can provoke dopamine withdrawal. Sodium deficiency impairs cognitive function, causes fatigue and symptoms of depression. Depletion of its reserves also causes long-term changes in the neural circuits that encode the value of salt, which ultimately increases cravings for salty food [4, 6].

A few sodium-containing drugs are used in medical practice. The most important drug to eliminate sodium deficiency in the body is a saline solution. In case of violation of the water-salt balance, it is administered intravenously. Therapy is continued until the macronutrient concentration in the blood is normalized. Isotonic sodium chloride solution (0.9%, 0.15 M) is used to dissolve or dilute injectable drugs, hypertonic sodium chloride solution (5 and 10%) dehydrates cells due to high osmotic pressure, promotes plasmolysis of bacteria, having an antimicrobial effect, and is also used for gastric lavage in case of poisoning with silver nitrate [5]. An aqueous solution of sodium bicarbonate as a result of hydrolysis by anion exhibits slightly alkaline properties and antimicrobial action and can also be used to equalize the acid-base state of the body and fight acidosis. Borax, chemically a 10-water sodium tetraborate crystallohydrate, is used externally as an antiseptic for rinsing, douching, and lubricating [7]. 10-aqueous sodium sulphate crystallohydrate is used as a laxative. Sodium thiosulfate acts as an anti-inflammatory and desensitizing agent, and sodium citrate acts as an anticoagulant. Sodium thiopental is a means for non-inhalation anaesthesia, according to its chemical structure it is a derivative of barbituric acid, which has a hypnotic and general anaesthetic effect, depressing the respiratory and vasomotor centres, as well as on the myocardium. Sodium oxybutyrate is a sodium salt of γ-hydroxybutyric acid, in chemical structure and pharmacological properties is close to γ-aminobutyric acid, the main inhibitory mediator of the central nervous system, has elements of nootropic activity and exhibits sedative, hypnotic, narcotic, central muscle relaxant effect, enhances the analgesic activity of narcotic and non-narcotic analgesics, enhances the stability of the body, including the brain brain, heart, retina to hypoxia, activates oxidative processes [8]. Metamizole sodium is known as a pyrazolone derivative, an analgesic-antipyretic that has analgesic, antipyretic and anti-inflammatory effects, the mechanism of which is associated with inhibition of prostaglandin synthesis. Levothyroxine sodium is a synthetic levorotatory isomer of thyroxine (T4), a thyroid hormone that has all the properties of an endogenous hormone, after biotransformation in the body of levothyroxine into liothyronine stimulates tissue growth and differentiation, increases tissue oxygen demand, stimulates the metabolism of proteins, fats, carbohydrates, increases the functional activity of the cardiovascular system and the central nervous system. The radioactive isotope ^{24}Na is used as a label to determine the speed of blood flow and is used to treat some forms of leukemia [9].

Conclusion

Analysis of literature sources has shown that sodium is one of the most important elements in the human body, also called extracellular alkaline cation. The concentration of sodium cations inside the cell is about 15 times

less than in the extracellular fluid. Due to the difference in potentials of sodium and potassium salts, the transition of substances from the extracellular space to the intracellular becomes possible, and the water-electrolyte balance of the body, regulation and distribution of fluid in it depends on the concentration of sodium. Together with potassium, sodium is contained in all liquid media of the body, participating in all processes of cellular metabolism. Due to the difference in the content of the cell and the intercellular fluid, sodium and potassium constantly tend to the area with a lower concentration of their own ions. Moving through the membrane, they carry out a passive transfer of fluids and substances: sodium transports amino acids, carbohydrates and other substances into the cell, and potassium removes the final products of metabolism. In other words, sodium contributes to the nutrition of the cell, and potassium to its purification. Sodium is a part of the cell membrane, in the form of a positively charged ion, activating the processes of nervous excitation, contraction of muscle fibers and several other equally important biochemical reactions.

Sodium enters the body with almost any food and water. But unprocessed fruits, vegetables, whole grains, nuts, meat, and milk cannot boast of its high concentrations. A much larger amount of sodium ions enters the human body when taking table salt and sea salt. Vitamins D and K contribute to the better digestibility of sodium. An excessive amount of potassium and chloride ions prevents the absorption of the nutrient. If the diet contains an excess of the mineral, there is a decrease in the concentration of calcium and magnesium. Diuretics, caffeine, and corticosteroids contribute to the leaching of the macronutrient. Sodium ions protect our body from the loss of life-giving moisture, but with its excess, the opposite effect is observed. It is important to remember that high concentrations of potassium ions, as a natural antagonist of sodium ions, can lead to excessive excretion of the latter from the body, which is accompanied by relaxation of the vascular wall and a decrease in blood pressure. Deficiency and excess of this mineral are equally dangerous to health, so you should properly prepare a diet to ensure the normal functioning of the body.

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