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The Importance of Iron in the Body's Metabolic Processes

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Annotation. Iron helps to support many important body functions, affecting vitality, concentration, gastrointestinal processes, the immune system and the regulation of body temperature. A shortage or excess of it has an immediate effect on well-being.

Keywords: iron, gastrointestinal processes, erythropoiesis, haemoglobin, pregnancy;

Iron in the form of various compounds is very common in nature, including in many foodstuffs. Iron ions are involved in the following chemical reactions: transport of electrons, cytochromes, iron-seroproteins; transport and deposition of oxygen with myoglobin and hemoglobin; formation of active centres of redox enzymes - oxidase, hydroxylase [7,11].

The physiological expenditure of iron is relatively low, but during acute or chronic blood loss the need for iron increases. Iron is essential for normal erythropoiesis and enters the bone marrow in the following ways: by destruction of erythrocytes, from the depot, with food and water. Normal erythropoiesis requires 12-15 mg of iron in the daily diet of an adult. Iron is stored in various organs and tissues, mainly in the liver and spleen [5,6,8].

In humans, iron is part of almost 70 essential enzymes. The total iron content in the body is about 4.5-5 g, of which 75-80% is in haemoglobin, which provides oxygen transport to tissues; 5-10% is in myoglobin; 1% is in respiratory enzymes that catalyse respiratory processes in cells and tissues. 20-25% of the body's iron is in reserve. The physiological loss of iron in the urine, sweat, faeces, hair and nails, irrespective of age and sex, is about 1 mg/day. In women with normal menstruation lasting 3-4 days, the iron loss is about 15 mg (30-50 ml of blood). In hyperpolymenorrhoea (up to 50-250 ml of blood) the iron loss increases significantly. During pregnancy, childbirth and lactation up to 1700-1800 mg of iron is lost. Through the breakdown of haemoglobin about 21-24 g of iron is released per day, which is many times more than the intake of iron from the digestive tract (1-2 mg/day) [1]. Thus, when there is an increased need for the element, iron deficiency is compensated by reserve and then transport iron.

In celiac disease (gluten enteropathy), iron- and B12-deficiency anaemia is found in 1.8-14.6% of cases, usually in combination with malabsorption of other nutrients [2].

Regulation of iron homeostasis

It should be noted that the amount of iron in the body is relatively stable and is provided by iron intake from food and by iron recycling, starting with the lysis of old erythrocytes. This process involves macrophages of the spleen, red bone marrow and,

to a lesser extent, Kupffer cells. Gastric hydrochloric acid, ascorbic acid from food, and the enzyme ferroreductase contribute to the absorption of iron in the intestine by converting trivalent iron to divalent iron. A number of enterocyte receptors facilitate the transfer of iron into the cell and from there into the plasma. In the mucosa of the small intestine there is an iron transfer protein called transferrin. In the cell, the transferrin-iron complex is broken down and the iron binds to another transfer protein, ferritin. The progenitor cells of mature red blood cells accumulate iron in ferritin. It is subsequently used when the cell begins to synthesise large amounts of haemoglobin [8,9,10,11].

Iron is reserved in the form of ferritin (easily mobilised form of reserve) or haemosiderin (difficult to mobilise form of reserve). Plasma transport includes transferritin iron and accounts for approximately 1% of total iron in the body.

Iron supplied from enterocytes (5%) and released by the recycling of old red blood cells with the involvement of mononuclear macrophages (95%) is transferred mainly to the bone marrow. An excessive iron intake produces a special biochemical form of iron, capable of generating free radicals, which leads to complications. Excessive amounts of iron in food or drug therapy over several days can lead to reduced iron absorption. This phenomenon, called 'mucus block', can occur even when the body is iron-depleted.

An excess of iron can occur in haematological patients after repeated transfusions of blood or erythromas. In these cases, the use of iron chelators, e.g. deferoxamine, deferasirox, is indicated (3). Similar iron overload can be observed, e.g. in myelodysplastic syndrome with repeated blood transfusions. Chelation therapy is also indicated in these cases [9]. The possibility of accelerated development of osteoporosis in iron overload was also confirmed in an experiment in mice [5].

The following protein compounds are involved in the regulation of iron homeostasis.

Hepsidine is an antimicrobial peptide synthesised in the liver in the form of a prepropeptide of 84 amino acids, excreted into the bloodstream as a mature structured peptide of 25 amino acids in the presence of 8 cysteine molecules forming four disulfur bridges. An increase in hepcidin reduces iron absorption and increases iron retention in the macrophage system. Conversely, decreased hepcidin production improves iron absorption and reduces iron retention in macrophages. Thus, hepcidin regulates iron absorption and metabolism, protecting the body against iron over-abundance. Hepcidin, by reducing iron toxicity, has been shown in experiments to reduce the area of cardiac infarction in myocardial infarction [6,9]. Iron deficiency anaemia is often seen in renal failure. In some patients it is refractory to iron or erythropoietin therapy and is considered as iron-refractory iron deficiency anaemia. It has been suggested that this pathology is genetically conditioned and associated with abnormalities in the metabolism of hepcidin, which plays an important role in iron homeostasis [7].

The HFE protein, consisting of 343 amino acids, plays an indirect role in iron metabolism. The absence of HFE protein on the cell surface leads to hyperabsorption and iron overload, the mechanisms of this process are not yet understood. The relationship between hepcidin and HFE protein currently needs to be clarified.

An important role in the regulation of erythropoiesis belongs to the nuclear factors GATA-1 (intranuclear regulator of transcription in the erythron) and NFE-2. Lack of GATA-1 inhibits erythrocyte differentiation, while lack of NFE-2 interferes with intestinal iron absorption and globin synthesis.

The regulation of iron homeostasis is also under the control of the endocrine glands. Normal erythropoiesis requires hormones that regulate protein metabolism (pituitary somatotropic hormone, thyroid hormone thyroxine, etc.) and calcium (parathormone, thyrocalcitonin). Male sex hormones (androgens) stimulate erythropoiesis, whereas female sex hormones (oestrogens) inhibit it, which seems to account for the lower number of erythrocytes in women compared to men.

1. It has been established that the key factor that ensures the proliferation and differentiation of erythroid cells, as well as prevents their apoptosis, is the circulating blood glycoprotein hormone erythropoietin. Erythropoietins are present in the blood of animals and humans experiencing hypoxia, as seen in anaemia, climbing to heights, muscular work, etc. The kidneys have been found to be the site of erythropoietin synthesis; they are also formed in the liver, spleen and bone marrow. The erythropoietin activity is possessed by erythrocyte polypeptides, whose molecular weight does not exceed 10,000. Erythropoietins act directly on erythroid progenitor cells: accelerate the transition of bone marrow stem cells into erythroblasts;
2. increase the number of erythroid cell mitoses; accelerate maturation of normoblasts, reticulocytes

Vitamins, especially vitamin B12 and folic acid, are essential for normal erythropoiesis and are involved in the synthesis of globin. Other B vitamins also play an important role in the regulation of erythropoiesis [7,8].

Erythropoiesis is influenced by interleukins synthesised by monocytes, macrophages, lymphocytes and other cells. Erythropoietin production is regulated at the level of its gene transcription. Under normal tissue oxygenation, the concentration of erythropoietin, as well as the volume of circulating red blood cells, remains constant. Thus, hypoxia is the only physiological stimulus that increases the number of erythropoietin-synthesizing cells [5,6].

Iron-containing organic compounds. Iron in the body is divided into cellular and extracellular iron.

Cellular iron

1. Haemoproteins whose main structural element is haem (haemoglobin, myoglobin, cytochromes, catalase and peroxidase). At the same time, haemoglobin carries exogenous oxygen and endogenous carbon dioxide. The erythrocyte in this case is a kind of buffer system regulating the overall gas-transport function.

2. Iron-containing enzymes of the non-hemin group (succinate dehydrogenase, acetyl-Coenzyme-A dehydrogenase, NADH-cytochrome, C-reductase, etc.). In them, iron is not incorporated into the hemin group and is only required for transfer reactions. Iron-containing enzymes and non-heminine iron are mainly found in mitochondria. Mitochondrial iron is necessary for tissue differentiation processes, and extramitochondrial iron plays an important role in cell growth and respiration processes. Cytochromes, catalase and peroxidase are the most studied and important enzymes for the organism. The main biological role of most cytochromes is involvement in electron transport in the processes of terminal oxidation in tissues [3,4].

Cytochromes are divided into the following groups:

- A - cytochromes with a formylporphin-bonding heme group;

- B - cytochromes with a protohemic group;
- C - cytochromes with a substituted mesogem group;
- D - cytochromes with a dehydroporphine-bonded hem-group.

The following cytochromes are found in humans: a1, aZ, b, b5, c, c1, P450. They are lipid complexes of haemoproteins and are tightly bound to the mitochondrial membrane. Cytochromes B5 and P450 are located in the endoplasmic reticulum.

Cytochrome oxidase is the final step in mitochondrial electron transport, responsible for the formation of ATP during oxidative phospholysis in the mitochondria.

Catalase is one of the most important enzymes that protect red blood cells from oxidative haemolysis. Like cytochrome oxidase, the enzyme consists of a single polypeptide chain linked to a heme group.

Peroxidase is found mainly in white blood cells and in the mucosa of the small intestine in humans. It has a protective role, protecting cells from destruction by peroxide compounds.

Myeloperoxidase is an iron-containing hemin enzyme located in the azurophilic granules of neutrophil leukocytes and released into phagocytic vacuoles during granule lysis. The destruction of the bacterial cell wall protein activated by this enzyme is fatal to the microorganism.

3. Ferritin and haemosiderin of internal organs. Ferritin and haemosiderin are mainly found in the reticuloendothelial system of the liver, spleen and bone marrow. Approximately one third of the human body's reserve iron, mainly in the form of ferritin, is found in the liver. The iron reserves can be mobilised for the body's needs when needed. There is no doubt that serum ferritin concentration reflects the state of the iron reserve in the human body.

Haemosiderin is the second iron reserve compound in the cell and contains significantly more iron than ferritin. Unlike ferritin, it is insoluble in water.

4. Iron loosely bound to proteins and other organic matter [1,2].

Extracellular iron

Transferrin is a specialized iron-binding protein that is found in small amounts in blood plasma. Transferrin not only transports iron to different tissues and organs, but also recognizes hemoglobin-synthesizing reticulocytes and other cells in need of iron. Transferrin only transfers iron to them if the cells have specific iron receptors.

When receptors are lost, the cell loses its ability to utilise iron. Thus, transferrin functions as a vehicle for iron, whose metabolism in the human body depends both on the total intake of iron in the blood plasma and on the amount of iron taken up by the different tissues according to the number of specific receptors for iron in these tissues. The most important reason determining plasma iron levels is the interaction of the processes of erythrocyte synthesis and breakdown. The amount of iron bound to transferrin is about 0.1% (4 mg) of all iron in the body. The total plasma iron-binding capacity due to transferrin concentration ranges from 44.7 to 71.6 μmol/L, and the free iron-binding capacity, or transferrin reserve capacity, is 28.8-50.4 μmol/L in a healthy person.

In healthy human plasma, transferrin can be found in 4 molecular forms:

1. apotransferrin;
2. monogelic transferrin A - iron occupies only A-space;
3. monogelic transferrin B - iron occupies only B-space;
4. digesic transferrin - both A- and B-spaces are occupied [8,9].

Lactoferrin. This protein is found in breast milk, lacrimal fluid, bile, synovial fluid, pancreatic juice and small bowel secretion. Under physiological conditions this iron-binding protein is saturated with up to 20% iron. It is found in negligible amounts in blood plasma. Although lactoferrin and transferrin are similar, these iron-binding proteins differ in their antigenic properties, composition of amino acids, proteins and carbohydrates. Lactoferrin is involved in immune processes and iron absorption in the small intestine. The use of bovine iron-enriched lactoferrin in pregnant women with anaemia has been shown to be advantageous over the commonly used iron sulphate. Haematological parameters of anaemia improved in parallel with an increase in serum prohepsidine levels [11,12].

Conclusion

Iron is a very common element in nature, including in foodstuffs. Iron is an essential component involved in the processes of erythrocyte maturation and differentiation from stem cell to normocyte. In healthy individuals the amount of iron resorbed in the intestine is independent of the body's requirements. As a consequence, prolonged high absorption of iron leads to siderosis. Excess iron is deposited in cells and tissues in the form of ferritin, a molecule that binds about 45,000 iron atoms. A distinction must be made between physiological iron consumption in the body and pathological iron loss due to haemorrhage.

References

1. Erkinovna K. Z., Rustamovna R. G., Suratovna H. F. Laboratory markers of perinatal hypoxic damage to the central nervous system in newborns //Наука, техника и образование. – 2020. – №. 10 (74). – С. 102-104.
2. Kudratova Z. E. et al. Медицинские науки principles of therapy of chlamydial and //Вопросы науки и образования. – С. 23.
3. Erkinovna K. Z., Berdirasulovich K. G., Andreevna Y. I. The importance of some laboratory indicators in lung diseases //Вестник науки и образования. – 2020. – №. 22-2 (100). – С. 70-72.
4. Kudratova Z. E. et al. The Role of Cytokine Regulation in Obstructive Syndrome of Atypical Genesis in Children //Annals of the Romanian Society for Cell Biology. – 2021. – С. 6279–6291-6279–6291.
5. Erkinovna K. Z. et al. Bronchial obstruction syndrome in young children with respiratory infections of different etiology: features of clinical manifestations and immune response //Проблемы науки. – 2021. – №. 1 (60). – С. 60-62.
6. Рузметова С.У., Мухамадиева Л.А., Умарова С.С., Кулдашев С.Ф. Диагностика и лечение соматических нарушений здоровья у детей раннего возраста, перенесших перинатальную гипоксию. Обзор литературы // Достижения науки и образования. 2021. №8 (80).
7. Кулдашев С., Мухаммадиева Л., Белых, Н., Рузметова С, Умарова С. (2022). Влияние особенностей макрота при острых и рецидивных бронхитах у детей.Журнал гепато-гастроэнтерологических исследований, 2(3.1), 33–35.
8. Рузметова С., Мухамадиева Л., Умарова С., Кулдашев С. (2022). Применение витамина д при лечении острого обструктивного бронхита у детей против насморка. Журнал гепато-гастроэнтерологических исследований, 2(3.2), 126-129.

9. Ибатова С.М., Маматкулова Ф.К., Кулдошев С.Ф. Изучение липидного и фосфорно-кальциевого обмена у детей с рахитом, получающих традиционное лечение //Евразийский журнал тяжелых и тяжелых заболеваний. – 2023. – Т. 3. – №. 4. – С. 253-261.
10. Erkinovna K. Z., Sadridinovna B. D., Matyakubovna N. R. Characteristics of antibiotic therapy of chlamydial and mycoplasma infections //Open Access Repository. – 2023. – Т. 4. – №. 02. – С. 19-24.
11. Абдирашидова Г. А. и др. Взаимоотношения реактивности вегетативной нервной системы и базофильных клеток аденогипофиза в постреанимационном периоде при моделировании 10-минутной клинической смерти //актуальные проблемы биомедицины-2020. – 2020. – С. 207-208.
12. Джаббарова, З. Р., Бурханова, Д. С. (2021). Депрессив бузилишларда адинамик компонентнинг клиникаси ва қиёсий ташхислаш усуллари. Журнал Биомедицины и практики, *6*(1).
13. Farkhadovna, I. I. F., & Sadridinovna, B. D. (2021). Effect of surfactant on the respiratory system, medicaments who are overtaking surfactant. *International Journal of Innovative Analyses and Emerging Technology*, *1*(1), 60-61.
14. Farkhadovna, I. I., & Sadridinovna, B. D. (2021, March). Theme: the thymus gland as an organ of the endocrine system. Physiology of the thymus. In *Euro-Asia Conferences* (Vol. 3, No. 1, pp. 22-25).