MICROELEMENTS AND SPORTS PERFORMANCE

Vasić Goran
Faculty of Physical Education and Sports, University of East Sarajevo, Pale, Republic of Srpska, B&H

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Abstract: *Athletes who take care of their health and want to be successful in sports take various vitamin and multimineral supplements, but most of them don't pay attention to traces of microelements found in human body. Studies state that 72 of them are needed in order for human to function properly. While only 8 microelements can be found in soil, and therefore in food, all of the 72 can be found in some type of seafood. Those who don't consume enough food of this kind can get their necessary doses of trace elements from multimineral supplements. The effects of microelements on the human body are great. By meeting daily needs, they can improve overall health and sports performance, but deficiency of just one of the trace elements can cause a number of health problems. lack of some microelements can lead to depression or sudden mood changes, while a lack of iron can lead to reduced energy production, a lack of iodine will cause problems in terms of intelligence, and if there is a lack of chromium, it could cause diabetes. The influence of trace elements is so farreaching that it is thought that they can even affect the lifespans of people. Unfortunately, modern methods of food preparation and storage often remove trace elements and other essential minerals from the food we eat. This is the reason why supplements in the form of rich, high-quality multimineral and vitamin preparations are necessary to compensate for nutritional deficiencies.*
Key words: *microelements, sports performance*

INTRODUCTION

Microelements are essential components of all human organisms as they play a key role in various biological processes. Although they are present in very small amounts, measured in micrograms (μg) and nanograms (ng), their presence is vital for the optimal functioning of the body. Among these microelements, the 15 most important include: iron (Fe), zinc (Zn), iodine (I), copper (Cu), manganese (Mn), cobalt (Co), selenium (Se), molybdenum (Mo), arsenic (As), chromium (Cr), fluorine (F), lead (Pb), nickel (Ni), vanadium (V), and silicon (Si). In the following text, we will focus on iron, zinc, chromium, selenium, and iodine.

Each of the aforementioned microelements has specific functions that contribute to maintaining the health and homeostasis of the human organism. A deficiency or excessive intake of any of these microelements can lead to serious health issues.

For athletes, microelements play a very significant role. High-intensity activities can increase the body's needs for certain microelements since physical activity stimulates sweat glands and depletes electrolyte reserves. For instance, iron is essential for prevent- ing anemia, which can reduce performance and increase fatigue. Zinc and magnesium are important for muscle recovery and immunity, while selenium acts as an antioxidant, protecting cells from oxidative stress. In addition to physiological functions, microele- ments also impact mental health and cognitive functions. Iodine deficiency, for example, can lead to cognitive issues and fatigue, while adequate zinc intake can improve mental sharpness. Furthermore, chromium helps regulate blood sugar levels, which is crucial for maintaining energy throughout the day.

Maintaining a balance of microelements is crucial for overall health. Although re- quired in very small quantities, their role is very valuable in supporting numerous bodily functions. Regular monitoring and proper nutrition can ensure that the body's needs for these essential elements are met, which is especially important for those who are physically active and have increased needs due to exercise.

IRON

Benefits

Adequate iron concentration in the body provides numerous benefits, including im- proved immunity, prevention of fatigue and anemia, and many studies link increased growth and development with blood iron levels. [1]

Daily Requirements

Reference values for daily iron intake, according to a 2001 study [2], indicate that infants aged 7 to 12 months require 11 mg of iron per day, children aged 1 to 3 years need 7 mg, and children aged 4 to 8 years require 10 mg. For older children, the value is 8 mg, and during adolescence, females require more iron than males, with 15 mg versus 11 mg. From the age of 19 onwards, the recommended daily intake for men is 8 mg, while for women aged 18 to 50 years, the value is higher, up to 18 mg. After the age of 50, women's needs decrease to 8 mg per day. During pregnancy, iron intake should increase to 27 mg per day, which can be achieved through supplementation. [2] Studies show that iron supplementation significantly affects athletic performance in athletes with low iron levels. Iron may influence optimal erythropoietic response during training in athletes with normal iron levels, but in some cases, it can trigger a negative hepcidin response, so the dose should be carefully monitored. [3]

Excessive Iron Intake

While there are many benefits to consuming iron in normal amounts, excessive intake can cause various symptoms such as an increase in the amount of free radicals, nau- sea, constipation, abdominal pain, vomiting, and diarrhea. In some cases, it can lead to stomach inflammation and ulcer formation. Similarly, high doses of iron can inter- fere with zinc absorption, which is one of the key microelements in the human body. Extreme doses of iron can cause organ damage, coma, seizures, and death. Increased iron levels in the body can also result from hemochromatosis, which leads to high iron concentration in the body and conditions such as cirrhosis and liver cancer. [4]

Insufficient Iron Intake

The most common health issue in individuals with insufficient iron concentration is anemia, although iron deficiency can occur without the presence of anemia symptoms, which are numerous. Some symptoms of iron deficiency include delayed cognitive de- velopment, weakened immunity, and impaired memory capacity. Iron deficiency during pregnancy is associated with numerous problems for both the mother and child, mani- fested through an increased risk of sepsis and miscarriage. [5] One of the most effective ways to treat anemia and low iron concentration in the body is oral supplementation. [6] Insufficient dietary intake, particularly in diets based on plant sources with low iron concentrations, is often the main cause of iron deficiency. [7]

Sources

Food can contain two types of iron: heme and non-heme iron. Heme iron is found in meat and fish and is better absorbed than non-heme iron, which is present in fruits and vegetables. Although non-heme iron is important for a balanced diet, it is less effectively absorbed by the body. [8] To increase absorbed iron concentration, consuming foods rich in vitamin C, such as tomatoes and citrus fruits, is recommended. [9]

ZINC

Benefits

Zinc is a microelement fundamental to all living organisms. Its importance in normal functioning of the body is evidenced by the fact that more than 300 different enzymes directly depend on the concentration of this element in the human body. These enzymes can be found in all known enzyme classes, and their concentration is remarkably high. [10] Zinc has also been shown to play a key role in protein and cell membrane struc- turing, as well as in gene expression. [11] Additionally, it is associated

with increased bone mineralization, improved immune system function, increased testosterone levels in men, enhanced stimulation of brain activity, and heightened senses. [12]

Daily Requirements

According to a 2001 study [2], the recommended daily intake of zinc for men aged 14 and older is 11 mg, while for women aged 14 to 18 years, it is 9 mg, decreasing to 8 mg in later years. Boys and girls aged 9 to 13 years should consume 8 mg daily, while children aged 4 to 8 years need 5 mg. For younger children, the recommended daily intake is 2–3 mg. Pregnant women should consume 11 mg of zinc daily. [2]

Excessive Zinc Intake

While there are numerous benefits to maintaining an adequate concentration of zinc in the body, excessive intake can lead to various adverse effects. Toxic doses for humans range from 300–600 mg of zinc, with such amounts linked to nausea, vomiting, diarrhea, and abdominal pain. [13] [14] In pregnant women, excessive zinc intake can result in miscarriage; however, insufficient zinc intake can also harm the embryo. [13]

Zinc Deficiency

Severe zinc deficiency is characterized by stunted growth, delayed sexual and skeletal maturation, the development of periorificial and acral dermatitis, diarrhea, hair loss (alopecia), loss of appetite, and behavioral changes. Mild zinc deficiency is harder to detect and is indicated by slower growth rates and reduced resistance to infections. [13] Some sources also mention atherosclerosis [15] and hypogonadism as side effects of zinc deficiency. [16] Because zinc is a key element for human health, even a slight deficiency can cause significant issues. Zinc deficiency is treated through supplementation or a diet enriched with this microelement. Some sources indicate that zinc deficiency is a significant problem among young athletes, increasing the risk of the previously mentioned side effects. [17]

Sources

Beefsteak, shellfish, and red meat are the richest sources of zinc, while nuts and veg- etables also have relatively good concentrations of this microelement. [12] The zinc concentration in fruits and vegetables depends on the zinc content in the soil where they are grown. [18]

CHROMIUM

Benefits

Chromium is an essential trace element involved in various metabolic processes in the body. It helps in the conversion of glucose into energy, thus promoting healthy blood glucose levels and blood pressure. It has also been observed to reduce appetite, which may help in maintaining a healthy body weight. [19] Some sources suggest that chromium is one of the essential trace elements for regulating blood sugar levels. [20]

Daily Requirements

According to a study from 2001 [2], the reference values for daily chromium intake for infants up to 6 months of age are 0.2 μg, for babies from 7 to 12 months it is 5.5 μg, for children from 1 to 3 years old it is 11 μg, and for children from 4 to 8 years old it is 15 μg. The reference value for male children aged 9 to 13 years is 25 μg, while for female children it is 21 μg. Boys aged 14 to 30, as well as older individuals up to 50 years old, should consume 35 μg, while the value for older individuals is slightly lower at 30 μg. Adolescent girls aged 14 to 19 should consume 24 μg, and women aged 19 to 50 should consume 25 μg. The reference value for women over 51 is 20 μg, while for pregnant women it is 29 μg or 30 μg depending on age. [2]

Excessive Chromium Intake

Negative effects of excessive chromium intake may be observed in individuals with liver and kidney problems. However, some sources suggest that chromium supplementation may lead to weight loss, anemia, dermatitis, and hypoglycemia. [21]

Insufficient Chromium Intake

Chromium deficiency in humans is most commonly observed in individuals who consume highly processed foods and athletes who do not have a well-adjusted diet in relation to their training regimen. Low chromium levels can cause diseases, metabolic dysfunctions, and various health problems. [19] Some sources indicate that chromium deficiency may lead to symptoms similar to diabetes in individuals who are under stress. [20]

Sources

Foods with the highest chromium concentrations include whole grains and their prod- ucts, such as oatmeal and bread, egg yolks, coffee, nuts, broccoli, onions, and various types of meat and seafood. [19] [22] It is recommended to avoid foods and drinks with high concentrations of added sugars, sodium, and saturated fatty acids.

SELENIUM

Benefits

Selenium is one of the key trace elements that helps maintain homeostasis in animals and humans. Its greatest impact is on the immune and reproductive systems, thyroid hormone metabolism, and antioxidant defense, i.e., slowing down the aging process, thereby reducing the risk of cancer. [23] [24] Studies also show that selenium affects sports performance by preventing oxidative processes in the body that occur due to physical exertion. [25]

Daily Requirements

The recommended daily intake values for selenium were provided by the Food and Nutrition Board in 2001 [2]. The recommended daily intake for infants up to 6 months of age is 15 μg, for babies from 7 to 12 months and children up to 3 years old, it is 20 μg, for children aged 9 to 13 years it is 40 μg, and 55 μg for older individuals. These values are valid for both genders, and for pregnant women, the intake should be increased to 60 μg. [2]

Excessive Selenium Intake

Excessive selenium in the body can be toxic to the system. These effects can be caused by both organic and inorganic forms of this trace element. [26] Symptoms of sele- nium poisoning can affect hair and skin loss, as well as damage to the nail plate. [27] Some early symptoms of acute poisoning include hypotension and tachycardia, while neurological symptoms are manifested by tremors and muscle contractions. [28] Other symptoms include anemia, dry cough, fever, and hypersalivation.

Selenium Deficiency

Insufficient daily intake of selenium leads to various health problems, including car- diomyopathy known as Keshan disease, which affects individuals from areas where the soil does not have a sufficient concentration of selenium. [13] Some sources indicate a connection between selenium deficiency and depression, as well as reduced nervous system function [29], while others suggest that selenium affects the normal function of the thyroid glands. [30] Supplementation with selenium tablets completely cured those suffering from Keshan disease, and it enabled the prevention of the disease, even though selenium deficiency was not the direct cause of the illness. [31]

Sources of Selenium

The highest concentration of selenium in food is found in protein-rich foods. The main dietary sources of selenium are bran, meat and dairy products, seafood, Brazilian nuts, [32] garlic (both black and white), tomatoes, and Brussels sprouts. [33]

IODINE

Benefits

Iodine is found in very small amounts in the human body, most of it located in the thyroid gland. The trace element iodine is an essential component for regulating the thyroid hormones thyroxine (T4) and triiodothyronine (T3). These hormones are cru- cial for the metabolism of the kidneys, liver, muscles, brain mass, and the central nervous system, as well as for development in children during fetal and later stages of brain mass, organ, and tissue development. [34]

Daily Iodine Requirements

Reference values for iodine intake were derived from a study conducted in 2001 [2]. Infants up to 6 months should consume 110 μg of iodine, and babies from 7 months to 1 year should consume 130 μg. Children from 1 to 8 years of age should consume 90 μg per day, with the upper limit ranging from 200 to 300 μg. The recommended daily intake for older children up to adolescence is 120 μg, and the upper limit increases to 600 μg. Iodine needs in later years are 150 μg, with an upper limit ranging from 900 to 1100 μg. These values remain constant for both men and women, but the daily recommendation for pregnant women is 220 μg [2]. Studies show that adequate and increased iodine intake can improve sports performance, as this trace element is lost through sweating during intense physical activity, and in some cases, the amount of iodine lost through sweat can match the concentration lost in urine. Conversely, insufficient iodine intake on a daily basis can result in performance issues and, in some cases, changes in thyroid gland function. [35]

Iodine Deficiency

Insufficient iodine intake leads to a deficiency of this trace element in the body. Iodine deficiency has various negative effects on the human organism. One of the leading factors affecting the reduction of intellectual abilities in children is iodine deficiency during the fetal period of human development. [36] Iodine deficiency in pregnant women and nursing mothers is one of the leading issues in health and nutrition. Inadequate iodine intake during childhood can slow down somatic growth and development, as well as cognitive and motor functions. [37] Studies indicate that around 2 billion individuals do not consume enough iodine, with the majority of them located in South Asia and Sub-Saharan Africa. However, about 50% of the population in Europe also experiences some form of iodine deficiency. [37] Research mentions iodizing sea salt as one of the most effective methods for increasing daily iodine intake, while supplementation is considered an alternative method for addressing this issue. [38]

Excess Iodine

Consuming iodine in large amounts, specifically more than the recommended 150 μg per day, can result in numerous negative effects on the body. In individuals prone to thyroid diseases, excess iodine can lead to dysfunction and negative changes in the glands, specifically causing hyperthyroidism and/or thyroid autoimmunity. Although persistent, this issue is not very common at the population level, but for those with existing thyroid problems, increased iodine intake can worsen their health condition. [39]

Sources of Iodine

The amount of iodine varies depending on the type of food and drink consumed, but it is generally found in very low concentrations. In various types of fruits and vegetables, the iodine concentration depends on the iodine content in the soil where they grow or on fertilizers enriched with this trace element. Its values range from 10μg per kilogram to 1 mg per kilogram, depending on the soil quality. [40] Iodine can be found in grains, garlic, sesame, and soy in certain amounts. [41] Certain concentrations

of this element will be ingested by animals that feed on vegetables and iodized supplements, meaning that a certain amount of iodine can also be ingested through meat. [42] Some sources also mention drinking water as one of the sources of iodine, though the iodine level in water depends on the iodine concentration in the soil and proximity to seawater. [40] For this reason, it is also recommended to consume sea fish and seafood several times a week. [41]

CONCLUSION

Microelements such as iron, zinc, chromium, selenium, and iodine are essential for the proper functioning of the human body. Their presence affects key processes such as immune function, cognitive development, hormonal balance, metabolism, and the maintenance of tissue and organ health.

Each of these elements is crucial for homeostasis and maintaining metabolism, par- ticularly in athletes, whose bodies lose significant amounts of electrolytes and microele- ments daily during training due to muscle activation and increased sweat gland secre- tion. On the other hand, insufficient intake of these microelements is often associated with serious health problems, such as anemia, weakened immune function, metabolic disorders, and stunted growth. Excessive intake, however, can lead to toxic effects, including organ damage, hormonal dysfunction, and other health complications.

Prevention and balanced intake of microelements are key to preserving health. A proper diet that includes diverse sources such as meat, fish, vegetables, fruits, and whole grains, combined with appropriate supplementation when necessary, can ensure optimal levels of these elements in the body. Additionally, individual needs must be carefully adjusted to specific life circumstances and health conditions.

Finally, understanding the benefits, risks, sources, and proper dosages of microele- ments forms the basis for making informed decisions about diet and supplementation, which is crucial for long-term health and well-being. Education about the importance of microelements and consultations with professionals, such as doctors and nutrition- ists, can further contribute to the adequate supply of these essential nutrients to the body. In this way, it is possible not only to maintain but also to improve quality of life through a responsible and proactive approach to personal health.

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MIKROELEMENTI I SPORTSKE PERFORMANSE

Vasić Goran

Sažetak: *Sportisti koji vode računa o svom zdravlju i žele biti uspešni u sportu, uzimaju razne vitaminske i multimineralne dodatke, međutim većina njih nedovoljno obraća pažnju o dodacima, kao što su mikroelementi (elementi u tragovima). Ljudsko telo ima potrebu za oko 72 mikroelementa, da bi normalno funkcionisalo. Samo oko osam mikroelemenata se mogu naći u poljoprivrednom zemljištu, a samim tim i u namirnicama, a svih 72 mikroelementa se mogu naći u nekim vrstama ribe. Oni koji ne konzumiraju plodove mora, mogu dobiti svoje potrebne elemente u tragovima iz multimineralnih dodataka. Efekti mikroelemenata po ljudski organizam su veliki. Unošenjem količina koje zadovoljavaju dnevne potrebe, mogu poboljšati sveukupno zdravlje i sportske performanse, a nedostatak samo jednog elementa u tragovima, može uzrokovati niz problema po zdravlje. Nedostatak nekih mikroelemenata, mogu biti nosioci depresivnih stanja i naglih promena raspoloženja, nedostatak gvožđa dovešće do smanjene produkcije energije, nedostatak joda će napraviti probleme u pogledu inteligencije, ako je posredi nedostatak hroma može uzrokovati pojavu dijabetesa. Uticaj mikroelemenata je toliko dalekosežan da se smatra da mogu uticati čak i na životni vek ljudi. Nažalost, modern metode spremanja hrane, čuvanja, često uklanjanju mikroelemente i ostale bitne minerale iz hrane koju jedemo. To je razlog zašto su dodaci u vidu bogatih kvalitetnih multimineralnih i vitaminskih preparata neophodni kao kompenzacija za nedostatke u ishrani.*
Ključne reči: *mikroelementi, sportske performance*