MINERALS WITH IMPLICATIONS IN SUPPORTING THE PHYSICAL EFFORT OF SOLDIERS

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Military reality has shown us, not a few times, that military operations are important economic, material, financial and human resources consumers, the time budget for their deployment not being very precise. Lack of precision in the completion of military operations may be a factor in supplementing all the resources needed to conduct combat actions, but also a motivation to find helpful solutions for the existing ones. Preparing and conducting combat actions, regardless of season and weather conditions, require operators to undertake a sustained physical and mental effort, most of the time.

From the point of view of human resources, especially of fighters, the support of combat ability can also be achieved by the use of nutritional supplements, vitamins and minerals. Besides, in this paper I will make a synthesis of three minerals as well as their role in supporting physical effort of soldiers in conducting combat actions.

Keywords: minerals; vitamins; physical effort; fighters; military conflicts; energy needs.

The development of human society involves profound changes in all its environments, coexisting and influencing each other. While maintaining the evolutionary trend, the military environment is no exception to these changes, sometimes being even radical, sometimes resorting to its violent forms of manifestation. Whether we accept it or not, the military environment with its military conflicts is an integral part of society, they are part of human life, with potentially negative, deep effects in collective or individual consciousness. From the military conflict, in its violent form of manifestation, armed struggle appears; whether it is lacking, its effects on man and society must be highlighted, lessons must be issued that allow us to evolve as humanity and why not, evolution should be found in new forms and ways of conducting the fight.

Even if society rejects and denies in some cases the existence of military conflicts, the military environment is also on the upward trend, the materialization of military evolution being found both in the development and consolidation of the "existent" situation and in the discovery and implementation of new means and methods, belonging to the future, in order to maintain the ability to fight and to conduct them. Effective armed struggle cannot be achieved independently of the human resource, whether we are talking about operators behind computers, ultramodern technologies, from the virtual environment, or we are talking about those present in the real battlefield, where direct contact with the enemy is omnipresent.

The involvement of the human component of the fighters in the real battlefield requires the intervention and use of all the means necessary to enable them to accomplish the objectives set forth, the missions entrusted, starting from logistic support (fighting technique, equipment, nutrition, medical assistance etc.) and continuing with the creation of specific training opportunities as well as their involvement in mixed training programs. The involvement of fighters in various forms of training requires them to make both neuro-mental and physical efforts. In fact, physical effort is defined as being "the process of conscious or unconscious overwhelming of mental and physical demands, varying in intensity, volume, complexity, as a result of participating in a form of training, in order to improve and modify the performance capacity and adaptation of the human body's systems"[1].

Minerals and their implications in physical effort

The energy needs of a healthy man to carry out daily activities require an energy consumption dictated by two requirements: the basic energy ratio and the effort energy ratio, additionally - this ratio is the one that allows the conduct of physical

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effort when an additional activity occurs and involves physical effort. In this situation, in order to maintain normal body activity, it is necessary, for each kilo of body mass, to have about 1,334 kcal per hour[2]. For example, a 75 kg man would have the following daily calorie requirements under normal conditions: 1,334 kcal x 24h x 75kg = = 2401 kcal.

The energy needs of fighters are clearly higher than those of civilians, situation demonstrated in the study "Energy requirements of military personnel"[3], where the energy consumption of soldiers ranged between 2,300-7100 kcal, with an average of 4,620 kcal. According to the same study, the energy consumption of the combat units is higher by about 20% than that in the second echelon units, the support ones. Also, energy consumption may increase, depending on the geographical area and the field conditions, on the number of consecutive days with prolonged activities, intensity and duration of military actions.

The energy needs of the body are assured by the three substances indispensable to life: carbohydrates, lipids and proteins. Along with these vital survival substances there are other components that play an important role in the correct functioning of the body and of its physiological processes: *water, vitamins and minerals*.

Vitamins are complex organic chemical substances necessary for the human body, obtained from the nutritional process[4], knowing that most of them cannot be synthesized by the body. They are found in most of the foods and natural fluids we consume, being divided into two categories: fat-soluble – A, D, E, K and water-soluble – B complex, C, PP. Vitamins play a role in the functioning of metabolic processes and are necessary for human evolution and reproduction.

With regard to *minerals*, these are inorganic elements essential to life, necessary for proper functionality of metabolism, having a role in cellular, enzymatic and hormonal activity. The most popular minerals are divided into two categories: macro-minerals – calcium, phosphorus, sulphur, magnesium, sodium, potassium and chlorine; micro-minerals – iron, zinc, manganese, cobalt, copper, fluoride, molybdenum, iodine, chromium, selenium.

Also, in the case of minerals and vitamins, as with carbohydrates, proteins and lipids, nutritional standards are set to ensure that the population benefits from an adequate diet, corresponding to the geographical area, the typology of the human, gender, activities performed and efforts made.

Of all known essential minerals, only some have undergone an analysis process and have been identified as relevant for cognitive and physical performance, these being accepted also by the US Department of Defence. Minerals with a potential impact on military activities that US Army researchers have focused on are *calcium, copper, iron, magnesium, selenium and zinc*. This paper aims to analyze the first three and to indicate their importance from the point of view of the physical effort of soldiers.

One of the most important minerals essential for humans is *calcium*. This is 99% found in the bone system and teeth, in an amount of about 1,000 g in women and 1,200 g in men. The daily calcium requirement for an adult is about 800 mg. This amount may be subject to changes based on daily activities, age, or gender. Calcium can be found in milk and dairy products, in meat, in a series of vegetables – beans, cabbage, cucumbers etc., in soymilk, in fruit but also in egg yolk. From the point of view of the importance of calcium in the body, it fulfils several roles: "structural – bones and teeth; neuromuscular – controlling excitability, releasing neurotransmitters, initiating muscle contraction; enzymatic – enzymatic co-factor in the blood coagulation system; hormonal – intracellular second messenger"[5].

The lack of calcium in the body is materialized by the occurrence of muscle cramps, trembling or uncontrollable twitching in the upper or lower limbs, insomnia, arrhythmias, dental problems, the occurrence of bone malformations, bone fragility by the reduction of bone density, increased blood clotting time, delay in the occurrence of muscle contraction, arthritis.

From the point of view of physical effort[6], of military service and of complex calcium intervention in the body, simply by observing the deficiencies caused by the lack of calcium, we can conclude that the decrease in its quantity in the body can have negative effects on the fulfilment of the tasks received by the fighters, as follows: as a result of its essential role in muscle contraction and bone system structure, no mission entrusted can be accomplished due to the impairment to the

locomotor system (osteoarticular and muscular system); the occurrence of muscle cramps or uncontrollable twitching in the limbs during a mission leads to delaying it or triggering involuntary shooting; bone fragility may be the cause of various fractures (microfracture recovery also depends on calcium intake) both in the case of the direct fight with the enemy, and in the case of the training of the motor skills specific to combat or of the utility and application skills (climbing, transport, digging, lifting of materials and objects, marching etc.). Besides, these utility and application skills "have been identified by the researchers as being ordinary physical activities of primary importance, carried out in the current NATO missions (humanitarian, counterterrorism, peacekeeping, conflict resolution etc.)"[7].

The second important element for the conduct of physical effort, implicitly the activity of soldiers, falling within the group of micro-minerals is *copper*. It is an important element for the proper functioning of internal organs, being present "in numerous oxidation reduction reactions... in the synthesis of adenosine triphosphate (nan. – substance that has the property "to decompose, releasing phosphoric acid and a certain amount of energy, being the real substance of the muscle action"[8]), iron transport"[9]. The role of copper is also found in the development of iron metabolism and hemoglobin formation, increase of immunity and prevention of osteoporosis, in most body systems, in the synthesis of melanin (element involved in maintaining the color of the skin, eyes and hair) and creation of collagen (protein that plays a role in cell regeneration and recovery), in the production of neurotransmitters.

The amount of copper present in the body ranges from 50 to 120 mg, and daily needs should contain about 1 mg for women and 1.4 mg for men. The sources from which copper can be obtained through a balanced diet are: liver, meat, eggs, peanuts, nuts, almonds, mushrooms, in some fruits, seeds and cereals, in seafood. It is known that processed food (semi-prepared and refined) is poorer in many minerals, including copper.

The implications of copper in physical activity and in the conduct of physical effort are numerous even though studies have not demonstrated immediate negative effects by copraemia decrease, knowing that "after a rest of 30 minutes after termination of effort, plasma levels return to resting state"[10]. Thus, by participating in ATP synthesis, copper influences the maintenance and performance of physical effort, by increasing the oxygenation process, it increases the aerobic effort and delays the occurrence and installation of fatigue, helps recover in various sports accidents (sprains, for example). An acute lack of copper in the body is often associated with reduced bone density, thus favoring the installation of osteoporosis. From the point of view of neurotransmitters – noradrenaline (it has a role in the sympathetic nervous system, being a mediator of nerve endings present in glands and smooth muscles), dopamine (substance with connection role and a transmitter of information between brain neurons, involved, among other things, also in triggering and continuing muscle contraction and movements) and serotonin (substance with implications in the induction and achievement of sleep, in affective and cognitive processes, in thermo-regulation and the cardiovascular system, in the functioning of the locomotor system), the presence of copper in the body facilitates the production of adrenaline which has the effect of reducing the reaction time to external or internal stimuli.

Observing the implications of copper in the body during physical activity, we can infer its importance also from the perspective of the soldiers' effort. Whether they are doing physical training or activities that involve energy consumption, copper is a mineral that supports the whole activity or can be a cause for the impossibility of carrying out a mission. Analysis, response and triggering of a motor reaction to the occurrence of an external stimulus (enemy fire with different types of weapons–light or heavy, air attack etc.) or moving from one objective to another, in combat conditions, determines the mobilization of minerals as supporters of the effort, implicitly of copper. Its severe lack in the body can lead to lack of reactions in combat situations, favoring failure to carry out the missions received.

The third mineral we approach in this material is *iron*. This is one of the most important and studied micro-minerals, being a component of many proteins and enzymes. An adult human body contains about 4 g of iron, and according to the International Committee for Nutrition and Food "the daily exogenous iron requirement is 16-18 mg / day for men and 12 mg / day for women (nan.

– through the loss of blood during the menstrual period, the amount of iron in their body decreases in a higher proportion than in normal life regimen, so the consumption must be higher)"[11]. From these values, only about 1 mg / day is absorbed by the male and female, to maintain the balance of iron in the body. Iron is found in most of the body's internal organs, but mostly in erythrocytes (about 65%), liver, spleen, bone marrow, plasma and muscles. About 6% cannot be determined where it is located in the body.

Food sources from which we can meet the daily needs are meat (more in red meat), chicken, fish, seafood, cereals, seeds, vegetables and fruits. Iron deficiency occurs in the body when the intake is not achieved through normal nutrition, when its absorption from food is not performed under normal body functionality conditions, during menstruation, in the case of very intense physical training, in the case of accidents where there are significant blood losses.

The most important role of iron in the body is to participate in the development of hemoglobin. It is known that the main role of the hemoglobin molecule interferes with the respiratory process, making possible the transport of oxygen to organs and cells and of carbon dioxide to the lungs to be eliminated. Knowing that the proper functioning of all internal organs and cells is conditioned by the presence of oxygen, highlighting the myocardium (the heart muscle) and the brain, we can simply infer its importance for body and existence. Iron also interferes with maintaining and developing the body's immunity. Iron deficiency can lead to fatigue, asthenia, and in severe cases of iron deficiency, anemia may occur – it is known to be a disease caused by the reduction in the number of red blood cells and blood hemoglobin or their quality.

Installation of anemia in the case of athletes can lead to the reduction of physical effort ability, implicitly of the number of training sessions and their quality, an accelerated heart rate and unjustified fatigue.

From the point of view of the importance of iron deficiency with implications for the physical activities conducted by soldiers, the consequences are "the impairment of the physical performance of work, impairment of cognitive functioning, poor immune functioning and change in emotional states"[12]. If we overlap these situations over the conduct of a mission in wars, especially in the conditions of a real combat situation, the chances of meeting the goals are significantly reduced, while affected operators can take irrational gestures, endangering the whole group. Loss of cognitive capacity simultaneously with unjustified change and alteration of feelings may be the cause of irreversible psychological changes on soldiers.

For the other three minerals (zinc, magnesium and selenium) specified at the beginning of this analysis, each of them has a well-defined role in ensuring the functionality of organs, of physiological and biochemical processes, of the body itself. *Zinc* plays an important role in vital body functions, in the growth and development of muscle tissue, and intervenes in the creation of ATP in the muscles, in various neurological processes, as well as in reproduction. Zinc deficiency, from the perspective of negative effects and that could influence the performance of the soldiers, can lead to diminishing the quality of vision, delay in wound healing, gastrointestinal diseases, slower recovery of effort ability and even favors the occurrence of muscle soreness.

Selenium is essential for the restoration of cell membranes that have undergone changes following a demanding physical effort, also having antioxidant properties. What is interesting for the physical activity of the soldiers, selenium deficiency affects the restoration of muscle tissue and causes prerequisites for the occurrence and installation of premature fatigue.

Magnesium is one of the mineral elements in a very large amount in the body, being exceeded only by potassium. The important function of magnesium in terms of physical effort is reflected by its intervention in energy metabolism, in neuromuscular excitability (transmission of the nervous impulse, muscle contraction) and biosynthesis. In other words, magnesium affects positively the action of skeletal muscles. Magnesium deficiency in the body creates a series of disorders, of which we only mention those that can adversely affect the activity of the soldiers during missions: "tetany[13], ataxia[14], tremor, convulsions, muscle weakness"[15].

Conclusions

The conduct of physical effort of fighters, both in the training activity, in the unit of origin and centralized before participating in a mission, as well as during the combat action, should also be

supported by proper nutrition and pharmacology means, by the administration of poly-vitamins and multi-minerals, activity carried out under the guidance and coordination of the medical service. Intake of minerals must be achieved primarily through regular rational nutrition and it is possible to resort to targeted nutrition programs and other additional means only in special cases.

Consumption of military personnel engaged in various forms of physical training or in the conduct of missions may generate greater demand for nutrients, given the effort parameters optimization for longer periods. If the goal was only to maintain health, then the intake would fall within the usual standards for the majority civilian population. In-depth knowledge of the missions to be accomplished, military-specific training forms, military scenarios involving fighters and the factors influencing the ability to fight at individual level, the loss of minerals as a result of physical effort, should be considered to create, if necessary, standards regarding additional intake of vitamins and minerals that can optimize soldiers' performance.

NOTES:

1 G.C. Ciapa, *Pregătirea fizică a militarilor din armata României în conflictele moderne, The Publishing House of the „Carol I" National Defence University*, Bucharest, 2018. p. 31.

2 British Athletic Federation, *Senior Coach – Coaching Theory Manual*, 3rd Ed. Reedprint Ltd, Windsor (UK), 1992, p. H1.

3 W.J. Tharion, H.R. Lieberman, S.J. Montain, A.J. Young, C.J. Baker-Fulco, J.P. DeLany and R.W. Hoyt, *Energy requirements of military personnel*, Appetite, 2005, 44: 47-65.

4 *Nutrition* is defined as "The sum of all the processes by which the substances necessary for the balance of the vital processes are driven from the outside to the living organism", according to Weineck J., Biologie du sport, M.T.S., Cports Research Center, Bucharest, 1995, p. 250; "The sum of the physiological processes by which organisms acquire the necessary nutrition to grow and to develop, to obtain energy for vital processes, for tissues regeneration etc.; p. ext. feeding, feeding; food. – From fr. nutrition, lat. nutritio", according to The Explanatory Dicționary of the Romanian Language (II[nd] Edition), Univers Enciclopedic Gold Publishing House, Romanian Academy – "Iorgu Iordan" Linguistic Institute, 2009.

5 E. Ionică, M. Costache, *Biochimie generală, vol. III - Vitamine și elemente minerale*, Ars Docendi Publishing House, Bucharest, 2013, p. 277.

6 It is well known that physical activity can have the effect of strengthening the bones, while being a solution to combat the lack of calcium intake in the body. In women, physical activity of high intensity can cause amenorrhea (lack of menstruation), resulting in bone substance loss.

7 G.F. Băițan, *Pregătirea fizică a militarilor din armata României în contextul integrării în NATO*, "Carol I" National Defense University Publishing House, Bucharest, 2018, p. 143.

8 I.C. Voiculescu, I.C. Petricu, *Anatomia şi fiziologia omului*, Medical Publishing House, Bucharest, p. 232.

9 Institute of Medicine of the National Academies, *Mineral Requirements for Military Personnel, Levels Needed for Cognitive and Physical Performance During Garrison Training,* The National Academies Press Washington DC, 2006, p. 85.

10 C. Popovici, S. Tache, „Cuprul și performanța fizică", *Palestrica Mileniului III – Civilizație și Sport*, Volumul IX, No. 3(33), Cluj-Napoca, 2008, pp. 205 - 209.

11 E. Ionică, M. Costache, *Biochimie generală*, vol. III – *Vitamine și elemente minerale*, Ars Docendi Publishing House, Bucharest, 2013, p. 338.

12 Institute of Medicine of the National Academies, *Mineral Requirements for Military Personnel, Levels Needed for Cognitive and Physical Performance During Garrison Training,* The National Academies Press Washington DC, 2006, p. 104.

13 *TETANÍE* s. f. *Syndrome characterized by muscle contraction and limb bruising as a result of illness or exceptional physical condition* – Din fr. *tetanie*, conform Dicționarului explicativ al limbii române (ediția a II-a revăzută și adăugită), Univers Enciclopedic Gold Publishing House, Academia Română – Institutul de Lingvistică „IorguIordan", 2009.

14 *ATAXÍE* s. f. (Med.) Tulburare a coordonării mișcărilor voluntare din cauza lezării unor căi nervoase și centrii nervoși. – Din fr. *ataxie*, conform The Explanatory Dicționary of the Romanian Language (II[nd] Edition), Univers Enciclopedic Gold Publishing House, Romanian Academy – "Iorgu Iordan" Linguistic Institute, 2009.

15 E. Ionică, M. Costache, *Biochimie generala, vol. III – Vitamine și elemente minerale*, Ars Docendi Publishing House, Bucharest, 2013, p. 295.

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