REVIEW ARTICLE

CONTENTS

Current issues in neuropsychonutrition in the professional training of medical students

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ABSTRACT

Aim: To analyze the impact of nutrients and food components on a person's psychological state and to justify the need to study nutrition among general medical students and future medical psychologists.

Materials and Methods: Collection, critical, constructive analysis of scientific literature. Analysis of psychosomatic and somatopsychological disorders associated with nutrition.

Conclusions: Nutrition is the cornerstone of health, harmonious physical and mental development of the individual. Therefore, doctors, including medical psychologistsmust must know the composition and the main therapeutic, dietary, and parapharmacological properties of food products and spices, and their impact on somatic health and the psychological status of patients. This knowledge is a prerequisite for a high professional level and the possibilities of alimentary prevention and parapharmacological, non-medication correction. The study of nutrition deepens knowledge of the basics of rational nutrition for a healthy person, lays the foundations of propaedeutics of dietetics and psychonutritionology, and takes into account modern scientific developments and achievements of medical science.

KEY WORDS: food components, brain, central nervous system, memory, attention, intellect

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INTRODUCTION

The rapid pace of modern life, social problems and upheavals, the expansion and complication of spheres of activity, the implementation of intensive, technologies in production and educational processes, and the increased demands on the level of general and specialized professional training require enhanced concentration, memory, mental work capacity, intellectual level, and stress resistance. At the same time, military actions, adverse political, socio-economic conditions, environmental factors, uncontrolled flow of diverse information negatively affect general and mental health, reduce the adaptive capabilities of the body, impair mental work capacity and the intellectual level of the population. Therefore, diagnosis (and, if necessary, timely correction) of the psychosomatic status of the organism is an important component of human health.

The world-famous psychologist and developer of the modern scientific and practical doctrine of intelligence, R. J. Eysenck, rightly believed that it was impossible to study and apply all the factors that can influence intelligence within the framework of psychology. He argued that attempts to influence intelligence exclusively through social, educational conditions, and the environment are ineffective, and the only possible way to overcome such stagnation is to improve and purposefully correct nutrition [1-3].

Nutrition is a factor of daily influence on the organism, which can be used not only to satisfy physiological needs for nutrients, energy, and maintenance of life processes, but also for the purpose of targeted correction of metabolic processes. Scientific research scientists has proven the role of certain nutrients and non-nutritive substances in food products in the functioning of the nervous system and the course of neuropsychiatric reactions [4, 5]. This justifies the establishment of a separate direction in the science of nutrition – neuropsychonutritionology, which defines the mechanisms of influence of nutrients, non-nutritive, and parapharmacological substances of food products, spices, aromatic plants, and phytodietary compositions on the psycho-emotional sphere, memory, intellect, mental work capacity, and adaptive capabilities of the organism [4, 6].

Therefore, the subject of study in neuropsychonutritionology should be considered as the integral assessment of the directed action of food components

(macro-, micronutrients, and non-nutritive regulatory substances) on the processes of higher nervous activity, the speed of mental reactions, operational and abstract thinking, and ultimately, on the level of intellect [5, 7-10]. The importance of doctors of various specialties mastering the basic principles of nutrition science is based on the role of nutrition in the physical and psychological development and health.

Modern medical education in Ukraine, as well as in leading universities in Europe and America, pays significant attention to the study of nutrition at various stages of specialist training, which allows expanding the professional possibilities of future doctors.

Understanding the mechanisms of the impact of natural food products on the body (healthy and ill individuals), which possess nutritive, parapharmacological and therapeutic properties, allows their use in comprehensive medication-diet therapy (for the treatment of acute diseases – with the aim of enhancing treatment effectiveness; in rehabilitation, preventive, and health programs – with the aim of activating reparative processes, preventing complications, and enhancing the body's resistance to the influence of any negative factors). In these conditions, nutrition is practically the only appropriate and safe means as well as a justified alternative to allopathic methods [11-15].

AIM

To analyze the impact of nutrients and food components on a person's psychological state and to justify the need to study nutrition among general medical students and future medical psychologists.

MATERIALS AND METHODS

Collection, critical, constructive analysis of scientific literature. Analysis of psychosomatic and somatopsychological disorders associated with nutrition. The research involved more than 120 sources of literature in English and Ukrainian; various electronic databases were used, in particular https://pubmed.ncbi.nlm.nih.gov/, https://www.sciencedirect.com/, https://www.scopus.com/home.uri, https://scholar.google.com.ua/, http://ir.librarynmu.com/.

REVIEW AND DISCUSSION

Numerous studies have proven the role of certain nutrients in brain function processes. Proteins are sources of essential amino acids, which participate in anabolic and regulatory processes in brain tissues. For example: L-glutamic acid and glycine are inhibitory neurotransmitters (they activate the processes of protective inhibition in the central nervous system (CNS), reduce psycho-emotional strain, normalize falling asleep and sleep); Glutamine is a precursor of glutamic acid (increases the level of gamma-aminobutyric acid (GABA), necessary for normal brain function and mental activity, is part of glutathione, stimulates protein metabolism and oxidative-reductive processes in the brain, participates in the transport of potassium ions and amino groups in neurons and in binding ammonia, which leads to improved mental endurance, memory, and intellect); Tyrosine is a precursor of neurotransmitters – dopamine, adrenaline, and noradrenaline (participates in the synthesis of thyroid hormones, stimulates the synthesis of melatonin, acts as a natural antidepressant and a mild psychostimulant); Threonine regulates the transmission of nerve impulses; Tryptophan is a precursor to the neurotransmitter serotonin (helps ensure emotional stability); Phenylalanine regulates the function of the thyroid gland, participates in the synthesis of adrenaline and noradrenaline, and acts as a natural antidepressant; L-tryptophan alleviates anxiety, insomnia, attention disorders, hyperactivity; Choline is a substrate for the synthesis of acetylcholine; Cysteine is part of glutathione (necessary to assimilate selenium and maintain oxidative-reductive homeostasis in the brain) [9, 16].

Traditional, complete sources of essential amino acids are only animal-derived proteins (meat of animals and poultry, fish and marine organisms, milk and dairy products, eggs). The widespread belief among vegetarians, particularly in its strictest form—veganism—that plant products (legumes, nuts, mushrooms, etc.) can fully satisfy the need for proteins and essential amino acids, is mistaken. Scientifically, it has been proven that the bioavailability of plant proteins is lower, and the amount of essential amino acids is significantly less, which is reflected in the reduced biological value of these proteins (amino acid score below 0.55, protein efficiency ratio (PER) below 1.0, net protein utilization (NPU) below 0.5 [17]. In particular, a comparative analysis of the biological value indicators of milk protein casein and soy proteins shows that the anabolic efficiency of milk protein is five times higher than soy proteins [18]. Thus, the principled stance of physicians and psychologists regarding-the spread of vegetarianism and, in particular, the forced vegetarian diet in children is absolutely objective. An official decision on this matter was made at a regular meeting of the WHO Expert Committee back in 2012. In this decision, vegetarianism and raw foodism were officially classified under group F 63.8 – mental disorders of habits and impulses that require treatment [19].

Fats are an important component of nutrition, directly involved in the formation of nervous tissues, the course of a number of physiological processes, including peroxidation, and the regulation of brain functions. Specifically, phospholipids form the sphingomyelin sheaths of brain neurons. A proven correlation exists between mental health, memory, learning abilities, level of intellect, and the content of phospholipids (lecithin) in the diet. A deficiency in lecithin slows cognitive processes regardless of age. Clinical signs of phospholipid deficiency in children are quite numerous and varied. In children of early years, a deficiency of phospholipids can lead to intracranial hypertension, and delays in psychomotor and speech development are noted. Classic manifestations of phospholipid deficiency in children include behavioral disorders (psycho-emotional imbalance, irritability, tearfulness), cognitive functions (reduced ability to concentrate, memory impairment, slowed thinking processes), decreased motor activity, and increased brain fatigue [9, 17, 18].

Classic sources of phospholipids (lecithin) are sunflower seeds, legumes (beans, peas, soybeans, chickpeas, lentils), nuts, egg yolks, and unrefined sunflower and soy oils. In its refined form, lecithin is obtained from sunflower meal (the solid residue of oilseed after oil extraction) and soy, and is available in the form of dietary supplements, including lecithin itself or as a separate supplement "Lecithin", which is widely used in the therapy of atherosclerosis and brain function disorders.

Important psychonutrientological effects of polyunsaturated fatty acids (PUFAs) Omega-3 have been established. They are serve as the biological substrate for the synthesis of prostacyclins, which provide help prevent atherosclerosis and thrombosis in brain vessels. Docosahexaenoic (DHA) and eicosapentaenoic (EPA) acids, through the prostacyclin system, participate in antioxidant and anti-inflammatory mechanisms, and affect the development of intellect and cognitive activity in childhood. A deficiency of Omega-3 PUFAs in brain tissues leads to neurocognitive dysfunctions – Attention Deficit Hyperactivity Disorder (ADHD). Furthermore, a decrease in the levels of DHA and EPA can lead to manifestations of aggression, anxiety, depression, and dementia [18, 20].

The role of DHA in the therapy and prevention of dementia, age-related cognitive decline, depression, stroke, vision disorders, and neurological pathology in children has been determined. The use of Omega-3 PUFAs is especially important in the treatment of Attention Deficit Hyperactivity Disorder (ADHD) in children [19-21].

The most important natural sources of Omega-3 PUFAs are the fat of marine fish and nuts, among which walnuts ranking highest in this indicator, flaxseed, and flaxseed oil. Leading companies worldwide have begun production of dietary supplements containing Omega-3 PUFAs with standardized content of DHA and EPA, which are widely used in geriatrics, cardiology, and neurology.

An important consideration that must be taken into account when comprehensively assessing the balance of diets for ensuring higher nervous activity, including the speed of mental processes, processing and assimilation of information, and the overall level of intellect, is the adequate energy provision for brain functioning. It is known that mental processes are energy-intensive and require the energy of macroergic compounds, evidenced by an increase in glucose consumption from 12 to 59% when the activity of the cerebral cortex increases. Thus, the main nutrition of the brain is provided through the aerobic oxidation of glucose**.** It is known that glucose is the only carbohydrate that circulates in the bloodstream in its free form and passes freely through the blood-brain barrier. At the same time, the role of protein in these conditions is important and even somewhat limiting, as it involves the functioning of mechanisms that ensure the delivery of glucose from the blood to the brain. In stressful situations or diseases (diabetes, hyperthyroidism, and others), the support of brain energy resources in the event of glucose insufficiency may involve the oxidation of ketone bodies and free fatty acids, but not more than 20% and only for a very short period [9, 18, 21].

Vitamins play an important role in normalizing the psychosomatic status: B vitamins help the nervous system function normally, increase resistance to stress, depression, and fatigue; they participate in energy provision processes and ~~in~~ the metabolism of fats, proteins, and carbohydrates; they normalize the function of the cardiovascular system, liver, stomach, and intestines, thereby preventing somatopsychic disorders. Specifically, thiamine known as the "vitamin of optimism," is involved in the processes of nerve impulse transmission, affects memory and cognitive abilities; riboflavin is linked to brain energy provision, participates in the synthesis of corticosteroids, glycogen, and the restoration of glutathione; niacin regulates the synthesis of serotonin, enhances inhibitory processes, helps saturate brain cells with oxygen, and normalizes sleep; pantothenic acid and pyridoxine are involved in the synthesis of neurotransmitters and neuroleptics, protecting the brain from toxins; folic acid is necessary for the synthesis of serotonin and norepinephrine; cyanocobalamin participates in the formation of the myelin sheath of nerves and in the processes of nerve conductivity, supports cognitive functions of the brain,

and regulates its diurnal activity. Biotin provides nerve cells with energy, participates in the synthesis of glucokinase – an enzyme that "initiates" the metabolism of glucose in nerve cells, improves the functioning of the nervous system, reduces symptoms of neuropathy. Vitamin C protects against distress, mental and physical overload, is stored in the adrenal glands and its reserves are depleted during stress, thus the need increases. Tocopherol provides antioxidant protection, regulates tissue oxygen saturation, protects the adrenal glands, normalizes liver function, and participates in the synthesis of phosphatidylcholine, which plays a crucial role in the functioning of the brain and the entire nervous system. It's important to know the natural sources of vitamins, the possibilities for their most effective use and preservation, factors that affect vitamin absorption, enhance or inhibit it, as well as conditions and diseases that require an increased intake of vitamins in the body.

In the mechanisms of neuroregulation and neuroprotection, mineral substances have a specific role. In particular, calcium balances the processes of excitation and inhibition in the cerebral cortex and participates in nerve impulse transmission; magnesium enhances inhibitory processes in the cerebral cortex, and provides calming, antispasmodic, vasodilatory, and diuretic effects; potassium regulates heart rhythm, water balance, and facilitates the penetration of nutrients through cell membranes; selenium provides powerful antioxidant protection, enhances the antioxidant efficiency of tocopherol; iodine is essential for the development and function of the brain and nervous system, supports mental work capacity and memory, the development of intellectual capabilities, and also for the synthesis of thyroid hormones. The problem of providing iodine is extremely important for Ukraine since, according to the WHO classification, Ukraine is a region endemic for iodine content [9, 21, 22].

It is important to know not only the main natural sources of minerals but also the factors that affect their absorption, the synergism and antagonism of individual mineral substances, thus, the appropriate combination of specific food products in dishes and meals that will provide maximum nutritional efficiency in meeting the body's needs [8, 9, 18, 23].

Among the non-nutritive substances in food, aromatic substances, which are components of products and spices, deserve special attention. They have a multifaceted impact on the CNS, brain functions, and indirectly, through neurohumoral regulation, on the functions of other organs and systems of the body. Extensive experience in using essential oils shows that each essential oil is multifunctional because it contains many components; however, all essential oils, without exception, have a beneficial effect on the nervous system; they are categorized into stimulants, adaptogens, and relaxants; all essential oils affect the emotional sphere and mental health; 65% of essential oils have analgesic properties; about 50% normalize the functions and condition of the circulatory system; nearly 40% of oils affect the digestive system, restore the functional state of the body's excretory systems, enhance the efficiency of detoxification mechanisms; 30% of essential oils activate immune defense systems; 20% optimize the function of endocrine glands, normalize hormonal levels; importantly, about 20% of essential oils have significant antiparasitic properties [24].

The need for a differentiated approach to the selection and recommendation of products belonging to the same group, taking into account their psychonutritional characteristics, is noteworthy. For example, consider citrus fruits—lemon, orange, grapefruit, mandarin—which have different, sometimes opposite, effects on the nervous system and emotional state. Essential oils from lemon have a distinctly toning effect, stimulate mental work capacity, increase attention concentration, improve memory, emotional state, and mood, help overcome stressful situations, and prevent distress. Essential oils from grapefruit have an antidepressant and toning effect, and suppress the feeling of hunger. Essential oils from orange have bimodal effectiveness and exert a harmonizing effect on the state and functions of the nervous system: on one hand, they tone the nervous system, reduce symptoms of depression and severe fatigue, and on the other hand, they have a calming effect, effective in heightened anxiety and phobias, as well as insomnia. Essential oils from mandarin are a natural calming agent, reduce nervous tension, anxiety, irritability, and aggression [17,18, 24].

Traditional medicine doesn't sufficiently utilize the centuries-old experience of various peoples in using spices for therapeutic and health-improving purposes. Specifically, the use of spices and aromatic vegetables in phytoalimentary correction of disorders of the nervous system and individual psychosomatic status is important. It is known that spices such as cloves, cinnamon, ginger, and rose stimulate the nervous system: cloves help quickly restore energy after nervous tension and stressful situations, prevent distress, and improve mental performance and memory; cinnamon is an effective antidepressant, improves mental performance and mood; ginger increases work capacity, reduces fatigue, weakness, apathy, and enhances communicative abilities; rose has toning properties, reduces fatigue, improves mental performance, and concurrently aids in restoring psychological balance and reducing anxiety and restlessness. A large group of spices – cardamom,

cinnamon, marjoram, mint, lemon balm, poppy, fennel, chicory, tarragon, turmeric – are considered calming: cardamom restores balance, peace, and clarity of thought; poppy reduces fatigue and improves sleep; mint, chicory, tarragon, turmeric restore psychological balance and improve sleep; fennel decreases nervousness, irritability, and fear. Spices that enhance mental performance and memory include ginger, cumin, and black pepper. The effects are achieved not only by the direct impact of spices on the nervous system but also thanks to their spasmolytic (cloves, cinnamon, basil, marjoram, thyme, cumin), detoxifying (basil, cinnamon, ginger, black pepper, turmeric, cloves, horseradish, chicory), analgesic (cloves, chili pepper, marjoram, lemon balm, mint, parsley, rosemary) properties, and the ability to improve microcirculation in tissues, including the brain (garlic, onion, cardamom, chicory, basil, rosemary, parsley, orange) and other regulatory properties.

Separate studies have confirmed the connection between the main determinants of the development of diseases of internal organs, in particular the intestine, and human psychological functions. A number of scientists have clearly defined the role of the intestine and its microbiocenosis in the formation of secondary and tertiary nutrient flows and the synthesis of regulatory substances, their role and place in the vital activity of the organism. There is a concept that disturbances in the psychological status of patients with the development of intestinal dysbiosis may be associated with the influence of neurotransmitters of bacterial origin. It has been proven that GABA and glutamate are produced by facultative and obligate anaerobic bacteria. Anomalies in the GABA-benzodiazepine receptor complex, which is part of the main inhibitory neurotransmitter system of the brain, play an important role in the occurrence of anxiety-phobic disorders. A decrease in GABA leads to the development of irritable bowel syndrome (IBS). For instance, patients suffering from IBS with diarrhea syndrome and a reduced number of bifidobacteria have registered an increased level of personal and situational anxiety, an increase in the overall level of neuroticism, anxiety-phobic, psychosomatic disorders, emotional tension, and sleep disturbances. In patients with IBS and an increased content of conditional-pathogenic flora and Staphylococcus aureus, the psychological status was characterized by an increase in the severity of anxiety-phobic disorders, personal and situational anxiety. The level of depressive disorders had a direct correlation with the increase in the number of conditional-pathogenic microflora, Staphylococcus aureus, and an inverse correlation with the content of enterococci in the colon. A negative correlation was established between the number of lactose-positive Escherichia coli and the degree of severity of anxiety-phobic, depressive disorders, overall level of neuroticism, and situational anxiety, while an increase in lactose-negative Escherichia coli was associated with the presence of depression and psychosomatic disorders. The severity of psychoemotional and psychosomatic disorders correlated with a decrease in the number of obligate flora (bifidobacteria, lactobacilli etc.). All this opens fundamentally new possibilities for the therapy of disturbances in the psychological status of patients and the correction of behavioral disorders with products and mixtures having probiotic efficacy [25, 26]. Within this problem the influence of optimizing dietary regimes, particularly functional foods containing pro-, pre-, sym-, and synbiotics on intellect, is substantiated. In turn, it is important that psychoemotional stress causes changes in the gut microbiocenosis, affecting both the obligate and facultative microflora. Thus, the complex of nutritive and non-nutritive substances contained in traditional food products, spices, and dietary supplements to food regimes represents a poly-pathogenetic complex influencing the functional state of the brain, processes of higher nervous activity, intellectual capabilities, and the psychological status of the individual and is an effective means of enhancing the professional level and expanding the professional capabilities of doctors, including psychologists. This justifies the necessity of in-depth study of these factors in the medical training training of doctors.

In the disciplines taught at the Department of the Food Hygiene and Nutrition Science of the National Medical University named after O.O. Bogomolets, "Fundamentals of Healthy Eating", "Nutritionology", and in separate sections of the discipline "Hygiene and Ecology", there is a study and deepening of knowledge students on the basics of rational nutrition of a healthy person, laying the foundation for the propaedeutics of dietology and psychonutritionology. Specific topics and sections include studying human nutritional status and its connection with psychological state, determining individual needs for specific nutrients; a detailed study of nutrient sources and justification for including certain food products in appropriate combinations in diets, taking into account individual nutritional and psychological status. Nutritionology classes involve discussions of approaches to various theories and approaches to nutrition for the purpose of their critical analysis; analyzes the diet of specific population groups, deepens and complements the nutritional and dietetic characteristics of traditional and non-traditional food products, their parapharmacological properties, the appropriateness of their use in rational, therapeutic, and prophylactic nutrition, including the possibility of

alimentary correction of somatic and psychosomatic disorders, which is subsequently used in the diet therapy of various diseases, thus anticipating the integration of teaching with clinical disciplines.

CONCLUSIONS

Studying the discipline of "Nutritionology" with elements of psychonutrition opens up wide opportunities for the formation of preventive thinking in future doctors, including psychologists, acquiring specialized professional skills for identifying the causes of development and signs of multinutrient deficiencies, preventing alimentary and alimentary-induced diseases, nutrient-induced disorders of physical and psychological status, and the possibility of prescribing adequate nutrition, which is an effective factor in the comprehensive system of primary and secondary prevention of diseases and their complications.

Knowledge of psycho-nutrition is a powerful base for doctors in the analysis of psychosomatic and somato-psychological disorders related to nutrition.

The "Nutritionology" course takes into account modern scientific prospective developments and achievements of medical science, priority directions, on the basis of which the international "Health of the Nation" program is formed, in which the main problems of alimentary diseases and ways to overcome them in the world and in Ukraine are formulated.

The course also considers the recommendations of European and international dietetics and nutrition societies (Deutsche Gesellschaft für Ernährung – DGE, Scientific Committee on Food – SCF), which is of particular importance in connection with Ukraine's integration into the European Union, teaching this course to students from other countries who are obtaining higher medical education in Ukraine, as well as for professionals planning further study and professional development abroad.

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CONFLICT OF INTEREST
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