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International Journal of Family & Community Medicine

Review Article

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The impact of nutrition on people's cognitive development

Summary

Background: Adequate nutrition of the brain maintains the structural and functional integrity of the brain and nervous tissue, which improves cognitive ability, improving the relationships we have every day and, above all, preventing cognitive deterioration associated with aging.

Keywords: aging, cognitive ability, relationships, eating habits, good diet

Volume 8 Issue 4 - 2024

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Received: June 25, 2024 | **Published:** July 10, 2024

Abbreviations: LC-PUFAs, long-chain polyunsaturated fatty acids; AD, Alzheimer's disease; DHA, docosahexaenoic acid; SFA, saturated fatty acids; ADHD, attention deficit hyperactivity disorder; NTD, neural tube defects; L, Lutein; Z, zeaxanthin

Introduction

Nutrition plays a pivotal role in shaping cognitive development across the lifespan. From infancy to old age, the nutrients we consume directly influence brain function, affecting learning, memory, and overall cognitive abilities. This essay explores how various aspects of nutrition impact cognitive development and the implications for individual health and society at large.

The importance of adequate nutrition and having bad eating habits has consequences for cognitive development such as poor school performance, decreased attention, difficulties communicating with others, having some type of reasoning and adapting to new environments and people. Furthermore, a good diet will always be a great line of defense against many diseases that can leave consequences and mark your physical development in adulthood. The present systematic review is to reveal the influence of eating habits on cognitive development. In which food is one of the pillars for physical, mental growth and cognitive development. Nutritional requirements for human beings vary considerably depending on aspects such as age, weight, height, physical activity, genetic and metabolic conditions, among others (Dakduk, 2011).

On the other hand, the way cognitive development focuses on thought processes and the behavior that reflects these processes is the basis of one of the five perspectives of human development that are mostly accepted. The cognitive process is the relationship that exists between the subject who knows and the object that will be known and that generally begins when he manages to make an internal representation of the phenomenon that has become an object of knowledge, which is why good nutrition is essential for the correct development of children and instilling good nutrition habits. adequate since this helps prevent diseases such as obesity or diabetes. The symptoms that can be generated by a diet are low in cognitive development with cardiovascular problems, psychological, motor, socialization and cognitive alterations. These symptoms can generate energy depletion and sometimes make you unable to perform other activities.

Justification

Eating habits are the set of customs that determine man's behavior in relation to food and eating. It includes everything from the way food is selected to the way it is consumed or presented to the people whose food is in their hands. Eating habits are the product of the interaction between culture and the environment.

Development

During early childhood, nutrition is critical for brain growth and development. Essential nutrients such as protein, vitamins (especially B vitamins), minerals (like iron and zinc), and omega-3 fatty acids are fundamental for neuronal development, myelination, and neurotransmitter synthesis. Adequate nutrition supports the formation of neural connections and enhances cognitive functions such as attention, memory, and problem-solving skills.

Studies have shown that malnutrition, particularly protein-energy malnutrition, can lead to irreversible cognitive impairments. Children deprived of essential nutrients may experience stunted growth, developmental delays, and diminished intellectual capacity. For example, chronic iron deficiency in infancy has been linked to poorer cognitive outcomes, including impaired learning and reduced academic performance later in life.

Nutrition continues to influence cognitive function during adolescence and adulthood. The brain remains plastic throughout life, continually adapting to environmental stimuli and nutritional inputs. Diets rich in antioxidants, such as vitamins C and E, and phytochemicals from fruits and vegetables, have been associated with better cognitive performance and a reduced risk of cognitive decline in older adults.

Conversely, diets high in saturated fats and refined sugars have been linked to cognitive deficits and an increased risk of neurodegenerative diseases such as Alzheimer's disease. These dietary patterns can induce oxidative stress, inflammation, and insulin resistance, which are detrimental to neuronal health and cognitive function.

Interventions and public health implications

Understanding the impact of nutrition on cognitive development has profound implications for public health policies and interventions. Promoting access to nutritious foods, especially among vulnerable

populations, is crucial for fostering optimal cognitive development from early childhood through adulthood. Programs that provide fortified foods, nutritional supplements, and nutrition education can mitigate the adverse effects of malnutrition and support cognitive resilience.

Furthermore, integrating nutrition education into school curricula and healthcare settings can empower individuals and communities to make informed dietary choices that enhance cognitive function and overall well-being. Early identification and intervention for nutritional deficiencies can prevent long-term cognitive impairments and promote equitable access to cognitive development opportunities.

The first years of life are decisive for a person's future, it is a stage in which the brain reaches 90% of adult size development and favors the development of psychomotor skills and learning about the environment and the experiences acquired. For the development of these processes, nutritional status is considered a pillar. Fundamental for guaranteed development potential and quality of life. A deficiency or excess of micronutrients or vitamins such as fatty acid, folic acid, zinc, iron and iodine that, together with health problems, socioeconomic, environmental, biological and family factors, can affect the normal functioning of motor and cognitive development. Food throughout history has been the main source of obtaining nutrients. We can define food as the process by which living beings consume different types of food to have proper functioning in the human body as it is one of the main activities and most essential processes to maintain homeostasis. Since the ingested foods are transformed and assimilated, that is, they will be incorporated into the metabolism thanks to metabolic and enzymatic processes, to degrade them and convert them into smaller molecules which we call nutrients. An adequate diet, which provides the body with the nutrients it needs, combined with regular physical activity, is key to enjoying good health. On the contrary, a poor diet can have very negative effects, reducing the capacity of the immune system and subtracting physical and mental energy to carry out basic activities normally (Moreno,2020). Let's talk a little more about the cognitive part where the brain needs a continuous supply of nutrients for its correct formation, development, and functioning. All nutrients are necessary, although some have a greater implication in cognition and mental health. Numerous studies have shown that many aspects of cognition (memory, reasoning, attention, IQ) and cognitive impairment (dementia, depression, Alzheimer's disease, Parkinson's) are affected by the consumption of inadequate diets.

Malnutrition is characterized by an imbalance between a person´s nutrient requirements and their nutrition consumption and includes conditions of overnutrition and undernutrition. Undernutrition is cause by an inadequate intake of energy, protein, or vitamins and minerals and is a present- day global problem.

The human brain requires all essential nutrients, including protein, fats, carbohydrates, vitamins, minerals and water, to form and maintain its structure, Therefore, adequate nutrition is essential for brain development and function.

Micronutrients, such as iron, zinc, choline, iodine, folate, B12, and long-chain polyunsaturated fatty acids (LC-PUFAs) have been identified to be particularly relevant to cognitive development.

Iron is essential for the development of neurological pathways in the brain that influence brain function. During the first two years of life, children experience rapid growth, which increases their iron requirement and places them at a higher risk for iron deficiency anemia. And this can impact overall intelligence and cognitive development.

Zinc is an essential trace mineral present in the brain that contributes to cerebral structure and function, Zinc deficiency during infancy is associated with motor development delays and detrimental effects on attention and short-term memory.

The impact of nutrition on cognitive development in Alzheimer's disease

Alzheimer's disease (AD) is a progressive neurodegenerative disorder characterized by cognitive decline, memory loss, and changes in behavior. While the exact causes of AD are multifaceted and not fully understood, research increasingly points to the role of nutrition in influencing the development and progression of this debilitating condition. This essay explores the relationship between nutrition and cognitive development in Alzheimer's disease, highlighting the potential impact of dietary factors on both prevention and management.

Nutritional factors in Alzheimer's disease

Mounting evidence suggests that certain nutrients play critical roles in brain health and may influence the onset and progression of Alzheimer's disease. For example, antioxidants such as vitamins C and E, along with phytochemicals found in fruits and vegetables, help combat oxidative stress and inflammation in the brain, which are implicated in the pathology of AD. Omega-3 fatty acids, particularly docosahexaenoic acid (DHA), are essential for neuronal membrane integrity and synaptic function, potentially reducing the risk of cognitive decline.

Conversely, diets high in saturated fats, trans fats, and refined sugars have been associated with increased inflammation, insulin resistance, and oxidative damage, all of which are detrimental to cognitive function and may accelerate neurodegeneration in individuals predisposed to AD.

Impact of nutrition on cognitive resilience

Optimal nutrition is crucial for maintaining cognitive resilience in individuals at risk for or living with Alzheimer's disease. A balanced diet rich in antioxidants, omega-3 fatty acids, and nutrients that support brain health, such as vitamin B12 and folate, may help protect against cognitive decline and delay the onset of symptoms. For instance, the Mediterranean diet, characterized by high consumption of fruits, vegetables, whole grains, nuts, and olive oil, has been consistently associated with a lower risk of AD and improved cognitive function in older adults.

Challenges and opportunities in nutritional interventions

Despite growing evidence supporting the role of nutrition in Alzheimer's disease, implementing effective dietary interventions poses challenges. Individual dietary preferences, accessibility to nutrient-rich foods, and cultural factors can influence dietary habits and nutrient intake. Moreover, the progression of Alzheimer's disease often complicates dietary management, as individuals may experience appetite changes, swallowing difficulties, and challenges in meal preparation.

However, ongoing research highlights promising avenues for nutritional interventions in AD management. For example, personalized nutrition approaches tailored to individual genetic profiles and disease progression stages may optimize therapeutic outcomes. Additionally, nutritional supplements targeting specific nutrient deficiencies or neuroprotective compounds continue to be

investigated for their potential to support cognitive function and quality of life in AD patients.

Nutrients and cognition

Carbohydrates

Importance of the glycemic index the human brain, due to its high metabolic activity, needs a continuous supply of glucose to maintain cognitive abilities. Glucose is the main energy substrate of neuronal tissue, the hippocampus (a key area of learning and memory), is especially vulnerable to interruptions in its supply. Low glycemic index foods reduce insulin resistance and may improve cognitive ability (attention, memory, mathematical ability) compared to high glycemic index foods. High consumption of simple sugars has been associated with difficulty concentrating and paying attention.

Proteins

The quantity and quality of the proteins we eat in our diet can modulate the synthesis of neurotransmitters. Since various studies show a positive association between the intake of certain amino acids and cognitive ability. The neurotransmitters serotonin and dopamine/adrenaline are synthesized from the amino acids tryptophan and tyrosine, respectively. Serotonin is involved in many physiological processes including cognitive function. Low levels of serotonin are associated with decreased learning, reasoning and memory. The conversion of tryptophan to serotonin depends on its plasma concentrations. Tryptophan is found in many foods (meat, dairy products, nuts), its supplementation improves attention, visual memory and learning.

Lipids

Unsaturated fatty acids have a beneficial role in cardiovascular disease, diabetes, cancer, depression and. cognitive function. However, high consumption of saturated fatty acids (SFA) is associated with cognitive impairment. Docosahexaenoic acid (DHA) is the main component of membrane phospholipids, especially in the cerebral cortex, and helps greatly in the intervention of visual and auditory function. Its deficiency has been related to a decrease in visual acuity, memory, cognitive performance and attention deficit hyperactivity disorder (ADHD), in addition to having an important role in preventing or delaying the progression of diseases. psychiatric and neurodegenerative (dementia, depression, bipolar disorder and Alzheimer's disease) DHA supplementation during pregnancy, lactation or in the first years of life appears to improve mental performance and psychomotor development in children.

Micronutrients: beneficial effects vitamins

Vitamin A that has an important role for vision, skin, bones and reproduction you can be found in carrots, sweet potatoes and spinach. Vitamin C a very important antioxidant that helps improve immune system and you can be found in oranges, strawberries and peppers. Vitamin E a strong antioxidant that helps stabilize cell membranes and can be found in almonds, spinach and sweet potatoes. Vitamin K important for blood clothing and bone health found in kale, spinach and broccoli.

Vitamins B1, B6, B12, B9 (folic acid) are essential for proper brain function. Vitamin B1 intervenes in the metabolism of carbohydrates, ensuring energy production. This vitamin modulates cognitive performance, especially in the elderly since a high intake of Thiamine helps a lot with cognitive improvement. Vitamin B9 is essential for proper brain development and function during the perinatal period. Its deficiency in pregnancy is related to neural tube defects (NTD) and low birth weight. Various authors show a positive association between the maternal status of this vitamin and the cognitive development of the offspring. Vitamins B6 and B12 are directly involved in the synthesis of neurotransmitters. Vitamin B12 delays the appearance of signs of dementia, and its supplementation improves brain and cognitive functions. Vitamin D not only helps treat different chronic diseases but also prevents cognitive deterioration and dementia, as well as choline, which is a precursor of the neurotransmitter acetylcholine and membrane phospholipids that influences sleep, memory and learning. Adequate maternal intake is associated with improved memory in offspring during childhood and a lower risk of NTD.

Minerals

Iron is necessary in the myelination process of neurons and in the synthesis of neurotransmitters. Iron deficiency anemia has been related to a decrease in concentration, reasoning, speed of correct answers, performance and ability to perform tasks throughout the day. Iodine is involved in the synthesis of thyroid hormones, necessary for proper brain and mental development.

Antioxidants

Cognitive impairment has been associated with oxidative stress; vitamin C intervenes in the synthesis of neurotransmitters, protecting nervous tissue from oxidative stress. Vitamin E (tocopherols and tocotrienols), only tocopherols are actively taken up by the brain and are involved in the protection of neuronal membranes. Serum tocopherol levels are inversely associated with the risk of cognitive decline. Zinc intervenes in energy metabolism, in antioxidant and immune defenses and in the synthesis of neurotransmitters and plays an important role in brain activities. Its deficiency is related to ADHD in children, memory and learning problems. In adolescents and stress, depression and cognitive impairment in adults and the elderly.

Carotenoids

Lutein (L) and zeaxanthin (Z) are potent antioxidants and anti-inflammatory agents that help protect the nervous system from oxidative and inflammatory stress. The brain and eyes are susceptible to free radical damage, as both have very high concentrations of AGPs and a high metabolic load. Hydration and cognitive capacity Water is an essential nutrient for proper brain function. A decrease in intake is related to states of confusion, irritability, lethargy and loss of cognitive function. Dehydration in the brain impairs nerve transmission and decreases cerebral blood circulation, which can affect mental performance. It has been observed that properly hydrated people have higher scores on intelligence tests. A dehydration.

Melatonin

Known as the sleep hormone because its basic function is to regulate the sleep cycle and heart rate, achieving complete and restorative rest. It performs various very specific biological functions such as re-synchronizing the circadian sleep-wake rhythm, retinal functions, tumor growth and participates in the release of free radicals and regulation of blood pressure. The synthesis and release of melatonin is stimulated by darkness and suppressed by light. Its precursor is the amino acid tryptophan, which is converted into serotonin thanks to the activity mediated by serotonin-acetyltransferase enzymes that convert it. serotonin into melatonin.

Tryptophan

One of the main amino acids that our brain requires is tryptophan because it is a modulator of appetite and satiety. Another of its

functions is that it acts as an intermediary between sleep, pain sensitivity and blood regulation, as well as alterations in our behavior. Therefore, it is one of the most essential amino acids because the body cannot produce it on its own, which is why we must include it in our diet where it is mainly found in foods of animal origin.

Serotonin and brain function

By consuming foods rich in tryptophan in our diet, this amino acid fulfills the function of being the main precursor of serotonin that helps moderate body temperature, regulate motor activity along with perceptual and cognitive functions, control bone density parameters, liver regeneration, regulation of sleep, moods, emotions and depressive states, intervenes in vascular and vascular functioning. heart rate, prevents mental imbalances such as schizophrenia, obsessive compulsive disorder or childhood autism.

Omega 3

It is a set of polyunsaturated fatty acids, and these are essential because the body cannot produce them on its own. Their importance lies because they are going to form. Part of the membranes of the brain cells that are neurons, for this reason it is key to maintain them in our daily diet, mainly found in fish such as pink salmon, trout, tuna, and shellfish, too. In nuts such as walnuts, almonds, and vegetable oils such as soybean or canola oil.

Conclusion

We must raise awareness about the foods we eat and know the nutritional usefulness they provide to our body. The main importance of a good diet is due to cognitive function, because it helps prevent neurodegenerative diseases such as Alzheimer's, and one of the main consequences that have been found in various studies is the lack of contribution of energy substrates to the brain that They compromise neuronal survival and trigger neurotoxicity processes due to the increase in glutamate neurotransmission. As this is one of the main neurotransmitters, its decrease affects cognitive function, in addition to a deficient production of ATP in the cells of the central nervous system, preventing the reuptake of glutamate in the sympathetic terminal of astrocytes, as well as the dynamic process of neuronal cells to transport information to their synaptic button. With the increase in life expectancy, the number of people with cognitive impairment and dementia has increased in recent decades. Therefore, it is important to maintain a balanced diet, from which the brain requires all the essential nutrients that will be necessary for its correct and healthy functioning.[1–12]

Acknowledgments

None.

Conflicts of interest

The author declares there is no conflict of interest.

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