

NUTRITION FOR THE BRAIN

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INTRODUCTION

Nutrients are very important for the normal growth and development of our body. It provides us energy to perform our day to day work and enhances our immunity to fight against various types of infections but besides this nutrient plays a very crucial role in proper functioning of the brain, therefore it affects our mood, behavior, cognitive and intellectual performance. Food has an immediate and lasting effect on our mental health and well-being. Under-nourished children often have deficient or delayed cognitive and motor development.

A good mental health of a person is a state of complete emotional and psychological well-being in which a person is able to cope with everyday's challenges, think clearly, be responsible, have good relationships with others.

Brain, which is one of the largest organs in our body like heart, liver etc. The cerebrum of the brain consists 4 lobes such as frontal lobe, parietal lobe, temporal lobe and occipital lobe. The frontal lobe of the brain controls our behavior, cognitive, intellectual performance, planning and problem solving ability. It controls all our activity in day to day life. Diets affect brain development and performance at all stages of life starting from fetal development and continuing through infancy, childhood, adulthood till old age. There are some important nutrients for brain development and function.. Nutrition plays an important role in normal brain development through affecting the growth and number of neurons, development of synapses, myelination of axons, production of neurotransmitters, etc. For example, in rats low

maternal energy or protein intake has been associated with decrease in brain weight, reduction in number of both neurons and glial cells impairment in dendritic development of the fetus.

A recent study suggests that diet plays an important role in preserving memory and reducing risk of dementia in later life. An US study of 2,258 people found that consuming Mediterranean diet (abundant in fruits, vegetables and cereals, some fish and alcohol, and a little dairy and meat) helps to reduce the risk of Alzheimer's disease by 30 - 40%. So it is clear that food has an immediate and lasting effect on our mental health and well-being. Deficiency of ω -3 fatty acids, tryptophan, some vitamins (B-complex and vitamin E) and some minerals (Se, Mg, Zn) causes depression while deficiency of folic acid, Mg, Zn and vitamin B₆ leads to anxiety, insomnia, lethargy and stress respectively. These symptoms of mental illnesses can be overcome with the help of some appropriate nutrients which includes - PUFAs - Omega 3 fatty acids (found in oily fish and some plants), minerals - Fe (Meat, fish, poultry, green leafy vegetable, eggs and fruits), Zn (whole grains, legumes, meat and milk), I (sea foods, eggs, some vegetables and iodised salt), Mg (green leafy vegetables, nuts, whole grains), vitamins - Folate (green leafy vegetables and fortified cereals), other B vitamins (whole grains, yeast, dairy products), and vitamin E (vegetable oils, nuts, whole grains and wheat germ oil). People consuming diets that are deficient in one or more of these nutrients and/or contain too much saturated fat, sugar seem to be at higher risk of developing the conditions such as attention-deficit hyperactivity disorder (ADHD), a range of depressive conditions,

schizophrenia ,dementia, including Alzheimer's disease.

Nutritional status of the individual affects the cognitive performance and it is known to decline

with the age which can be better understand with this picture :

Figure 1: Cognitive performance decline with the age



The prevalence of mental disorders is more in old age and the one of the possible reasons could be nutrition. Nutrition, now a days, has become the prior area of research in the field of food science and it has drawn the attention of various neurologists, psychologists and nutritional scientists in relation to its role in mental health and brain functioning.

A person's food intake affects mood, behavior and brain function. A hungry person may feel irritable and restless whereas a person who has just eaten a meal may feel calm and satisfied. A tired or sleepy person may feel more productive after a cup of tea and a light snack. A person who has consistently eaten less food or energy than needed over a long period of time may be apathetic and moody. Intake of energy and several different nutrients affect neurotransmitter levels in the brain. Neurotransmitters transmit nerve impulses from one nerve cell to another and they influence mood, sleep patterns and thinking ability. Deficiencies or excesses of certain vitamins or minerals can damage nerves in the brain, causing changes in memory, limiting problem solving ability and impairing brain function.

ENERGY INTAKE AND MENTAL HEALTH

Energy is derived from carbohydrates, proteins, fats in foods & beverages. Brain demands 20-30% of the total body energy. It is even higher for children (up to 60%) because of brain maturation and growth. Changes in energy or nutrient intake can alter both brain chemistry and functioning of nerves. Chronic hunger and energy deprivation profoundly affects mood and responsiveness. Developing fetus and young infants are particularly susceptible to brain damage from malnutrition. The extent of damage depends on the timing of the energy deprivation in relation to stage of development. Malnutrition early in life has been associated with below-normal intelligence, functional and cognitive defects.

CARBOHYDRATES AND MENTAL HEALTH

Carbohydrates significantly affect mood and behavior. Meals which are high in carbohydrates

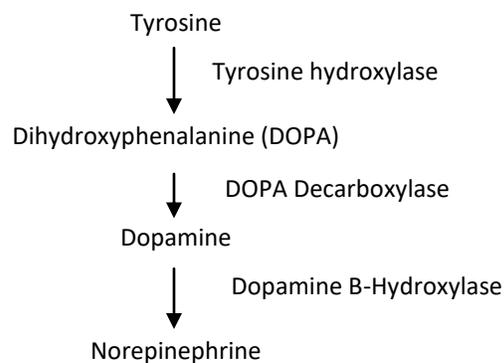
triggers the release of insulin, as insulin levels rise, more tryptophan enters in to the brain, as more tryptophan enters in to the brain more of the neurotransmitters serotonin is produced and high serotonin levels in the brain enhance mood, have sedative effect and promote sleepiness.

In addition to protein and fat, carbohydrate in the gastrointestinal tract triggers the release of Cholesistokinin and this cholesistokinin stimulates vagal fibers and these vagal fibers then transmit messages to the amygdale and hippocampus. The amygdale and hippocampus are the parts of the

brain circulatory system responsible for laying down and recalling memory.

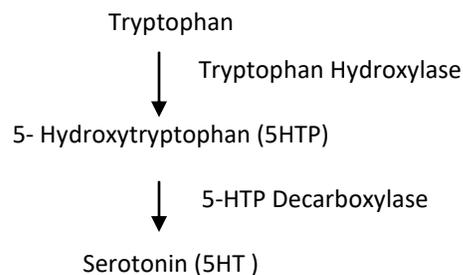
PROTEIN AND MENTAL HEALTH

Intake of protein and individual amino acids can affect brain functioning and mental health. Many of the neurotransmitters in the brain are derivatives of amino acids. Tyrosine is the precursor of dopamine and norepinephrine. Dopamine is a neurotransmitter which plays a very important role in perception, memory, motivation and motor control.



Synthesis of DOPA and Norepinephrine

Tryptophan is required for the synthesis of neurotransmitter serotonin which has a role in mood, sleep, sensory perception and depression.



Synthesis of Serotonin

FAT AND MENTAL HEALTH

Dietary intake of fats also plays a role in regulating mood and brain function. Some studies suggest that reducing fat and cholesterol in the diet may deplete brain serotonin levels causing mood changes, anger, and aggressive behavior. Cognitive performance among the elderly was improved by intake of fish oil (supplier of omega-3 FAs). High dietary fat, cholesterol in particular leads to atherosclerosis which causes decreased blood flow to the brain and eventually impaired brain function.

VITAMINS AND MENTAL HEALTH

Thiamin : Thiamin is intricately involved with metabolizing glucose - the primary source of energy to the brain. Thiamin deficiency leads to axonal degeneration and demyelization of peripheral neurons. Severe thiamin deficiency results in Wernicke- Korsakoff Syndrome which is characterized by confusion, mental changes, abnormal eye movements, unsteadiness, can progress to severe memory loss.

Niacin : Niacin is involved in releasing energy from carbohydrates, proteins and fats. Deficiency of niacin produces - irritability, headache, loss of memory, inability to sleep and emotional instability. Severe niacin deficiency progresses to a condition called pellagra which is characterized by four D's: dermatitis, diarrhea, dementia, death. The symptoms in pellagra can progress to psychosis, delirium, coma and death.

Folic acid : Folic acid deficiency leads to neural tube defects in developing fetus, increases risk of stroke, leads to a range of mental disorders - depression, lowers the levels of serotonin in the brain.

Vitamin B12 : Vitamin B12 is needed to maintain the myelin sheath of nerve cells. Inadequate myelin

results in nerve damage and impaired brain function. Vitamin B12 deficiency eventually causes: irreversible nerve damage, dementia, brain atrophy.

Vitamin B6 : Vitamin B₆ is needed for the production of the neurotransmitters. Deficiency of Vitamin B₆ is rare, but certain antidepressant drugs can induce Vitamin B₆ deficiency. Vitamin B6 deficiency is characterized by mental changes such as fatigue, nervousness, irritability, depression, insomnia, dizziness, nerve changes. Excess of Vitamin B₆ also causes nerve damage, dizziness, sensory loss and numbness.

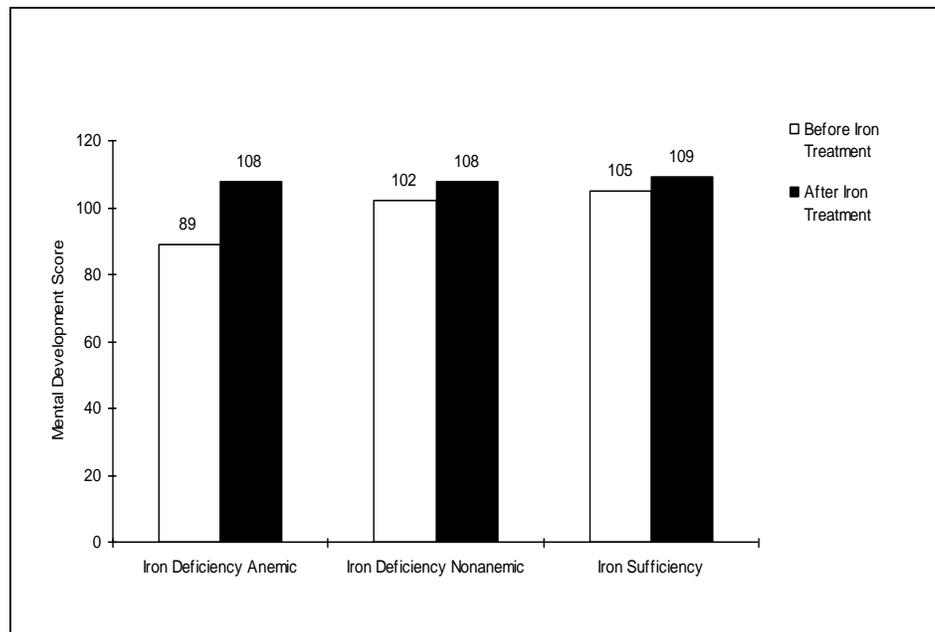
Vitamin E : Vitamin E deficiency causes changes in red blood cells and nerve tissues. It progresses to dizziness, vision changes muscle weakness, sensory changes. Untreated vitamin E deficiency can cause irreversible nerve damage. Vitamin E (antioxidant) has also been found useful in the treatment of neurological conditions such as Parkinson's and Alzheimer's disease . Vitamin E slows the progression of Parkinson's disease.

MINERALS AND MENTAL HEALTH

Iron : Iron deficiency during the first two years of life can lead to permanent brain damage. In children, iron deficiency anemia is strongly associated with impaired cognitive development and intellectual performance. The behavioral disturbances of iron deficiency anemia in both adults and children frequently include irritability, mental fatigue, shortened attention span, impaired memory, anxiety, depression.

Increasing Iron Intake Improves Mental Development Scores in Toddlers

Mean Mental Development Score Before and After Treatment with Ferrous Sulfate in 12 to 18 Month Infants:



Idjradinata P, Pollitt E. (1993)

IODINE : Iodine is an indispensable component of thyroid hormones. The thyroid hormones affect neuronal differentiation, migration, neural networking and synaptogenesis. IDD occurs in areas where iodine was depleted from the soil by the effects of rain, glaciations and flooding water. Iodine is particularly important during fetal development and is critical for normal maturation of the CNS. Moderate iodine deficiency in children and adults often causes abnormalities of psychomotor and intellectual development including - lower IQ, slower visual-motor performances, loss of fine motor skills, deficits in perceptual and neuromotor abilities, apathy. IDD leads to a disease endemic cretinism which is characterized by congenital disorder of the CNS manifested by deaf mutism, mental retardation. The WHO considers that 50 million people have some degree of mental impairment caused by IDDs.

Zinc : Zinc deficiency can cause neurological impairment influencing appetite, taste, smell, vision. It is also associated with apathy, irritability and fatigue. Zinc status during pregnancy affects the development of fetal nervous system and later cognitive functioning. In older adults (aged 65-90)

dietary zinc is positively linked to cognitive function and low levels of zinc in the blood and brain tissues relate to Alzheimer's disease.

Zinc is essential for development and functioning of brain Zinc dependent enzymes & Neurotransmitters play a role in the central nervous system in turn affect cognition. Zinc deficiency in human can lead to structural malformations in the brain, changes in enzymes and proteins important for neurotransmission. Behavioral problems such as reduced attention, reduced memory, reduced ability to learn.

Magnesium : In addition to its involvement in bone structure, it aids in the transmission of nerve impulses. Magnesium deficiency can cause: restlessness, nervousness, muscular twitching, and unsteadiness. Acute magnesium deficiency can progress to apathy, delirium, convulsions, coma and death.

Copper : Copper is involved in brain function. Copper deficiency impairs brain functioning including changes in certain chemical receptors in the brain and lowered levels of neurotransmitters.

Manganese : Manganese is involved in carbohydrate metabolism and brain functioning. Miners of manganese in South America have developed manganese toxicity called “manganese madness” with neurological symptoms similar to Parkinson’s disease.

Selenium : Selenium toxicity causes nervous system changes, fatigue and irritability.

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