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Correspondence

## Impact of nutrition in brain function and development: Potential brain foods

*Dear editor,*

The importance of diet in health and disease has been recognized since the dawn of time. Hippocrates wrote the proverb "Let food be thy medicine and medicine be thy food" approximately 400 B.C. Moses Maimonides, a renowned philosopher and physician, declared in the 12th century that "any illness that can be healed by diet should be addressed by no other means." In the twenty-first century, we are inundated with media claims about "superfoods," miraculous nutritional supplements, and special diets that promise to treat or prevent illness, enhance health, and restore function. Research into neurological illnesses, brain health, and psychological functioning has gotten a lot of press attention (behavior, cognition, and emotion). Aside from exaggeration, we have come a long way in understanding the significance of certain nutrients and dietary patterns in brain development, physiology, and function in the last two decades [1–3]. Interaction between inherited genotype and outside environmental influences including food, determines how well human brains function. Food and nutrition, which are crucial for maintaining brain function, can help prevent and treat mental problems. Several experimental models and epidemiological investigations, have demonstrated that both the general nutritional profile of human diet and particular dietary elements have effects on brain function. A summary of the relationship between diet and five key aspects of brain function that are related to mental health and performance include: (1) brain development; (2) signaling networks and neurotransmitters in the brain; (3) cognition and memory; (4) balance between protein production and degradation; and (5) deteriorating effects brought on by chronic inflammatory processes [4]. For optimal overall brain development during prenatal stage and early years of life, enough levels of vital nutrients must be provided at specific susceptible times. All nutrients are required for brain development, but some nutrients—like protein, long-chain polyunsaturated fatty acids (LCPUFAs), iron, copper, zinc, iodine, and vitamins A—have disproportionately large effects during the first few years of life and they exhibit critical or sensitive periods for neurodevelopment. These times also correspond to the times when a particular brain region is growing and needs the greatest nutrients [5].

Several micronutrients, including vitamins and trace minerals, are crucial for early stages of brain development. Numerous mental problems have been linked to vitamin B deficiency, and studies on the B vitamins of B6, folate (B9), and B12 in relation to brain development have received the greatest attention. An interaction to 1-carbon metabolism which is crucial for brain development and production of phospholipids and DNA methylation, is made possible by the relationship between homocysteine concentrations and a number of vitamins and their related compounds including folate, vitamin B12, choline, and glycine betaine. The existence of vitamin D-specific receptors in the brain and its impact on brain development, vitamin D has been dubbed "the overlooked neurosteroid." It is generally known that it contributes to calcium absorption from gut, which is an essential part of synaptic transmission. A precise balance must be struck as a high calcium and vitamin D intake is linked to brain damage. An important micronutrient in neurodevelopment is iron which is necessary for healthy neurotransmission, myelination, and brain growth. Zinc is essential for several biological processes, including neurogenesis, neuronal migration, synapse development, myelination, and modulation of intra- and intercellular communication. The effects of mild to severe zinc deficiency on sensorimotor or cognitive development, however, are less well understood. Significant structural changes in the brain are caused by severe zinc shortages. Iodine shortage, commonly known as "cretinism," results in irreversible brain damage because thyroid hormones, which are required for correct neuronal migration and myelination of the brain throughout prenatal and early postnatal development, must be produced. Some research suggests that even a mild to severe maternal iodine deficiency may have impact on a child's neurological or cognitive development [6].

From conception through age three, nutrition is crucial for brain development. Access to nutritious food should be a priority for preconception, pregnant, and breastfeeding women in public health initiatives. When children are between the ages of one and three, they are most susceptible to the whims of their parents' diets, therefore guidelines should encourage nursing for newborns during the first year and increase oversight of quality of food that children are provided. Important individual steps that practitioners can do include obtaining dietary histories, assessing for food insecurity, and actively educating parents [7]. Strong social support and a stable bond, absence of toxic stress and inflammation, and provision of appropriate nutrition all stand out as having very significant effects on early brain development [8]. Contrary to popular belief, food can prevent and defend against diseases in addition to serving as an energy source and a part of the body. In the past five years, scientists have uncovered strong evidences that diet has an effect on a variety of biochemical systems and pathways that support maintenance of brain function. For instance, it has been demonstrated that an omega-3-rich diet improves cognitive abilities in humans [9] and upregulates genes related to synaptic function and plasticity in mice [10]. As a result, it is now understood that high-saturated-fat diets damage the molecular bases for cognitive function and increase the risk of neurological dysfunction in both people and animals [11]. Even though these studies show that food has a major effect on the brain, further research is needed to pinpoint the mechanisms of action and establish the requirements for its therapeutic use in humans. Along with other facets of everyday life like exercise, nutrition has been a major influence on cognitive function and evolution of the brain for thousands of years [12].

Numerous environmental factors, including diet, parental

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supervision, social interactions, stress, and illnesses, and individual genotypes have effects on how the brain develops and works [13]. Diet, exercise, and other aspects of our day-to-day interactions with environment can all have an impact on our mental health and function. Certain foods have been identified to affect cellular or molecular processes crucial for cognitive function, which in turn influences cognition. This opens up the intriguing possibility of dietary adjustments in enhancing cognitive function, safeguarding the brain, promoting healing, and slowing down aging. According to current studies, the impacts of other lifestyle factors like exercise and sleep are linked to the effects of nutrition on the brain [14]. There are important implications for both public health and development of therapeutic remedies from how specific diets and forms of exercise affect the molecular systems involved in synaptic plasticity. The topic has received a lot of media interest as a result of the encouraging findings of clinical and preclinical studies that demonstrated advantageous effects of food on the brain. Brain networks related to emotions, rewards, and cognition are associated with brain networks that control eating. The treatment of obesity and food addiction, two key social and economic issues in Western culture, would almost certainly benefit from a deeper knowledge of how these networks interact. It makes sense that contemporary psychiatry is beginning to consider how some of these ideas might be used to treat mental diseases. For instance, the Committee on Research on Psychiatric Treatments of the American Psychiatric Association created a consensus report outlining broad recommendations for using omega-3 fatty acids to treat mood disorders [15].

The general relationship between nutrition and brain development and function can be summarized by the proverb "What's excellent for your heart, is terrific for your brain." As a result, the brain benefits from a heart-healthy diet that encourages weight loss and reduces the risks of developing insulin resistance. Together with other environmental factors and long-term epigenetic mechanisms, early nutrition for pregnant woman's diet and nutritional status of newborn babies and young infants influences brain development. It is unknown if one-sided neural development will improve brain performance or have unanticipated detrimental effects given the delicate balance of synapses and neurons during childhood and adolescence as well as the requirement for synaptic pruning [16].

In conclusion, nutrition is critically important for brain development. Given that diet may have a direct or indirect impact on brain growth and function, careful planning and expertly executed basic and clinical research are required to better understand brain development and to determine whether or not diet-related strategies can be used to treat or prevent brain disorders.

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## Author contribution

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## Data statement

All data are available in the manuscript.

## Provenance and peer review

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## Declaration of competing interest

Authors declare that they have no conflicts of interest.

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