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Cognitive Disorders and Impact of Nutrition: An Updated Review.

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Abstract:

Background: Cognitive health encompasses the ability to think, learn, remember, and regulate emotions and motor skills. It is essential for maintaining independence, coping with challenges, and supporting recovery from illness. While age-related changes, trauma, and diseases can impact brain health, lifestyle factors such as nutrition have a significant role in preventing or mitigating cognitive decline, particularly in older adults. Researchers highlight the concept of "cognitive reserve," which refers to the brain's ability to resist damage and maintain function. Given the growing body of research on the relationship between diet and cognitive health, it is critical to examine the role of nutrition throughout life, especially in preventing age-related cognitive decline.

Aim: This review explores the impact of nutrition on cognitive health, focusing on the developmental stages from childhood to adulthood, and investigates how various nutrients influence cognitive function, cognitive reserve, and the prevention of cognitive decline in older adults.

Methods: The review synthesizes existing literature on the role of nutrition in brain development and cognitive function across the lifespan, with particular attention to micronutrients, dietary patterns, and their impact on cognitive performance. Studies that assess the effects of specific nutrients, including B-vitamins, vitamin D, iron, and antioxidants, on brain health are highlighted.

Results: Evidence suggests that micronutrient deficiencies, such as iron, iodine, and vitamins B12 and D, negatively impact cognitive development and function. Antioxidant-rich foods, along with specific dietary patterns like the Mediterranean and Nordic diets, have been associated with a reduced risk of cognitive decline and dementia. Additionally, breakfast consumption has shown positive effects on cognitive tasks like memory and attention.

Conclusion: Proper nutrition is critical at all stages of life for supporting brain health, preventing cognitive decline, and improving the quality of life in older adults. Adopting balanced dietary patterns, especially those rich in antioxidants and essential nutrients, is beneficial for cognitive performance. Further research is needed to clarify the long-term effects of dietary interventions on cognitive aging.

Keywords: Cognitive health, nutrition, brain development, cognitive decline, dementia, antioxidants, dietary patterns, B-vitamins, vitamin D, Mediterranean diet.

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Introduction:

The growth and maintenance of a complex cognitive structure that permits older persons to preserve their independence, sense of purpose, and social ties is referred to as cognitive health (Hendrie et al., 1). Additionally, it improves coping with lingering functional deficiencies and promotes functional recovery from sickness or injury. Mental aptitude, learned skills, and the ability to use these talents to carry out meaningful tasks or activities are important aspects of cognitive health (2). Cognitive health includes thinking, learning, and remembering, as well as motor skills like balance and movement control, emotional regulation in recognizing and reacting to emotions, and tactile skills like reacting to touch sensations. In order to properly cope with life's obstacles, people with optimal brain health are able to identify their own abilities and modify their cognitive, psychological, emotional, and behavioral reactions. Numerous factors, such as age-related changes, traumas, mood problems, substance addiction, and diseases, can affect the health of the brain. Although certain factors cannot be changed, there is evidence that a number of lifestyle choices that can be changed, including nutrition, exercise, social interaction, and controlling alcohol and tobacco use, can stabilize or enhance cognitive performance (3). These variables may raise or lower the risk of dementia through a variety of processes. Furthermore, researchers have put forth the idea of cognitive reserve, which describes the brain's capacity to fend off illness. Only once a considerable threshold of brain damage has been reached may cognitively decline or dementia symptoms become noticeable (4). Documenting the current body of scientific information is essential, especially in light of the rapidly developing research on the connection between diet and cognitive health across the human lifespan. Although the function of nutrition in early life brain development has historically received a lot of attention, there is an increasing need to investigate the ways in which several lifestyle factors, such as diet, nutrition, and physical activity, affect age-related cognitive decline. New approaches to controlling, preventing, or treating age-related cognitive problems and enhancing older individuals' quality of life may result from this investigation.

Brain Development:

Different areas of the brain have different developmental and maturation trajectories during the continuous process of brain development from childhood to early adulthood (5). Although genetic predisposition plays a significant role in brain development, early experiences can have a significant impact on brain function. These events may cause individual variances that lead to behavioral dysfunctions and an increased lifetime risk of chronic diseases (6). Nutrition has a major role in early brain development and often has a stronger effect on brain function than a child's environment. In addition to general macronutrient undernutrition, deficiencies in specific nutrients can have long-term repercussions and dramatically impair neurodevelopment. Pregnancy-related brain growth requires protein, iron, copper, zinc, iodine, folate, and certain lipids (7). The demand for these nutrients persists into later life since brain growth is an ongoing process. During infancy, when the body is heavily dependent on nutrients and the brain is growing and developing quickly, nursing is essential. The composition of breast milk and nursing itself may influence cognitive development through various mechanisms (8). Breastfeeding has been associated with improved IQ scores for kids and teens across all income brackets (9). It's interesting to note that nursing appears to have cognitive benefits that persist into adulthood. Learning difficulties, including worse academic performance and issues with self-regulation, are often the result of long-term damage to brain development caused by starvation throughout fetal development and in the first few months after birth (10). The rapid synaptic development in early and middle childhood and the selective pruning of particular synapses later in adolescence underscore the ongoing need for a steady supply of nutrients to support brain growth (8). Adolescence in particular is associated with enhanced cognitive ability and ongoing brain growth (11). Research indicates that certain nutrients are needed in adulthood to enhance brain function, encourage neuroplasticity, and mitigate the negative effects of aging on the brain (12).

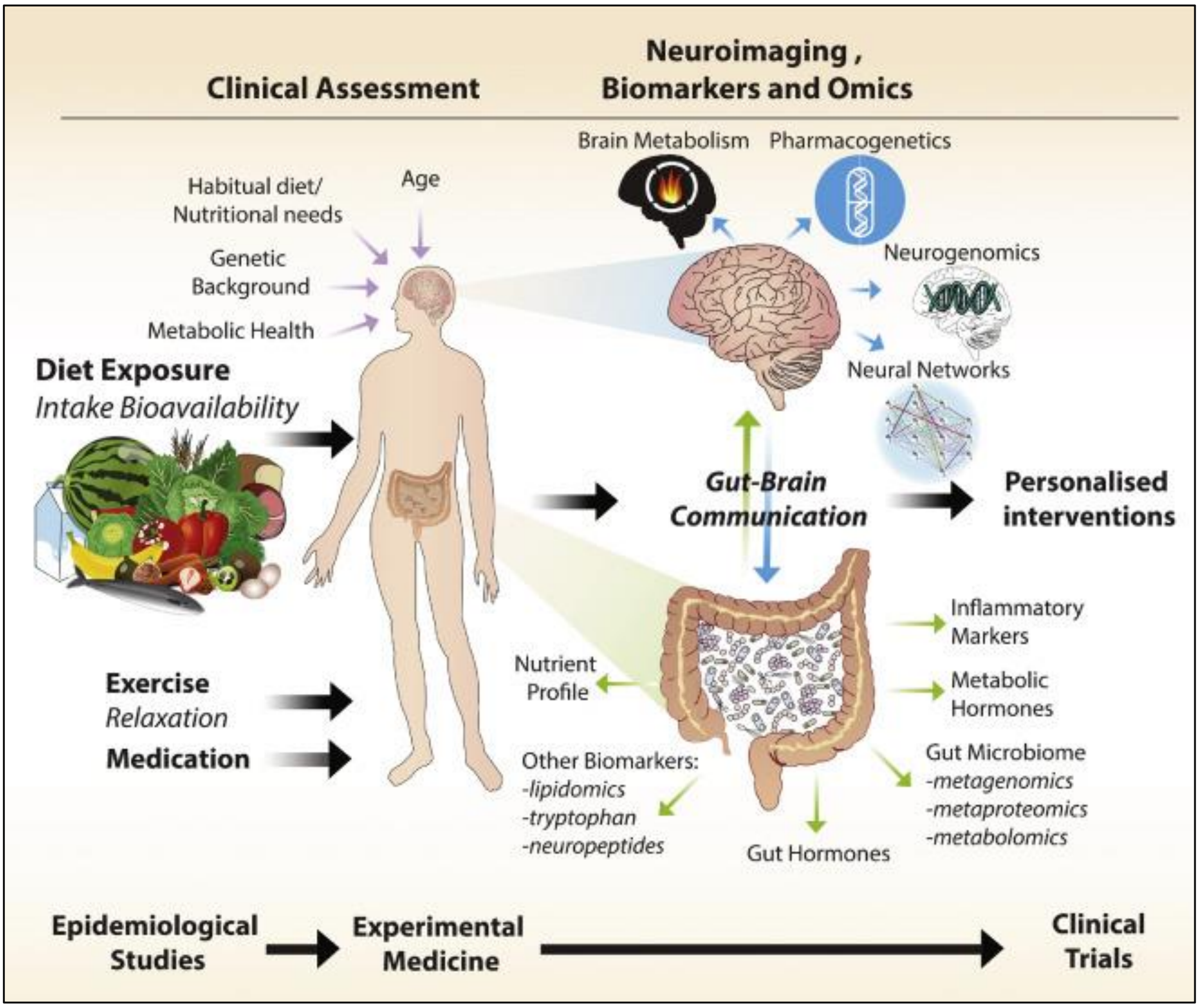

Figure 1: Nutrition and Mental Health.

Micronutrients and Brain Development:

Because they facilitate the synthesis of hormones, enzymes, and other vital substances needed for healthy growth and development, micronutrients are vital to the body (24). Iron, iodine, and vitamin A deficiencies are serious public health issues that disproportionately impact vulnerable groups like pregnant women and young children in low-income nations (24). The impact of fat-soluble vitamins on cognitive development in early life has not received much attention recently, with most studies concentrating on their function in cognitive decline in later life. This is in contrast to the extensive research on the role of B-vitamins in brain development. B vitamins play a number of roles in the development and operation of the brain. Because vitamin B-12 is essential for neural myelination, brain development, and fetal and child growth, Venkatramanan et al. (25) stressed the significance of having an appropriate vitamin B-12 status, particularly during pregnancy and early childhood. The results of studies on the connection between B vitamins and older persons' cognitive abilities have been conflicting (26–28). B-vitamins (niacin, folate, B6, and B12) have been linked to improved midlife cognitive performance, according to one American study. Furthermore, decreased folate intake was linked to a higher risk of dementia and mild cognitive impairment (MCI) among postmenopausal women without MCI.

Studies have shown that people with Alzheimer's disease (AD) and cognitive impairment had lower serum 25-hydroxyvitamin D (25(OH) D) levels than healthy controls, which has raised awareness of the importance of vitamin D for brain health (29, 30). Furthermore, it was discovered that low vitamin D levels increased the risk of AD by seven years (31). Only visuospatial memory improved with the greater dose of vitamin D3 (4,000 IU/day) in an 18-week study comparing it to a low-dose supplement (400 IU/day) in healthy people; other cognitive domains showed no discernible changes (32). Although its relationship to episodic memory was less evident, a review by Annweiler et al. (33) indicated that lower serum 25(OH) D concentrations predicted executive impairment (33). Low 25(OH) D levels were associated with worse cognitive function and an increased risk of dementia, according to a systematic review by van der Schaft et al. (35) and a meta-analysis that also found cognitive impairment in those with vitamin D deficiency (34). Moreover, subjective cognitive symptoms linked to hypovitaminosis D may be a predictor of dementia and cognitive decline (36).

Although the evidence is conflicting, antioxidant vitamins like E and C have been demonstrated to lower the risk of cognitive decline. Vitamin E and C supplementation were associated with a lower risk of cognitive deterioration in a prospective cohort trial conducted in Canada (37). Other research, however, found either no correlation (38) or a negative correlation (39) between antioxidants and cognitive performance. Higher vitamin E intake was linked to improved verbal memory, quick recall, and language/verbal fluency ability, according to a cross-sectional study conducted in the United States (40). In a similar vein, Chouet et al. (41) observed that enhanced cognition and cognitive behavior were associated with higher dietary consumption of phylloquinone (vitamin K) in 192 older French individuals. Since iron is a crucial part of hemoglobin, it is necessary for the transportation of oxygen to all organs, including the brain. One established risk factor for both acute and chronic cognitive impairment is iron deficiency anemia (IDA). IDA has been linked to cognitive and academic difficulties in later childhood as well as impaired mental and motor development in infancy (8). Since early intervention can better protect the brain from inadequate iron levels, preventing iron insufficiency is thought to be preferable to treating it later in life, especially during the prenatal and early infancy years (21). The brain's neurophysiological functions are disturbed by iron deficiency, which jeopardizes motor and cognitive development, including memory, attention, executive function, and coordination (42). Iron overload in the brain, on the other hand, also affects neurophysiological processes, increasing oxidative stress and neuronal cell death, both of which are linked to deteriorations in cognitive and motor abilities. Slow motor function altered feedback processing, memory loss, and poor decision-making are some examples of this (43).

Dietary Patterns:

Food types and dietary patterns have a big impact on cognitive function and brain health. A healthy diet may help prevent diseases like dementia and moderate cognitive impairment and maintain brain function. According to Smyth et al. [42], boosting consumption of nutritious meals can be a useful tactic for lowering the prevalence of cognitive decline worldwide. Wright et al. [44] also showed that independent of socioeconomic level or race, better cognitive performance is associated with improved dietary quality, especially in language retention and memory. This lends credence to the "whole diet approach" argument, which contends that the quality of a diet as a whole, as opposed to specific nutrients, is more advantageous for brain function. The Mediterranean diet, the Nordic diet, and the Dietary Approaches to Stop Hypertension (DASH) diet are notable dietary patterns that are thought to be more beneficial than concentrating on individual foods or nutrients.

In addition to cheese, yogurt, fruits, and vegetables, the Mediterranean diet, which is popular in places like Greece, Spain, France, Italy, Egypt, Algeria, and Libya, is distinguished by a high consumption of unprocessed carbohydrates and starches. Consumption of meat is restricted; red meat is only eaten occasionally each month, although chicken, fish, and eggs are occasionally eaten weekly. This diet contains between 28 and 40 percent fat, mostly from unsaturated fats like olive oil [45]. According to research, following this diet lowers the risk of dementia, Alzheimer's disease, depression, and cognitive decline [46–50]. Participants on the Mediterranean diet demonstrated enhanced cognitive function, but those on a control diet exhibited cognitive loss, according to a sub-study of the PREDIMED trial that evaluated cognitive performance at baseline and four years later [51]. The Mediterranean diet has been found to offer moderate protective effects against Alzheimer's disease and cognitive decline in a number of longterm observational studies, including extensive meta-analyses [48, 52, 53]. Additionally, as demonstrated by numerous cross-sectional, longitudinal studies, and trials, a systematic review by van de Rest et al. [54] emphasized that increased adherence to the Mediterranean diet is associated with decreased cognitive decline, dementia, and Alzheimer's disease.

The Nordic diet emphasizes fruits, vegetables, fish, canola oil, and different kinds of meat and is based on the historic eating habits of Scandinavian nations [55]. 1,140 men and women in good cognitive health participated in a four-year study that looked at how the Nordic diet affected cognitive function. According to the study, those who followed the Nordic diet had better cognitive performance than those who did not follow it [56]. Smaller portion sizes and a low sodium intake are key components of the DASH diet, which is well-known for its many health advantages. It has been demonstrated that this diet improves cardiovascular risk factors and benefits those with higher cardiometabolic risks more [57]. The Mediterranean and DASH diets are combined to create the MIND (Mediterranean-DASH Diet Intervention for Neurodegenerative Delay) diet, which focuses on brain health. Antioxidant-rich foods like blueberries to enhance memory and green leafy vegetables to prevent cognitive decline are part of the MIND diet [55, 58–60]. Because of its beneficial benefits on cognitive function, fish, which has high quantities of EPA and DHA, is also included [61]. To fully determine this diet's potential for preserving brain health, more research is required. Consuming whole grains, soy products, green leafy vegetables, green tea, mushrooms, and seaweed are all hallmarks of Asian plant-based diets. Better logical memory or higher global cognitive assessment scores, a slower rate of cognitive decline, and a decreased risk of cognitive impairment have all been closely linked to these dietary patterns [62]. Apart from these particular diets, van de Rest et al. [57] pointed out that other healthy dietary patterns—such as the Healthy Diet Indicator and Healthy Eating Index—that were discovered using techniques like factor analysis and regression models have also been connected to a decreased risk of dementia and cognitive decline [54].

Importance of Breakfast

Numerous studies have examined the effects of breakfast consumption on cognitive performance. The composition of breakfast has been shown to significantly influence various cognitive domains, including attention capacity [63], processing speed [64], working memory [65], and both immediate and delayed recall, as well as recognition [66]. Adolphus et al. [67] found that breakfast consumption in children and adolescents (ages 4–18) had a positive short-term impact on cognitive tasks requiring attention, executive function, and memory, when compared to fasting. In adults over 18 years, breakfast intake was associated with a small, yet robust improvement in memory, particularly in delayed recall, although the effects on attention and executive function were less consistently established. No effects were observed regarding language performance [68].

Food Group Intake

There is ample evidence of the connection between different food groups and cognitive decline and brain function. While eating unrefined cereals and whole grains is linked to better cognitive outcomes [47, 70, 71], eating refined cereals and grains has been linked to worse cognitive performance and decline [69]. Consumption of refined carbohydrates has been found to be negatively correlated with nonverbal IQ [72]. Fish consumption and cognitive function have been found to positively correlate in both cross-sectional and longitudinal studies [51, 69, 73, 74]. Eating fish has been linked to a lower incidence of dementia, moderate cognitive impairment (MCI), and cognitive decline [69, 70, 73, 74]. According to one study, people who ate fish had superior executive function, working memory, visual memory, episodic verbal memory, and attention than people who ate red meat, who had worse cognitive and executive function [74]. On the other hand, eating dairy products, especially high-fat milk, was associated with poorer cognitive function and cognitive decline [74,69], although eating cheese or ice cream did not have the same effect [75,69]. A number of foods have also been linked to delayed cognitive decline [78], including avocados [76], berries [60], and extra-virgin olive oil [77].

Research on plant-based diets has repeatedly demonstrated that those who ate walnuts [72, 74, 78], legumes [71], olive oil [51, 74, 76], and plant-based foods had improved cognitive performance and a decreased risk of cognitive decline [47, 73–75]. However, the intake of fruits, berries, vegetables, and potatoes was not linked to better cognitive function [51, 70, 74, 77, 78], and the consumption of green leafy vegetables did not seem to lower the risk of cognitive impairment [75]. In their evaluation of the impacts of a plant-based diet, Medawar et al. [79] focused on how it affected personality traits, emotional well-being, brain activity linked to language and empathy activities, and cognition. Consuming citrus fruits, grapes, berries, almonds, green tea, cocoa, and coffee also had a favorable impact on certain cognitive domains, especially executive skills, according to Rajaram et al. [62]. Nevertheless, no link between plant-based diets and their alleged impacts on neurological, cerebral, or cognitive processes was found. When compared to those on a control diet, participants in a research that paired the Mediterranean diet with nuts demonstrated benefits in memory [80]. Long-term nut consumption was linked to improved cognitive performance in older persons, according to two observational studies, the Doetinchem Cohort [81] and the Nurses' Health Study [82]. However, after a 5- to 6-year follow-up period, it did not correlate with a decrease in cognitive decline.

With the exception of a study conducted in Spain that found wine consumption to be associated with improved global cognition in community-dwelling adults [51], alcohol consumption generally had no discernible effect on cognitive performance [70, 73, 74, 80, 81]. Longitudinal studies looking at beer or spirits use did not find any association with cognitive decline [69]. In a similar vein, longitudinal studies found no correlation between cognitive decline or impairment and the use of processed foods, fast or fried foods, sweets, pastries, sodium, sugar-sweetened beverages, or animal-based cooking fats [69, 71, 75, 83]. Healthy foods (including whole grains, seafood, fruits, and vegetables) are positively correlated with better executive function, according to a systematic analysis evaluating the effect of a balanced diet on executive function in kids and teens. Conversely, lower executive functioning was associated with the use of red/processed meats, sugary drinks, and less healthful snacks [84]. Some herbs have demonstrated potential for improving cognitive function and postponing cognitive aging. In people with mild cognitive impairment (MCI), for instance, ashwagandha (Indian ginseng) has been shown to improve executive skills [85]. The key ingredient in turmeric, curcumin, lowers oxidative damage, enhances aging-related cognitive function, and prevents β-amyloid plaques from aggregating, which makes it helpful for Alzheimer's disease. In individuals over 60, 400 mg/day of curcumin enhanced working memory and sustained attention, according to a randomized controlled experiment [86]. Commonly used as a memory booster, brahmi (also known as waterhyssop or Indian pennywort) is also mentioned for possible cognitive advantages.

Other Dietary Components

Flavonoids, lignans, stilbenes, coumarins, and tannins are just a few of the many substances that make up polyphenols, which are secondary metabolites that are present in plants. Vegetables, tea, spices, herbs, olive oil, and vibrant fruits like tomatoes, cherries, and grapes are rich in these compounds. Like antioxidants, polyphenols support anti-inflammatory processes and control oxidative stress to support brain health [87]. Flavonoids are one type of polyphenol that has been thoroughly researched for possible cognitive advantages. Flavonoids have been linked in studies to benefits in verbal memory and language [46], as well as delayed cognitive deterioration [88]. In particular, it has been demonstrated that the cocoa flavonoids included in dark chocolate improve cognitive function [87,88]. However, the outcomes of a study that looked at cocoa flavonoids in people with cognitive impairment were not entirely clear [89]. A high-flavanol cocoa diet was linked to a 41% lower risk of cognitive deterioration [91] and improved gyrus function after three months [90] in a randomized controlled trial (RCT) with healthy persons aged 50–69.

Cognitive function is also associated with another class of dietary components called carotenoids. High amounts of carotenoids, especially those present in green vegetables, were linked to improved performance on visual-spatial tasks, according to Jirout et al. [10]. One of the main carotenoids in the brain, lutein, is essential for both baby brain growth and cognition. Additionally, it is connected to macular pigment density, which influences cognitive function [92]. Children's brains have far higher levels of lutein than do adults', and these levels are linked to cognitive processes like memory, learning, executive function, and language [93]. Additionally, it has been demonstrated that lutein speeds up young adults' temporal processing [94].

With few research offering insights, the impact of caffeine in memory and cognitive enhancement is still being studied. In one case-control investigation, 124 older people with moderate cognitive impairment (MCI) had higher serum caffeine levels, which were linked to a delayed progression of dementia [95]. But according to a different study, there is no connection between caffeine use and the risk of dementia, Alzheimer's disease (AD), or cognitive impairment [96]. Coffee drinking was associated with a lower level of cognitive decline in a long-term research, but the impact was not dose-dependent [97]. There is conflicting information about the effects of soy isoflavones, such as genistein and daidzein, on cognition [98]. The effects seem to reverse in older women, despite some research reporting an early favorable influence in adults. There is also conflicting evidence about the impact of soy isoflavones on men [98]. Higher consumption of allium vegetables (onion, garlic, and leek) was linked to worse results on tests of cognitive flexibility and processing speed in cross-sectional analyses of the Doetinchem Cohort Study, which involved 2,613 people ages 43 to 70. Allium consumption and cognitive impairment, however, did not correlate, according to longitudinal evidence [81].

Microbiome-Gut-Brain Axis

The complex ecology of bacteria that live in the gut, including their genes, proteins, and metabolites, is referred to as the "gut microbiome" [100]. Immune signaling is thought to be crucial in the process of brain development, even though the evidence regarding the gut microbiome's potential influence is still developing [102]. More and more studies are showing that humans and microorganisms have a symbiotic relationship that extends to mental health, with the gut-brain axis being a key factor in maintaining brain health through two-way communication between the gut microbes and the brain [101, 102]. In addition to influencing behavior, this communication system has a role in the pathophysiology of mental diseases [101, 103].

The microbiota, gut, and brain axis is a well-established bidirectional relationship between the gut and the brain. Recent studies have demonstrated the importance of the gut microbiota in this system, which allows microorganisms to interact with the brain and vice versa [102]. Negative lifestyle variables, including poor eating habits, sleep deprivation, circadian rhythm disruptions, persistent noise, and sedentary activity, have a major impact on the gut flora. Additionally, these characteristics are important risk factors for Alzheimer's disease and other non-communicable diseases [104]. Dietary fibers and probiotics have been shown to have positive benefits on gut microbial management, which can lessen these adverse consequences. According to research, intestinal dysbiosis brought on by dietary modifications, antibiotic use, non-steroidal anti-inflammatory drug use, and the presence of harmful microbes can impair cognitive abilities [104].

Through immune cells, cytokines, and chemokines, the gut microbiome communicates with the brain and influences brain functions in both directions [99, 105]. The microbiota can affect brain development and function through immune signaling, endocrine, and neurological pathways. Each of these communication routes may be modulated by nutritional variables [102]. Neurotransmitters that impact intestinal motility, permeability, cortisol levels, and immunological function can therefore have an impact on the gut from the brain. Throughout life, the gut microbiota's makeup varies dynamically, with crucial times occurring during infancy, adolescence, and age. These phases are especially susceptible to outside disruptions, which can make people more prone to brain problems. Negative mental health outcomes and substantial long-term consequences on neurodevelopment can result from early-life disturbances in the development of the gut microbiota.

Furthermore, the development of neurological diseases and aging may be impacted by the microbiota. By modifying the amounts of their precursors, the gut microbiome controls important neurotransmitters. For example, Lactobacillus and Bifidobacterium species produce the inhibitory neurotransmitter γ-aminobutyric acid (GABA); Escherichia, Bacillus, and Saccharomyces spp. produce noradrenaline (norepinephrine); Bacillus, Streptococcus, Escherichia, and Enterococcus spp. produce serotonin; Bacillus produces dopamine; and some Lactobacillus species are capable of synthetylcholine [106, 107]. These neurotransmitters from microbes have the ability to pass through the gut mucosa and may have an impact on brain activity [106]. Furthermore, the central nervous system may be impacted directly or indirectly by short-chain fatty acids (SCFAs), such as propionate, butyrate, and acetate, which are metabolic consequences of gut microbial activity [108–110]. Animal studies, especially those involving induced infections [111], antibiotic and nutritional manipulations [112, 113], and probiotic therapies [114], provide the majority of the evidence for the gut microbiota's role in cognition [115].

Conclusion:

Cognitive health is influenced by a complex interplay of genetic factors, environmental experiences, and lifestyle choices. Among these, nutrition plays a pivotal role throughout the lifespan, affecting both brain development in early life and the maintenance of cognitive function in older age. Research has shown that nutrient deficiencies, particularly in iron, iodine, B-vitamins, and vitamin D, can impair cognitive performance and increase the risk of neurodevelopmental disorders, cognitive decline, and dementia. This underscores the importance of ensuring adequate nutrition, especially in vulnerable populations like pregnant women, infants, and older adults. Early brain development, particularly in the first few years of life, is highly sensitive to nutritional influences. Breastfeeding, for instance, has been associated with improved cognitive outcomes across the lifespan, emphasizing the role of early nutrition in shaping lifelong brain health. Similarly, the growing body of evidence on the impact of micronutrients such as B12, folate, and iron highlights the critical role these nutrients play in brain function. Adequate intake of these nutrients not only supports neurodevelopment but also helps to mitigate the effects of aging on the brain. For instance, vitamin B12 is essential for myelination and cognitive function, while low vitamin D levels are linked to cognitive impairment and dementia risk. Moreover, dietary patterns, rather than individual nutrients, have gained attention for their potential to prevent cognitive decline. Diets such as the Mediterranean and Nordic diets, rich in fruits, vegetables, fish, and unsaturated fats, have been shown to provide moderate protection against cognitive decline and Alzheimer's disease. The benefits of these diets may be attributed to their antioxidant-rich content, which helps combat oxidative stress, a key factor in aging-related cognitive deterioration. Furthermore, diets that include whole grains, legumes, and fish rich in omega-3 fatty acids are beneficial for maintaining cognitive function. In addition to nutrient-specific recommendations, research suggests that dietary patterns that focus on whole foods, such as the Mediterranean diet, are more effective in promoting cognitive health than focusing solely on individual nutrients. These dietary patterns not only enhance brain function but also support overall health, reducing the risk of chronic diseases such as cardiovascular disease, which are closely linked to cognitive decline. In conclusion, the evidence supports the idea that proper nutrition, particularly in the form of balanced, nutrient-rich diets, is essential for maintaining cognitive health and preventing decline. However, more research is needed to explore the specific mechanisms through which nutrition influences brain health and to determine the optimal dietary interventions for preventing age-related cognitive impairments. Ensuring proper nutrition throughout life, especially during critical periods of brain development and aging, can enhance cognitive function and improve quality of life, making it a key public health priority.

References:

1. Hendrie, HC, Albert, MS, Butters, MA, Gao, S, Knopman, DS, Launer, LJ, et al. The NIH cognitive and emotional health project. Report of the critical evaluation Study committee. *Alzheimers Dement*. (2006) 2:12–32. doi: 10.1016/j.jalz.2005.11.004

2. Centers for Disease Control and Prevention and the Alzheimer's Association. The Healthy Brain Initiative: A National Public Health Road Map to Maintaining Cognitive Health. Chicago, IL: Alzheimer's Association. (2007) Available at: www.cdc.gov/aging and www.alz.org

3. Anstey, KJ, Cherbuin, N, and Herath, PM. Development of a new method for assessing global risk of Alzheimer's disease for use in population health approaches to prevention. *Prev Sci*. (2013) 14:411–21. doi: 10.1007/s11121-012-0313-2

4. Clare, L, Wu, Y-T, Teale, JC, Macleod, C, Matthews, F, Brayne, C, et al. Potentially modifiable lifestyle factors, cognitive reserve, and cognitive function in later life: a cross-sectional study. *PLoS Med*. (2017) 14:e1002259. doi: 10.1371/journal.pmed.1002259

5. Lebel, C, Gee, M, Camicioli, R, Wieler, M, and Martin, WBC. Diffusion tensor imaging of white matter tract evolution over the lifespan. *NeuroImage*. (2012) 60:340–52. doi: 10.1016/j.neuroimage.2011.11.094

6. Miguel, PM, Pereira, LO, Silveira, PP, and Meaney, MJ. Early environmental influences on the development of children's brain structure and function. *Dev Med Child Neurol*. (2019) 61:1127–33. doi: 10.1111/dmcn.14182

7. National Institutes of Health (NIH) (2011). Iodine: fact sheet for health professionals. Retrieved from: https://ods.od.nih.gov/factsheets/Iodine-HealthProfessional

8. Prado, EL, and Dewey, KG. Nutrition and brain development in early life. *Nutr Rev*. (2014) 72:267–84. doi: 10.1111/nure.12102

9. Victora, CG, Horta, BL, de Mola, CL, Quevedo, L, Pinheiro, RT, Gigante, DP, et al. Association between breastfeeding and intelligence, educational attainment, and income at 30 years of age: a prospective birth cohort study from Brazil. *Lancet Glob Health*. (2015) 3:e199–205. doi: 10.1016/S2214-109X(15)70002-1

10. Jirout, J, LoCasale-Crouch, J, Turnbull, K, Gu, Y, Cubides, M, Garzione, S, et al. How lifestyle factors affect cognitive and executive function and the ability to learn in children. *Nutrients*. (2019) 11:1–29. doi: 10.3390/nu11081953

11. Black, MM, Walker, SP, Fernald, LCH, Andersen, CT, DiGirolamo, AM, Lu, C, et al. Advancing early childhood development: from science through the life course. *Lancet*. (2017) 389:77–90. doi: 10.1016/S0140-6736(16)31389-7

12. Goyal, MS, and Iannotti, LLRME. Brain nutrition: a life span approach. *Annu Rev Nutr*. (2018) 38:381–99. doi: 10.1146/annurev-nutr-082117-051652

13. Li, Y, Li, S, and Wang, WZD. Association between dietary protein intake and cognitive function in adults aged 60 years and older. *J Nutr Health Aging*. (2020) 24:223–9. doi: 10.1007/s12603-020-1317-4

14. O'Donnell, CA, Manera, V, and Köhler, SIK. Promoting modifiable risk factors for dementia: is there a role for general practice? *Br J Gen Pract*. (2015) 65:567–8. doi: 10.3399/bjgp15X687241

15. Coelho-Júnior, HJ, Calvani, R, Landi, F, Picca, A, and Marzetti, E. Protein intake and cognitive function in older adults: a systematic review and meta-analysis. *Nutr Metab Insights*. (2021) 14:117863882110223. doi: 10.1177/11786388211022373

16. Okereke, OI, Rosner, BA, Kim, DH, Kang, JH, Cook, NR, Manson, JE, et al. Dietary fat types and 4-year cognitive change in community-dwelling older women. *Ann Neurol*. (2013) 72:124–34. doi: 10.1002/ana.23593.Dietary

17. Francis, HSR. The longer-term impacts of Western diet on human cognition and the brain. *Appetite*. (2013) 63:119–28. doi: 10.1016/j.appet.2012.12.018

18. Spencer, SJ, Korosi, A, Layé, S, Shukitt-Hale, B, and Barrientos, RM. Food for thought: how nutrition impacts cognition and emotion. *NPJ Sci Food*. (2017) 1:7. doi: 10.1038/s41538-017-0008-y

19. Barbagallo, M. Type 2 diabetes mellitus and Alzheimer's disease. *World J Diabetes*. (2014) 5:889–93. doi: 10.4239/wjd.v5.i6.889

20. Bazinet, RPLS. Polyunsaturated fatty acids and their metabolites in brain function and disease. *Nat Rev Neurosci*. (2014) 15:771–85. doi: 10.1038/nrn3820

21. Cusick, SE, and Georgieff, MK. The role of nutrition in brain development: the Golden opportunity of the first 1000 days brain development in late fetal and early postnatal life. *J Pediatr*. (2016) 175:16–21. doi: 10.1016/j.jpeds.2016.05.013.The

22. Gillette-Guyonnet, S, Secher, M, and Vellas, B. Nutrition and neurodegeneration: epidemiological evidence and challenges for future research. *Br J Clin Pharmacol*. (2013) 75:738–55. doi: 10.1111/bcp.12058

23. Ding, B, Xiao, R, Ma, W, Zhao, L, Bi, Y, and Zhang, Y. The association between macronutrient intake and cognition in individuals aged under 65 in China: a cross-sectional study. *BMJ Open*. (2018) 8:1–8. doi: 10.1136/bmjopen-2017-018573

24. World Health Organization (WHO) (2021). Ageing and health. Available at: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health.

25. Venkatramanan, S, Armata, IE, Strupp, BJ, and Finkelstein, JL. Vitamin B-12 and cognition in children 1–3. *Adv Nutr*. (2016) 7:879–88. doi: 10.3945/an.115.012021

26. Agnew-Blais, JC, Wassertheil-Smoller, S, Kang, JH, Hogan, PE, Coker, LH, Snetselaar, LG, et al. NIH public access. *Bone*. (2008) 115:231–41. doi: 10.1016/j.jand.2014.07.006

27. Dangour, AD, Allen, E, Clarke, R, Elbourne, D, Fletcher, AE, Letley, L, et al. Effects of vitamin B-12 supplementation on neurologic and cognitive function in older people: a randomized controlled trial 1, 2. *Am J Clin Nutr*. (2015) 102:639–47. doi: 10.3945/ajcn.115.110775

28. Doets, EL, In't Veld, PH, Szczecińska, A, RAM, D-R, Cavelaars, AEJM, Van't Veer, P, et al. Systematic review on daily Vitamin B12 losses and bioavailability for deriving recommendations on Vitamin B12 intake with the factorial approach. *Ann Nutr Metab*. (2013) 62:311–22. doi: 10.1159/000346968

29. Goodwill, AMSCA. Systematic review and meta-analysis of the effect of low Vitamin D on cognition. *J Am Geriatr Soc*. (2017) 65:2161–8. doi: 10.1111/jgs.15012

30. Afzal, S, and Bojesen, SENBG. Reduced 25-hydroxyvitamin D and risk of Alzheimer's disease and vascular dementia. 2014 may; 10(3):296-302. *Alzheimers Dement*. (2014) 10:296–302. doi: 10.1016/j.jalz.2013.05.1765

31. Annweiler, C, Rolland, Y, Schott, AM, Blain, H, and Vellas, BBO. Serum vitamin D deficiency as a predictor of incident non-Alzheimer dementias: a 7-year longitudinal study. *Dement Geriatr Cogn Disord*. (2011) 32:273–8. doi: 10.1159/000334944

32. Pettersen, JA. Does high dose vitamin D supplementation enhance cognition?: A randomized trial in healthy adults. *Exp Gerontol*. (2017) 90:90–7. doi: 10.1016/j.exger.2017.01.019

33. Annweiler, C, and Llewellyn, DJBO. Low serum vitamin D concentrations in Alzheimer's disease: a systematic review and meta-analysis. *J Alzheimers Dis*. (2013) 33:659–74. doi: 10.3233/JAD-2012-121432

34. Etgen, T, Sander, D, Bickel, H, and Sander, KFH. Vitamin D deficiency, cognitive impairment and dementia: a systematic review and meta-analysis. *Dement Geriatr Cogn Disord*. (2012) 33:297–305. doi: 10.1159/000339702

35. van der Schaft, J, Koek, HL, Dijkstra, E, Verhaar, HJ, van der Schouw, YTE-VMH, van der Schaft, J, et al. The association between vitamin D and cognition: a systematic review. *Ageing Res Rev*. (2013) 12:1013–23. doi: 10.1016/j.arr.2013.05.004

36. Landel, V, Annweiler, C, Millet, P, Morello, M, Féron, F, Wion, D, et al. Cognition and Alzheimer's disease: the therapeutic benefit is in the D-tails. *J Alzheimers Dis*. (2016) 53:419–44. doi: 10.3233/JAD-150943

37. Basambombo, LL, Carmichael, PH, and Côté, SLD. Use of Vitamin E and C supplements for the prevention of cognitive decline. *Ann Pharmacother*. (2017) 51:118–24. doi: 10.1177/1060028016673072

38. Nooyens, AC, Milder, IE, van Gelder, BM, Bueno-de-Mesquita, HB, and van Boxtel, MPVWM. Diet and cognitive decline at middle age: the role of antioxidants. *Br J Nutr*. (2015) 113:1410–7. doi: 10.1017/S0007114515000720

39. Galasko, DR, Peskind, E, Clark, CM, Quinn, JF, Ringman, JM, Jicha, GA, et al. Antioxidants for Alzheimer disease: a randomized clinical trial with cerebrospinal fluid biomarker measures. *Arch Neurol*. (2012) 69:836–41. doi: 10.1001/archneurol.2012.85

40. Beydoun, MA, Fanelli-Kuczmarski, MT, Kitner-Triolo, MH, Beydoun, HA, Kaufman, JS, Mason, MA, et al. Dietary antioxidant intake and its association with cognitive function in an ethnically diverse sample of US adults. *Psychosom Med*. (2015) 77:68–82. doi: 10.1097/PSY.0000000000000129

41. Chouet, J, Ferland, G, Féart, C, Rolland, Y, Presse, N, Boucher, K, et al. Dietary vitamin K intake is associated with cognition and behaviour among geriatric patients: the CLIP study. *Nutrients*. (2015) 7:6739–50. doi: 10.3390/nu7085306

42. Smyth, A, Dehghan, M, Anderson, C, Teo, K, Gao, P, Sleight, P, et al. Healthy eating and reduced risk of cognitive decline. *American Acad. Neurol.* (2015) 84:2258–65. doi: 10.1212/WNL.0000000000001638

43. Ferreira, A, Neves, P, and Gozzelino, R. Multilevel impacts of iron in the brain: the cross talk between neurophysiological mechanisms, cognition, and social behavior. *Pharmaceuticals*. (2019) 12:1–26. doi: 10.3390/ph12030126

44. Morgan, M. Rogers-Carter1 2 JAV 2 KBGAFPMTMMR, Christianson1 JP. Diet quality and cognitive function in an urban sample: findings from the healthy aging in neighborhoods of diversity across the life span (HANDLS) study. *Physiol Behav*. (2017) 20:92–101. doi: 10.1017/S1368980016001361

45. Aridi, YS, Walker, JL, and Wright, ORL. The association between the Mediterranean dietary pattern and cognitive health: a systematic review. *Nutrients*. (2017) 9:674 doi: 10.3390/nu9070674

46. Kesse-Guyot, E, Andreeva, VA, Lassale, C, Ferry, M, Jeandel, C, Hercberg, S, et al. Mediterranean diet and cognitive function: a French study. *Am J Clin Nutr*. (2013) 97:369–76. doi: 10.3945/ajcn.112.047993

47. Samieri, C, Grodstein, F, Rosner, BA, Kang, JH, Cook, NR, Manson, JE, et al. Mediterranean diet and cognitive function in older age. *Epidemiology*. (2013) 24:490–9. doi: 10.1097/EDE.0b013e318294a065

48. Lourida, I, Soni, M, Thompson-Coon, J, Purandare, N, Lang, IA, and Ukoumunne, OCLDJ. Mediterranean diet, cognitive function, and dementia: a systematic review. *Epidemiology*. (2013) 24:479–89. doi: 10.1097/EDE.0b013e3182944410

49. Solfrizzi, VPF. Mediterranean diet and cognitive decline. A lesson from the whole-diet approach: what challenges lie ahead? *J Alzheimers Dis*. (2014) 39:283–6. doi: 10.3233/JAD-130831

50. Woodside, JV, Gallagher, NE, and Neville, CEMMC. Mediterranean diet interventions to prevent cognitive decline--opportunities and challenges. *Eur J Clin Nutr*. (2014) 68:1241–4. doi: 10.1038/ejcn.2014.178, Epub 2014 Sep 3

51. Valls-Pedret, C, Lamuela-Raventós, RM, Medina-Remón, A, Quintana, M, Corella, D, Pintó, X, et al. Polyphenol-rich foods in the Mediterranean diet are associated with better cognitive function in elderly subjects at high cardiovascular risk. *J Alzheimers Dis*. (2012) 29:773–82. doi: 10.3233/JAD-2012-111799

52. Fiatarone Singh, MA, Gates, N, Saigal, N, Wilson, GC, Meiklejohn, J, Brodaty, H, et al. The Study of mental and resistance training (SMART) study—resistance training and/or cognitive training in mild cognitive

impairment: a randomized, double-blind, double-sham controlled trial. *J Am Med Dir Assoc*. (2014) 15:873–80. doi: 10.1016/j.jamda.2014.09.010

53. Psaltopoulou, T, Sergentanis, TN, Panagiotakos, DB, Sergentanis, IN, and Kosti, RSN. Mediterranean diet, stroke, cognitive impairment, and depression: a meta-analysis. *Ann Neurol*. (2013) 74:580–91. doi: 10.1002/ana.23944

54. van de Rest, O, Berendsen, AAM, Haveman-Nies, A, and de Groot, LCPGM. Dietary patterns, cognitive decline, and dementia: a systematic review. *Adv Nutrition*. (2015) 6:154–68. doi: 10.3945/an.114.007617

55. Morris, MC. Nutrition and risk of dementia: overview and methodological issues. *Ann N Y Acad Sci*. (2017) 1367:31–7. doi: 10.1111/nyas.13047

56. Männikkö, R, Komulainen, P, Schwab, U, Heikkilä, HM, Savonen, K, Hassinen, M, et al. The Nordic diet and cognition--the DR's EXTRA Study. *Br J Nutr*. (2015) 114:231–9. doi: 10.1017/S0007114515001890

57. Siervo, M, Lara, J, Chowdhury, S, Ashor, A, and Oggioni, CMJC. Effects of the dietary approach to stop hypertension (DASH) diet on cardiovascular risk factors: a systematic review and meta-analysis. *Br J Nutr*. (2014) 113:1–15. doi: 10.1017/S0007114514003341

58. Boespflug, EL, Eliassen, JC, Dudley, JA, Shidler, MD, Kalt, W, Summer, SS, et al. In mild cognitive impairment. *Nutr Neurosci*. (2018) 21:297–305. doi: 10.1080/1028415X.2017.1287833.Enhanced

59. Nilsson, A, Salo, I, Plaza, M, and Björck, I. Effects of a mixed berry beverage on cognitive functions and cardiometabolic risk markers; a randomized cross-over study in healthy older adults. *PLoS One*. (2017) 12:e0188173–22. doi: 10.1371/journal.pone.0188173

60. Whyte, AR, Cheng, N, Fromentin, E, and Williams, CM. A randomized, double-blinded, placebo-controlled study to compare the safety and efficacy of low dose enhanced wild blueberry powder and wild blueberry extract (Thinkblue™) in maintenance of episodic and working memory in older adults. *Nutrients*. (2018) 10:660. doi: 10.3390/nu10060660

61. Ghasemi Fard, S, Wang, F, Sinclair, AJ, Elliott, G, and Turchini, GM. How does high DHA fish oil affect health? A systematic review of evidence. *Crit Rev Food Sci Nutr*. (2019) 59:1684–727. doi: 10.1080/10408398.2018.1425978

62. Rajaram, S, Jones, J, and Lee, GJ. Plant-based dietary patterns, plant foods, and age-related cognitive decline. *Adv Nutr*. (2019) 10:S422–36. doi: 10.1093/advances/nmz081

63. An, YJ, Jung, KY, Kim, SM, and Lee, CKDW. Effects of blood glucose levels on resting-state EEG and attention in healthy volunteers. *J Clin Neurophysiol*. (2015) 32:51–6. doi: 10.1097/WNP.0000000000000119

64. Jones, EK, and Sünram-Lea, SIWK. Acute ingestion of different macronutrients differentially enhances aspects of memory and attention in healthy young adults. *Biol Psychol*. (2012) 89:477–86. doi: 10.1016/j.biopsycho.2011.12.017

65. Owen, L, Scholey, AB, Finnegan, Y, and Hu, HS-LS. The effect of glucose dose and fasting interval on cognitive function: a double-blind, placebo-controlled, six-way crossover study. *Psychopharmacology*. (2012) 220:577–89. doi: 10.1007/s00213-011-2510-2

66. Sünram-Lea, SI, Owen, L, and Finnegan, YHH. Dose-response investigation into glucose facilitation of memory performance and mood in healthy young adults. *J Psychopharmacol*. (2011) 25:1076–87. doi: 10.1177/0269881110367725

67. Adolphus, K, Lawton, CL, Claire, L, and Champ 2, LD. The effects of breakfast and breakfast composition on cognition in adults. *Adv Nutrition*. (2016) 7:576S–89S. doi: 10.3945/an.115.010231

68. Galioto, R, and Spitznagel, MB. The effects of breakfast and breakfast composition on cognition in adults. *Adv Nutr*. (2016) 7:576S–89S. doi: 10.3945/an.115.010231

69. Shakersain, B, Rizzuto, D, Larsson, SC, Faxén-Irving, G, Fratiglioni, L, and Xu, WL. The nordic prudent diet reduces risk of cognitive decline in the Swedish older adults: a population-based cohort study. *Nutrients*. (2018) 10:229. doi: 10.3390/nu10020229

70. Anastasiou, CA, Yannakoulia, M, Kosmidis, MH, Dardiotis, E, Hadjigeorgiou, GM, Sakka, P, et al. Mediterranean diet and cognitive health: initial results from the Hellenic longitudinal investigation of ageing and diet. *PLoS One*. (2017) 12:e0182048–18. doi: 10.1371/journal.pone.0182048

71. Wengreen, H, Munger, RG, Cutler, A, Quach, A, Bowles, A, Corcoran, C, et al. Prospective study of dietary approaches to stop hypertension-and Mediterranean-style dietary patterns and age-related cognitive change: the Cache County Study on memory, health and aging. *Am J Clin Nutr*. (2013) 98:1263–71. doi: 10.3945/ajcn.112.051276

72. Abargouei, AS, Kalantari, N, Omidvar, N, Rashidkhani, B, Rad, AH, Ebrahimi, AA, et al. Refined carbohydrate intake in relation to non-verbal intelligence among Tehrani schoolchildren. *Public Health Nutr*. (2012) 15:1925–31. doi: 10.1017/S1368980011003302

73. Bhushan, A, Fondell, E, Ascherio, A, Yuan, C, and Grodstein, FWW. Adherence to Mediterranean diet and subjective cognitive function in men. *Eur J Epidemiol*. (2018) 33:223–34. doi: 10.1007/s10654-017-0330-3

74. Bajerska, J, Woźniewicz, M, and Suwalska, AJJ. Eating patterns are associated with cognitive function in the elderly at risk of metabolic syndrome from rural areas. *Eur Rev Med Pharmacol Sci*. (2014) 18:3234–45.

75. Hosking, DE, Eramudugolla, R, and Cherbuin, NAKJ. MIND not Mediterranean diet related to 12-year incidence of cognitive impairment in an Australian longitudinal cohort study. *Alzheimers Dement*. (2019) 15:581–9. doi: 10.1016/j.jalz.2018.12.011

76. Scott, TM, Rasmussen, HM, Chen, O, and Johnson, EJ. Avocado consumption increases macular pigment density in older adults: a randomized, controlled trial. *Nutrients*. (2017) 9:919. doi: 10.3390/nu9090919

77. Klimova, B, Novotný, M, Kuca, K, and Valis, M. Effect of an extra-virgin olive oil intake on the delay of cognitive decline: role of secoiridoid oleuropein? *Neuropsychiatr Dis Treat*. (2019) 15:3033–40. doi: 10.2147/NDT.S218238

78. Klimova, B, Dziuba, S, and Cierniak-Emerych, A. The effect of healthy diet on cognitive performance among healthy seniors–a mini review. *Front Hum Neurosci*. (2020) 14:1–9. doi: 10.3389/fnhum.2020.00325

79. Medawar, E, Huhn, S, Villringer, A, and Veronica Witte, A. The effects of plant-based diets on the body and the brain: a systematic review. *Transl Psychiatry*. (2019) 9:226. doi: 10.1038/s41398-019-0552-0

80. Valls-Pedret, C, Sala-Vila, A, Serra-Mir, M, Corella, D, de la Torre, R, Martínez-González, MÁ, et al. Mediterranean diet and age-related cognitive decline: a randomized clinical trial. *JAMA Intern Med*. (2015) 175:1094–103. doi: 10.1001/jamainternmed.2015.1668

81. Nooyens, AC, Bueno-de-Mesquita, HB, van Boxtel, MP, van Gelder, BM, and Verhagen, HVWM. Fruit and vegetable intake and cognitive decline in middle-aged men and women: the Doetinchem cohort Study. *Br J Nutr*. (2011) 106:752–61. doi: 10.1017/S0007114511001024

82. O'Brien, J, Okereke, O, Devore, E, Rosner, B, Breteler, M, and Grodstein, F. Long-term intake of nuts in relation to cognitive function in older women. *J Nutr Health Aging*. (2014) 18:496–502. doi: 10.1007/s12603-014-0014-6

83. Qin, B, Adair, LS, Plassman, BL, Batis, C, Edwards, LJ, and Popkin, BMMMA. Dietary patterns and cognitive decline among Chinese older adults. *Physiol Behav*. (2017) 176:139–48. doi: 10.1097/EDE.0000000000000338.Dietary

84. Cohen, JF, Gorski, MT, Gruber, SA, and Kurdziel, LBREB. The effect of healthy dietary consumption on executive cognitive functioning in children and adolescents: a systematic review. *Br J Nutr*. (2016) 116:989–1000. doi: 10.1017/S0007114516002877

85. Ng, QX, Loke, W, Foo, NX, Tan, WJ, Chan, HW, and DYYWS, L. A systematic review of the clinical use of Withania somnifera (Ashwagandha) to ameliorate cognitive dysfunction. *Phytother Res*. (2020) 34:583–90. doi: 10.1002/ptr.6552

86. Cox, KH, and Pipingas, ASA. Investigation of the effects of solid lipid curcumin on cognition and mood in a healthy older population. *J Psychopharmacol*. (2015) 29:642–51. doi: 10.1177/0269881114552744

87. Cherniack, EP. A berry thought-provoking idea: the potential role of plant polyphenols in the treatment of age-related cognitive disorders. *Br J Nutr*. (2012) 108:794–800. doi: 10.1017/S0007114512000669

88. Schaffer, S, and Halliwell, B. Do polyphenols enter the brain and does it matter? Some theoretical and practical considerations. *Genes Nutr*. (2012) 7:99–109. doi: 10.1007/s12263-011-0255-5

89. Mintzer, J, Donovan, KA, Kindy, AZ, Lock, SL, Chura, LR, and Barracca, N. Lifestyle choices and brain health. *Front Med (Lausanne)*. (2019) 6:1–11. doi: 10.3389/fmed.2019.00204

90. Adam, MB, Usman, AK, Frank, AP, Lok-Kin, Y, Wendy, S, Hagen, S, et al. Enhancing dentate gyrus function with dietary flavanols improves cognition in older adults. *Nat Neurosci*. (2016) 176:139–48. doi: 10.1038/nn.3850.Enhancing

91. Moreira, A, Diógenes, MJ, de Mendonça, A, and Lunet, NBH. Chocolate consumption is associated with a lower risk of cognitive decline. *J Alzheimers Dis*. (2016) 53:85–93. doi: 10.3233/JAD-160142

92. Mulder, KA, Innis, SM, Rasmussen, BF, Wu, BT, Richardson, KJ, and Hasman, D. Plasma lutein concentrations are related to dietary intake, but unrelated to dietary saturated fat or cognition in young children. *J Nutr Sci*. (2014) 3:e11–8. doi: 10.1017/jns.2014.10

93. Jia, YP, Sun, L, Yu, HS, Liang, LP, Li, W, Ding, H, et al. The pharmacological effects of lutein and zeaxanthin on visual disorders and cognition diseases. *Molecules*. (2017) 22:1–22. doi: 10.3390/molecules22040610

94. Lieblein-Boff, JC, Johnson, EJ, Kennedy, AD, Lai, CS, and Kuchan, MJ. Exploratory metabolomic analyses reveal compounds correlated with lutein concentration in frontal cortex, hippocampus, and occipital cortex of human infant brain. *PLoS One*. (2015) 10:1–19. doi: 10.1371/journal.pone.0136904

95. Cao, C, Loewenstein, DA, Lin, X, Zhang, C, Wang, L, Duara, R, et al. High blood caffeine levels in MCI linked to lack of progression to dementia. *Physiol Behav*. (2017) 176:139–48. doi: 10.3233/JAD-2012-111781.High

96. Gelber, RP, Petrovitch, H, Masaki, KH, Ross, GW, and White, LR. Coffee intake in midlife and risk of dementia and its neuropathologic correlates. *J Alzheimers Dis*. (2011) 23:607–15. doi: 10.3233/JAD-2010-101428

97. Arab, L, Biggs, ML, O'Meara, ES, Longstreth, WT, and Crane ALF, PK. Gender differences in tea, coffee, and cognitive decline in the elderly: the cardiovascular health Study. *Bone*. (2014) 23:1–7. doi: 10.3233/JAD-2011-110431.Gender

98. Soni, M, Rahardjo, TB, Soekardi, R, Sulistyowati, Y, Lestariningsih, Y-UA, and Irsan, AHE. Phytoestrogens and cognitive function: a review. *Maturitas*. (2014) 77:209–20. doi: 10.1016/j.maturitas.2013.12.010

99. Alekel, DL, Genschel, U, Koehler, KJ, Hofmann, H, Van Loan, MD, Beer, BS, et al. Soy Isoflavones for reducing bone loss Study: effects of a 3-year trial on hormones, adverse events, and endometrial thickness in postmenopausal women. *Menopause*. (2015) 22:185–97. doi: 10.1097/GME.0000000000000280

100. Hill, JH, and Claudia Solt, MTF. Obesity associated disease risk: the role of inherent differences and location of adipose depots. Horm Mol biol. *Clin Investig*. (2018) 16. doi: 10.1515/hmbci-2018-0012

101. Korecka, A, and Arulampalam, V. The gut microbiome: scourge, sentinel or spectator? *J Oral Microbiol*. (2012) 4:9367. doi: 10.3402/jom.v4i0.9367

102. Keunen, K, Van Elburg, RM, Van Bel, F, and Benders, MJNL. Impact of nutrition on brain development and its neuroprotective implications following preterm birth. *Pediatr Res*. (2015) 77:148–55. doi: 10.1038/pr.2014.171

103. Mohajeri, MH, Brummer, RJM, Rastall, RA, Weersma, RK, Harmsen, HJM, Faas, M, et al. The role of the microbiome for human health: from basic science to clinical applications. *Eur J Nutr*. (2018) 57:1–14. doi: 10.1007/s00394-018-1703-4

104. Askarova, S, Umbayev, B, Masoud, AR, Kaiyrlykyzy, A, Safarova, Y, Tsoy, A, et al. The links between the gut microbiome, aging, modern lifestyle and Alzheimer's disease. *Front Cell Infect Microbiol*. (2020) 10:1–12. doi: 10.3389/fcimb.2020.00104

105. Mayer, EA, Knight, R, Mazmanian, SK, Cryan, JF, and Tillisch, K. Gut microbes and the brain: paradigm shift in neuroscience. *J Neurosci*. (2014) 34:15490–6. doi: 10.1523/JNEUROSCI.3299-14.2014

106. Devasia, S, Kumar, S, Stephena, PS, Inoue, N, Sugihara, F, Koizumi, S, et al. A double blind, randomised, four arm clinical study to evaluate the safety, efficacy and tolerability of collagen peptide as a nutraceutical therapy in the management of Type II diabetes mellitus. *J Diabetes Metab*. (2020) 10:839. doi: 10.35248/2155-6156.19.10.839

107. Wall, R, Cryan, JF, Ross, RP, Fitzgerald, GF, and Dinan, TGSC. Bacterial neuroactive compounds produced by psychobiotics. *Adv Exp Med Biol*. (2014) 817:221–39. doi: 10.1007/978-1-4939-0897-4_10

108. Dinan, TG, and Cryan, JF. Gut instincts: microbiota as a key regulator of brain development, ageing and neurodegeneration. *J Physiol*. (2017) 595:489–503. doi: 10.1113/JP273106

109. Stilling, RM, van de Wouw, M, Clarke, G, Stanton, C, and Dinan, TGCJF. The neuropharmacology of butyrate: the bread and butter of the microbiota-gut-brain axis? *Neurochem Int*. (2016) 99:110–32. doi: 10.1016/j.neuint.2016.06.011

110. Paul, B, Barnes, S, Demark-Wahnefried, W, Morrow, C, Salvador, C, Skibola, C, et al. Influences of diet and the gut microbiome on epigenetic modulation in cancer and other diseases. *Clin Epigenetics*. (2015) 7:112–1. doi: 10.1186/s13148-015-0144-7

111. Gareau, MG, Wine, E, Rodrigues, DM, Cho, JH, Whary, MT, Philpott, DJ, et al. Bacterial infection causes stress-induced memory dysfunction in mice. *Gut*. (2011) 60:307–17. doi: 10.1136/gut.2009.202515

112. Desbonnet, L, Clarke, G, Traplin, A, O'Sullivan, O, Crispie, F, Moloney, RD, et al. Gut microbiota depletion from early adolescence in mice: implications for brain and behaviour. *Brain Behav Immun*. (2015) 48:165–73. doi: 10.1016/j.bbi.2015.04.004

113. Ohland, CL, Kish, L, Bell, H, Thiesen, A, Hotte, N, and Pankiv, EMKL. Effects of *Lactobacillus helveticus* on murine behavior are dependent on diet and genotype and correlate with alterations in the gut microbiome. *Psychoneuroendocrinology*. (2013) 38:1738–47. doi: 10.1016/j.psyneuen.2013.02.008

114. Davari, S, Talaei, SA, and Alaei, HSM. Probiotics treatment improves diabetes-induced impairment of synaptic activity and cognitive function: behavioral and electrophysiological proofs for microbiome-gut-brain axis. *Neuroscience*. (2013) 240:287–96. doi: 10.1016/j.neuroscience.2013.02.055

115. Puri, S., Shaheen, M., & Grover, B. (2023). Nutrition and cognitive health: A life course approach. *Frontiers in public health*, *11*, 1023907.

اضطرابات الإدراك وتأثير التغذية: مراجعة محدثة

الملخص :

الخلفية: يشمل الصحة الإدراكية القدرة على التفكير والتعلم والتذكر وتنظيم العواطف والمهارات الحركية. وهي ضرورية للحفاظ على الاستقلالية، والتكيف مع التحديات، ودعم التعافي من المرض. بينما يمكن أن تؤثر التغيرات المرتبطة بالعمر، والصدمة، والأمراض على صحة الدماغ، فإن العوامل المتعلقة بنمط الحياة مثل التغذية تلعب دورًا كبيرًا في الوقاية أو التخفيف من التدهور الإدراكي، خاصةً لدى كبار السن. يسلط الباحثون الضوء على مفهوم "الاحتياطي الإدراكي"، الذي يشير إلى قدرة الدماغ على مقاومة الأضرار والحفاظ على الوظيفة. ونظرًا لتزايد الأبحاث المتعلقة بالعلاقة بين النظام الغذائي والصحة الإدراكية، من الضروري فحص دور التغذية طوال الحياة، خاصةً في الوقاية من التدهور الإدراكي المرتبط بالعمر .

الهدف: تستعرض هذه المراجعة تأثير التغذية على الصحة الإدراكية، مع التركيز على المراحل التنموية من الطفولة إلى البلوغ، وتحقق كيف تؤثر العناصر الغذائية المختلفة على الوظائف الإدراكية، والاحتياطي الإدراكي، والوقاية من التدهور الإدراكي لدى كبار السن.

الطرق: تقوم المراجعة بتلخيص الأدبيات الموجودة حول دور التغذية في تطوير الدماغ والوظيفة الإدراكية على مدار الحياة، مع إيلاء اهتمام خاص للعناصر الغذائية الدقيقة، وأنماط النظام الغذائي، وتأثيراتها على الأداء الإدراكي. تبرز الدراسات التي تقيم تأثيرات العناصر الغذائية المحددة، مثل الفيتامينات ب، وفيتامين د، والحديد، ومضادات الأكسدة، على صحة الدماغ .

النتائج: تشير الأدلة إلى أن نقص العناصر الغذائية الدقيقة مثل الحديد، واليود، والفيتامينات ب 12 و د، يؤثر سلبًا على التطور الإدراكي والوظيفة. ارتبط تناول الأطعمة الغنية بمضادات الأكسدة، إلى جانب أنماط النظام الغذائي المحددة مثل النظام الغذائي المتوسطي والنظام الغذائي الشمالي، بتقليل خطر التدهور الإدراكي والخرف. بالإضافة إلى ذلك، أظهر تناول وجبة الإفطار تأثيرات إيجابية على المهام الإدراكية مثل الذاكرة والانتباه.

الخاتمة: إن التغذية السليمة أمر بالغ الأهمية في جميع مراحل الحياة لدعم صحة الدماغ، والوقاية من التدهور الإدراكي، وتحسين جودة الحياة لدى كبار السن. إن تبني أنماط غذائية متوازنة، خاصة تلك الغنية بمضادات الأكسدة والعناصر الغذائية الأساسية، مفيد للأداء الإدراكي. هناك حاجة إلى مزيد من البحث لتوضيح التأثيرات طويلة المدى للتدخلات الغذائية على شيخوخة الدماغ .

الكلمات المفتاحية: الصحة الإدراكية، التغذية، تطور الدماغ، التدهور الإدراكي، الخرف، مضادات الأكسدة، أنماط النظام الغذائي، الفيتامينات ب، فيتامين د، النظام الغذائي المتوسطي.