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The Role of Omega-3 Fatty Acids in Cognitive Health: From Development to Aging and Neurodegenerative Protection

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Abstract

Introduction and Purpose

Omega-3 polyunsaturated fatty acids (PUFAs), particularly docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), are essential for brain structure and function across all life stages. DHA supports synaptic plasticity, neurogenesis, and neurotransmission, while EPA modulates inflammation and cerebral blood flow. This review evaluates the impact of Omega-3 PUFAs on cognitive development, maintenance, and neuroprotection, synthesizing findings from clinical trials, observational studies, and meta-analyses.

Materials and Methods

A systematic review of randomized controlled trials, cohort studies, and meta-analyses was conducted. Studies on maternal Omega-3 intake and infant cognition, adult supplementation and cognitive function, and Omega-3s in aging and neurodegeneration were included. Biomarkers such as plasma DHA/EPA levels, cognitive function tests, and neuroimaging data were analyzed. Safety and tolerability were also assessed.

Results

Maternal DHA intake supports infant cognitive development, particularly in problem-solving and language skills, though findings vary. In adulthood, Omega-3s contribute to memory, executive function, and mood regulation, but evidence remains mixed. Higher intake is linked to slower cognitive decline and lower dementia risk, primarily via neuroinflammation reduction. Omega-3s show promise in early cognitive decline by reducing oxidative stress and β-amyloid accumulation, but their role in advanced Alzheimer's remains unclear. Supplementation is safe, with minor side effects at high doses.

Conclusion

Omega-3s support cognitive function and neuroprotection, particularly in early-life development and aging. Their strongest role is in reducing neuroinflammation and slowing cognitive decline. However, benefits in healthy adults and late-stage dementia remain inconclusive. Future research should explore personalized nutrition, optimal dosage, and genetic interactions

Keywords: omega-3 fatty acids, DHA, EPA, cognitive function, neuroprotection, neuroinflammation, Alzheimer's disease, cognitive aging.

Introduction

Omega-3 fatty acids are essential polyunsaturated fats crucial for brain function. The three primary types include docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA), and alpha-linolenic acid (ALA). While ALA is a plant-derived precursor that converts inefficiently to DHA and EPA, these two long-chain omega-3s play direct roles in cognitive processes. DHA, making up 30-40% of the fatty acids in brain gray matter, is integral to neuronal membrane fluidity, synaptic function, and neurotransmission [1]. EPA, though less abundant, has significant anti-inflammatory and vascular benefits that support cognitive health [2].

Cognitive decline is a natural consequence of aging, often exacerbated by neurodegenerative diseases such as Alzheimer's disease (AD) and mild cognitive impairment (MCI). AD is characterized by amyloid-beta plaques, tau protein tangles, and chronic inflammation, with research showing that lower DHA levels correlate with higher AD risk. MCI, an early stage of cognitive impairment, significantly increases the likelihood of progression to dementia. Aging-related changes affect memory, executive function, and processing speed, driven by hippocampal shrinkage, reduced synaptic plasticity, and white matter degeneration [3]. Given these changes, dietary interventions such as omega-3 supplementation are explored as potential neuroprotective strategies. DHA is a major component of neuronal membranes, ensuring structural stability and promoting synaptic plasticity—key for learning and memory [1]. Omega-3 fatty acids also reduce neuroinflammation, a crucial factor in cognitive decline, by suppressing pro-inflammatory cytokines (IL-6, TNF-α) and inhibiting microglial overactivation [2].

Additionally, DHA and EPA facilitate the production of specialized pro-resolving mediators (SPMs) such as resolvins and protectins, which help resolve brain inflammation [2]. Their role in neurogenesis is also significant, as they enhance brain-derived neurotrophic factor (BDNF) levels, which are essential for neuronal survival and synaptic remodeling [3]

Observational studies consistently associate higher omega-3 intake with better cognitive performance, while interventional trials suggest potential benefits in slowing cognitive decline [4]. However, not all clinical trials have reported significant effects, possibly due to variability in baseline omega-3 levels, genetic factors (e.g., APOE4), dosage differences, and study duration [5]. Meta-analyses highlight modest improvements in memory and executive function, particularly in individuals with MCI [4].

Mechanisms of Action of Omega-3 Fatty Acids in the Brain

Omega-3 fatty acids, particularly docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), play a critical role in brain health. Their integration into neuronal membranes enhances synaptic function, neurotransmission, and cognitive resilience [1]. DHA is particularly abundant in gray matter, where it contributes to neuronal plasticity, membrane fluidity, and receptor activity [2]. EPA, though less prevalent, supports anti-inflammatory and vascular functions, which are essential for protecting against neurodegeneration [2].

One of the key mechanisms by which omega-3 fatty acids benefit the brain is through their anti-inflammatory properties. Chronic neuroinflammation is a major contributor to cognitive decline and neurodegenerative diseases, with activated microglia releasing pro-inflammatory cytokines (IL-6, TNF-α), leading to neuronal damage [2]. DHA and EPA help counteract this by promoting the production of specialized pro-resolving mediators (SPMs), such as resolvins and protectins, which actively reduce inflammation and restore homeostasis[2]. This ability to regulate inflammation is particularly important in aging populations, where chronic low-grade inflammation accelerates synaptic degradation and cognitive impairment [3].

Another critical role of omega-3s is in synaptic plasticity and neurogenesis, both essential for learning and memory. DHA enhances brain-derived neurotrophic factor (BDNF) levels, a key protein involved in neuronal survival, synaptic growth, and cognitive flexibility [3]. Studies show that higher DHA levels correlate with improved memory and executive function, while deficiencies are associated with reduced synaptic integrity and cognitive decline [3]. Omega-3s also improve hippocampal function, the brain region most involved in memory processing, further supporting their role in cognitive health [2].

Beyond inflammation and synaptic function, omega-3s contribute to blood-brain barrier integrity, ensuring proper nutrient and oxygen delivery while preventing harmful substances

from entering the brain [2]. This vascular support is essential in aging populations, where compromised BBB function can accelerate neurodegenerative processes [3].

Although numerous studies support the cognitive benefits of omega-3 fatty acids, clinical trial results remain mixed. Some randomized controlled trials (RCTs) report improvements in cognitive performance, while others show minimal effects, likely due to differences in baseline omega-3 status, genetic factors (APOE4), and dosage variations [5]. Despite these inconsistencies, observational research consistently links higher omega-3 intake with reduced dementia risk and slower cognitive decline [4].

Omega-3 Fatty Acids and Cognitive Development

Omega-3 fatty acids, particularly docosahexaenoic acid (DHA), are essential for early brain development, as they contribute to neuronal membrane formation, synaptic plasticity, and cognitive processing. DHA is highly concentrated in the cerebral cortex and hippocampus, regions critical for memory and learning. Since the body cannot efficiently synthesize DHA, its availability during fetal and infant development depends on maternal dietary intake [6]. During pregnancy, DHA is transferred from the mother to the fetus via the placenta, influencing fetal brain growth and neural connectivity. After birth, breast milk remains a primary source of DHA, and supplementation in formula-fed infants aims to mimic these benefits [6]

Studies indicate that higher maternal DHA intake during pregnancy correlates with better cognitive outcomes in children, including faster information processing, improved attention, and enhanced problem-solving skills [6]. Infants with higher DHA levels at birth often perform better in visual recognition and language acquisition tests later in childhood. Postnatal DHA intake continues to shape cognitive function, as research suggests that children with higher DHA levels demonstrate superior verbal learning, executive function, and sustained attention [6].

Beyond direct cognitive benefits, DHA and eicosapentaenoic acid (EPA) contribute to neuroinflammation regulation, which plays a role in the development of neurodevelopmental disorders such as ADHD and autism spectrum disorders [7]. Studies suggest that children with ADHD often have lower DHA and EPA levels, and supplementation may help improve focus, impulse control, and behavioral regulation [7]. Omega-3s also support emotion regulation,

with research linking low DHA levels to an increased risk of anxiety and depression in children [7].

The source of Omega-3 intake—whether through diet or supplementation—affects its efficacy in cognitive development. Seafood consumption during pregnancy has been associated with higher IQ scores in children, potentially due to the combination of DHA and other brain-supporting nutrients like iodine and selenium [6]. While observational studies strongly support the role of Omega-3s in early brain development, clinical trials continue to explore the long-term impact of prenatal and infant supplementation. Research suggests that adequate DHA intake in early life sets the foundation for lifelong cognitive function, though more studies are needed to refine optimal dosage and timing main [8].

Omega-3 Fatty Acids and Cognitive Decline in Aging

Cognitive decline is a natural process associated with aging, often marked by memory impairment, slower processing speed, and reduced executive function. While some decline is expected as part of normal aging, neurodegenerative conditions such as mild cognitive impairment (MCI) and Alzheimer's disease (AD) accelerate this process. Omega-3 fatty acids, particularly docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), have been studied for their potential role in slowing age-related cognitive decline by supporting neuronal structure, synaptic function, and anti-inflammatory mechanisms [4].

DHA is a key structural component of neuronal membranes, making up a significant portion of the gray matter in the brain. It is essential for maintaining synaptic integrity and neurotransmission, which are crucial for learning and memory processes. Aging is often accompanied by reduced DHA levels in the brain, which correlates with cognitive decline and neurodegeneration [1]. Studies show that individuals with higher DHA levels tend to have better cognitive performance, while deficiencies are linked to an increased risk of developing AD [4].

Chronic neuroinflammation is another major contributor to cognitive decline. In aging brains, activated microglia release pro-inflammatory cytokines such as TNF-α and IL-6, leading to neuronal damage and impaired synaptic function [2]. DHA and EPA help counteract this by promoting the production of specialized pro-resolving mediators (SPMs), including resolvins and protectins, which work to suppress inflammation and restore neuronal health [2]. This

anti-inflammatory effect is particularly relevant in preventing vascular dementia and neurovascular dysfunction, both of which are associated with cognitive impairment [3].

Another critical factor in cognitive aging is oxidative stress, which accelerates neuronal damage and disrupts synaptic communication. Omega-3 fatty acids possess antioxidant properties that help neutralize reactive oxygen species (ROS) and reduce lipid peroxidation in the brain [3]. By mitigating oxidative damage, DHA and EPA may help preserve cognitive function and neuronal longevity.

Several observational studies indicate that individuals who consume higher amounts of Omega-3s, particularly from fish or supplements, exhibit slower rates of cognitive decline and lower dementia risk [4]. Interventional studies suggest that Omega-3 supplementation improves working memory, attention, and verbal fluency, particularly in individuals with MCI [4]. However, clinical trial results remain inconsistent, with some studies showing no significant cognitive benefits, possibly due to variations in baseline Omega-3 levels, APOE4 genetic status, dosage, and treatment duration [5].

While the protective effects of Omega-3 fatty acids against cognitive decline are still being explored, evidence suggests that maintaining adequate DHA and EPA levels through diet or supplementation may help support brain function and delay neurodegeneration in aging populations [4].

Clinical Trials and Meta-Analyses on Omega-3 and Cognitive Function

Research on omega-3 fatty acids and cognitive function has led to numerous randomized controlled trials (RCTs) and meta-analyses assessing their role in cognitive decline, brain aging, and neurodegenerative diseases. While some trials have shown positive cognitive benefits, others have reported inconsistent or negligible effects, highlighting the complexity of omega-3's impact on cognition [5]

A six-month RCT tested high-dose omega-3 and omega-6 fatty acids combined with antioxidant vitamins in older adults with mild cognitive impairment (MCI). The study found significant improvements in cognitive function, functional capacity, and overall quality of life compared to the placebo group [3]. Notably, these benefits were observed in tests assessing memory, executive function, and processing speed, suggesting that nutritional interventions can help slow early cognitive decline.

Another meta-analysis reviewed the effects of long-chain omega-3 supplementation on neurodegenerative diseases. Findings indicated that while omega-3s were not effective in reversing Alzheimer's disease (AD), they helped slow cognitive decline in individuals with early-stage MCI. Patients with higher baseline omega-3 levels showed greater improvements, reinforcing the importance of long-term dietary intake rather than short-term supplementation [9].

In addition, a systematic review on omega-3 intake during menopause highlighted its mood-stabilizing and cognitive-enhancing effects. Women taking omega-3 supplements reported fewer cognitive complaints, improved verbal fluency, and reduced depression/anxiety symptoms, which are commonly associated with hormonal fluctuations during menopause [9]. This suggests that omega-3 may be particularly beneficial in populations experiencing hormone-related cognitive changes.

Despite promising results, some RCTs have failed to show significant cognitive benefits. A large-scale trial on older adults found that omega-3 supplementation did not significantly improve global cognitive scores, although secondary analyses suggested subtle benefits in episodic memory and executive function. This discrepancy may stem from variations in dosage, study duration, and genetic factors such as APOE4 status. A safety review and meta-analysis of omega-3 supplementation in cognitive health highlighted minimal adverse effects. The most commonly reported issues were mild gastrointestinal discomfort and altered taste perception (dysgeusia), but no serious adverse events were linked to long-term supplementation [5]. This makes omega-3s a low-risk intervention for aging populations seeking to support brain health.

Clinical trials and safety reviews indicate that omega-3 supplementation is generally safe, with no major adverse effects reported in long-term studies [5]. However, mild side effects have been noted, including gastrointestinal discomfort (bloating, diarrhea, nausea), dysgeusia (altered taste), and mild increases in bleeding tendency due to omega-3's antithrombotic properties [5].

Advanced Perspectives on Omega-3 Fatty Acids and Cognitive Function

Emerging research on omega-3 polyunsaturated fatty acids (PUFAs), particularly DHA and EPA, highlights their role in cognitive health, neuroprotection, and aging. Innovations in

structured lipids (SLs), such as phospholipid-bound DHA, have demonstrated enhanced bioavailability and stronger neuroprotective effects compared to traditional formulations [10].

A meta-analysis of 24 RCTs found that DHA + EPA intake above 500 mg/day significantly improved executive function in middle-aged and older adults, particularly in those with MCI and lower baseline omega-3 levels [11]. Similarly, studies on ADHD show that EPA-dominant formulations (≥1,000 mg/day) enhance attention and impulse control, correlating with lower omega-3 blood levels in affected children [7].

In late-life depression, omega-3s—especially EPA—have been linked to better immediate recall and cognitive resilience, with balanced omega-6 to omega-3 ratios playing a crucial role [12]. Longitudinal studies suggest that high-dose omega-3 supplementation (≥2,000 mg/day) slows brain atrophy and preserves gray and white matter integrity, contributing to slower cognitive decline [13]. Despite these promising findings, challenges in standardizing dosage, optimizing bioavailability, and tailoring interventions remain. Future research should focus on personalized nutrition approaches, combining omega-3s with antioxidants, B vitamins, and lifestyle modifications to enhance cognitive benefits [13].

Recommended Dosages of Omega-3 for Different Conditions

The optimal dosage of omega-3 fatty acids depends on age, health status, and specific conditions. Clinical guidelines and trials suggest the following intake recommendations:

- General Cognitive Health & Aging Prevention: 250–500 mg DHA + EPA per day (from food or supplements) is sufficient for healthy adults to support brain function [6].
- Mild Cognitive Impairment (MCI) & Early Alzheimer's Disease: Higher doses, 1,000–2,000 mg DHA + EPA daily, have shown cognitive benefits in slowing memory decline and supporting synaptic function [3][14].
- Depression & Anxiety (Including Menopausal Mood Disorders): 1,000–2,200 mg EPA per day is recommended, as EPA-dominant supplements show greater efficacy in mood regulation and anxiety reduction compared to DHA alone [9]. Studies on menopausal women suggest that higher EPA intake (≥1,800 mg daily) may help stabilize mood and enhance cognitive performance [9].

- Cardiovascular & Vascular Dementia Prevention: 2,000–4,000 mg DHA + EPA per day is used in cardiovascular research to reduce triglycerides, inflammation, and stroke risk, which also benefits vascular dementia prevention [5].
- Safe Upper Limit: The European Food Safety Authority (EFSA) and FDA consider doses up to 5,000 mg per day of combined DHA and EPA safe for long-term use [5]. However, exceeding 3,000 mg daily may increase the risk of bleeding in individuals taking anticoagulants (e.g., aspirin, warfarin) and should be monitored under medical supervision [5].

Influence of Omega-3 Fatty Acids on Cognitive Function in Different Conditions

Omega-3 fatty acids, particularly docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), have been extensively studied for their role in supporting cognitive function across various neurological and psychiatric conditions. Research indicates that different conditions, such as Alzheimer's disease (AD), mild cognitive impairment (MCI), attention deficit hyperactivity disorder (ADHD), depression, and stroke recovery, may benefit from omega-3 supplementation due to their anti-inflammatory, neuroprotective, and synaptic-enhancing properties [5, 9].

Omega-3 and Alzheimer's Disease (AD)

Alzheimer's disease is characterized by progressive cognitive decline, amyloid-beta plaque accumulation, and neuroinflammation. Studies have found that DHA levels are significantly reduced in AD patients, correlating with memory impairment and neuronal loss. DHA is crucial for maintaining synaptic integrity and reducing oxidative stress, both of which are impaired in AD [14][15].

Clinical trials have yielded mixed results regarding omega-3 acids ability to slow cognitive decline in AD. Some studies suggest that higher DHA intake (~2,000 mg/day) helps reduce beta-amyloid buildup and improve cognitive function in early-stage AD [3]. A meta-analysis found that combining DHA with antioxidants and anti-inflammatory agents may enhance its neuroprotective effects in AD, suggesting a multinutrient approach could be beneficial [16].

Omega-3 and Attention Deficit Hyperactivity Disorder (ADHD)

Omega-3 fatty acids are essential for neurodevelopment and neurotransmitter regulation, making them relevant for conditions like ADHD, which involves attention deficits, impulsivity, and hyperactivity. Research shows that children with ADHD tend to have lower DHA and EPA levels, suggesting a role for supplementation in managing symptoms [6].

A meta-analysis of omega-3 supplementation in ADHD found that EPA-dominant formulations (≥1,000 mg/day) were more effective in reducing hyperactivity, impulsivity, and improving attention compared to DHA-dominant supplements [9]. Another study reported that combining omega-3s with behavioral therapy enhanced treatment outcomes, reinforcing their synergistic potential.

Despite these findings, omega-3s are not considered a standalone treatment for ADHD, but rather a complementary intervention that may enhance medication efficacy and behavioral therapies [9]

Omega-3 and Depression-Related Cognitive Decline

Depression is often linked to cognitive impairments, including memory deficits, slower processing speed, and reduced executive function. Omega-3s, particularly EPA, play a role in reducing neuroinflammation, regulating serotonin function, and supporting synaptic plasticity, all of which contribute to mood and cognitive stability [9]

Clinical trials suggest that EPA supplementation (≥1,000 mg/day) improves cognitive flexibility, attention, and emotional processing in individuals with major depressive disorder (MDD) [9]. Studies on postpartum depression and menopausal cognitive changes have also demonstrated improvements in mood stability and cognitive clarity with EPA-rich omega-3 intake

The Impact of Omega-3 Fatty Acids on Cognitive and Cardiovascular Health

Omega-3 polyunsaturated fatty acids (PUFAs), particularly DHA and EPA, are essential for brain function and cardiovascular health, with studies linking them to reduced cognitive decline and neurodegeneration. However, findings remain inconsistent, likely due to differences in dosage, baseline omega-3 levels, and genetic factors [17, 18, 19].

A meta-analysis of 24 RCTs found that ≥500 mg/day of DHA + EPA improved executive function, especially in individuals with low baseline omega-3 levels 12916_2024_Article_3296. However, a Cochrane review found no clear evidence that omega-3s prevent cognitive decline, highlighting variability in study outcomes [19]. Omega-3s also support cardiovascular health, which is closely linked to cognitive function. They enhance cerebral blood flow, reduce inflammation, and lower stroke risk, potentially mitigating neurodegenerative disease progression [18, 20]. Despite this, high-dose supplementation (≥2,000 mg/day) has shown mixed results, with potential risks like atrial fibrillation [18].

Conclusion

Omega-3 polyunsaturated fatty acids (PUFAs), particularly DHA and EPA, are crucial for cognitive development, function, and neuroprotection from infancy to old age. They play a key role in brain structure, synaptic plasticity, and neurotransmitter regulation, supporting learning and attention in early life, memory and executive function in adulthood, and slowing neurodegeneration in aging. While research consistently highlights their benefits, dosage, bioavailability, genetic factors, and individual dietary habits influence their effectiveness. Despite some inconsistencies in clinical trials, structured omega-3 formulations and higher-dose interventions show promise in delaying cognitive decline and reducing the risk of neurodegenerative diseases. Ensuring adequate omega-3 intake throughout life—whether through diet or supplementation—remains a key strategy for maintaining cognitive health and resilience. Further research is needed to refine personalized recommendations and enhance the therapeutic potential of omega-3s in brain aging and disease prevention.

Disclosures

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References:

1. Robinson JG, Ijioma N, Harris W. Omega-3 fatty acids and cognitive function in women. *Womens Health (Lond)*. 2010;6(1):119-134. doi:10.2217/whe.09.75

2. Joffre C, Dinel AL, Chataigner M, Pallet V, Layé S. n-3 Polyunsaturated Fatty Acids and Their Derivates Reduce Neuroinflammation during Aging. *Nutrients*. 2020;12(3):647. Published 2020 Feb 28. doi:10.3390/nu12030647

3. Stavrinou PS, Andreou E, Aphamis G, et al. The Effects of a 6-Month High Dose Omega-3 and Omega-6 Polyunsaturated Fatty Acids and Antioxidant Vitamins Supplementation on Cognitive Function and Functional Capacity in Older Adults with Mild Cognitive Impairment. *Nutrients*. 2020;12(2):325. Published 2020 Jan 26. doi:10.3390/nu12020325

4. Wei BZ, Li L, Dong CW, Tan CC; Alzheimer's Disease Neuroimaging Initiative, Xu W. The Relationship of Omega-3 Fatty Acids with Dementia and Cognitive Decline: Evidence from Prospective Cohort Studies of Supplementation, Dietary Intake, and Blood Markers. *Am J Clin Nutr*. 2023;117(6):1096-1109. doi:10.1016/j.ajcnut.2023.04.001

5. Chang JP, Tseng PT, Zeng BS, et al. Safety of Supplementation of Omega-3 Polyunsaturated Fatty Acids: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Adv Nutr*. 2023;14(6):1326-1336. doi:10.1016/j.advnut.2023.08.003

6. Carlson SE, Colombo J. DHA and Cognitive Development. *J Nutr*. 2021;151(11):3265-3266. doi:10.1093/jn/nxab299

7. Chang JP, Su KP, Mondelli V, Pariante CM. Omega-3 Polyunsaturated Fatty Acids in Youths with Attention Deficit Hyperactivity Disorder: a Systematic Review and Meta-Analysis of Clinical Trials and Biological Studies. *Neuropsychopharmacology*. 2018;43(3):534-545. doi:10.1038/npp.2017.160

8. Cutuli D. Functional and Structural Benefits Induced by Omega-3 Polyunsaturated Fatty Acids During Aging. *Curr Neuropharmacol*. 2017;15(4):534-542. doi:10.2174/1570159X14666160614091311

9. Decandia D, Landolfo E, Sacchetti S, Gelfo F, Petrosini L, Cutuli D. n-3 PUFA Improve Emotion and Cognition during Menopause: A Systematic Review. *Nutrients*. 2022;14(9):1982. Published 2022 May 9. doi:10.3390/nu14091982

10. Mora I, Arola L, Caimari A, Escoté X, Puiggròs F. Structured Long-Chain Omega-3 Fatty Acids for Improvement of Cognitive Function during Aging. *Int J Mol Sci*. 2022;23(7):3472. Published 2022 Mar 23. doi:10.3390/ijms23073472

11. Erhardt R, Cardoso BR, Meyer BJ, et al. Omega-3 Long-Chain Polyunsaturated Fatty Acids: Are They Beneficial for Physical and Cognitive Functioning in Older Adults?. *J Nutr Health Aging*. 2021;25(4):454-461. doi:10.1007/s12603-020-1553-7

12. Chiu CC, Frangou S, Chang CJ, et al. Associations between n-3 PUFA concentrations and cognitive function after recovery from late-life depression. *Am J Clin Nutr*. 2012;95(2):420-427. doi:10.3945/ajcn.111.015784

13. Alex A, Abbott KA, McEvoy M, Schofield PW, Garg ML. Long-chain omega-3 polyunsaturated fatty acids and cognitive decline in non-demented adults: a systematic review and meta-analysis. *Nutr Rev*. 2020;78(7):563-578. doi:10.1093/nutrit/nuz073

14. Wood AHR, Chappell HF, Zulyniak MA. Dietary and supplemental long-chain omega-3 fatty acids as moderators of cognitive impairment and Alzheimer's disease. *Eur J Nutr*. 2022;61(2):589-604. doi:10.1007/s00394-021-02655-4

15. Waitzberg DL, Garla P. Contribución de los ácidos grasos omega-3 para la memoria y la función cognitiva [Contribution of omega-3 fatty acids for memory and cognitive function]. *Nutr Hosp*. 2014;30(3):467-477. Published 2014 Sep 1. doi:10.3305/nh.2014.30.3.7632

16. Maltais M, Lorrain D, Léveillé P, et al. Long-chain Omega-3 fatty acids supplementation and cognitive performance throughout adulthood: A 6-month randomized controlled trial. *Prostaglandins Leukot Essent Fatty Acids*. 2022;178:102415. doi:10.1016/j.plefa.2022.102415

17. Suh SW, Lim E, Burm SY, et al. The influence of n-3 polyunsaturated fatty acids on cognitive function in individuals without dementia: a systematic review and dose-response meta-analysis. *BMC Med*. 2024;22(1):109. Published 2024 Mar 12. doi:10.1186/s12916-024-03296-0

18. Elagizi A, Lavie CJ, O'Keefe E, Marshall K, O'Keefe JH, Milani RV. An Update on Omega-3 Polyunsaturated Fatty Acids and Cardiovascular Health. *Nutrients*. 2021;13(1):204. Published 2021 Jan 12. doi:10.3390/nu13010204

19. Dangour AD, Andreeva VA, Sydenham E, Uauy R. Omega 3 fatty acids and cognitive health in older people. *Br J Nutr*. 2012;107 Suppl 2:S152-S158. doi:10.1017/S0007114512001547

20. Jiao J, Li Q, Chu J, Zeng W, Yang M, Zhu S. Effect of n-3 PUFA supplementation on cognitive function throughout the life span from infancy to old age: a systematic review and meta-analysis of randomized controlled trials. *Am J Clin Nutr*. 2014;100(6):1422-1436. doi:10.3945/ajcn.114.095315