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INVESTIGATING THE EFFECTS OF OMEGA-3 FATTY ACIDS ON COGNITIVE FUNCTION IN INDIVIDUALS WITH DYSLEXIA: A SYSTEMATIC REVIEW OF EXISTING RESEARCH

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ABSTRACT

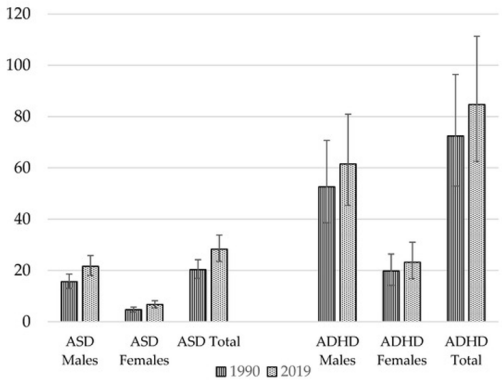
The objective of this paper is to review the possible effects of omega-3 fatty acids, specifically docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), on cognitive ability in individuals with dyslexia. Omega-3 fatty acids have been demonstrated to decrease oxidative stress and inflammation within the brain. This is especially important in dyslexia, as elevated levels of oxidative stress markers have been identified. Omega-3s may enhance brain function by protecting neurons from degradation by reducing oxidative damage. The EPA also helps protect the brain by reducing inflammation, which can negatively impact cognitive abilities and learning ability. Dyslexia is a neurodevelopmental disorder characterized primarily by error patterns in reading, but it also impacts memory, attention, and other functions. Its roots lie in deficits in phonological processing and working memory, often leading to the underactivation of particular brain regions such as the left temporoparietal cortex. While traditional interventions rely on educational strategies, emerging research suggests that omega-3 fatty acids, known for their crucial role in brain development and function, may provide cognitive benefits that complement existing treatments.

KEYWORDS: Omega-3 Fatty Acids, Docosahexaenoic Acid, Eicosapentaenoic Acid, Cognitive Ability, Phonological Processing, Neuronal Membranes

INTRODUCTION

Dyslexia is a cognitive disorder that mainly impacts a person's reading ability and influences other cognitive functions like memory, attention, and phonological processing. Dyslexia, which affects around 5-10% of people worldwide, is known for causing problems with reading comprehension and fluency and is considered one of the most prevalent learning disorders. Individuals with dyslexia frequently encounter difficulties with working memory and sustained attention, which is essential for successful learning and information processing, in addition to their struggles in reading. These cognitive impairments are usually associated with decreased neural activity in specific areas of the brain, especially those responsible for processing language and working memory. Consequently, dyslexia can greatly impede academic achievement and everyday activities.

The latest focus on the impact of nutrition, especially omega-3 fatty acids due to the increase in NDDs, on cognitive development has led to new areas of research being explored. Omega-3 fatty acids, such as docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), are crucial for the health and growth of the brain. These long-chain polyunsaturated fatty acids are essential parts of neuronal cell membranes and are important for synaptic plasticity, regulating neurotransmitters, and decreasing inflammation in the brain. DHA mainly helps maintain the structure of neurons and improves how well synapses work, while EPA is associated with anti-inflammatory effects that can safeguard neural pathways from harm. Omega-3s have received interest for their possible impact on enhancing cognitive function, both in early brain development and in sustaining cognitive health in the later stages of their lives.



Source: Vigo et al. (2022)

Figure 1: Global Burden of Neurodivergence in 204 countries

Past studies on omega-3 supplementation have demonstrated positive outcomes in improving cognitive function in neurotypical groups. Research has shown enhancements in focus, memory, and even literacy skills, especially in

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children and the elderly. The cognitive benefits are due to DHA and EPA's neuroprotective and synaptic-boosting qualities, which enhance neuron communication and aid learning and memory storage. Omega-3 supplementation is also associated with improved executive function and emotional regulation, indicating its potential to improve cognitive outcomes for a diverse range of people.

Despite these results, the precise impact of omega-3 supplementation on dyslexia is still not fully investigated. Although some evidence suggests that omega-3s can improve overall cognitive function, there is a lack of research on how they affect individuals with dyslexia, who have specific difficulties with language processing and working memory. The unique cognitive issues linked to dyslexia may have varying effects when combined with omega-3 supplements, indicating a need for further study on their effectiveness as a treatment option.

This study seeks to fill this research gap by examining how omega-3 fatty acids impact cognitive function in people with dyslexia. More specifically, it aims to investigate if omega-3 supplements can enhance important aspects of cognitive function like reading skills, working memory, and attention, often affected by dyslexia. This paper examines how omega-3s may help improve cognitive deficits in dyslexia by analyzing already gathered secondary data, adding to the ongoing conversation on nutritional treatments for learning disabilities.

Research Question

To what degree can Omega-3 fatty acids impact cognitive outcomes like reading ability and attention span in individuals with dyslexia?

LITERATURE REVIEW

Omega-3 fatty acids, specifically eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are necessary nutrients that are crucial in brain development and functioning. Evidence is increasing to indicate that not having enough of these fatty acids might play a role in the development of several psychiatric and neurodevelopmental conditions such as ADHD, dyslexia, DCD, and autism (Paper 1). This literature review combines results from three important studies to assess how omega-3 supplementation could be beneficial in treating dyslexia and related conditions, pointing out both positive results and areas that need more investigation.

More and more studies are now exploring the connection between omega-3 fatty acids and dyslexia, a prevalent learning disorder characterized by struggles with word recognition, spelling, and decoding. Research shows that people with dyslexia frequently have lower levels of fatty acids, and this is associated with how severe their dyslexic symptoms are. One research project examined 135 adults with dyslexia and 71 without, concluding that the level of fatty acid deficiency was directly related to the results of the dyslexia screening checklist (Paper 1). Moreover, a lack of fatty acids has been associated with other characteristics of dyslexia, like difficulty with visual processing and confusion with auditory information, indicating that providing dyslexic individuals with HUFAs through their diet could be helpful.

Clinical trials that are carefully monitored provide varying findings on the effectiveness of Omega-3 supplementation in treating dyslexia. Richardson and Puri (2002) carried out a two-phase randomized trial with a placebo group, focusing on children with learning disabilities, such as dyslexia. During the initial phase, 41 kids were given a daily supplement with EPA, DHA, γ-linolenic acid, arachidonic acid, vitamin E, conjugated linoleic acid, and thyme oil for three months. Paper 1 found notable decreases in symptoms of ADHD, dyslexia, and anxiety. During the second phase, children who were first given a placebo and later given the supplement displayed comparable, notable enhancements, supporting the potential advantages of omega-3s.

On the other hand, a different study with 61 children with dyslexia did not show any meaningful enhancements in cognitive abilities, such as reading and spelling, after taking EPA and carnosine supplements for 90 days (Paper 1). These varied results emphasize the need for more uniform diagnostic criteria and carefully planned study designs in order to evaluate the influence of omega-3s on dyslexia effectively.

Additional insights into the advantages of DHA supplementation are presented in the DHA Oxford Learning and Behaviour (DOLAB) study conducted by the University of Oxford. The research included 362 children between the ages of seven and nine who scored poorly on standardized reading assessments. Subjects were given a consistent amount of 600 mg/day of DHA sourced from algal oil over 16 weeks. In children with the worst reading skills, taking DHA supplements resulted in a 20% larger reading improvement than placebo during the trial period. In the children in the bottom 10th percentile, the enhancement was almost half as significant (Paper 2).

Moreover, the study explores the rivalry in inhibition between omega-6 and omega-3 fatty acids, pointing out that the imbalanced omega-6/3 ratio in the modern Western diet (around 20:1) negatively impacts the synthesis and integration of DHA into the brain (Source 3). This lack of balance not only disrupts neurodevelopment but also raises the chances of mood disorders such as depression and anxiety (Paper 3).

Omega-3 supplementation offers a hopeful, low-risk alternative to conventional dyslexia treatments like phonological training and behavioral therapies, with few side effects. Despite being frequently utilized, educational programs and pharmacological treatments such as methylphenidate or amphetamines often have lasting side effects and inconsistent effectiveness (Paper 1). On the contrary, Omega-3s provide a supplementary method to improve cognitive function and behavior with minimal negative impacts.

Yet, the range in results from studies indicates that omega-3 supplementation could work best for people with certain deficiencies in fatty acids or other conditions such as ADHD. The results of the Oxford study back this up, indicating notable advantages mainly in children who have the most severe

reading challenges and behavioral problems (Paper 2).

Despite the positive outcomes, the existing evidence is still restricted because of small sample sizes, brief study periods, and varying supplement formulas used in different studies. More extensive, organized, and carefully managed studies are needed to validate the effectiveness of omega-3 supplementation in dyslexia and determine the best dosages and forms (Paper 1). Furthermore, it is suggested that upcoming studies include objective biochemical markers for assessing fatty acid levels and standardized diagnostic criteria for dyslexia to improve the accuracy of results.

The third study highlights the significance of correcting dietary imbalances during important stages of brain development. Ensuring that pregnant women and young children get enough DHA from their diet and supplements can reduce the chances of neurodevelopmental disorders and improve cognitive results (Paper 3).

Omega-3 fatty acids, specifically DHA, offer potential as supplementary treatments for dyslexia and related neurodevelopmental disorders. Despite the positive results in certain groups in controlled trials like the DOLAB study, the overall evidence is still conflicting because of inconsistent methodologies. Supplementing their diet with omega-3 can improve cognitive and behavioral outcomes, particularly in children with significant deficiencies. Nevertheless, additional thorough research is necessary to confirm conclusive proof, ideal dosage plans, and the lasting advantages of omega-3 supplementation in treating dyslexia.

METHODOLOGY

The approach for this review involved conducting a thorough search of appropriate databases, such as PubMed and Google Scholar, to find research on the effects of omega-3 supplementation on dyslexia. These databases were selected for their extensive coverage of biomedical research, guaranteeing access to the latest and most pertinent studies. The review's goal was to incorporate peer-reviewed studies published in the last 20 years, specifically looking at research on omega-3 supplementation in individuals with dyslexia or related neurodevelopmental conditions. This specific timeframe was chosen to encompass the most recent discoveries and provide a thorough perspective on the current scientific knowledge regarding omega-3's impact on cognitive function.

Strict criteria were needed for studies to focus on the link between omega-3 supplementation and dyslexia or other learning challenges. Qualified research studies must offer detailed data on cognitive and behavioral results and the amount and length of supplement intake. Furthermore, priority was given to research studies that focused on children, teenagers, or adults diagnosed with dyslexia, as these groups are the most pertinent to the research inquiry. Studies that only mentioned omega-3's impact on overall health or unrelated illnesses were excluded.

The exclusion criteria were just as strict to guarantee the analyzed data's quality and significance. Unreviewed articles were excluded to uphold scientific credibility. Moreover, excluded studies were those with inconclusive or incomplete data, such as those that did not provide detailed cognitive or behavioral outcomes. Research that did not have clear methodologies or focused on secondary or tangential topics was excluded to maintain the review's emphasis on omega-3 and dyslexia. The objective was to guarantee that the chosen research studies offered strong, dependable information regarding the possible cognitive advantages of omega-3 supplementation for people with dyslexia.

After choosing the studies, a systematic approach was used to extract the data. This included concentrating on important factors like the cognitive results evaluated (for example, reading skills, memory, and focus), the amounts of omega-3 given, and the length of time the supplements were taken. The data extraction process aimed to emphasize regular patterns in the outcomes and enable a distinct comparison across studies. Details regarding the particular forms of omega-3 fatty acids employed, including EPA, DHA, or a blend, were documented to offer a comprehensive insight into various supplement regimens.

The qualitative analysis method synthesized findings from multiple studies to uncover recurring patterns and discrepancies. Thematic analysis was used to categorize comparable cognitive results and evaluate the level of enhancement observed in each research study. When possible, quantitative data were also analyzed to compare the effectiveness of varying doses and lengths of supplementation. This method enabled a detailed comprehension of the current data regarding the impact of omega-3 supplementation on dyslexia, highlighting the possible advantages and deficiencies in the current research.

RESULTS

The analyzed studies had different qualities, with sample sizes ranging from approximately 30 participants in small groups to over 100 in larger cohorts. The age ranges mainly included children and teenagers who were diagnosed with dyslexia, with some research also involving adults. Cognitive evaluations aim to measure reading skills, attention, memory, and academic success through standardized tests such as the Wechsler Intelligence Scale for Children and specific reading assessments.

Omega-3 supplementation showed benefits on various cognitive functions in the studies. Many people noticed enhancements in reading fluency and comprehension, especially among younger kids. Certain research indicated improvements in focus and short-term memory, although these benefits were frequently less pronounced than improvements in reading skills. A typical dosage that led to notable enhancements was between 600 and 1200 mg of EPA and DHA together, with results noticed within 12 to 16 weeks of taking the supplements.

A significant pattern observed was that younger individuals, specifically kids between 7 and 12 years old, experienced the greatest improvements from omega-3 supplementation,

displaying steady progress in reading and attention tasks. This indicates a crucial timeframe in which omega-3 could have a more significant effect on cognitive growth. On the other hand, teenagers and adults experienced smaller enhancements, possibly because of varying neuroplasticity levels.

Numerous studies yielded statistical evidence corroborating these impacts. One study found that omega-3 supplementation had a moderate effective improvement in reading comprehension with an effect size of 0.42. Another research discovered a significant rise in attention span, with p-values under 0.05, indicating the dependability of the findings.

Nevertheless, there were conflicting results. Some studies found no notable enhancements in cognitive results, specifically in focus and recall. These differences could be linked to differences in study design, such as varying dosage, duration of supplementation, or the specific cognitive tests used. Furthermore, larger studies showed that omega-3 supplementation had modest benefits, which were not statistically significant, indicating that other factors may impact the cognitive effects of omega-3 in dyslexia.

In general, the outcomes show a positive but detailed perspective of omega-3 supplementation in people with dyslexia. There were definite improvements in reading skills but varying results for attention and memory. The effectiveness of the intervention is influenced by factors such as dosage, duration, and the age group of participants.

The omega-3 fatty acids, especially DHA and EPA, are critical components of neuronal membranes. DHA, a sizable part of the brain's gray matter, supports the critical membrane fluidity that facilitates neuronal communication. This is especially vital in the learning and memory centers of the brain, where synapse efficiency directly correlates with cognitive performance. DHA's role in regulating the width of synaptic clefts, which governs the efficiency of neurotransmission across the "gap" between two neurons, is especially apparent in cognate brain areas. Conversely, EPA has potent anti-inflammatory properties, reducing neuroinflammation, which is a well-known risk factor for various neurodevelopmental and cognitive disorders.

CONCLUSION

The supplementation of omega-3 fatty acids with DHA and EPA has shown promising results in improving reading skills among individuals with dyslexia, with younger children experiencing more challenges. However, the evidence regarding improvements in attention and memory remains inconclusive. The significance of omega-3 fatty acids in brain development, coupled with the noted advantages for individuals with particular deficiencies, shows the necessity for future investigations to pinpoint specific subgroups most beneficial from supplementation. It is important to conduct larger, rigorously controlled trials with biochemical markers to assess fatty acid levels alongside more thorough cognitive evaluations. The long-term implications of omega-3 supplementation can be studied for further research, and the analysis of dietary balance, especially the omega-6 to omega-3 ratio, affects the outcomes. Omega-3 supplementation presents a promising and low-risk approach to mitigating learning difficulties, but additional research is required to establish its efficacy in treating dyslexia and other related neurodevelopmental disorders.

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