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https://jcsrr.org/index.php/jcsrr **ORIGINAL ARTICLE**

The Role of Omega-3 Long Chain Polyunsaturated Fatty Acids (Lcpufas) in Child Development and Cognitive Function

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Abstract
This literature review delves into the significance of long-chain omega-3 polyunsaturated fatty acids (LCPUFAs) in the cognitive development and well-being of children. It highlights their importance during pregnancy for fetal brain development and their ongoing role in children's diets. Scientific evidence suggests that Omega-3 supplementation can enhance cognitive skills, reduce allergies, and potentially improve academic performance.
Key findings include the benefits of Omega-3 supplementation during pregnancy, evidence-based dietary recommendations for children, and their potential positive impact on mental health, particularly in reducing the risk of depression. Overall, Omega-3 LCPUFAs are crucial for brain development, and promoting their inclusion in children's diets is both a scientific endeavor and a public health imperative for a healthier future.

Keyword: Omega-3 LCPUFAs and Child Development. Omega-3 LCPUFAs and Cognitive Function in Children

Introduction

Long-chain omega-3 polyunsaturated fatty acids (LCPUFAs) have gained attention as intriguing food ingredients that may have an impact on young children's cognitive development. This literature review explores the theoretical underpinnings and empirical evidence that support our developing understanding of the crucial role of Omega-3 LCPUFAs in these important facets of children's health and well-being. In a world where early childhood development and cognitive well-being are of paramount importance, unravelling the mysteries of how these fatty acids influence young minds is both a scientific endeavour and a public health imperative.

The exploration of Omega-3 LCPUFAs begins by delving into their connection with maternal nutrition during pregnancy, a relationship of paramount importance. Throughout pregnancy, the mother assumes the central role in providing sustenance for her developing foetus. It's within this critical timeframe that Omega-3 LCPUFAs are conveyed from the mother's bloodstream into the placenta, subsequently reaching the developing fetal brain. Omega-3 LCPUFAs are essential foundational elements for the fetal brain and the central nervous system. They contribute to the creation of neural cells, the protection of nerve fibres through myelination, and the general structural advancement of the brain. Omega-3 LCPUFAs are integral building blocks for the fetal brain and central nervous system. They play a role in the growth of neural cells, myelination, the covering of nerve fibres, and the general structural development of the brain. These fatty acids play a crucial role in the development of cognition as the embryonic brain experiences rapid growth and intricate organization. But the influence of Omega-3 LCPUFAs doesn't end at birth; it's merely the beginning. The incorporation of Omega-3 fats in children's nutrition becomes a top priority, driven by the goal of optimizing cognitive well-being and developmental milestones. Scientific studies indicate that introducing omega-3 LCPUFAs into the diets of children holds the potential to improve focus, and language-related cognitive abilities, potentially diminish the risk of allergies and even potentially improve their academic performance and problem-solving aptitude.

The objectives of this literature review include:

- To investigate the impact of omega-3 supplementation during pregnancy on fetal brain and retina development, as well as cognitive function in children, with the goal of understanding the potential benefits of omega-3 intake during pregnancy

- To provide evidence-based dietary recommendations for the incorporation of Omega-3 LCPUFAs into children's diets, with a focus on optimizing cognitive health and developmental outcomes.
- To explore the relationship between omega-3 fats and children's mental health, including aspects such as depression, and emotional well-being, to comprehensively assess their impact on mental health outcomes in children and adolescents

Methods

This section outlines the methodical process employed to conduct an extensive evaluation of the literature review on "The Role of Omega-3 LCPUFAs in Child Development and Cognitive Function." The methodological framework includes Database selection, Search techniques, Inclusion and exclusion standards, Quality evaluation, and Ethical considerations. This review seeks to present a thorough and transparent synthesis of the pertinent research on the effect of Omega-3 LCPUFAs on child development and cognitive function by adhering to this organized methodology.

1. Database Selection:
Academic databases and search engines such as Google Scholar, Research gate and, Pub med were used for the literature search to acquire articles.

2. Search Techniques:
The literature search will be done using pertinent terms and phrases associated with the subject. The following search terms were used:
• Omega-3 LCPUFAs and Child Development.
• Omega-3 LCPUFAs and Cognitive Function in Children.

3. Inclusion and exclusion standards:
Articles will be included if they are directly connected to the impact of Omega-3 LCPUFAs on child development and cognitive function. Papers that don't pertain to the subject, or papers that don't include primary research findings will be excluded.

4. Quality evaluation
Peer-reviewed research articles and primary sources will be given priority over secondary sources in order to ensure the review's accuracy and dependability.

5. Ethical considerations:
Throughout the review process, ethical issues, such as proper citation and referencing of sources will be observed.

Key Findings From The Literature

Overview of the studies

A literature search yielded a total of 32 articles, with 10 sourced from PubMed, 8 from Google Scholar, and 6 from ResearchGate. After eliminating 8 duplicated articles, a thorough screening of the remaining 24 articles for eligibility was conducted by reviewing their titles and abstracts.

Numerous studies have suggested that omega-3 fats play a role in children's neurodevelopment. Omega-3 has a substantial relationship with children's cognitive development in observational studies. Generally, these studies addressed a variety of topics, which are detailed below.

The Role of Omega-3 Fatty Acids in Fetal Development.

Guidelines for maternal nutrition have long emphasized a diet with enough calories and protein, but recently fatty acids have also been deemed significant (Ramakrishnan et al., 2010). However, a rising amount of research has recently illuminated the crucial function of fatty acids in maternal nutrition. Specifically, omega-3 fatty acids such as Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA), have garnered significant attention due to their profound impact on maternal and fetal health. This is in part because prenatal EPA and DHA supplementation have been linked to a number of advantages for the fetus (Swanson et al., 2012). The placenta passes nutrients, such as DHA from the mother to the fetus throughout pregnancy (Helland et al., 2008). It is crucial that the mother consumes enough food since the amount of omega-3 fatty acids in the fetus is associated with the mother's intake (Bazan, 2003).

Numerous studies have supported the value of taking omega-3 supplements while pregnant for the healthy development of the brain and retina. DHA is more crucial for healthy cell membrane function and is essential for the development of the embryonic brain and retina than EPA (Swanson et al., 2012). During this phase, the fetus undergoes a significant build-up of DHA in the brain. The development and healthy operation of brain cells, neurons, and synapses depend on this build- up. Complex brain structures, the basis for a variety of cognitive functions are supported by DHA. DHA has been found to be essential for controlling neurogenesis, myelination, membrane integrity, signal transduction, neurotransmission, and neuroplasticity in neurons. (Tanaka et al., 2012; Weiser et al., 2016).

There are Massive levels of DHA accumulation in the fetal tissue throughout the third trimester (Judge et al., 2007). DHA accumulates in the fetal brain at a significantly higher percentage compared to the rates of deposition in the body. The retina and brain, which may be associated with abnormal vision and brain function, are the 2 most invaded fetal regions (Dunstan et al., 2008). Omega-3 fats play a vital role in cell signalling during pregnancy, and their importance is relevant for both expectant mothers and the developing fetus. DHA is a major precursor of compounds like docosanoids, which have a crucial role in cell signalling during pregnancy (Bazan, 2003; Hong et al., 2003)

Studies have shown that dietary DHA provides several health advantages for people of all ages, including the development of foetuses' and new-born's brains and eyes (Drover et al., 2011; Dunstan et al., 2008; Judge et al., 2007; Willatts et al., 2016). Additionally, it promotes ideal visual performance, assisting in preserving strong eyesight over time. DHA is still crucial for cognitive function in adults after childhood, potentially lowering the incidence of age-related cognitive decline. It becomes increasingly clear that omega-3 fatty acids, particularly DHA, are not just dietary components but vital contributors to a healthier, brighter future for generations to come.

Nutritional Recommendations for Omega-3 in Children's Diets

Ensuring optimal cognitive development places, a great focus on ensuring the development and general well-being of children, and evidence-based dietary recommendations emphasize the significance of adding omega-3- LUPUFAs in their daily diet. Long-chain polyunsaturated fatty acids especially those of the n-3 family, such as docosahexaenoic acid (C22:6 n-3) and eicosapentaenoic acid (C20:5 n-3) play important biochemical and physiological roles in human metabolism and health. In this sense, DHA is a crucial ingredient for growing and developing children (Báez & González, 2017).

A substantial amount of this fatty acid is virtually solely found in a variety of seafood (fish, shellfish, micro- and macroalgae). In fact, the use of aquatic foods in the middle of the Upper Paleolithic period was a crucial turning point in human evolution (Milte et al., 2012).

A crucial phase in the development of a child's brain and vision is closely tied to the dietary choices of the mother during her pregnancy and lactation periods. Specifically, meals that are abundant in DHA play a vital role in nurturing the child's brain and visual development. This underscores the significance of the mother's diet, particularly her consumption of foods rich in DHA, in influencing the optimal growth of her child's cognitive abilities and vision during these critical stages. According to a study carried out by (Báez & González, 2017) children aged 9 and 12 months who received fish oil supplements containing natural omega-3 long-chain polyunsaturated fatty acids (n-3 LCPUFA), specifically EPA and DHA exhibited enhanced attention performance during a free-play test. They suggested that the inclusion of omega-3 fatty acids from fish oil in their diet appeared to positively influence the children's capacity to concentrate and maintain attention during unstructured play, hinting at potential cognitive benefits in terms of focus and concentration for young children. On the other hand, the act of providing fish oil supplements to infants resulted in a reduction in systolic blood pressure. This suggests that including omega-3 long-chain polyunsaturated fatty acids (n-3 LCPUFA) in the diet during the later stages of infancy may have dual benefits. Specifically, it could potentially improve cognitive development and offer advantages for cardiovascular health (Harbild et al., 2013).

In a randomized, placebo-controlled, double-blind research carried out by (Nelson & Ryan, 2008) the effects of 400 mg/d of DHA supplementation given to healthy 4-year-old children over the course of 4 months were assessed. The results of the regression analysis revealed a significant positive correlation between the blood levels of DHA and the children's performance in tests assessing their listening, comprehension, and vocabulary acquisition. This suggests

that DHA supplementation has a positive impact on language-related cognitive skills in young children. An increase in the erythrocyte DHA content was linked to improved attention and focus during tasks that require listening and processing information such as lectures or classroom activities.

In a randomized controlled trial comparing the effects of EPA- and DHA-rich oils to safflower oil in children with attention-deficit/hyperactivity disorder (ADHD) aged 7 to 12 years old. Additionally, EPA and total n-3 LCPUFA levels were linked to lower levels of anxiety and shyness. As a result, adding n-3 LCPUFA to a child's diet was linked to changes in their behaviour, making it more manageable and adaptive (Milte et al., 2012).

In accordance with the existing body of literature, a recurring theme emerges regarding the potential protective effect of LCPUFAs against allergic manifestations in infants and young children. Early fish introduction to new-borns has been linked to lower incidences of Eczema (Alm et al., 2009; Oien et al., 2010), Allergic Rhinitis (Virtanen et al., 2010), and Recurrent wheezing (Dunstan et al., 2008). This recurrent pattern in the literature serves as a compelling testament to the potential benefits of LCPUFAs, such as those found in fish in mitigating the risk of allergic manifestations during infancy and early childhood.

Evidence-based dietary recommendations advocate for the incorporation of foods rich in omega- 3 LCPUFAs into children's diets from the early stages of development to optimize cognitive health and developmental outcomes. These fatty acids hold promise in enhancing attention, language- related cognitive skills, and behaviour, and even mitigating the risk of allergic conditions, underscoring their significance in promoting the overall well-being of children.

Omega-3 fats and its impact on children's mental health

Mental disorders have gained significant prominence in public health due to their status as a major contributor to global disability representing approximately 20% of total years lived with impairments (Whiteford et al., 2015). Even though mental illnesses are a major cause of impairment worldwide, it's critical to emphasize the significance of managing mental health problems in children and adolescents. Since the formative years are so important for development, young people's mental health should be of the utmost importance.

Major depressive disorder (MDD) prevalence rates are low in prepubescent children but significantly rise during adolescence. A recent representative survey of more than 10,000 teenagers between the ages of 13 and 18 found that the prevalence over the course of a year was estimated to be 7.5% and 11.0%, respectively (Avenevoli et al., 2015). Between the ages of 12 and 17, females are three times more likely than males to experience their first depressive episode (Breslau et al., 2017). Given that modern societies nutritional environments do not align with people's genetic makeup, a drastic change in human lifestyle particularly dietary habits in children and young adults may be a contributing factor in the rise of civilization diseases like obesity, cardiovascular disease, cancer, inflammatory and autoimmune diseases, as well as mental disorders like depression (Simopoulos, 2011).

High intakes of fish which is a rich source of omega-3 fats appear to be protective factors against the development of MDD, particularly in females, according to epidemiological research (Timonen et al., 2004).

High fish consumption lowers the relative risk for child and teenage depression, according to case- control studies (Murakami et al., 2010). The decreased presence of omega-3 fatty acids in the red blood cells of individuals experiencing depression offers additional proof that there is a potential link between these PUFA(s) metabolism and depressive disorders (Lin et al., 2010). This indicates that depression is associated with lower levels of omega-3 fatty acids in red blood cells, suggesting a potential relationship between omega-3 fats and depressive symptoms. In a survey conducted in Japan involving 6,700 children aged 12 to 15 years, a relationship was identified. Specifically, eating fish daily was associated with a lower occurrence of depressive symptoms. However, this correlation was evident among adolescent boys attending college but was not observed among adolescent girls of the same age group. In essence, regular fish consumption appeared to have a positive impact on reducing depressive symptoms but this effect was gender-specific benefiting college-aged boys rather than girls (Murakami et al., 2010).

The growing recognition of mental health issues as a significant contributor to global disability underscores the importance of addressing these concerns, particularly in children and adolescents. With the prevalence of major depressive disorder rising significantly during adolescence, understanding potential contributing factors becomes essential. While dietary habits and lifestyle changes in modern society have raised concerns about their impact on physical and mental well- being. Studies indicate that high fish consumption, a rich source of omega-3 fats is

associated with a reduced risk of depression in young individuals. As we continue to explore these connections, promoting healthy dietary choices that incorporate omega-3-rich foods may hold promise for enhancing the mental well-being of our younger generations.

Conclusion

This comprehensive literature review has shed light on the pivotal role of long-chain omega-3 polyunsaturated fatty acids (LCPUFAs) in the cognitive development and overall well-being of children. From the crucial connection between maternal nutrition during pregnancy and the fetal brain's structural advancement to the profound influence of Omega-3 LCPUFAs in children's diets, the evidence underscores their significance.

Omega-3 LCPUFAs, particularly Docosahexaenoic acid (DHA) and Eicosapentaenoic acid (EPA), emerge as essential building blocks for the developing brain, impacting neurogenesis, myelination, and cognitive function. The literature consistently suggests that early introduction of these fatty acids into children's diets may enhance focus, and language-related cognitive abilities, and even reduce the risk of allergies, setting the stage for healthier cognitive and physical development.

Moreover, the exploration of Omega-3 LCPUFAs' potential influence on children's mental health adds a critical dimension to this review. With the prevalence of major depressive disorder on the rise during adolescence, the role of omega-3 fats in mental well-being particularly in females becomes noteworthy. Epidemiological research and case-control studies indicate that high fish consumption, a rich source of omega-3 fats, may serve as a protective factor against depression in children and adolescents.

As we navigate the intricate interplay of nutrition, cognitive development, and mental health in the younger population, it becomes evident that Omega-3 LCPUFAs are not just dietary components but agents of hope for a brighter future. Their incorporation into children's diets is not merely a scientific endeavour but a public health imperative. Encouraging healthy dietary choices that embrace omega-3-rich foods may pave the way for a generation of children and adolescents with enhanced cognitive abilities, better mental health, and overall well-being ultimately shaping a healthier and more prosperous future for all.

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