Effects of Breastfeeding and Long-Chain Polyunsaturated Fatty Acids on Term Infant Cognitive Development

NDFS 424
April 11, 2013
ABSTRACT

LC-PUFAs are necessary for cognitive development. There are potential benefits of prenatal and early postnatal supplementation with LC-PUFAs on neurodevelopment. Research articles were found using EBSCO databases. Based on the research available, there is not enough evidence that LC-PUFA supplementation of infant formula is beneficial for neurodevelopment. Intensity of breastfeeding and duration of breastfeeding has been shown to be positively associated with mental development scores. In addition, genetic variants in the FADS gene cluster and ELOVL5 gene affect lipid metabolism. Further research considering multifactor variables is necessary to determine benefits of LC-PUFA supplementation. Since evidence is inconclusive, it is appropriate to continue with current recommendations from the American Academy of Pediatrics and the American Dietetic Association. It is recommended to consume 8 to 12 ounces of low mercury fish each week to improve maternal DHA status, and breastfeed for the first 6 months of life and continue breastfeeding for the second 6 months for optimal nutrition during infancy.
INTRODUCTION

Brain development is not completely understood but depends on both genetic and environmental factors. The adult brain is composed of lipids, 35% of which are long chain polyunsaturated fatty acids (LC-PUFAs). During development, LC-PUFAs are necessary for efficient neurogenesis, myelination, neurite outgrowth, dendritic arborisation and neurotransmission. The major LC-PUFAs docosahexaenoic acid (DHA) and arachidonic acid (AA) may be derived directly from the diet or they may be formed through a series of elongating and desaturating reactions from the precursors a-linolenic acid (ALA) and linoleic acid (LA). The fetus receives essential LC-PUFAs from the mother’s diet through the placenta. After the baby is born, breast milk or formula supplies essential LC-PUFAs.

The fetal brain accumulates more AA (omega-6 fatty acid, n-6) than DHA (omega-3 fatty acid, n-3). However, DHA accumulation surpasses that of AA post term and is the major LC-PUFA in the adult brain. DHA affects brain and eye development and infants derive DHA from their mothers before birth and up to age two. Connor et al. found that dietary DHA supplementation facilitates synaptic plasticity and increases synaptic transmission, which allows for greater capacity to learn. Considerable amounts of LC-PUFAs accumulate in the brain in the first months after birth and depend on the duration and concentration of supplementation. There are potential benefits of prenatal and neonatal supplementation with LC-PUFAs, particularly DHA, on neurodevelopment in term infants. The evidence for DHA supplementation is promising but inconclusive. Since the research is inconclusive, it is appropriate to continue with current recommendations from the American Academy of Pediatrics and the American Dietetic Association.

The primary objective of this review is to analyze findings from peer-reviewed journals about the effects of LC-PUFA supplementation on cognitive development during infancy. This collection of articles addresses differences in infant supplementation of LC-PUFAs and maternal supplementation of LC-PUFAs, and the role of genetics on enzyme activity and LC-PUFA synthesis.

METHODS

Journal articles were found using EBSCO databases. Databases used included Academic Search Premier, Alt Health Watch, Biomedical Reference Collection: Basic, ERIC, MEDLINE, Primary Search, and TOPICsearch. The advance search tool bar was used. Search terms included “LC-PUFA supplementation”, “cognitive development”, “child cognition”, “pregnancy”, “lactation”, “breastfeeding”, and “DHA supplementation”. Publication date was limited to 2002-2012. The searches resulted in one to two pages of research. It is difficult to find consistent results for LC-PUFA supplementation because studies done on the subject are inconsistent in their methods approach. There are multifactor variables to consider including lifestyle habits, maternal pre pregnancy nutritional status, and genetic variation in metabolism. This review will discuss current research available on LC-PUFA supplementation.
Research shows that prenatal and neonatal LC-PUFA status is associated with child cognitive development. DHA and AA concentrations indicate neurodevelopment outcome in early infancy, but only DHA status is associated with neurodevelopment outcome in adolescence and adulthood. Prenatal and neonatal supplementation of LC-PUFAs will be discussed based on research available.

90 percent of fetal fat deposition occurs during the third trimester, thus the mother’s plasma concentrations of fatty acids increase throughout pregnancy to satisfy fetal demands. The higher concentrations of fatty acids are the result of accelerated breakdown of maternal fat stores during the last trimester. This suggests that the fetal LC-PUFA supply does not only depend on the LC-PUFA content of the maternal diet or supplementation during pregnancy but also on the LC-PUFA content of the diet before pregnancy. Poor maternal dietary intake of LC-PUFAs places infants at risk for deficiency during critical periods of cognitive development.

LC-PUFA supplementation of infant formula may reduce the risk of deficiency. Infants consuming LC-PUFA supplemented formula have similar plasma levels of DHA (n-3) LC-PUFA to breastfed infants. Infants consuming non-LC-PUFA supplemented formula may benefit their LC-PUFA plasma levels from supplementation. Drover et al. found that LC-PUFA supplementation of formula with 0.32% DHA in term infants is associated with beneficial neurodevelopmental outcome at 18 months of age. However, a Cochrane Review conducted a meta-analysis of ten randomized studies on formula supplemented with LC-PUFA. Eight of the ten included trials were of good quality. The review suggests that LC-PUFA infant formula supplementation does not benefit neurodevelopment. There are limitations in the studies conducted on LC-PUFA supplementation of infant formula: failure to consider lifestyle differences between those who breastfeed and those who opt for formula feeding, and optimal ratios of DHA/AA to supplement in commercialized formula. There is still not enough evidence to suggest that LC-PUFA supplementation of infant formula is beneficial for neurodevelopment.

There are benefits of breastfeeding that outweigh the use of infant formula. Breastfeeding women experience hormonal, physical, and psychosocial benefits, that include greater self-confidence and bonding with their infants. Infants experience nutritional and immunological benefits that support adequate growth and protect against infection. In addition, Meldrum et al. found that breast milk DHA was a better indicator of infant erythrocyte LC-PUFA status than direct supplementation. The study showed that direct supplementation with fish oil can elevate DHA levels in infants. However, an observation was made that breast milk DHA had a strong effect on infant erythrocyte and plasma phospholipid DHA status. Direct supplementation was not as efficient as breast milk in promoting DHA status in infants.

Guxens et al. assessed the role of parental psychosocial factors and colostrum LC-PUFA levels on child neurodevelopment at 14 months. Maternal information was collected using trained psychologists to administer questionnaires; colostrum samples were collected at delivery; and child neurodevelopment was assessed at 14 months using the Bayley Scales of Infant Development test. 504 subjects with complete neurodevelopment and breastfeeding data were used. Multivariable adjustments for parental education, social class, attachment to the child, IQ,
and mental health were made. Results showed mental development scores were linearly and positively associated with intensity of breastfeeding and duration of exclusively breastfeeding, whereas no association was found with psychomotor development scores. Furthermore, higher levels of DHA and high ratios of DHA to AA had a beneficial effect on mental development, especially in accumulated breastfeeding. How often and how long women breastfed was a good indicator of DHA status in infants. A limitation in the study was the use of colostrum to represent milk fatty acid profiles throughout lactation.

The American Academy of Pediatrics and the American Dietetic Association recommend exclusive breastfeeding for the first 6 months of life and continuation of breastfeeding for the second 6 months for optimal nutrition during infancy.8 The composition of breast milk changes throughout lactation. The fatty acid profile of breast milk varies with the diet of the mother. When diets are high in PUFA, more PUFA are present in breast milk. Fish is an excellent source of DHA, and the amount or frequency of intake is associated with higher maternal DHA status. Current Dietary Guidelines for Americans recommend pregnant women eat 8 to 12 ounces of low mercury seafood each week.8

Maternal DHA status correlates with breast milk DHA, and maternal DHA status has been shown to increase with DHA supplementation.11 Jensen et al.12 found that five-year-old children whose mothers received modest DHA supplementation versus placebo for the first 4 months of breastfeeding performed better on a test of sustained attention. This suggests that DHA intake during early infancy has benefits on neurodevelopment. However, there are no official recommendations for fish oil supplementation. There is not enough evidence that DHA supplementation confers long-term neurologic benefits.

Research suggests that prenatal and neonatal DHA status is only partially based on DHA consumption. Other factors that may contribute to the association are lifestyle habits, maternal pre pregnancy nutritional status, and genetic variations in metabolism.2 Morales et al.1 found that LC-PUFA supplies during pregnancy and lactation are genetically determined by maternal desaturase and elongase activity. Maternal genetic variation in LC-PUFA metabolizing enzymes determines the colostrums LC-PUFA profile. Maternal genetic variants in the FADS gene cluster and ELOVL5 gene were associated with higher colostrum levels of n-3 LC-PUFA (i.e. EPA and DHA). Children of mothers with genetically determined lower levels of AA, higher EPA/AA, and higher capacity to synthesize DHA, showed a significant advantage in cognition at age 14 months. In addition, infants are able to synthesize LC-PUFA their precursors of LA and ALA. Child genetic variants in desaturase and elongase enzymes determine the child’s ability to synthesize LC-PUFA from dietary intake of essential fatty acids. It was found that children with variants associated with lower synthesis of LC-PUFA had higher scores when breastfed, while those with greater capacity to synthesize these fatty acids had higher scores regardless of breastfeeding practices.

CONCLUSION

There are potential benefits of prenatal and neonatal supplementation with LC-PUFAs on neurodevelopment in term infants. However, there is not enough evidence that LC-PUFA supplementation confers benefits on neurodevelopment outcome. Future research requires long-
term studies that apply age-specific, sensitive neurodevelopmental tools, which also take into account lifestyle habits, maternal pre pregnancy nutritional status, and genetic variations in metabolism. Since evidence is inconclusive, it is appropriate to continue with current recommendations from the American Academy of Pediatrics and the American Dietetic Association. It is recommended to consume 8 to 12 ounces of low mercury fish each week to improve maternal DHA status, and breastfeed for the first 6 months of life and continue breastfeeding for the second 6 months for optimal nutrition during infancy.
REFERENCES


