Maternal Supplementation With Very-Long-Chain n-3 Fatty Acids During Pregnancy and Lactation Augments Children's IQ at 4 Years of Age

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FROM ABSTRACT:

Objectives.
Docosahexaenoic acid (DHA; 22:6 n-3) and arachidonic acid (AA; 20:4 n-6) are important for development of the central nervous system in mammals.

There is a growth spurt in the human brain during the last trimester of pregnancy and the first postnatal months, with a large increase in the cerebral content of AA and DHA.

The fetus and the newborn infant depend on maternal supply of DHA and AA.

Our hypothesis was that maternal intake of DHA during pregnancy and lactation is marginal and that high intake of this fatty acid would benefit the child.

We examined the effect of supplementing pregnant and lactating women with very-long-chain n-3 polyunsaturated fatty acids (PUFAs; cod liver oil) on mental development of the children, compared with maternal supplementation with long-chain n-6 PUFAs (corn oil).

Methods.
The study was randomized and double-blinded. Pregnant women were recruited in week 18 of pregnancy to take 10 mL of cod liver oil or corn oil until 3 months after delivery. The cod liver oil contained 1183 mg/10 mL DHA, 803 mg/10 mL eicosapentaenoic acid (20:5 n-3), and a total of 2494 mg/10 mL n-3 PUFAs.
[1,183 mg of DHA and 803 mg of EPA per day]

The corn oil contained 4747 mg/10 mL linoleic acid (18:2 n-6) and 92 mg/10 mL -linolenic acid (18:3 n-3). **[92 / 4,747 = 2%; this means that the corn oil used was 98% omega–6 and 2% short chain omega-3]**

The amount of fat-soluble vitamins was identical in the 2 oils (117 μg/mL vitamin A, 1 μg/mL vitamin D, and 1.4 mg/mL dl--tocopherol).

A total of 590 pregnant women were recruited to the study, and 341 mothers took part in the study until giving birth.

All infants of these women were scheduled for assessment of cognitive function at 6 and 9 months of age, and 262 complied with the request.

As part of the protocol, 135 subjects from this population were invited for intelligence testing with the Kaufman Assessment Battery for Children (K-ABC) at 4 years of age. The K-ABC is a measure of intelligence and achievement designed for children aged 2.5 years through 12.5 years. This multi-subtest battery comprises 4 scales: Sequential Processing, Simultaneous Processing, Achievement (not used in the present study), and Nonverbal Abilities. The Sequential Processing and Simultaneous Processing scales are hypothesized to reflect the child's style of problem solving and information processing. Scores from these 2 scales are combined to form a Mental Processing Composite, which serves as the measure of intelligence in the K-ABC.

Results.
We received dietary information from 76 infants (41 in the cod liver oil group and 35 in the corn oil group), documenting that all of them were breastfed at 3 months of age.

Children who were born to mothers who had taken cod liver oil (n = 48) during pregnancy and lactation scored higher on the Mental Processing Composite of the K-ABC at 4 years of age as compared with children whose mothers had taken corn oil (n = 36.

The Mental Processing Composite score correlated significantly with head circumference at birth (r = 0.23), but no relation was found with birth weight or gestational length.

The children's mental processing scores at 4 years of age correlated significantly with maternal intake of DHA and eicosapentaenoic acid during pregnancy.

In a multiple regression model, maternal intake of DHA during pregnancy was the only variable of statistical significance for the children's mental processing scores at 4 years of age.

Conclusion.
Maternal intake of very-long-chain n-3 PUFAs during pregnancy and lactation may be favorable for later mental development of children.

Abbreviations:
DHA = docosahexaenoic acid
AA = arachidonic
PUFA = polyunsaturated fatty acid
EPA = eicosapentaenoic acid

THESE AUTHORS ALSO NOTE:

"Docosahexaenoic acid (DHA; 22:6 n-3) and arachidonic acid (AA; 20:4 n-6) are important for development of the central nervous system in mammals."

"There is a growth spurt in the human brain during the last trimester of pregnancy and the first postnatal months, with a large increase in the cerebral content of AA and DHA."

"The capacity for elongation and desaturation of alpha-linolenic acid (18:3 n-3) **[vegetarian plant sources of omega-3 fatty acids, also known as short-chain omega-3s, like flax seed oil]** to DHA is inadequate in the fetus and the newborn." **[VERY IMPORTANT]**

"Maternal very-long-chain polyunsaturated fatty acid (PUFA) status during pregnancy is critical for the very-long-chain PUFA status in the newborn, and newborn infants depend on a dietary supply of these fatty acids."

"In contrast to most formulas, breast milk contains DHA and AA, but the concentrations of these very-long-chain PUFAs are variable, depending on the mother's diet."

There is a positive correlation between breastfeeding and cognitive development.

Premature infants are more vulnerable to DHA deficiency than term infants, because they do not receive the third-trimester intrauterine supply of DHA.

"Supplementation with DHA to premature infants may increase early maturation of visual function and information processing."

In this study, the authors supplemented pregnant mothers with very-long-chain n-3 PUFAs.

Very-long-chain n-3 PUFAs are defined as those that are 20 carbons long (EPA) and 22 carbons long (DHA), and come from fish oil.

RESULTS

"The breast milk of mothers who received cod liver oil contained more DHA (approximately 270%) and less AA (88%) than breast milk of mothers who received corn oil."

"Children in the cod liver oil group had significantly higher scores than the children in the corn oil group on the Mental Processing Composite of the K-ABC test at 4 years of age."

DISCUSSION

"This is the first study to examine the long-term effects on children of maternal supplementation with very-long-chain n-3 PUFAs during pregnancy and lactation."

"Our present study shows that 4-year-old children have higher mental processing scores when the mothers are supplemented with very-long-chain n-3 PUFAs (from cod

liver oil) during pregnancy and lactation, as compared with children of mothers who are supplemented with long-chain n-6 PUFAs (from corn oil)."

"The maternal intake of DHA during pregnancy seems to be important for mental development measured at 4 years of age."

"Higher maternal intake of DHA results in higher maternal plasma levels and thereby increased transfer of DHA to the fetus."

This study is the first to show a correlation "between head circumference at birth and mental processing skills in healthy term infants," and head circumference also correlated with maternal long-chain omega-3 ingestion.

The authors assume that DHA may be important for mental development at least during childhood.

CONCLUSION

"This study indicates that maternal supplementation with very-long-chain n-3 PUFAs during pregnancy and lactation improves the intelligence of children at 4 years of age."

"Perhaps an adequate supply of very-long-chain PUFA during pregnancy is just as important as in the neonatal period."

KEY POINTS FROM DAN MURPHY

(1) Docosahexaenoic acid (DHA; 22:6 n-3) and arachidonic acid (AA; 20:4 n-6) are critical for development of the central nervous system.

(2) The growth spurt in the human brain during the last trimester of pregnancy and the first postnatal months require a large increase in AA and DHA.

(3) The fetus and the newborn infant depend on maternal supply of DHA and AA.

(4) The ability for the fetus and the newborn to convert vegetarian plant sources of omega-3 fatty acids, also known as short-chain omega-3s, like flax seed oil (alpha-linolenic acid (18:3 n-3)) to EPA and DHA is inadequate.

(5) Therefore, maternal very-long-chain polyunsaturated fatty acid (PUFA) status (20 carbon EPA and 22 carbon DHA) during pregnancy is critical for fetal brain development.

(6) Formulas rarely contain adequate concentrations of the long-chain PUFAs.

(7) A child's mental processing and mental development scores and intelligence at age 4 is significantly correlated with maternal intake of DHA and EPA during pregnancy.