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Essential fatty acids and the infant brain

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In a nutshell

The overall weight of evidence suggests that long chain PFA supply, both in pregnancy and infancy, has an influence on visual acuity and neural development of infants.

This seemsm to be especially important in premature infants.

NUTRITION RESEARCH REVIEW

Background

We begin with some background for those of you who may not be entirely familiar with the terms involved in fatty acid research.

Essential fatty acids (EFAs) are believed to be vital to the growing foetus because they are involved in the development of cell membranes, including those in the brain. The body also uses them as precursors for the synthesis of ecosanoids (e.g. prostaglandin compounds), and they possibly have a role in energy production.

EFAs include:

- the omega-6 family: derived particularly from plant oils (such as linoleic acid and arachidonic acid)
- the omega-3 family: derived particularly from fish oils (such as gamma-linolenic acid, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

The body converts EFAs by lengthening them. The EFAs towards the end of the metabolic process are called long chain polyunsaturated fatty acids (LCPFAs).

Study one: EFAs and problem solving in infants

Research just published in The Lancet has confirmed the crucial role that LCPFAs appear to play in the development of the brain during the earliest weeks of infancy.

Subjects: Forty four full-term formula-fed infants from a Scottish hospital.

Method: The infants were randomised to receive either a formula enriched with LCPFAs or one without enrichment. They took the assigned formula from birth to 4 months of age, and were then tested for problem solving ability six months later (i.e. when aged 10 months).

Problem solving ability was scored using a method which assesses the child's ability to reach a toy when they have to show some degree of `planning'. For example, getting the toy after they have seen it hidden under a cover. The infants were scored on any behaviour which expressed the intention to solve the problem, as well as on successfully getting the toy.

Table 1: Median scores for problem solving at 10 months of age

	LCPFA	Control	Signif.
Intention to solve (Quartiles)	14.0 (11.8-17.1)	11.5 (10.0-13.3)	p=0.035
Intentional solution	2.0 (0.5- 3.0)	0.0 (0.0- 2.0)	p=0.021

Results: The LCPFA-supplemented formula infants did significantly better in problem solving at 10 months of age than the control infants - see Table (above).

Ref: Lancet 1998;352:688-91

Study two: EFAs and growth in pre-term infants

Arachidonic acid status is related to intra-uterine rather than post-natal growth. On the other hand, dietary DHA is important to brain growth in the first 6 weeks after birth. These are the conclusions from the authors of a recent Dutch study.

Subjects: 143 low birth weight infants (<= 2500gm, gestational age 30-41 weeks)

Method: Arachidonic acid and DHA were measured during days 10 to 42 after birth. Infants received pre-term formula either with or without LCPFAs, whilst another group was given maternal milk. Anthropometric measures and growth rates were assessed.

Results: Red cell arachidonic acid levels at 10 days of age significantly correlated ($p<0.05$) with various measures of intra-uterine growth in formula-fed infants, including birth weight and a composite score for weight, length and head circumference. It also correlated with birth weight in breast fed infants.

DHA red cell levels correlated with brain weight on days 10 and 42 in formula-fed infants (accounting for 21-34% of the variance in brain growth parameters)

Ref: Eur J Pediatr, 1998; 157:146-52

Study three: EFAs and visual acuity

A new study from Denmark found no significant correlation between visual acuity and the amount of EFA in formula given to full-term infants..

Subjects: Thirty-seven full-term Danish infants.

Method: They were randomised at average age of 25 days to receive two weeks of one of three formulas: i. Enriched with DHA and gamma-linolenic acid ii Enriched with DHA only iii. Standard formula without LCPFAs

There were 17 breast-fed controls.

Visual acuity evoked potential was measured at 4 months of age.

Results: There was a significant relationship overall between visual acuity and feeding (breast fed infants had better visual acuity than the combined EFA supplemented group, which in turn was better than the control infants: AOV p=0.05).

However, there was no significant correlation between visual acuity and individual formulas.

Ref: J Pediatr Gastroenterol Nutr, 1998;26:412-21

Comments

Clinical studies on the importance of EFAs in foetal and infant development are a relatively new and exciting area of nutrition. These three papers help convey some of that excitement.

The growing foetus is unusually dependant on maternal LCPFAs in particular, because it has limited ability to synthesise them from their shorter chain precursors (such as linoleic and linolenic acid). This applies to the foetus and in early infancy.

Premature babies are especially dependant on the EFA content of breast milk or formula, because their premature birth has deprived them of precious time in the uterus when they should have been building up their own LCPFA stores.

Breast milk is normally a good source of LCPFAs. But a combination of inadequate EFA in the mother's diet, prematurity and use of infant formula with not enough of the right kind of EFA could potentially lead to a LCPFA deficiency, with clinical consequences. The question is: what kind of consequences?

The relationship between LCPFA levels and neural development was first identified in relation to visual acuity in the early 1990's. However, the exact nature of the connection is still being explored.

The Danish study above does not find a significant correlation in full-term infants, but other studies have (e.g. see Pediatr Res 1993;34:425-427). However, the Danish researchers only started supplementing the infants after three weeks.

Comments (cont.)

The overall weight of evidence suggests that LCPFA supply both in pregnancy and infancy DOES have an influence on visual acuity and neural development, and that this is especially important in premature infants.

The results from Scotland summarised in study one above are therefore particularly important, as they are in full-term infants and measure cognitive development near the end of the first year of life. Previous studies have tended to concentrate on visual acuity testing during the first month or two. The Dutch results confirm the particular importance of LCPFAs in the early growth of low birth weight infants.

Overall there is plenty of reason to get excited about this field of research. Studies such as these are showing us that EFAs have significant impacts on brain development and growth. Manufacturers of infant formula are paying particular attention. It was not that long ago that they began to offer EFA-enriched formula, but mainly using shorter chain EFAs such as linoleic and linolenic. We are now beginning to see infant formulas with more concentrated LCPFA content.

One crucial link in the chain of better care for infants is that it is very easy to influence the levels of LCPFAs in the growing foetus and infant. Dietary enrichment for the mother readily increases EFA levels in pregnancy and in breast milk. The formula-fed baby infant's levels can also be easily increased by supplementing the formula.

This is quite unlike iron (or even calcium), where supplementing the mother does not seem to influence the breast milk much (although it helps the mother).

In summary, this research may open up a way to provide simple, cost-effective interventions that can help infants in a practical way, particularly in regions where fish (especially deep sea fish - the richest source of LCPFAs) are abundant.