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Human milk lipids, brain development, and other health outcomes

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Human milk lipids contribute about 45-55% of the milk energy content, amounting to a total fat intake of about 5.5 kg in a fully breastfed baby during the first six months of life (1). Milk lipids provide indispensable polyunsaturated fatty acids (PUFA) of the omega-6 and omega-3 series affecting infant health, growth and development (2-4). Human milk lipid content is more variable than the milk content of other macronutrients. Lipid content changes with the duration of breastfeeding, during the course of a day, and increases markedly during a feeding (5). The milk PUFA contents depend on maternal dietary intake. With increasing duration of lactation linoleic (LA, C18:2,n-6) and α-linolenic acid (ALA, C18:3) increase, whereas the long-chain polyunsaturated fatty acids (LC-PUFA) arachidonic acid (C20:4, n-6;15-16 mg/dL) and docosahexaenoic acid (DHA, C22:6, n-3; 7-8 mg/dL) remain fairly constant, reflecting greater metabolic control of milk LC-PUFA levels (1, 5). Of interest, a review of human milk composition worldwide showed rather stable arachidonic acid levels of 0.4-0.6%, whereas DHA content is highly variable and depends on maternal dietary DHA intake primarily from marine foods (6). The LC-PUFA supply with human milk modulates LC-PUFA incorporation into the developing infant brain and visual, cognitive, motor and immune functions (7). The rate of conversion of LA and ALA to the LC-PUFA metabolites is generally low in humans and particularly low in those people who have less common variants of the genes for the fatty acid desaturating enzymes, FADS1 and FADS2 (8). Breast milk fatty acid composition depends on both the quality of maternal dietary fat supply and FADS gene polymorphisms which have a significant effect on arachidonic acid contents both in early lactation and at 6 months after birth (9). The human brain grows and develops very rapidly during the last part of pregnancy and the first two years after birth. At birth, the brain comprises as much as 13% of body weight, and at the age of 2 years it has already reached about 80% of its final adult weight. In addition to brain weight gain, pre- and postnatally there is also critical development and differentiation, including dendrictic arborisation, synapse formation, and myelination, which depend on the adequate supply of energy and building blocks (10). Breastfeeding has been associated with a small but consistent advantage for later IQ development, with a benefit of about 3 IQ points in a meta-analysis of studies in term infants that adjusted for major confounding factors, and a greater benefit in VLBWI.

However, it has been controversial whether this benefit is caused by the nutrient supply with breast milk, such as the content of DHA and other LC-PUFA, or by residual confounding linked to better socioeconomic status, education and health-consciousness in families that chose to breastfeed. Recent gene-nutrient interaction studies demonstrated that the benefit of breastfeeding providing LC-PUFA on IQ at school age is greater by more than 4 IQ points in those children whose ability to synthesize LC-PUFA endogenously is lower due to their genotype (11). Similarly, Standl et al found a marked protective effect of prolonged breastfeeding providing LC-PUFA on doctor's diagnosed asthma up to the age of 10 years in children with a genotype resulting in low LC-PUFA synthesis, whereas there was no significant effect in children homozygous for the major genetic allele (12). These studies support the conclusion that LC-PUFA status of infants is causally important for brain and immune development and health. This conclusion is supported by a randomized clinical trial supplementing breastfeeding women during the first 4 months of lactation with 200 mg DHA/day or placebo. The investigators found a significant improvement in the psychomotor development at 2½ years of age and significantly improved sustained attention at the age of 5 years with improved early DHA supply (13, 14). Based on these and other data, it has been recommended that pregnant and breastfeeding women should consume preformed n-3 LC-PUFA providing an average intake of at least 200 mg DHA/day (15, 16). On average this intake can be reached by eating 1-2 portions of sea fish per week including oily fish. Lactating women that do not consume fish, e.g. women following vegetarian or vegan diets, are advised to take supplements with DHA.

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