ENCYCLOPEDIA on Early Childhood Development

Nutrition and Its Impact on Psychosocial Child Development: Perspective on Preterm Infants

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Introduction

Early nutrition, both the amount and the quality of nutrients, is increasingly recognized as having a major influence on the growth and development of preterm infants. Importantly, inadequate early nutrition may profoundly impact preterm infants' neurodevelopment causing impairments in educational and cognitive competency throughout childhood and young adulthood.[1,2] This paper will highlight new research that links specific aspects of nutrition in early life with benefits for early growth and brain function in preterm infants.

Subject

While breastfeeding is associated with optimal neurodevelopment and mother's own milk is universally recommended for preterm infants,[3-5] mothers may elect not to breastfeed or their milk supply is insufficient to meet the baby's needs. If mother's milk is not available, preterm infants

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are usually fed with commercial formula designed to meet their nutritional needs. However, donor human milk is now being advocated as a substitute for infant formula for in-hospital feeding,[4,6] potentially providing another source of the special components of human milk that are associated with benefits to neurodevelopment.

Problems

Research has consistently found that preterm infants who are fed their mother's milk early in life have greater visual acuity, language skills and developmental outcomes (up to 24 months of age) than do a comparable group of infants fed cow milk-based infant formula or even donor human milk.[3,4,7,8] Further research is necessary to define the specific nutrient(s) and/or socio-environmental factors related to feeding practices that may explain the observed developmental advantages associated with feeding mother's milk.

Research Context

Due to ethical constraints, there are no randomized controlled trials (RCT) comparing the neurodevelopmental outcomes in preterm infants fed mother's milk versus formula or mixed feeding. However, reviews of prospective and retrospective data are consistent with an overall beneficial effect of mother's milk on brain development and cognitive functioning into childhood compared to infant formula.[4,9] Since required processing of donor milk renders it different to mother's milk, a separate assessment of the effect of donor milk compared to mother's milk on neurodevelopmental outcomes is needed.

Over the past two decades, research has focused on long-chain polyunsaturated fatty acids (LCPUFA), particularly docosahexaenoic acid (DHA) and arachidonic acid (AA), as the factors in mother's milk responsible for neurodevelopmental benefits. DHA and AA play a key role in the structure and function of retinal (eye) and neural (brain) tissues. Preterm birth disrupts the most significant accretion of DHA and AA that occurs during the second and third trimester. Thus, preterm infants must receive these fatty acids in their diet after birth due to insufficient endogenous synthesis.[10] Studies on the effect of LCPUFA on neurodevelopmental outcomes have had inconsistent results due to many variations in study design. Despite current standard practice in many countries that infant formula products contain DHA and AA, cognitive, language and motor advantages still appear to be greater in infants fed mother's milk compared to formula supplemented with LCPUFA.

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Key Research Questions

The key research question is whether feeding preterm infants their mother's own milk benefits neurobehavioural development, which in turn, affects intellectual programming and social behaviour; and if so, by what mechanism (nutrients and/or feeding behaviour). If nutrients unique to human milk are found to confer neurobehavioural benefits, then the sequential research question is which (if any) of these factors are inactivated or destroyed during the processing (heating, freezing, thawing) of donor milk. Accordingly, it must be determined whether components labile to processing can be added back to donor milk or infant formula in amounts that will support the same developmental benefits as in fresh mother's own milk.

Recent Research Results

Mother's milk: The observed positive benefits of breastfeeding compared to formula feeding on short-term visual and developmental outcomes are summarized in several reviews.[4,7,9,11] Persistent beneficial effects of mother's milk during the early postnatal period on cognitive functioning are apparent for preterm infants up to 18,[8] 24[3] and 30 months of age.[12] A dose-response effect for mother's milk has been described in preterm infants, where each 10 mL/kg/day increase in mother's milk results in a 0.59 point increase in the Mental Developmental Index (MDI), a 0.56 point increase in the Psychomotor Developmental Index and the total behaviour percentile score increased by 0.99 points.[12] However, sometimes it is difficult to compare findings across studies due to differences between studies in partial and exclusive breastfeeding, use of fortified and unfortified human milk, differences in the type of cognitive assessments and the age at which they were conducted.

Donor milk: Fresh mother's own milk contains many components that may directly or indirectly facilitate the growth and development of the nervous system.[4] Awareness of the benefits of mother's milk has led to the increased use of donor milk. However, recent studies revealed that donor milk does not confer benefits to neurodevelopment compared to formula in preterm infants. In a recent Canadian RCT (n=363), donor milk-fed preterm infants did not achieve higher cognitive composite scores at 18 months' corrected age compared to formula-fed infants.[5] Furthermore, language and motor composite scores were not different between donor milk and formula-fed infants. Pooled data from a Cochrane systematic review of 9 studies (n=1070) also supports the fact that donor milk does not confer any neurodevelopmental advantage over formula.[13]

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LCPUFA supplements: Evidence is inconsistent regarding whether LCPUFA supplementation in early life provides a cognitive advantage in infancy and later childhood. On the positive side, preterm infants who received mother's milk supplemented with DHA and AA compared to mother's milk alone from birth to 9 weeks of age had better recognition memory and higher problem-solving scores at 6 months of age.[14] Further, breastfed preterm infants with higher circulating DHA levels at 4 weeks of age had improvements in psychomotor development at 5 years of age.[15] In contrast, in a large multi-centre RCT (n=657) in Australia, the MDI at 18 months corrected age did not differ in infants supplemented with DHA versus those receiving a standard diet.[16] In the same cohort at 7 years of age (n=604), DHA supplementation did not result in any improvements in overall IQ scores.[17] Interestingly, in a subgroup analyses girls in the high-DHA group showed improvements in the MDI scores at 18 months of age[16] but at 7 years of age had poorer parent-reported executive function and behaviour.[17] Thus, LCPUFA supplementation may accelerate the pace of neurodevelopment in preterm infants without offering any significant advantage in overall developmental outcome, as suggested by a recent systematic review and meta-analysis of 11 RCTs and 2272 participants.[18]

Research Gaps

The specific factor(s) in fresh mother's own milk that confers a developmental advantage for preterm infants remains to be identified. If it is not a specific neurotrophic factor in human milk that contributes to improvements in neurodevelopmental outcomes, thought should be given to how the nutrition source (mother's own milk, donor milk, formula) may be influencing other neonatal morbidities[19] (i.e., extended periods of parenteral nutrition, sepsis, necrotising enterocolitis, bronchopulmonary dysplasia, etc.) that could interfere with neurodevelopment.

Conclusions

Studies published to date provide evidence that mother's own milk confers a developmental advantage when compared to infant formula in preterm infants, but it is not likely that LCPUFA are solely responsible for this benefit. It is absolutely essential for brain and retinal development that preterm infants receive target amounts of LCPUFA (comparable to in utero accretion rates), but there is no strong evidence to support dietary supplementation with high levels of LCPUFA to improve cognitive, language or motor functioning.

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Given that some studies have reported no difference in neurodevelopmental outcomes between donor milk and formula (with/without LCPUFA), it is possible that the beneficial effects of human milk are specific to mother's own fresh milk. A consensus on whether donor milk confers any neurodevelopmental advantage over formula is needed, and if it can be considered comparable to mother's own milk.

Implications for Policy and Services

Despite lack of supporting evidence, pregnant and breastfeeding mothers are increasingly encouraged to supplement their diet with LCPUFA to optimize brain development in their offspring. Clear guidelines that detail sufficient, but not excessive, intakes need to be established and communicated to mothers. Recent results suggest that high levels of omega-3 LCPUFA in the perinatal period may even have a negative impact on behaviour[17] and respiratory health in preterm infants.[20] Other long-term morbidities potentially associated with LCPUFA supplementation may not be apparent yet given that many of the LCPUFA supplementation trials over the past decade have not had lengthy follow-up periods.

Development of infant nutrition products specifically for preterm infants should consider the influence of specific nutrients on neurodevelopment and not just somatic growth. In order to adequately assess the efficacy of the macronutrient balance, micronutrient levels and other neurotrophic ingredients on neurodevelopmental outcomes, tests are needed that are more sensitive to diet-induced alteration in behavioural and cognitive functions, both in early life and at school age.

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