

Early Life Nutrition May Influence Developmental Myelination and Cognition

Myelination supports cognitive and behavioral functioning due to its vital role in brain connectivity during early neurodevelopment. Studies have shown that myelination and cognitive outcomes may be impacted by early life nutrition, and that human milk provides the best outcomes.

The varying nutritional composition between breast and infant formula milk may help to explain some of the observed difference in overall cognitive functioning and ability between breast and formula-fed infants. Numerous cognitive and brain imaging studies comparing breast and formula-fed infants have been conducted, yet there have been some limitations. These studies generally:

- Were cross-sectional
- Were performed in older children and adolescents
- Relied on parental recall of infant feeding
- Treated formula-fed children as a single group (despite the differences among formula compositions)

Recent longitudinal, observational study with a combination of prospective and retrospective dietary data assessment by Deoni et al. further investigated the role of nutritional composition on early brain and cognitive growth

In 2017, this study by Deoni et al. aimed to address some of the limitations from previous studies on the effect of nutritional composition on early brain and cognitive growth. It used neuroimaging to examine longitudinal trajectories of brain myelination as well as cognitive tests to identify development among children:

- Who were exclusively breastfed (n = 62) versus formula-fed (n = 88) for at least 3 months
- Who received different formula compositions (Formula 1, n = 21; Formula 2, n = 28; Formula 3, n = 39)

This analysis was particularly important because it allowed for a more specific investigation of the role of nutritional composition on early brain and cognitive growth. It investigated the impact of different formulas on myelin trajectories and cognition.

A separate analysis looked at specific nutrients present in the different formulas and found that some nutrients were associated with myelination, suggesting that these nutrients have an important role in this developmental process.

Study results:

- Breastfed infants had significantly increased myelination accompanied with higher general verbal and non-verbal cognitive abilities compared with formula-fed infants (**Figures 1a and 1b**). These differences even persisted into early childhood.

Formula-feeding compared to breastfeeding

Figure 1a: Longitudinal myelin curve for the corpus callosum (largest white matter structure of the brain) brain region between the exclusively breastfed and formula-fed infants.

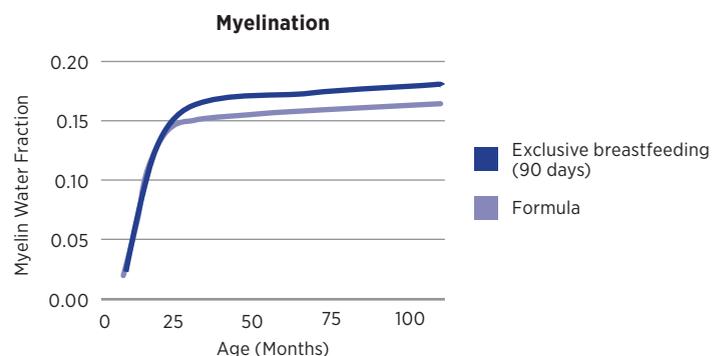
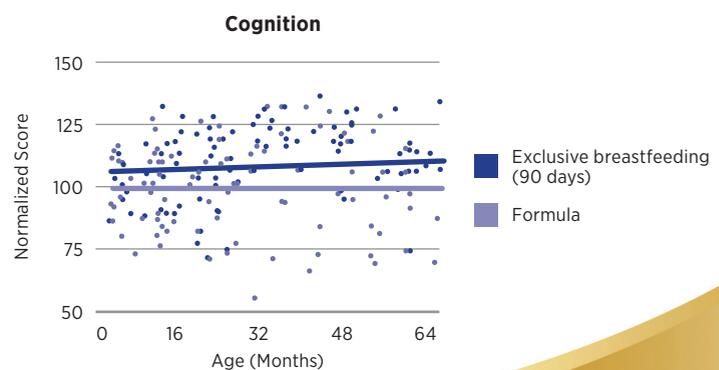


Figure 1b: Comparison of longitudinal maturation curves (Early Learning Composite [ELC] score of the Mullen Scales of Early Learning) between exclusively breastfed and formula-fed children.



IMPORTANT NOTICE: The World Health Organization (WHO*) has recommended that pregnant women and new mothers be informed on the benefits and superiority of breastfeeding – in particular the fact that it provides the best nutrition and protection from illness for babies.

Mothers should be given guidance on the preparation for, and maintenance of, lactation, with special emphasis on the importance of a well-balanced diet both during pregnancy and after delivery. Unnecessary introduction of partial formula-feeding or other foods and drinks should be discouraged since it will have a negative effect on breastfeeding. Similarly, mothers should be warned of the difficulty of reversing a decision not to breast-feed.

Before advising a mother to use an infant formula, she should be advised of the social and financial implications of her decision: for example, if a baby is exclusively formula-fed, more than 400g per week will be needed, so the family circumstances and costs should be kept in mind. Mothers should be reminded that breast-milk is not only the best, but also the most economical food for babies.

If a decision to use an infant formula is taken, it is important to give instructions on correct preparation methods, emphasizing that unboiled water, unsterilized bottles or incorrect dilution can all lead to illness.

*See: *International Code of Marketing of Breast Milk Substitutes, adopted by the World Health Assembly in Resolution WHA 34.22, May 1981. For healthcare professionals use only. Not intended for public distribution*

Study results (continued):

- Analysis of the exclusively formula-fed infants showed that intake of different formulas was associated with differences in myelination and cognitive abilities, with some formula trajectories closer to those of breastfed infants (**Figures 2a and 2b**). This data suggests that nutritional intake in early life may explain these observations.

Different formula compositions compared

Figure 2a: Longitudinal myelin curve for the corpus callosum (largest white matter structure of the brain) brain region between different formula compositions. Breastfeeding data is shown for reference.

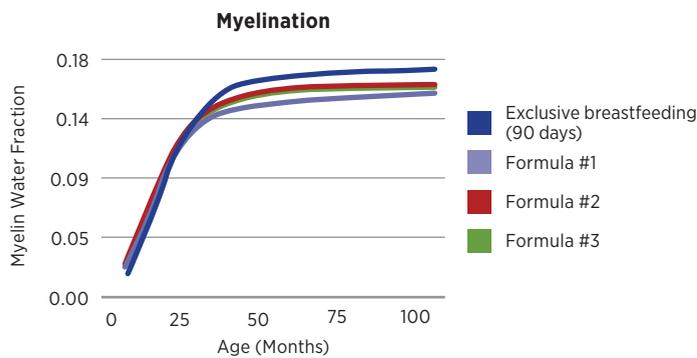
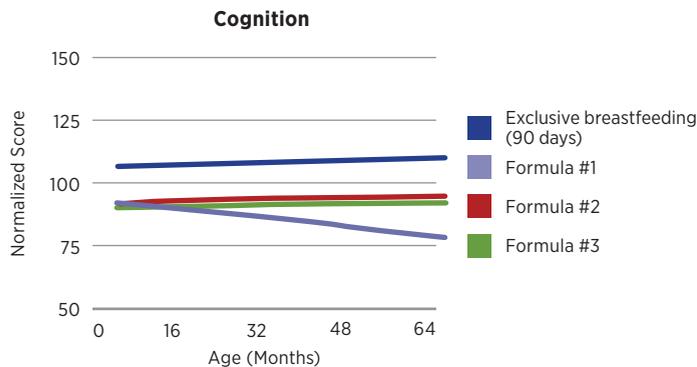


Figure 2b: Comparison of longitudinal maturation curves (Early Learning Composite [ELC] score of the Mullen Scales of Early Learning) between children who received different formula compositions. The trend for exclusively breastfed children is provided for reference.



- Nutritional differences exist among the different formulas in the study (**Figure 3**). For example, children who received formula compositions with higher levels of docosahexaenoic acid (DHA), arachidonic acid (ARA), folic acid, sphingomyelin (SM), iron, and phosphatidylcholine (PC) showed increased levels of myelin development. Moreover, higher levels of SM and PC were associated with increased myelination across the brain rather than in specific regions.

Figure 3: Nutritional differences between individual infant formulas

Nutrient	Unit	Formula #1	Formula #2	Formula #3
ARA	mg/L	173	238	255
DHA	mg/L	62.2	117	120.6
Folic Acid	mcg/L	304	232	146.2
Phosphatidylcholine	mg/L	85	58	60
Sphingomyelin	mg/L	28.1	62	28.1
Iron	mg/100g	10.6	8.42	11.65
Choline	mg/100g	170	92.5	144

While there is evidence from prior literature that support the role of the nutrients identified in brain and cognitive development, the authors recognize the weakness of collecting the nutrient data retrospectively. It is important to understand that this observational data provides correlations, but does not offer conclusions on supplementation effects. Therefore, nutrient effects and efficacy need to be tested in a randomized controlled clinical trial.

KEY TAKEAWAYS

- Myelination is an integral part of brain connectivity and supports brain and cognitive function.
- Exclusively breastfed infants had significantly higher myelination as well as higher cognitive scores (within normal ranges) compared to exclusively formula-fed infants.
- Exclusively formula-fed infants showed significant deviations from breastfed infants in myelin and cognitive development across different formula compositions.
- The retrospective analysis of nutrient levels in infant formulas suggests an important role for DHA, ARA, folic acid, SM, iron, and PC in myelination.

Citation:

Deoni S, Dean III D, Joelson S, O'Regan J, Schneider N. Early nutrition influences developmental myelination and cognition in infants and young children. *NeuroImage*. 2018. doi: 10.1016/j.neuroimage.2017.12.056.

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