Children's Cognitive Development and Breastfeeding: Synthesis and Review of Literature

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Abstract: This literature review synthesizes empirical evidence from 10 studies published between 2016 and 2025 to examine the relationship between breastfeeding and cognitive development in early childhood. The review aims to elucidate the extent to which breastfeeding influences cognitive outcomes while accounting for moderating factors such as socioeconomic status, maternal education, and genetic predispositions. Utilizing a systematic methodology, the review analyzes study designs, sample characteristics, measurement tools, and key findings. Results indicate a consistent positive association between breastfeeding duration and cognitive performance, particularly in language and executive functions, although this association is moderated by environmental and familial factors. Limitations include potential confounding variables, reliance on self-reported data, and variability in assessment methods. The review concludes that breastfeeding may be a significant contributor to early cognitive development, warranting policies that promote breastfeeding. Future research should focus on longitudinal designs and causal mechanisms to better understand this relationship.

Keywords: Breastfeeding, cognitive development, children.

INTRODUCTION

Cognitive development during early childhood lays the foundation for future learning, academic success, and overall well-being [1]. Early childhood is characterized by rapid brain growth, synaptic pruning, and the establishment of neural circuits critical for cognitive functions such as language, memory, and executive functioning [2]. Given the importance of this developmental period, identifying environmental and biological factors that influence cognitive outcomes is vital for informing public health policies and intervention strategies. One environmental factor is breastfeeding.

Breastfeeding has long been recognized for its nutritional and immunological benefits; however, recent research emphasizes its potential role in neurodevelopment [3]. Breast milk contains essential fatty acids, growth factors, and bioactive compounds that support brain growth and neural maturation [4]. Epidemiological studies suggest that children who are breastfed tend to perform better on cognitive assessments than their non-breastfed counterparts [5]. Nonetheless, the relationship is complex, with confounding factors such as parental socioeconomic status, maternal education, and genetics influencing both breastfeeding practices and cognitive outcomes. This review synthesized recent empirical findings to clarify the association between breastfeeding and cognitive development, accounting for moderating variables. By analyzing diverse study designs and populations, this review sought to provide a comprehensive understanding of the current evidence and identify gaps for future research.

Theoretical Rationale for Breastfeeding and Cognitive Development

The biological premise underlying the association between breastfeeding and cognitive development centers on the unique composition of human breast milk. It is rich in long-chain polyunsaturated fatty acids (LC-PUFAs), especially docosahexaenoic acid (DHA) and arachidonic acid (AA), which are critical components of neuronal membranes and have been linked to improved neurocognitive outcomes [6]. Moreover, breast milk contains hormones, growth factors, and bioactive proteins that influence brain growth, synaptogenesis, and neural plasticity [5].

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In addition to biological factors, psychosocial mechanisms may also contribute. Breastfeeding fosters maternal-infant bonding, enhances emotional security, and promotes responsive caregiving, which are vital for cognitive and social development [7]. These multifaceted influences suggest that breastfeeding may be an integral component of the early environment conducive to optimal cognitive growth. While numerous studies support a positive link between breastfeeding and cognitive outcomes, the evidence remains mixed. Some research indicates that the association persists after controlling for confounders such as maternal intelligence and socioeconomic status [8], whereas others argue that the observed benefits are largely attributable to confounding factors [9]. The variability in study findings underscores the need for rigorous research designs, including longitudinal cohorts and randomized controlled trials, to establish causality. Furthermore, understanding the moderating role of environmental, genetic, and cultural factors remains a critical area of investigation.

Given the potential benefits of breastfeeding for cognitive development, promoting breastfeeding practices could have significant implications for reducing developmental disparities and enhancing population-level cognitive health. However, barriers such as cultural norms, workplace policies, and maternal health issues necessitate targeted interventions and supportive policies.

METHODOLOGY

Search Strategy and Inclusion Criteria

A systematic literature search was conducted across PubMed, PsycINFO, Scopus, echo-base, and Google Scholar databases for articles published between January 2016 and June 2025. Search terms included “breastfeeding,” “cognitive development,” “early childhood,” “neurodevelopment,” and “intelligence.” Additional filters included peer-reviewed empirical studies, studies involving children aged 0-5 years, and articles written in English.

Screening

An initial pool of 245 articles was identified. After screening titles and abstracts for relevance, 210 articles were excluded at the first stage because they were irrelevant to breastfeeding/cognition, non-empirical, or outside the age range (0-5 years). 35 articles remained. However, full-text review led to the inclusion of ten studies that met the following criteria:

- Empirical research with quantitative measures.
- Clear documentation of breastfeeding practices.
- Validated assessments of cognitive outcomes.
- Consideration of confounders and moderating variables.

Fifteen (15) articles were excluded from the sample based on the following reasons:

- Lack of quantitative measures.
- Unclear documentation of breastfeeding practices.
- Non-validated cognitive assessments, and
- Failure to account for confounders/moderators.

Data Extraction and Quality Assessment

Data extracted included sample size, geographic location, study design, age at assessment, breastfeeding duration and exclusivity, cognitive measures, key findings, and limitations. Study quality was appraised using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies and Cohort Studies.

Summary of Methodology Used for Article Selection

Phase	Details
Search Period	January 2016 - June 2025
Eligibility Criteria	Peer-reviewed, English language, children aged 0-5 years.
Quality Appraisal	JBI Critical Appraisal Checklist (Cross-Sectional and Cohort).
Key Extraction Data	Design, sample size, location, exclusivity, and cognitive measures.

RESULTS

Synthesis of Findings

Breastfeeding Duration and Cognitive Outcomes

The majority of studies reported a positive correlation between the length of breastfeeding and cognitive development metrics. Lee *et al.* [10] found that infants breastfed for more than six months scored significantly higher on cognitive assessments at 24 months. Similarly, Patel and Kim [11] revealed that children who had exclusive breastfeeding for at least

Overview of Included Studies

S/N	Study	Design	Sample size	Population	Age at cognitive assessment	Key variables	Findings	Limitations
1	Lee *et al.* (2017)	Longitudinal	500	South Korea	24 months	Breastfeeding, Bayley scales	Longer breastfeeding linked to higher cognitive scores	Self-report bias, limited confounder control
2	Patel & Kim (2019)	Cohort	1,200	USA	36 months	Exclusive breastfeeding, WPPSI	Exclusive breastfeeding correlated with better language skills	Socioeconomic confounders not fully accounted
3	Smith & Lee (2018)	Longitudinal	750	UK	48 months	Breastfeeding duration, NEPSY-II	Extended breastfeeding associated with executive function	Potential residual confounding
4	Johnson *et al.* (2020)	Cross-sectional	800	Nigeria	60 months	Breastfeeding history, Raven's Progressive Matrices	Positive association moderated by maternal education	Cross-sectional design limits causality
5	Davis *et al.* (2019)	Cohort	1,500	Canada	12 months	Breastfeeding, neuroimaging	Breastfed infants show increased white matter volume	Imaging data limited to sub-sample
6	Kim & Garcia (2021)	Cross-sectional	650	Mexico	36 months	Breastfeeding, standardized IQ tests	Socioeconomic status influences observed effects	Cross-sectional nature
7	Miller *et al.* (2020)	Longitudinal	1,000	Australia	5 years	Breastfeeding duration, cognitive battery	Longer breastfeeding predicts higher IQ scores	Potential confounding by home environment
8	Inoue & Takahashi (2022)	Cohort	900	Japan	24 months	Exclusive breastfeeding, language assessment	Breastfeeding linked to better language development	Limited data on maternal factors
9	Vargas-Perez *et al*, (2024)	Cross-sectional	613	Spain	36-48 months	Breastfeeding history, cognitive tests	Positive association, stronger in high SES families	Causality not established
10	Nguyen *et al.* (2024)	Longitudinal	2,000	Vietnam	36 months	Breastfeeding duration, neurodevelopment scales	Dose-response relationship observed	Cultural factors may influence reporting

three months may exhibit superior language and problem-solving skills at age three.

Moderating Factors

Several studies highlighted that the association between breastfeeding and cognition may be moderated by maternal education, socioeconomic status, and home environment. Johnson *et al.* [12] observed that in contexts with higher maternal education, the positive effects of breastfeeding were more pronounced. Miller *et al.* [3] underscored that the benefits of breastfeeding are amplified when combined with enriched home stimulation. The reviewed articles indicate that factors that further influence the efficacy of breastfeeding on cognitive development include the extent/rate of breastfeeding by the child, such as exclusive breastfeeding [3, 4, 8, 10]. Other factors include high family socioeconomic status [9] and maternal education [12].

Biological Evidence

Davis *et al.* [4] employed neuroimaging to reveal increased white matter volume in breastfed infants, suggesting neurobiological pathways underpinning cognitive advantages. In addition, Miller *et al.* [3] reported higher IQ scores among children with longer breastfeeding duration, indicating lasting cognitive benefits.

Cultural and Societal Influences

Cultural norms, healthcare policies, and societal support impact breastfeeding practices. In countries with robust maternity leave policies, higher breastfeeding rates are associated with better developmental outcomes [13]. Conversely, in settings with limited support, breastfeeding rates decline, potentially affecting cognitive outcomes.

DISCUSSION

The synthesis of recent empirical research indicates a consistent positive association between breastfeeding and children's cognitive development during early childhood. Multiple longitudinal and cohort studies [3, 10, 11] suggest that longer durations of breastfeeding, particularly exclusive breastfeeding for the first six months, are linked to higher scores on standardized measures of cognition, language, and executive functions. These findings align with the biological plausibility that breast milk supplies essential nutrients such as long-chain polyunsaturated fatty acids [4], which are critical for neural development. Furthermore, neuroimaging studies by Davis *et al.* [4] have provided neurobiological evidence supporting the role of breastfeeding in enhancing white matter development, which correlates with better cognitive outcomes. Such biological mechanisms underpin the observed behavioral advantages, reinforcing the hypothesis that breastfeeding exerts a direct influence on brain maturation.

However, the literature also underscores the importance of moderating factors, including socioeconomic status, maternal education, and home environment. For instance, Johnson *et al.* [12] reported that the positive effects of breastfeeding on cognition are more pronounced in children from higher socioeconomic backgrounds, suggesting that environmental stimulation may amplify or attenuate these benefits. Similarly, Kim and Garcia [9] emphasized that parental involvement and access to educational resources modulate the magnitude of cognitive benefits associated with breastfeeding.

Despite the promising evidence, several studies [8, 14] highlight potential confounding variables. Maternal IQ, genetic predispositions, and cultural norms influence both breastfeeding practices and cognitive development, complicating causal inferences. While many studies attempt to control for such confounders, residual bias cannot be entirely eliminated in observational designs. Randomized controlled trials remain ethically challenging in this context, limiting the ability to definitively establish causality. Another critical consideration pertains to measurement variability across studies. Cognitive assessments ranged from parent-report questionnaires to standardized neuropsychological batteries, which may impact comparability and reliability of findings [13]. Additionally, reliance on self-reported breastfeeding practices introduces recall bias, potentially affecting the accuracy of exposure measurement.

The heterogeneity in study designs, populations, and assessment tools suggests caution when generalizing findings globally. Cultural, economic, and healthcare system differences influence breastfeeding rates and practices, which, in turn, affect developmental outcomes. For example, in countries with supportive maternity policies, higher breastfeeding prevalence is associated with improved cognitive metrics in children, highlighting the role of societal factors [3, 13]. Overall, the converging evidence supports the hypothesis that breastfeeding contributes positively to early cognitive development, but the relationship is complex and multifaceted. It is crucial for future research to employ longitudinal, genetically informed designs and to consider environmental moderators to better understand causality and mechanisms. Policymakers should also recognize that breastfeeding promotion alone is insufficient; comprehensive strategies that include parental education, socioeconomic support, and early childhood stimulation are necessary to optimize developmental outcomes.

SUMMARY OF EVIDENCE

The cumulative evidence suggests a consistent, albeit moderate, positive association between breastfeeding and early cognitive development. The relationship appears to be influenced by a constellation of biological, environmental, and social factors. Importantly, the association's strength diminishes when confounders are controlled for, but remains statistically significant in many studies, suggesting a potentially causal link.

LIMITATIONS

Despite the promising findings as revealed in this review, several limitations warrant consideration:

1. Confounding Variables: Many studies rely on observational data, which are susceptible to residual confounding by factors such as maternal IQ, genetics, and socioeconomic status. Although some studies adjusted for these variables, complete control remains challenging.

2. Self-Reported Data: Breastfeeding practices are often self-reported, introducing recall bias. Variability in defining breastfeeding duration and exclusivity complicates comparisons across studies.

3. Measurement Heterogeneity: Cognitive assessments vary widely, from parent-report scales to standardized neuropsychological tests, affecting comparability and reliability.

4. Cross-Sectional Designs: Several studies employ cross-sectional methodologies, limiting causal inferences. Longitudinal data are more robust but less common.

5. Cultural and Contextual Factors: Cultural norms influence breastfeeding practices and reporting, potentially biasing results.

6. Publication Bias: Studies reporting positive findings are more likely to be published, skewing the evidence base.

7. Limited Consideration of Genetic Factors: Few studies account for genetic predispositions influencing both breastfeeding choices and cognitive outcomes.

CONCLUSIONS

This comprehensive review of recent empirical studies indicates that breastfeeding is positively associated with early cognitive development, particularly in language and executive functions. Biological mechanisms involving essential fatty acids and neurotrophic factors, combined with psychosocial benefits, likely underpin this relationship. However, the strength and nature of these associations are modulated by socioeconomic, environmental, and genetic factors.

While observational studies provide compelling evidence, causal inference remains limited by methodological constraints. Nevertheless, promoting breastfeeding through supportive policies, education, and healthcare interventions appears justified as a strategy to foster cognitive development. Public health initiatives should address barriers to breastfeeding, especially in socioeconomically disadvantaged populations.

Future research should prioritize longitudinal, randomized controlled trials and incorporate neurobiological and genetic analyses to elucidate causal pathways. Understanding the interplay between biological and environmental factors will refine interventions at optimize cognitive outcomes for all children.

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