

THE IMPACT OF BREASTFEEDING ON CHILD NEUROLOGICAL DEVELOPMENT: CLINICAL IMPLICATIONS OF BREASTFEEDING ON CHILD NEUROLOGICAL DEVELOPMENT

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Abstract: Objective: To elucidate the impact of inadequate breastfeeding on child development, addressing its short and long-term repercussions, in addition to highlighting the crucial benefits of exclusive breastfeeding in the first 6 months of life. Method: We used available scientific evidence, focusing on the PubMed database, through the search strategy “Breastfeeding”, “Neurodevelopment”, associated with the Boolean operator “AND”. Initially, we identified 96 articles, 11 of which were selected as official sources to support the review. Discussion: Studies highlight the relevance of breastfeeding in the neurological development of infants, and is also a protective factor against chronic diseases due to its components. In summary, the review highlights relevant clinical implications that can be mitigated through breastfeeding, promoting the integrity of neurological health and the well-being of infants. Conclusion: The clinical implications discussed highlight the need to encourage and support this practice, aiming for the full neurological development and global well-being of infants.

Keywords: Breastfeeding, child development, neurodevelopment, neurological health, infant.

INTRODUCTION

Historically, a progressive reduction in the rate of breastfeeding has been observed, with a significant decrease in the prevalence of infants exclusively breastfed up to 6 months, comparing the period from 1911 to 1915 with the interval from 1946 to 1950, with a decrease of approximately 40 %. Within this context of decreased breastfeeding, the interruption of solutions identified by ancient civilizations for the insufficiency of breastfeeding is also notable, such as the practice of donating milk, cross-nursing and the introduction of foods before breast milk (BRAHM et al, 2017; WILDE, 2021).

As a result of this process, short- and long-term effects on children's health arise. In the short term, insufficient breastfeeding is associated with avoidable neonatal hospitalizations caused by complications such as hypernatremia, dehydration, hypoglycemia and hyperbilirubinemia (jaundice). These conditions represent the leading cause of newborn readmissions in the United States, and acute bilirubin encephalopathy is responsible for a significant portion of neonatal deaths in Nigeria (WILDE, 2021).

In the long term, studies have revealed a dose-response relationship between the duration of exclusive breastfeeding and the increase in scores in criteria assessed by the intelligence quotient (IQ), also demonstrating an improvement in cognitive development. Furthermore, a decreased risk of developing autism spectrum disorder and attention deficit disorder was observed in infants who were exclusively breastfed for at least 6 months, in contrast to the increased risk of reduced IQ, development of ADHD, and cognitive delays. in newborns with insufficient breastfeeding (BRAHM et al., 2017; WILDE, 2021).

Furthermore, maternal age, parental education level, birth weight and marital status demonstrated positive and significant associations with breastfeeding ($p < 0.05$), while maternal smoking and maternal weight gain showed a negative relationship (STELMACH et al., 2019). This implies that longer periods of breastfeeding have positive effects on children's language development during middle childhood (WILDE, 2021).

The objective of this literature review article is to examine and synthesize the impact of breastfeeding on child neurological development, based on available scientific evidence, and discuss the clinical implications of these findings.

METHODOLOGY

This study refers to a literature review conducted according to the criteria of the PVO strategy, which is an acronym that covers the population or research problem, variables and results. This approach was used to design the research around the following central question: "What is the impact of breastfeeding on children's neurological development, and what is the scientific evidence that supports these influences? What are the clinical implications of these findings?" The searches were conducted through searches in the PubMed Central (PMC) database. Descriptors were used in combination with the Boolean operator "AND": Breastfeeding AND Neurodevelopment. The inclusion criteria covered articles in English, Portuguese and Spanish, published between 2017 and 2023 and that addressed themes related to this research. We considered studies such as review, systematic review, meta-analysis, observational and cross-sectional studies, as long as they were available in full. Duplicate articles, those available only in abstract form and that were not directly related to the study proposal were excluded. As a result, we selected a total of 11 articles to compose this study.

DISCUSSION

Recent studies have highlighted the positive impact of exclusive breastfeeding on premature babies, who, by their very nature, have an unfavorable prognosis for general development. A significant positive influence on growth and neurodevelopment is observed, attributed to the nutrients present in breast milk, such as fatty acids, lactoferrin and oligosaccharides. These components act as protective factors, effectively responding to oxidative stress in premature infants, regulating the hormonal response and intestinal colonization to reduce the invasion

of pathogens and inflammatory factors. In the long term, these benefits provide protection against chronic diseases in adulthood, including hypertension, obesity and diabetes (JING-JUN; JUN, 2019).

The exact mechanisms by which breastfeeding influences cognitive development are complex, encompassing not only the nutrients present in breast milk, but also positive socio-economic and psychosocial factors, playing a crucial role in the human developmental environment. The adequate concentration of nutrients in breast milk, determined by the mother's diet, has a direct influence on adequate nutrition in the first six exclusive months of life. Current evidence already demonstrates superior cognitive and metabolic abilities in infants exclusively breastfed compared to formula (A. ZIELINSKA et al., 2019).

In cases of premature babies, defined as those born at less than 37 weeks of gestation and allocated to neonatal intensive care units, breastfeeding plays a crucial role in reducing neonatal complications. It strengthens the gut-brain axis, improving the microbiota and fortifying immunity. Donating breast milk to hospital milk banks is vital, as donated human milk protects premature babies against infections, enterocolitis and pathogens. Studies indicate superior neurological development in premature children aged 12 to 18 months when compared to mixed feeding strategies or formulas alone (GUO et al., 2023).

Premature babies often present nutritional deficits immediately after birth, which can result in compromised growth and neurological development throughout their evolution. Breastfeeding premature babies, based on exclusive breastfeeding and, sometimes, specific fortifiers, is an adopted practice. However, the diverse use of fortifiers can impact the nutrient density and osmolarity of breast milk, interfering with gastric emptying and peristalsis, potentially

causing food intolerance and increasing the risk of necrotizing enterocolitis. Reports also indicate intestinal obstruction with a "milk curd" appearance and concerns related to rapid weight gain, associated in the long term with insulin resistance and hypertension (BROWN et al., 2020).

The first 1000 days of life, from pregnancy to 2 years of age, are crucial for child neurodevelopment, as the central nervous system (CNS) is formed during this period. Maternal nutrition, supplementation during pregnancy and breastfeeding, in addition to food introduction, play a fundamental role in this process. Recent studies indicate that breastfeeding recommended by the WHO, exclusive up to 6 months and complementary up to 2 years, is associated with increased development of brain white and gray matter. Evidence also points to improvements in motor and memory skills. The variation in micronutrients in breast milk highlights the adaptation to the specific needs of each population (LOCKYER et al., 2021).

When comparing studies, there is a convergence regarding the benefits of breastfeeding on child neurodevelopment. Research such as that by Ottolini et al. (2020) highlight, through brain magnetic resonance imaging, the increase in the myelin water fraction (marker of microstructural development of white matter) in babies fed with breast milk compared to infant formulas. Furthermore, these babies have better verbal, visual, cognitive and motor development. It is concluded that exclusive breastfeeding has a significant impact on child neurodevelopment. Evidence points to benefits in both brain microstructure and global skill development in breastfed babies. This review highlights the relevance of considering breastfeeding as a crucial intervention to promote long-term neurological health and well-being in preterm infants.

Breastfeeding has stood out as a protective factor against several atopic and cardiovascular diseases, necrotizing enterocolitis and celiac disease. Its positive impact on children's neurological development is notable, being associated with improvements in IQ and a reduced risk of disorders such as attention deficit and generalized developmental and behavioral disorders (BRAHM et al., 2017).

A meta-analysis of observational cohort and case-control studies revealed a significant difference of 3.16 points more in cognitive development between breastfed and formula-fed children. In low birth weight infants, duration of breastfeeding directly correlated with verbal IQ scores and performance on the Wechsler Scale at 7-8 years (BRAHM et al., 2017). However, STELMACH et al. (2019) suggest that exclusive breastfeeding for 6 months was not associated with psychomotor development in 1-year-old children, indicating that the benefits may depend on the interaction with other positive parental behaviors.

Breast milk is rich in bioactive factors such as microRNAs (miRNAs), long non-coding RNAs (lncRNAs), stem cells and microbiome, all of which play a crucial role in infant neurodevelopment. MiRNAs regulate gene expression, lncRNAs protect against brain damage, oxidative stress and inflammation, while the microbiome contributes to the baby's epigenetics and neurodevelopment (GIALELI et al., 2023). Possible long-term neurological effects due to lack of exclusive breastfeeding include attention deficit hyperactivity disorder, autism, cerebral palsy, cognitive and developmental delay, epilepsy, hearing impairment, kernicterus, language disorder, mood swings, lower IQ and specific learning disorder. Raising awareness about the impact of breastfeeding on child development is crucial (WILDE, 2021).

The importance of protein-fortified

breast milk in the development of premature babies, especially with regard to growth and neurodevelopment, has been shown to be important. By comparing different protein concentrations in fortifiers, researchers identified that a high protein concentration ($\geq 1.4\text{g}/100\text{ mL}$ of EBM) compared to a moderate concentration ($\geq 1\text{g}$ to $< 1.4\text{g}/100\text{ mL}$ of EBM) resulted in small increases in weight gain during neonatal admission. Furthermore, it was observed that a moderate concentration of protein, compared to a low concentration ($< 1\text{g protein}/100\text{ mL EBM}$), can provide small increases in weight and length gain. These findings highlight the relevance of adequate nutrition provided by fortified breast milk to promote healthy growth in preterm infants. However, the certainty of the evidence is considered variable, and there is a significant gap in understanding long-term impacts, such as adverse effects or neurodevelopmental outcomes (GAO et al., 2020).

The results, from two studies involving 307 premature or low birth weight babies, indicated that there were no significant differences in growth between the groups that practiced exclusive breastfeeding for 4 months and for 6 months. Outcomes analyzed included weight-for-age z-score at 12 months corrected age, absolute weight gain from 16 to 26 weeks of age, linear growth gain from 16 to 26 weeks of age, reported morbidity, and motor developmental milestones.

However, the findings highlight the uncertainty of the evidence regarding the effects of exclusive breastfeeding for less than 6 months in this specific population. The certainty of the evidence was assessed as very low for most results, indicating the need for more studies to obtain more conclusive answers (YANG et al., 2022).

FINAL CONSIDERATIONS

The analysis of breastfeeding in this literature review highlights its importance as a determining factor in child development. The practice contributes significantly to health in the short term, reducing avoidable neonatal hospitalizations, and, in the long term, promoting healthy growth and neurodevelopment. Breastfeeding emerges

as a valuable intervention, especially in cases of prematurity, associated with brain development and improvement of motor and cognitive skills. Understanding these benefits highlights the relevance of promoting and supporting the practice of exclusive breastfeeding in the first six months of life, aiming to ensure the comprehensive and healthy development of children.

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