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Original Article

Effect of Exclusive Breastfeeding on Neurodevelopmental of Children 6-24 Months: A Case-Control Study

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Abstract:

Background: A positive correlation between breastfeeding and a child's neurodevelopmental has been established. However, the specific impact of exclusive versus non-exclusive on neurodevelopmental outcomes has not been extensively studied. This study aims to compare neurodevelopmental outcomes between exclusively and non-exclusively breastfed children.

Method: A case-control study was conducted on children aged 6-24 months at the Pediatric Neurology Clinic, Department of Child Health, FKUI-RSCM (Cipto Mangunkusumo National Central General Hospital) Jakarta and Anakku Clinic Pondok Pinang Center South Jakarta, from March 2021 to May 2021. Data were collected through parent interviews and subject observations. Statistical analysis was performed using SPSS Statistics for Windows.

Results: The study included 140 subjects equally divided into two groups: 70 children with exclusive breastfeeding history and 70 children with non-exclusive breastfeeding (breast milk and formula). Although neurodevelopmental delays were observed to be lower in the exclusive breastfeeding group compared to the non-exclusive group, statistical analysis across all four domains showed no significant differences (gross motor $p = 0.087$; fine motor $p = 0.207$; social-emotional $p = 0.441$; language $p=0.727$).

Conclusion: Exclusive breastfeeding showed a trend towards reduced risk of neurodevelopmental delays in children aged 6-24 months, although not statistically significant. Infant formula can be a safe alternative to complement breast milk, especially when breast milk production decreases, while maintaining optimal nutritional status.

Keywords: children aged 6-24 months, exclusive breastfeeding, neurodevelopment

Introduction

Based on the 2018 Indonesian Health Research, 17.7% of children under five years old are undernourished and malnourished, 8% are overweight, and 10.2% are wasted and severely wasted.[1] Breastmilk feeding is closely related to a child's nutritional status, as it is the primary source of nutrition and energy for children under 6 months old.[2] Exclusive breastfeeding before birth is highly beneficial for a baby's health, as they receive colostrum, which is rich in protein and antibodies and boosts the child's immune system.[3] Those who exclusively breastfeed for six months are less likely to develop future health problems, probable reductions in overweight, and increases in intelligence.[4] Breastfeeding benefits the neurodevelopmental progress of both full-term and preterm infants. This is due to the nutritional differences between breast milk and formula, as well as the unique bond formed between mother and child during breastfeeding.[5]

Although a positive correlation between breastfeeding and a child's neurodevelopmental progress has been established, the neurodevelopmental differences between exclusively breastfed and non-exclusively breastfed children aged 6 to 24 months has not been extensively studied.[5] Therefore, this study aims to investigate the differences in neurodevelopment between exclusively breastfed and non-exclusively breastfed children aged 6 to 24 months in both a tertiary referral hospital and a private clinic in South Jakarta.

Method

Study Design

A case-control study was conducted among children aged 6 to 24 months who visited the Neurology Outpatient Clinic at Cipto Mangunkusumo Hospital in Jakarta and Anakku Pondok Pinang Center from March until May 2021. Inclusion criteria for the study were children aged 6 to 24 months who were either exclusively breastfed or non-exclusively breastfed (breastmilk combined with formula milk), with either normal or impaired neurodevelopmental status. Exclusion criteria included children with chronic diseases, congenital diseases, and conditions that could hinder motor development.

Data Collection

Data was gathered through both parent interviews using questionnaires and direct observation of the subjects. The questionnaires assessed family history, nutritional status, and neurodevelopment stages based on age-appropriate milestones, which is divided into four domains: gross motor skills, fine motor skills, social-emotional, and language.

Data Analysis

Data analysis was conducted using SPSS version 20. Bivariate analysis, employing the chi-square test, was used to analyze the data. Statistical significance was determined by

a p-value of less than 0.05, and results were presented in terms of odds ratios and confidence intervals 95%.

Ethical Approval

Ethical approval for this study was obtained from the Faculty of Medicine Universitas Indonesia – Cipto Mangunkusumo Hospital's ethics committee (No. 235/UN.F1/ETIK/PPM.00.02.2021). Informed consent was obtained from participants' parents prior their inclusion in the study. The consent process ensured that the guardians understood the study's objectives and the voluntary nature of their participation.

Result

A total of 140 children who met the inclusion criteria were included as subjects in this study. Of these, 70 children were exclusively breastfed, while the remaining 70 received a combination of breastmilk and formula. The majority of the respondents were male (n=91, 65.0%), aged 21 – 24 months (n=65, 46.4%), with a gestational age of more than 37 weeks (n=129, 92.1%), and a birth weight of more than 2500 grams (n=130, 92.9%). The characteristics of the subjects are presented in **Table 1**.

Table 1. Characteristics of subjects.

Characteristics	Total (n=140) n (%)
Gender	
Male	91 (65.0%)
Female	49 (35.0%)
Age	
6 – 10 months	24 (17.1%)
11 – 15 months	27 (19.3%)
16 – 20 months	24 (17.2%)
21 – 24 months	65 (46.4%)
Gestational Age	
<37 weeks	11 (7.9%)
≥ 37 weeks	129 (92.1%)
Birth weight	
<2500 gram	10 (7.1%)
≥2500 gram	130 (92.9%)

In the domains of gross motor skills, fine motor skills, and language, a higher proportion of non-exclusively breastfed infants had developmental delays compared to exclusively breastfed infants (25.7% vs. 12.9%, 17.1% vs. 8.6%, and 40.0% vs. 35.7%, respectively). However, bivariate analysis indicated that exclusive breastfeeding was not statistically significantly correlated with neurodevelopment in all domains.

This is evidenced by p-values greater than 0.05 in all domains and wide confidence intervals (gross motor p = 0.087; fine motor p = 0.207; social-emotional p = 0.441; language p=0.727) **(Table 2).**

Table 2. Bivariate analysis comparing the neurodevelopment status of exclusively and non-exclusively breastfed infants.

Neurodevelopment Domains	Exclusively Breastfed (n = 70)	Non-exclusively Breastfed (n = 70)	p-value	OR	95% Confidence Interval
Gross Motor					
Appropriate	61 (87.1%)	52 (74.3%)	0.087	2.346	0.972 – 5.665
Delayed	9 (12.9%)	18 (25.7%)			
Fine Motor					
Appropriate	64 (91.4%)	58 (82.9%)	0.207	2.207	0.778 – 6.259
Delayed	6 (8.6.%)	12 (17.1%)			
Social-emotional					
Appropriate	65 (92.9%)	68 (97.1%)	0.441	0.382	0.072 – 2.041
Delayed	5 (7.1%)	2 (2.9%)			
Language					
Appropriate	45 (64.3%)	42 (60.0%)	0.727	1.200	0.394 – 7.483
Delayed	25 (35.7%)	28 (40.0%)			

Additionally, an analysis of nutritional status revealed a higher prevalence of undernourishment or malnutrition among non-exclusively breastfed infants compared to exclusively breastfed infants (7.1% vs. 4.3%), although this difference was not statistically significant **(Table 3).**

Table 3. Bivariate analysis comparing the nutritional status of exclusively and non-exclusively breastfed infants.

Nutritional Status	Exclusively Breastfed (n = 70)	Non-exclusively Breastfed (n = 70)	p-value	OR	95% Confidence Interval
Normal	67 (95.7%)	65 (92.9%)	0.718	1.718	0.394 – 7.483
Undernourished /Malnourished	3 (4.3%)	5 (7.1%)			

Discussion

Child development can be assessed into four key domains: gross motor skills, fine motor skills, speech and language, and social-emotional development. These domains

are interconnected and influenced by the maturation of the central nervous system.[6] This study revealed an interesting finding between exclusive breastfeeding and neurodevelopment in children aged 6 – 24 months. Exclusively breastfed children exhibited a lower incidence of neurodevelopment delays compared to non-exclusively breastfed children, with the exception in social-emotional development. However, these differences were not statistically significant. Similarly, a study conducted by Enambere et al., revealed no significant neurodevelopmental differences between exclusive breastfeeding, formula feeding, and non-exclusive breastfeeding.[7] In contrast, a study by Nurlaila et al., reported a significant correlation between exclusive breastfeeding and motoric development.[8]

Exclusive breastfeeding provides numerous benefits for children development. Breastmilk contains a complex nutrient, such as lactose, calcium, vitamin B16, zinc, and long-chain fatty acids, specifically docosahexaenoic acid (DHA) and arachidonic acid (ARA). These nutrients are important for the child's gross motor skills, which are an essential domain to children growth and development.[8] Breastmilk also important for promoting brain and retinal development.[9-11] Exclusive breastfeeding supports children in reaching their optimal growth potential.[12]

Several factors can impede exclusive breastfeeding practice, such as, mother experience breast pain, inverted nipples, and inadequate milk production. Children who are not exclusively breastfed face a higher risk of developmental delay.[9]

The majority of the study participants were 21-24 months old (46.4%). At this age, breastmilk is no longer the primary source of nutrient, complementary feeding becomes the predominant source of nutrition, surpassing the role of breast milk.[13] This dietary transition aligns with WHO recommendations, which promote continued breastfeeding beyond the age of two, although with decrease proportions.[14] These circumstances may influence the result of the study, as evaluating the long-term benefits of exclusive breastfeeding become increasingly complex due to the presence of various confounding factors that can influence the outcomes during this nutritional transition.[15]

A good nutritional status indicates that the child's nutritional needs, including for brain development, has been adequately met. No significant difference in nutritional status was observed between exclusively and non-exclusively breastfed children in this study, with 95.7% and 92.9% of children, respectively, has good nutritional status. We concluded that complementary feeding may have effects on improving nutritional status regardless of previous breastfeeding practices, resulting in no significant incidence of developmental delay between two groups. This also highlights the importance of maintaining optimal nutritional status during the critical growth period for neurodevelopment.[16]

Formula milk can also be a suitable alternative to breast milk, as long as it provides adequate nutrition.[17] Although there are ongoing debates about the formula milk, it remains a primary choice for children who cannot be breastfed. There are two types of formula milk: complete starting formula, designed for healthy infants without any particular requirements, and adapted starting formula, formulated for infants with specific physiological needs and often requiring a lower mineral content. Additionally, specialized milk formula also can be administered to children with lactose intolerance, such as lactose-free formulas. Furthermore, hydrolysed protein formulas with simple fats can prescribed for infants with acute or chronic diarrhea, and preterm infant formular are designed for premature to gain more energy.[18]

There is an ongoing pursuit to make infant formulas as similar to breast milk as possible. However, some nutritional component cannot be perfectly replicated and certain combination can result in undesirable interactions. For example, supplementing eicosapentaenoic acid without adequate DHA or adding excessive amounts of polyunsaturated fatty acids and iron without sufficient antioxidant protection can have detrimental effects. Another challenge in formulating infant formula is ensuring optimal bioavailability. While the goal is to mimic the complex composition of breastmilk, differences in the relative proportion of nutrients can impact their bioavailability. For instance, in situation where there is competition for enzymes (between n-3 and n-6 polyunsaturated fatty acids) or receptor binding sites in the intestine (zinc, iron, and copper) relative proportions may have significant implications.[19]

Several factors influence the breastfeeding practice, including maternal education level. In Indonesia, study has shown a significant correlation between maternal education and exclusive breastfeeding practice. Higher level of education is associated with increased self-efficacy, leading to more positive exclusive breastfeeding practice. Another factor is the mother's employment status. Working mothers often encounter difficulties in practicing exclusive breastfeeding due to time constraints and limited opportunities for pumping and feeding their child.[20-22]

Urban children are more likely to received exclusive breastfeeding compared to rural children. This may be attributed to increased exposure for mothers to information regarding the benefit of exclusive breastfeeding. In contrast, rural areas often have limited access to accurate health information. Socioeconomic factors also play a significant role in the practice of exclusive breastfeeding.[20, 21, 23]

This study highlights the impact of exclusive breastfeeding in neurodevelopment. However, further research is needed to identify potential confounding factors that may influence the neurodevelopment, such as environmental stimulation. Environmental factors and lifestyle habits, including excessive screen time, can

significantly impact child development.[24-27] Therefore, a more comprehensive approach that addresses both nutritional and environmental factors is needed.

Conclusion

Exclusive breastfeeding has been associated with a lower incidence of neurodevelopmental delay in children aged 6-24 months, although not statistically significant. Formula milk can be suitable alternative for children who cannot be breastfed, provided that adequate nutritional intake is maintained.

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Conflict of Interest

None declared.

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