Exclusive breast milk optimizes children’s development: a systematic literature review

Luh Mertasari¹, Anak Agung Ngurah Jaya Kusuma², Luh Seri Ani*³

INTRODUCTION

Exclusive breastfeeding is the main standard in baby feeding. All mothers breastfeeding are expected to make breastfeeding their babies a tradition. However, some mothers still do not give milk to their babies. One of the causes is mothers’ lack of knowledge about the benefits of breastfeeding or EBF. Exclusively breastfed infants showed better nutritional status, physical growth and cognitive development compared to non-exclusively breastfed infants. Breastfeeding was also found to correlate positively with children’s cognitive performance and socio-affective responses. Breast milk is reported to support newborn brain development because it has the activity of long-chain polyunsaturated fatty acids such as docosahexaenoic acid (DHA) and arachidonic acid (AA). The coverage of EBF continues to increase from year to year. Exclusive breastfeeding in 2005 was reported at 35%, rising to 42% in 2018. However, this figure has not reached the target of achieving EBF in the world, which is to get 50% by 2025 and 70% by 2030. Each country in the world reports EBF rates that vary from 1-69%. Indonesia reported EBF in 2018 at 66%.

Low coverage of EBF will impact achieving children’s quality of life. Various studies that identify the benefits of EBF on child development have been conducted. However, no consistency has been found in the findings. In addition, there were also limitations in previous studies, especially in measuring data on EBF and duration. For this reason, identification of the benefits of breastfeeding on the baby’s development is still needed. The results of the investigation are expected to be a source of information about the benefits of EBF for child development and as material for providing education/health promotion about EBF.

The benefits of breastfeeding on the psychological effects of children have been identified. However, the review only reviewed the effects of breastfeeding on the cognitive aspects of children, while the best duration of breastfeeding to optimize psychological development in...
infants has not been discussed. Therefore, this systematic literature review aims to identify and evaluate the benefits of EBF on child development at a minimum duration of three months. This systematic review of the literature review is expected to complement the limitations of the previous literature.

**METHOD**

This systematic literature review follows the framework of Arksey and O’Malley, which explores the benefits of EBF for child development. The framework has five stages: identifying research objectives, relevant studies, selecting studies, mapping data, compiling, summarizing, and reporting results. A systematic literature search for relevant articles was conducted in five databases: PubMed, Science Direct, Sefforra, Publish or Perish, and Research Gates. The search was conducted using text words in various combinations related to the benefits of exclusive breastfeeding for development consisting of exclusive breastfeeding*, benefits of exclusive breastfeeding, breastfeeding* and growth, breastfeeding and development, and advantages of exclusive breastfeeding.

**Study Selection Criteria**

The articles sought to review the benefits of exclusive breastfeeding for children, focusing on the benefits of exclusive breastfeeding for the duration of exclusive breastfeeding. Inclusion criteria used to select relevant articles included a focus on exclusive breastfeeding for at least three months, articles published in English between 2013-2023 and original articles. Articles from Scopus Q1-Q4 indexed journals.

**Search result**

The first stage of the search found 5,420 article titles. After the duplication was removed, the number of articles was reduced to 95 articles. A total of 50 articles were excluded because there was no statement regarding the scope of EBF, and another 20 articles were excluded because they did not discuss the benefits of EBF for child development. Of the remaining 25 articles, 22 met the search inclusion criteria. Of the 22 articles, as many as 7 could not be accessed, so the number of eligible articles in this study was 15. This literacy selection process follows the numbers on selected reporting items for systematic review and meta-analysis (prism). The article selection process is presented in Figure 1.

**Quality Assessment**

The authors assessed the quality of the included studies using the Critical Review Checklist for Cross-sectional Analysis checklists and the Newcastle-Ottawa Quality Rating Scale. Longitudinal studies will be used to assess the quality of included studies. The effect of breastfeeding on infant development would be considered the primary outcome.

**Data extraction and analysis**

The author's process is to review the paper's title and filter the abstract for feasibility to reduce the subjectivity of the analysis. Data from the articles included in the literature review were extracted manually using two templates developed by the authors. The template contains general research characteristics, and the second template contains the benefits of EBF for development. The information extracted includes the author's name, year of publication and country of study, population design and characteristics, methods, and research results related to the duration and the benefits of EBF for child development.

The author independently extracts data from the article using templates. The author reviews the notability criteria of the article. The extracted data is arranged in the form of a table. The study's results grouped the author's name, title, location, method, sample, duration of breastfeeding and research results. A summary of the findings from the article is presented, and the data is analyzed using narrative synthesis.

Ethical approval was not required in this literature review as the data used were obtained from published studies, and there would be no concerns regarding confidentiality. The results of this study will provide relevant information on the relationship between breastfeeding and child development and can be used to...
encourage increased breastfeeding rates.

RESULTS

The articles selected for this review varied in research design and the setting in which the research was conducted. Sociodemographic characteristics were reported in 15 studies. Most of the research was conducted in developed countries (N: 10) and developing countries (N5). All studies (N 15) published from 2013-2022, Studies published by Scopus indexed journals Q4-Q1. The study design included a randomized control trial (RCT) (3), Cohort (N 8), and Cross-sectional (N4). The number of respondents who participated in this study was (N 1300) and the number of child respondents (N 3.443). None of the studies involved only fathers or the extended family. The following table describes the 15 literature

<table>
<thead>
<tr>
<th>No</th>
<th>Title</th>
<th>Type of Research (year)</th>
<th>Sample</th>
<th>Developmental Assessment Time</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exclusive Breastfeeding Predicts Higher Hearing-Language Development in Girls of Preschool Age</td>
<td>Cohort study (2020)</td>
<td>Eighty mother-child pairs of children aged 6 months were observed for 5 years.</td>
<td>Children's ages, when measured, were 6,12,18,24,36, and 60 months by Griffiths Mental Development Scales, parental intelligence (IQ)</td>
<td>Exclusive breastfeeding is associated with higher auditory language development in children aged five years regardless of the mother's IQ, age and BMI (body mass index).</td>
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<tr>
<td>2</td>
<td>Breastfeeding Duration and Cognitive Development at 2 and 3 Years of Age in the EDEN Mother-Child Cohort</td>
<td>Cohort Study (2013)</td>
<td>Sample 1387 children aged 2 years and 1199 children aged 3 years.</td>
<td>The age of the children at the time of observation was 2-3 years.</td>
<td>Children who had never been breastfed scored 3.7 ± 1.8 (P = 0.038) points higher than those who never had breastfeeding children on CDI, and 6.2 1.9 (P = 0.001) points higher on the ASQ. Among children who were exclusively breastfed</td>
</tr>
<tr>
<td>3</td>
<td>The Science of Breastfeeding and Brain Development</td>
<td>Cohort study (2017)</td>
<td>Pregnant women and infants who are fully exclusively breastfeeding (N=1300)</td>
<td>Assess several aspects of neurodevelopment at ages 3 and 7 years,</td>
<td>Exclusive breastfeeding for a longer duration plays an important role in early childhood cognitive and neurodevelopment.</td>
</tr>
<tr>
<td>4</td>
<td>The relationship between exclusive breastfeeding and infant development: A 6- and 12-month follow-up study</td>
<td>Cross-sectional (2018)</td>
<td>Two hundred fifty-five mothers and their infants living in South Korea were seen at three-time points based on the ages of the infants (4, 6, 12 months).</td>
<td>Tests for Infants &amp; Children are administered at 6 and 12 months to measure developmental milestones.</td>
<td>Compared to babies who were not breastfed at all, babies who were exclusively breastfed until 4 months of age, followed by mixed breastfeeding, had better communication and social interaction at 6 months and better cognition, communication, and social interaction at 12 months. Exclusive breastfeeding until 6 months of age had no clear impact on outcomes at 6 and 12 months. Breastfed children increased white matter development in later relationships. A positive relationship between white matter microstructure and duration of breastfeeding was also demonstrated in several brain regions, which is anatomically consistent with the observed improvements in cognitive and behavioral performance measures. Significantly increased overall myelination in breastfed children accompanied by improvements in general cognitive, verbal, and non-verbal abilities compared to exclusively formula-fed children.</td>
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<tr>
<td>5</td>
<td>Breastfeeding and Early White Matter Development: A Cross Sectional Study</td>
<td>Cross-sectional (2013)</td>
<td>Sample Healthy children from 10 months to 4 years old</td>
<td>Age 2.2 to 4 years (800 to 1541 days)</td>
<td>Breastfed children have lower test scores, but the breastfed and non-breastfed children had similar growth patterns in test scores over time. Breastfeeding is positively associated with improved outcomes. Academic tests but not related to behavioral problems. Duration Longer exclusive breastfeeding for at least 5 months significantly impacts BMI growth patterns.</td>
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<td>6</td>
<td>Early nutrition influences developmental myelination and cognition in infants and young children</td>
<td>Cross-sectional (2018)</td>
<td>Children from birth and 5 (N 500)</td>
<td>Developmentally, children were scanned and cognitively assessed at 6 months increments from the time of recruitment to age 2 years,</td>
<td>Breastfeeding outcomes: an investigation of the nurturing hypothesis</td>
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REVIEW

<table>
<thead>
<tr>
<th>No</th>
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<tr>
<td>9</td>
<td>Exclusive Breastfeeding and Developmental and Behavioral Status in Early Childhood (2013)</td>
<td>RCT</td>
<td>Children who receive complementary foods from the age of 4 months in addition to breast milk (CF, n = 60) or exclusively breastfeed until 6 months (EBF, n = 59).</td>
<td>aged 6 years to collect data back</td>
<td>The sustained effect of a longer duration of exclusive breastfeeding is seen in certain developmental measures and behavioral statuses at 18 months. However, at 30-35 months, a smaller percentage of parents of children who were introduced to complementary foods at four months of age expressed concern about their gross motor development. In the unadjusted model, EBF in the 3–6 month period was associated with ASQ-3 scores of 0.44 SD, 0.34 SD and 0.36 SD higher in the communication, gross motor, and problem-solving domains, respectively. There are weak associations in the fine motor and social-emotional domains. Compared with children who were never breastfed, i.e., those who were breastfed for 6 months and exclusively breastfed for 3 months, had reduced possible difficulty with emotional symptoms. (OR: 0.52; 95% CI: 0.27–0.99), did the problem (OR: 0.24; 95% CI: 0.10–0.54) and total difficulty (OR: 0.39; 95% CI: 0.18–0.85) before adjustment. This association was no longer significant after adjustment for overall child development (b: 0.38; confidence limit = 0.23 to 0.53). Comply with WHO recommendations for exclusive breastfeeding for 6 months followed by a provision of complementary foods until the age of 2 years associated with a 0.4-SD increase in overall child development.</td>
</tr>
<tr>
<td>10</td>
<td>Associations between exclusive breastfeeding duration and children’s developmental outcomes: Evidence from Siaya county, Kenya (2022)</td>
<td>RCT</td>
<td>570 children under 6 months of age at the time of the interview</td>
<td>children under 6 months of age at the time of the interview</td>
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<tr>
<td>11</td>
<td>Breastfeeding and Later Psychosocial Development of Children at 6 Years of Age (2014)</td>
<td>Cohort study</td>
<td>Sample Children (N = 1442)</td>
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<tr>
<td>12</td>
<td>Breastfeeding, Physical Growth, and Cognitive Development (2021)</td>
<td>Cohort study</td>
<td>Sample of 2288 children aged 36 months</td>
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<td>...</td>
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<tr>
<td>13</td>
<td>Does exclusive breastfeeding correlate with infant’s early language milestone? (2019)</td>
<td>Cross-sectional</td>
<td>Sample 30 Newborns</td>
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<tr>
<td>14</td>
<td>Breastfeeding and IQ Growth from Toddlerhood through Adolescence (2015)</td>
<td>RCT</td>
<td>A sample of 11,582 children (6,059 girls) with 4115 monozygotic twins and 7450 dizygotic twins.</td>
<td></td>
<td>The twins were assessed at 2, 3, 4, 7, 9, 10, 12, 14 and 16 years of intelligence. Breastfeeding is associated with small gains but significant in IQ at age 2 in girls (β = 0.07, 95% CI from 0.64 to 3.01; N = 3.035) but not in boys (β = 0.04, 95% CI from -0.14 to 2.41). The results show a positive correlation between durations of breastfeeding and MDI scores. After adjusting for covariates, infants who breastfed for ≥ 9 months have developed much better cognitively than those who have not been breastfed.</td>
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<tr>
<td>15</td>
<td>Effect of Breastfeeding Duration on Cognitive Development in Infants: 3-Year Follow-up Study (2016)</td>
<td>Cohort study</td>
<td>Sample 697 babies</td>
<td></td>
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</table>

Of the 15 studies, 2 articles (n=2) discussed the benefits of EBF for hearing and language, 5 articles (n=5) discussed the benefits of EBF on the cognitive development index, 1 article (n=1) discussed the benefits of EBF for emotional symptom difficulties, and 1 article (n=1) discussed the benefits of EBF for overall developmental difficulties. The relationship of EBF with gross motor skills is discussed in 1 article (n=1). Other articles discuss the benefits of EBF on IQ (n= 1), on communication and social interaction (n=1), white matter microstructure on performance, cognitive and behavior, on increased myelination in children, on improving general, verbal,
and non-verbal cognitive abilities (n=1)
Based on the sample criteria used, as
many as 10 (n=10) studies used samples of
children who received EBF during the first
six months, 4 studies (n=4) used samples of
children with EBF for five months, 1
(n=1) studies with samples of children
with exclusive rice for > 6 months.

The observed age of babies also varies
from 6-60 months. A total of 1 (n=1)
study conducted observations in children
aged 6 and 12 months, as many as 1 (n=1)
study in children aged 2 and 6 years, 1
(n=1) study in children aged 3 and 7 years,
1 (n=1) study in children aged 2.2 years
and 4 years, 1 (n=1) study in children aged
6 months and 2 years, 1 (n=1) study in
children aged 18, 30 and 35 months. There
was also a study that measured children
the age of <6 months (n=1), and 1 study
carved out adolescents <18 years (n=1).

DISCUSSION
Based on the reported findings, there
are variations in the benefits of EBF. An
Italian study found a link between EBF and
language development, with higher
hearing in five-year-olds regardless of the
mother's IQ, age, and BMI. Research
conducted in France found that children
who had never been breastfed scored 3.7 ±
1.8 (p=0.038) points higher than children
who had never been breastfed on CDI
and 6.2 ± 1.9 (p=0.001) points higher on
ASQ. Research conducted in the United
States found that EBF for a longer duration
plays an important role in early childhood
cognitive and neural development. Research
conducted in South Korea found that infants
who received EBF up to 4 months of age followed by mixed breast
feeding had better communication, social
interaction, and cognition at 6 months of
age than EBF until 6 months of age at 6
and 12 months.

Breastfed children are found to have
increased white matter development later in life. A positive association between the
duration of EBF and the microstructure of
white matter was shown in several brain
regions, which consistently improved
cognitive and behavioral performance.
Increased myelination, accompanied by
improved cognitive, verbal, and non-
verbal abilities, is generally more prevalent in exclusively breastfed children than
formula-fed children. Another study
found that breastfed children had higher
test scores than children who were not
exclusively breastfed, despite having
similar growth patterns. Breastfeeding
was positively associated with improved
academic test results but not with
behavioral problems. Studies provide
evidence that the effect of a longer duration
of EBF indicates the development and
status of certain behaviors in children aged
18 months. The percentage of development
was seen to be smaller in children aged
30-35 months who were introduced to
complementary foods from the age of four
months. A study conducted in Kenya found
that EBF in the 3-6 month period was
associated with higher ASQ-3 scores of
0.44 SD, 0.34 SD and 0.36 SD in
communication, gross motor, and
problem-solving domains, respectively.
Research in the United States found that
EBF for 6 and 3 months reduced the
likelihood of difficulty with emotional
symptoms (odds ratio [OR]: 0.52; 95% confidence interval [CI]: 0.27–0.99), made
the problem (OR: 0.24; 95% CI: 0.10–
0.54), and total difficulty (OR: 0.39; 95% CI:
0.18–0.85) before adjustment. This
association was no longer significant after
adjustment for overall child development
(β=0.38; confidence limit 0.23 to 0.53).

A study conducted in Brazil also found
a relationship between EBF and child
development. While research conducted
in Indonesia found that EBF status was
significantly associated with two language
milestones, namely Auditory Expressive 6
(AE 6), infants’ ability to produce mono
babbling (0.044), and Auditory Receptive
6 (AR 6), infants inhibited ‘no’ (0.011).
Breastfeeding was also found to increase
IQ slightly in girls aged 2 years (β= 0.07,
95% CI= 0.64 -3.01). Other results found
a positive correlation between
breastfeeding duration and MDI scores.
Babies who were breastfed for ≥9 months
had much better cognitive development
than babies who had not breastfed.

Exclusive breastfeeding positively
affects the development of IQ,
neuroscience, language, hearing, visual,
behavioral, and social-emotional, even
during administration up to three
months after birth. This finding can be a
consideration to encourage the intention
of breastfeeding mothers in EBF so that
the scope of EBF is increasing. However,
this study has potential limitations of
information bias because it only used
English articles. In addition, the research
methods analyzed were cross-sectional,
longitudinal and cohort studies that did not
allow for exploring the causal relationship
between breastfeeding factors and child
development effects. Longitudinal studies
conducted only at relatively short intervals
allow for bias in the results.

Advantages and disadvantages
Compared to other literature reviews, this
study has the advantage of the complexity
of optimizing child development. Building on this literature has enabled the
development of a specific search strategy
for future review. However, this review
may not have identified all the studies on
the association of exclusive breastfeeding
with child development. Most of the
included articles relate to the duration of
exclusive breastfeeding.

CONCLUSION
The conclusion of this study determines
that the duration of exclusive breastfeeding
for at least three months provides benefits in optimizing aspects of child
development. Future literature reviews
should include a comprehensive search of
more databases to access and include more
studies evaluating the benefits of exclusive
breastfeeding for the full six months
following WHO recommendations. In
addition, when conducting a study, the
groups of men and women should
be conducted separately. Longitudinal
studies refer more to the stages of child
development with intervals that are not
too long to anticipate the possibility of bias
in the study results.

CONFLICT OF INTEREST
The authors declare that they have no
conflict of interest.

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Jaya Kusuma.Sp. OG. Subsp.K.Fm,MARS
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**AUTHOR CONTRIBUTION**

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Methodology: Luh Mertasari and Luh Seri Ani  
Validation: AA Ngurah Jaya Kusuma and Luh Seri Ani  
Writing – original draft: Luh Mertasari  
Writing – review & editing: Luh Seri Ani

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**REFERENCES**