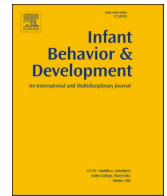




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The impact of ever breastfeeding on children ages 12 to 36 months: A secondary data analysis of the standardization study of the Dominican system for evaluating early childhood development

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ABSTRACT

Extensive research has shown that breastfeeding offers many benefits to children, including advantages in lifelong health, physical development, cognitive function, behavior, and brain development, compared to those not breastfed. In the Dominican Republic, the prevalence of exclusive breastfeeding among infants aged 0–6 months remains low, and the lack of a surveillance system has made it challenging to measure the impact of breastfeeding on early childhood development (ECD). This study aims to address the effect of ever breastfeeding on ECD. We conducted secondary data analysis from the Dominican System for Measuring Early Childhood Development (SIMEDID), a screening tool adapted and validated to the Dominican context that measures four areas of development: gross-motor, fine-motor, language, and socioemotional development. The data from SIMEDID can be cross-analyzed with other datasets generated by the National Institute for Early Childhood Comprehensive Care (INAIFI) that include information about breastfeeding. The children were evaluated during the standardization study of SIMEDID. To determine the breastfeeding impact, we: 1) conducted an analysis of covariance using ECD scores as dependent variables and ever breastfed as the independent variable, with age and sex as covariates (previously confirmed with an analysis of variance indicating the relevance of age and sex at birth in ECD); 2) analyzed the relative risk (RR) of developmental delay by breastfeeding status. We studied a sample of 699 Dominican children aged 12–36 months who receive services at INAIFI (the government institution responsible for administering comprehensive early childhood services). The results show that ever breastfed children had higher scores in overall ECD than those who were not; higher scores in language and fine motor development primarily drove this effect. The never breastfed group had a greater risk of developmental delay in fine motor and

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socioemotional development. These findings underscore the importance of promoting and supporting breastfeeding to improve child neurodevelopmental outcomes. This is particularly relevant in low-resource settings, where mothers may need additional support. Moreover, the study's results provide evidence of SIMEDID's validation, which can help inform future research and evidence-based decision-making toward optimal ECD in similar contexts.

Breastfeeding enhances children's survival and thriving and is one of the best practices globally in child health and nutrition. Extensive research has shown that breastfeeding offers a plethora of benefits to children, including health advantages, physical development, intelligence and cognitive function, behavior, and healthy brain development, compared to those who are not breastfed (Bar et al., 2016; Brahm & Valdés, 2017; Couto et al., 2020; Herba et al., 2013). Breastfeeding reduces the risk of child mortality and malnutrition, contributes to achieving the expected weight and height—thus developing better physical and psychomotor skills (Ahmed et al., 2023)—, and reduces the risk of obesity and chronic health conditions in adulthood (Pérez-Escamilla et al., 2023).

The breastfeeding benefits are long-term (Binns et al., 2016; Brahm & Valdés, 2017; Colen & Ramey, 2014; Horta et al., 2018) and are attributed to: a) breast milk's unique nutritional composition (Demmelmair et al., 2017; Lyons et al., 2020; Paquette et al., 2023)—which strengthens children's immune systems and protects them from gastrointestinal, respiratory, endocrine, and obesity-related diseases (Couto et al., 2020), and b) the mother-infant attachment established during breastfeeding (Linde et al., 2020; Pérez-Escamilla et al., 2023). Breastmilk's benefits for infant health and development due to its nutritional content and immune protection are enhanced by the nurturing effect of breast suckling (Pérez-Escamilla et al., 2023) and responsive caregiving (Ventura, 2017).

Breastfeeding is a major contributor to the Nurturing Care Framework. The framework provides guidance for promoting early childhood development (ECD) by leveraging multidisciplinary evidence and highlighting the importance of providing a supportive environment from pregnancy to age three (WHO, 2018). It consists of five interdependent components crucial for optimal child development: a) good health, which relies on caregivers' responsiveness to children's needs, hygiene maintenance, hazard protection, health service utilization, and illness management while considering caregivers' well-being; b) adequate nutrition, involving the provision of essential nutrients to pregnant women and the promotion of exclusive breastfeeding, facilitating nutritional fulfillment and fostering emotional attachment through skin-to-skin contact; c) safety and security, entailing the safeguarding of children from physical and emotional harm; d) responsive caregiving, encompassing the observation and response to children's cues, fostering emotional bonds and cognitive development; e) opportunities for early learning, occurring pre-formal schooling through social interactions within the family environment (WHO, 2018). Breastfeeding encompasses all these nurturing care components because it provides optimal nutrition, fosters good health, safeguards emotional health due to skin-to-skin contact, increases responsive caregiving, and promotes close social interaction, all contributing to early learning.

Globally, in 2016–2022, 95% of newborns were ever breastfed (UNICEF, 2023) and exclusive breastfeeding for the first six months had a prevalence of 48% (UNICEF, 2023)—lower than the 2030 target of 70% (Global Breastfeeding Collective, 2022). By UNICEF world region, the highest prevalence of ever breastfeeding in 2022 was found in Eastern Europe and Central Asia and in West and Central Africa (97%), followed by Latin America and the Caribbean (96%), South Asia and Eastern and Southern Africa (95%), East Asia and the Pacific (93%), and Middle East and North Africa (92%). The greatest regional variations are found in the prevalence of exclusive breastfeeding for the first six months, with the highest found in South Asia (60%), followed by Eastern and Southern Africa (58%), Latin America and the Caribbean (43%), East Asia and the Pacific (41%), West and Central Africa (40%), Eastern Europe and Central Asia (36%), Middle East and North Africa (35%), and North America (26%); no data were available for Western Europe (UNICEF, 2023). A study conducted in Europe in 2015 found an exclusive breastfeeding prevalence ranging from 13% to 39% and between 56% and 97% of infants receiving human milk (Theurich et al., 2019). The United States had a prevalence of 25% of exclusive breastfeeding at 6 months and 83% of infants receiving any human milk (CDC, 2023).

In the Dominican Republic, the most recent data show that 92.2% of children were ever breastfed and that 15.8% of children were exclusively breastfed during the first six months (ONE & UNICEF, 2022). The government of the Dominican Republic has significantly promoted breastfeeding among mothers and their children during early childhood. Through Law 8–95 on Breastfeeding, enacted in 1984, the promotion, teaching, and dissemination of breastfeeding have become a national priority, laying the groundwork for subsequent campaigns and advocating for the rights of breastfeeding mothers under Article 240 of the 1992 Dominican Labor Code and Law 16–92 (Government of the Dominican Republic, 1992) and the 2008 Public Function Law 41–08 (Government of the Dominican Republic, 2008). Despite these efforts, the country still faces significant challenges, such as inadequate information about breastfeeding, limited work arrangements, and the lack of community support (Kristensen-Cabrera et al., 2019). Additionally, the pernicious effect of commercial milk formula manufacturers' marketing practices should not be underestimated (Pérez-Escamilla et al., 2023; Rollins et al., 2016).

The purpose of this study was to explore the role of breastfeeding on early childhood development in Dominican children aged 12–36 months and to evaluate the potential risk of developmental delay based on breastfeeding status. To do this, we conducted a secondary analysis of data from the standardization study of the Dominican System of Early Childhood Development Measurement (SIMEDID). SIMEDID is a developmental screening tool validated in the Dominican context (Alonso et al., 2022; Sánchez-Vincitore et al., 2023) and implemented by the National Institute for Early Childhood Comprehensive Care (INAIPI). INAIPI is dedicated to managing the provision of high-quality, comprehensive care services for children aged 0 to 5 years and their families nationwide. They currently serve approximately 167,050 children, constituting 17.8% of the national under-five population.

1. Material and methods

This study aims to address the effect of breastfeeding on early childhood development of a sample of Dominican children aged 12–36 months who received services at INAIPI and were evaluated during SIMEDID's normalization study. We cross-analyzed that data with INAIPI's Initial Health and Nutrition Assessment Form, which includes information about breastfeeding, among other variables.

1.1. Participants

The original standardization study, from which we obtained data for the current study, included 2251 participants whose ages ranged from 2 to 60 months (Sánchez-Vincitore et al., 2023). The original study had a representative sample of children receiving INAIPI services. For the current study, we included the data from participants meeting the inclusion criteria, which consisted of being between 12 and 36 months of age and whose records contained breastfeeding information. We excluded infants (children under 12 months) because the variance in ECD among them would have been very small, which would have precluded detecting any potential effect of breastfeeding. We set the age limit to 36 months because several studies have shown that early childhood development is particularly vulnerable up to that age, while interventions to redress the impact of adversity have the greatest chance to succeed during that timeframe (Black et al., 2017; Richter et al., 2017; WHO, 2018).

Out of the 2251 participants in the standardization study, 699 children were within the selected age range. To confirm that the sample size would be appropriate for an analysis of covariance (ANCOVA), we conducted a power analysis that considered a small effect size ($f = .15$), a significance level of $\alpha = .05$, and a desired power of .95; we considered one degree of freedom for the numerator, two groups, and two covariates. The ANCOVA's total sample size required a minimum of 580 participants, which meant that the selected 699 participants surpassed the minimum requirement.

Since this is a secondary data analysis, no additional sociodemographic information was available. Still, it is important to note that the inclusion criteria for INAIPI services are rooted in vulnerability, indicating that the beneficiaries are primarily drawn from low socioeconomic backgrounds. Table 1 describes the sample by age group and sex at birth.

1.2. Instruments

1.2.1. Dominican Infant Development Measurement System (SIMEDID)

SIMEDID is a screening tool designed to track child development via a mobile application with a developmental measurement instrument (Alonso et al., 2022; Sánchez-Vincitore, 2023). This instrument allows for the assessment of a child's developmental progress across various developmental areas: gross motor skills (consisting of 33 items), fine motor skills (with 33 items), language and communication (comprising 34 items), and socio-emotional development (including 33 items). Additionally, it provides an overall development score, combining the scores from all these areas (133 items). The list of indicators within the system is organized in ascending order of complexity. Furthermore, the mobile application automatically selects the specific developmental milestones for observation based on the child's age. Scoring within each developmental area is determined by a count of the number of correct items. As a progressive scale, the application presents only the relevant items that correspond to the child's age, ensuring accuracy, with at least three items falling below the child's expected level of development. Once a participant demonstrates accurate responses below their expected age, the preceding items are automatically scored as accurate. The data collected on the platform are transferred via the internet to INAIPI servers.

1.2.2. INAIPI's Initial Health and Nutrition Assessment Form

This form collects data about the health of children who enter INAIPI services, perinatal history, date of birth, sex at birth, nutrition, maternal health history, immunizations, family history, physical examinations, warning signs, and nutrition including ever breastfeeding. The INAIPI Health and Nutrition Agents complete the form when a child first enters the service. Enrollment in INAIPI services is not age-specific, so this questionnaire is administered at the time of enrollment, irrespective of the child's age, and focuses on historical data. During the standardization study period, the data collected included age in days (measured as the count of days since the date of birth), sex at birth (categorized as female or male), ECD, and ever breastfeeding (indicating whether the child was ever fed with breastmilk), but the data were not linked to mother's education or socioeconomic information, and detailed breastfeeding characteristics were not available at the time of the study.

Table 1
Sample size, by age group and sex at birth, Dominican Republic, 2023.

Age (in months)	Female	Male	Total
12-15	24	37	61
15-18	38	58	96
18-24	66	94	160
24-30	84	74	158
30-36	121	103	224
Total	333	366	699

1.3. Procedure

The research team received the anonymized data from the original SIMEDID standardization study. This dataset comprised unique codes that were subsequently integrated with anonymized data from the forms completed by parents when registering for INAIPI services, which also contained information regarding breastfeeding.

1.4. Ethical considerations

The original standardization study, from which we obtained data for this secondary analysis, received approval from the Ethics Committee of Universidad Iberoamericana (CEI2021–3). This ensured the safety, confidentiality, and well-being of study participants. Parents or caregivers provided consent by signing a consent form when receiving services from INAIPI, allowing INAIPI to assess their children's development and use these data for research purposes.

1.5. Data analysis plan

For the first study aim, and before assessing the relationship between breastfeeding and early childhood development, we determined whether age and sex at birth should be considered as covariates by conducting a series of one-factor analyses of variance (ANOVA) with each development score as the dependent variable and sex at birth as the independent variable. To determine the relationship between ever breastfeeding and ECD, we conducted successive ANCOVA analyses with the dependent variables (overall development, gross motor skills, fine motor skills, language and communication, and socio-emotional development), fixed factor ever breastfeeding, and covariates age in days and sex at birth.

For the second study aim, we analyzed the relative risk (RR) of developmental delay by breastfeeding status (ever breastfed vs. never breastfed) by categorizing participants into two groups based on their developmental scores: those with scores below -1 standard deviation within their age group were categorized into the developmental delay group, and those with scores above this threshold were placed in the other group. Subsequently, we computed the relative risk of being in the developmental delay group according to breastfeeding status using this formula:

$$RR = \frac{\text{Risk of developmental delay in never breastfed children}}{\text{Risk of developmental delay in ever breastfed children}}$$

As part of the relative risk analysis, we conducted a Chi-square analysis to determine whether there were significant differences in the distribution of risk factors among children who ever and never breastfed.

2. Results

Among our sample of 699 participants, 580 were ever breastfed (83.0%) and 119 were not (17.0%). We found that females were ever breastfed more frequently than males, but the differences were not statistically significant (85.9% vs. 80.3%, $\chi^2(1) = 3.430$, $p = 0.64$, continuity correction applied).

The series of ANOVAs showed that age in days and sex at birth were significant predictors of ECD, as shown in Table 2. Female children outperformed males in all the development dimensions except for gross motor. Therefore, age in days and sex at birth were included as covariables in subsequent analyses.

As shown in Table 3, the series of ANCOVAs showed that ever breastfed children outperformed those who never breastfed in the overall development score ($F(1698) = 5.80$, $p < .05$), fine motor ($F(1698) = 5.61$, $p < .05$), and language ($F(1698) = 4.45$, $p < .05$).

Table 4 shows that the never breastfed group had a greater risk of developmental delay across all dimensions (scores below -1 standard deviation in each dimension), with the highest relative risk observed in fine motor development ($RR = 2.06$) and socio-emotional development ($RR=1.86$). In these two development areas, Chi-squared tests showed significant differences in risk ($p < 0.01$), meaning that not being breastfed more than doubles ($RR=2.06$) the risk of fine motor development delay and increases almost twice ($RR=1.87$) the risk of socioemotional delay. In gross motor, language, and overall development, there is a trend for increased risk of delay among never breastfed children; however, the relative risks are not statistically significant.

Table 2

Effect of age in days and sex at birth on developmental level by dimension (analysis of variance), among children ages 12 to 36 months, Dominican Republic, 2022.

Dimension (DV)	Age in days (IV)	Sex at birth (IV)
Overall development	$F(1697) = 914.497^{***}$; $R^2 = .57$	$F(1697) = 12.141^{**}$; $\eta^2 = .017$
Gross Motor	$F(1697) = 513.620^{***}$; $R^2 = .42$	$F(1697) = 3.380$; $\eta^2 = .005$
Fine Motor	$F(1697) = 733.426^{***}$; $R^2 = .51$	$F(1697) = 18.503^{***}$; $\eta^2 = .026$
Language	$F(1697) = 574.957^{***}$; $R^2 = .45$	$F(1697) = 11.895^{**}$; $\eta^2 = .017$
Socioemotional	$F(1697) = 487.911^{***}$; $R^2 = .41$	$F(1697) = 7.774^{**}$; $\eta^2 = .011$

Notes:

** $p < 0.01$

*** $p < 0.001$; DV: Dependent variable; IV: Independent variable.

Table 3

Development differences by breastfeeding status, adjusted by age in days and sex at birth (analysis of covariance) among children ages 12 to 36 months, Dominican Republic, 2022.

Dimension	ANCOVA	Estimated marginal mean (never breastfed)	Estimated marginal mean (ever breastfed)	η^2
Overall development	F(1698) = 5.80*	88.31	91.30	.004
Gross Motor	F(1698) = 3.05	22.98	23.67	-
Fine Motor	F(1698) = 5.61*	22.23	23.00	.008
Language	F(1698) = 4.45*	18.66	19.70	.006
Socioemotional	F(1698) = 1.79	24.45	24.92	-

Note:

* $p < 0.05$.

Table 4

Relative risk of developmental delay by breastfeeding status, by dimensions, among children ages 12 to 36 months, Dominican Republic, 2022.

Dimension	Risk of developmental delay in never breastfed children	Risk of developmental delay in ever breastfed children	Relative Risk (RR)	Chi-square
Overall development	0.176	0.121	1.46	$\chi^2(1, N = 699) = 2.71$; $p = .10$
Gross Motor	0.168	0.126	1.34	$\chi^2(1, N = 699) = 1.52$; $p = .22$
Fine Motor	0.185	0.090	2.06**	$\chi^2(1, N = 699) = 9.46$; $p = .002$
Language	0.185	0.136	1.36	$\chi^2(1, N = 699) = 1.89$; $p = .17$
Socioemotional	0.210	0.112	1.87**	$\chi^2(1, N = 699) = 8.46$; $p = .004$

Notes: developmental delay is set at scores below – 1 standard deviation in each developmental dimension

** $p < 0.01$.

3. Discussion

This study aimed to investigate the relationship between breastfeeding and early childhood development by analyzing developmental data for Dominican children aged 12 to 36 months. Our findings indicate that, after accounting for age and sex at birth, children who were ever breastfed exhibited significantly better overall developmental outcomes than those who were not. These results align with previous literature that shows the benefits of breastfeeding on ECD (Bar et al., 2016; Brahm & Valdés, 2017; Couto et al., 2020; Herba et al., 2013; McGowan & Bland, 2023) and support the Nurturing Care Framework approach (WHO, 2018).

In our study, the differences between children who were ever and never breastfed were particularly evident in language development and fine motor skills, results that are in line with previous studies. A literature review found that breastfed children outperform non-breastfed children in language skills and that breastfeeding had a protective effect against language disorders (Smith, 2015). This could be explained by the non-nutritive aspects of breastfeeding, which have been associated with a positive psychological impact that fosters the infant's secure attachment to their mother through various mechanisms: skin-to-skin contact, direct sensory feedback, regular and sensitive interactions, and release of oxytocin and prolactin hormones that enhance maternal caregiving through heightened emotional attunement and increased empathy towards the infant (Linde et al., 2020). In addition, there is evidence that children breastfed for less than four months perform significantly worse in fine motor tasks than children breastfed for a longer period (Oddy et al., 2011). Our study also found that children who were never breastfed have higher risks of developmental delay in fine motor and socioemotional development compared to those who were ever breastfed, indicating that breastfeeding may provide a protective effect, as seen in the literature (Oddy et al., 2011).

As expected, older children achieved higher scores than younger children. Female children outperformed males across all developmental domains except gross motor (for which there were no statistically significant differences)—a finding consistent with a cross-sectional study conducted in the Dominican Republic where female children outperformed males in overall development (Sánchez-Vincitore & Castro, 2022). These findings are similar to those from a cross-sectional study conducted in seven countries, in which, in all countries with data, female children outperformed males in language, socio-emotional, and fine motor development; in contrast, findings from gross motor development were mixed (Bando et al., 2024). While sex differences in early childhood development have been evidenced, the precise mechanisms underlying these differences remain unclear (Etchell et al., 2018). Further exploration is warranted to investigate potential confounding variables, such as potential genetic predispositions and environmental and cultural factors, which may contribute to the observed variations.

The present study has some limitations that should be considered for its interpretation. The breastfeeding data analyzed were limited to the child being ever breastfed—at the time of the study, no information was available on the time of initiation, duration, or exclusivity of breastfeeding. This lack of fine-grain detail may account for the small effect size, as various studies suggest that the longer the duration of breastfeeding, the more positive impact on children's development. Exclusive breastfeeding for the first 6 months and continued complementary feeding until 2 years of age is a protective factor that reduces the chances of attention deficits,

autism spectrum disorder, and other behavioral disturbances throughout early childhood (Brahm & Valdés, 2017). Other authors support the benefits of exclusive breastfeeding for cognitive skills related to learning, decision-making, reasoning, visual and auditory memory, literacy, mathematics (Couto et al., 2020), and language skills (Salinas et al., 2022).

Another limitation is that the study did not consider other psychosocial and sociodemographic factors, above and beyond age and sex at birth, that contribute to both breastfeeding practice and childhood development. Future studies should account for these variables to understand breastfeeding practices better. Moreover, the study sample is extracted from a population of highly vulnerable children. The prevalence of ever breastfeeding found in the sample (83.0%) is much lower than that found among the lowest-income group in the 2019 national household survey (92.6%) (ONE & UNICEF, 2022). This difference could be explained by the existence of core structural hurdles that deter the establishment of a conducive breastfeeding atmosphere, such as gender inequality, urbanization, labor markets that fail to support women's reproductive and caregiving roles, and inadequate healthcare, including the over-medicalization of childbirth (Pérez-Escamilla et al., 2023). The fact that 62.9% of births in the Dominican Republic are by cesarean attests to this form of medicalization (ONE & UNICEF, 2022), and the inadequate healthcare during childbirth in public health facilities in the country has been extensively documented (Castro, 2019; Castro, 2024; Castro & Savage, 2019; Preaux & Castro, 2023).

Finally, another study limitation is using a screening tool to assess early childhood development. SIMEDID is designed to function as a surveillance system for early childhood development in the Dominican Republic, and surveillance systems typically do not employ diagnostic instruments. In this study, we used surveillance data to test a hypothesis. While obtaining significant results with a less precise instrument underscores the trustworthiness of the screener, using a diagnostic instrument capable of providing an in-depth assessment of early childhood development could offer richer and more detailed information. While the prevalence of breastfeeding within our sample was lower than the national rates, INAIPI has initiatives that actively promote breastfeeding through tailored programs involving home visits, parental training, and installing breastfeeding rooms at INAIPI facilities. As SIMEDID becomes the primary tool for developmental monitoring at INAIPI and gradually becomes integrated with other INAIPI databases and higher-quality data are obtained, cross-analyses between datasets hold the potential to provide a more holistic understanding of the effects of breastfeeding.

Notwithstanding these limitations, the observed positive impact of breastfeeding on various dimensions of ECD in the present study emphasizes the importance of tailored multisectoral interventions to encourage breastfeeding practices. These interventions should target persisting barriers such as inadequate information about breastfeeding, work arrangements, and the influence of commercial milk formula marketing. Targeting these challenges through comprehensive strategies has the potential to elevate breastfeeding rates in the Dominican Republic, subsequently fostering a positive impact on early childhood development.

CRediT authorship contribution statement

Angie Jiménez: Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Paulette Marie Peterson Elías:** Writing – review & editing, Writing – original draft, Conceptualization. **Karina Milagros Vargas de Jesús:** Writing – review & editing, Writing – original draft, Conceptualization. **Arachu Castro:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Conceptualization. **Laura V. Sánchez-Vincitore:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Daniel Cubilla-Bonnetier:** Writing – review & editing, Writing – original draft, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **María Elena Valdez:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization.

Data availability

We have shared the link to my data at the Attach File step.

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