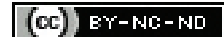


# Exclusive Breastfeeding as a Predictor of Growth and Development in Infants: Evidence from a Longitudinal Cohort in Southern India

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## ABSTRACT

**Introduction:** Exclusive Breastfeeding (EBF) has a potential role for infants in attaining timely developmental milestones. However, limited research has examined the benefits of EBF in infants in their initial stages.

**Aim:** This study was conducted with the objective to assess the attainment of developmental milestones every month to determine its association with EBF.

**Materials and Methods:** A community-based longitudinal study was conducted over 12 months in 252 mother-infant pairs living in Southern Chennai and adjoining districts of Chengalpet and Kanchipuram. They were followed-up for six time-points in each month to assess the EBF status, measure growth and check for developmental milestones appropriate for age. The relationship between EBF duration in each of the first six months and infant development was analysed

using t-test and logistic regression analysis was applied to determine the magnitude of association.

**Results:** Infants who were exclusively breastfed until six months of age had a better weight gain ( $p < 0.01$ ) and communication skills {OR-0.75 (0.58-0.96)} at six months when compared to infants who did not breastfeed at all. However, no such association could be established between the two groups when growth and development was assessed in each month.

**Conclusion:** EBF in infants up to six months was associated with significantly better infant development however the same couldn't be established for EBF of shorter duration. This study could be further strengthened by expansion of this research to include a long term follow-up into early childhood with a larger sample size and a diverse population group.

**Keywords:** Association, Developmental milestones, Nutrition

## INTRODUCTION

According to the National Family and Health Survey (NFHS)-4, India, about 55% of infants are exclusively breastfed till six months of age [1]. EBF is feeding infant only breast milk for the first six months and no other solids or liquids with the exception of drops or syrups consisting of vitamins, minerals, supplements, or medicines [2]. It is recommended that mothers worldwide exclusively breastfeed till six months of age to achieve optimal growth, development, and health. The benefits of breastfeeding for health and illness prevention are widely recognised [3]. Proper timing and the attainment of developmental milestones reflect adequate neurologic integrity, and the early identification of developmental delay is important for the prevention of consequent problems, such as abnormal behaviours and long term disability [4]. The potential role of breastfeeding in

developmental milestones such as fine motor, gross motor, cognitive, social and language in early childhood has been investigated in many experimental [5-7] and observational [8-10] studies. The majority found that neurodevelopment was more advanced among individuals who were breastfed rather than formula-fed in early life [11-13], but some found no difference [14,15]. However, literature regarding the association between breastfeeding and development of infants below one year of age is limited. Also, the benefits of breastfeeding in the initial stages of life have been less explored. Moreover, concerns have been raised regarding the strength of association as most of the studies do not control adequately for known confounders [16].

Both, breastfeeding and certain aspects of infant development are influenced by certain socio-economic and psychosocial factors and must be taken into account [17,18]. Also, many

of the studies have included participants from selective groups like preterm and Low Birth Weight (LBW) [5,7]. Due to the inconsistency in results, it is not clear how far the results of such studies can be extrapolated to the general population. This study adopted longitudinal approach with the objective to assess the attainment of developmental milestones every month to determine its association with EBF.

## MATERIALS AND METHODS

**Study design and setting:** This community-based longitudinal study was conducted among mother-infant pairs in Southern Chennai and adjoining districts of Chengalpet and Kanchipuram. The study was conducted from October 2018 to October 2019 (92-IHEC/12-16).

**Sample size and sampling technique:** Sample size was determined using single population proportion formula  $\{n = \frac{(Z_{\alpha/2})^2 * P(1-P)}{d^2}\}$  by assuming 95% confidence level of  $Z_{\alpha/2} = 1.96$ , estimated prevalence of EBF (P) as 21% from study done in Vellore by Reddy NS et al., 5% margin of error (d) [19]. The final sample size was 252 mothers. A line listing of all the mother-infant pairs was obtained from the database available in the Department of Obstetrics and Gynaecology of Chettinad Hospital and Research Institute and a simple random sampling technique was used to select respondent to be interviewed within the selected villages.

Inclusion criteria were all the mother-infant pairs were infants with congenital anomalies, upper and lower limb deformities, birth weight <1000 grams, gestational age <28 weeks, genetic abnormalities, dysmorphic features and severe asphyxia.

**Data collection:** A structured interviewer administered questionnaire was prepared and modified from different literatures [9,10]. The questionnaire was prepared in English and translated to Tamil and finally retranslated back to English by a person who can speak both languages. The questionnaire consisted of socio-demographic factors (age, occupation, sex of the child, socio-economic status (modified Kuppaswamy Classification [20]), birth weight, birth order, place of delivery, mode of delivery, admission to Neonatal Intensive Care Unit (NICU), initiation of breastfeeding, lactational counselling and pre-lacteal feeding). A pretest for validation of the questionnaire was carried out among 25 (9.9%) of the sample prior to the actual data collection in a nearby village other than those included in the actual study. The Cronbach's alpha was obtained to be 0.73.

Mothers were followed-up each month (till six months) and were asked about EBF practice for that month along with assessment of growth of child (weight, head circumference and length) using appropriate anthropometry measuring instruments and

procedures. Weight was recorded on an electronic scale that was calibrated on a weekly basis with known weights. The baby was undressed/ with very light clothing and was placed on the scale. Weight was recorded to the nearest 0.1 kg. Length was measured to the nearest 'cm' without clothes with the subject sleeping on the infantometer with feet held at the base of the scale. The same equipment was used for height and weight measurements and the same observer took the measurements to ensure consistency and to avoid any inter-observer variability. The head circumference was measured using a nonstretchable tape from the broadest part of the forehead above eyebrow, above the ears and the most prominent part of the back of the head [21].

The developmental milestones appropriate for that age were assessed mainly using the technique of observation and in some cases, minor stimulation without applying force or causing stress to the child using techniques as mentioned in the textbook of pediatrics by Ghai OP [21]. To assess the gross motor developmental milestones, neck holding (three months), rolling over (five months) and sitting in tripod fashion (six months) were considered and for fine motor skills, bidextrous reach and unidextrous reach at four and six months, respectively were taken into account. To assess the social and adaptive milestones, social smile at two months, recognising mother and recognising strangers at three and six months were considered and the language milestones were assessed by alertness to sound (one month), cooing three months, laughing loud (four months) and speaking monosyllables (six months). The principal investigator supervised the data collection process, alongwith the help of a trained social health worker and a nurse.

## STATISTICAL ANALYSIS

Statistical Package for the Social Sciences (SPSS) Version 21 software was used for analysis of the data. The characteristics of the study subjects were summarised using descriptive analysis with frequency distribution, proportion and mean±standard deviation. The growth and developmental milestones at each completed month were stratified based on EBF duration. The relationship between EBF duration and infant development was analysed using multiple binary logistic regression analysis. The confounding factors (mother's age at birth, family type, mother's employment status, sex of baby, birth order, birth weight, admission to NICU) were accounted for in this analysis to isolate the specific benefits of breastfeeding duration. Statistical significance was considered at  $p < 0.05$  and the corresponding 95% CI.

## RESULTS

Two hundred fifty-two mothers were recruited postdelivery and were followed-up till the children attained six months of age. Majority of the participants were in the age group of 20-30 years

(69.84%). Majority of the women {194 (76.98%)} resided in urban and semi-urban areas; 35.70% had more than one living children at the time of the study; majority (82.53%) of the mothers had delivered at a private hospital with 52 (20.63%) of the newborns requiring admission to NICU. Of 252 mothers, 86 (34.12%) had caesarian delivery and close to one third i.e., 82 (32.53%) of the mothers initiated breastfeeding immediately after birth. Total 90% had received advice on breastfeeding and 19.84% reported to have given pre-lacteal feeds to newborns [Table/Fig-1].

Variables	Category	N=252 (%)
Mother's age (Years)	<20	14 (5.55)
	20-30	176 (69.84)
	>30	62 (24.60)
Family type	Nuclear	132 (52.38)
	Joint	120 (47.61)
Socio-economic status	Lower	157 (62.3)
	Middle	87 (34.52)
	Upper	8 (3.17)
Employed mother	Yes	122 (48.41)
Residence	Urban	120 (47.61)
	Semi-urban	74 (29.36)
	Rural	58 (23.01)
Sex of baby	Female	130 (51.58)
	Male	122 (48.41)
Mean gestational age (weeks)		35.12±3.26
Mean birth weight (kg)		2.58±0.87
Birth weight (kg)	≤2.5	48 (19.04)
	>2.5	204 (80.95)
Birth order	1	162 (64.28)
	2	86 (34.12)
	3	4 (1.58)
Place of delivery	Government hospital	44 (17.46)
	Private hospital	208 (82.53)
Mode of delivery	Cesarean delivery	86 (34.12)
	Normal vaginal delivery	166 (65.87)
NICU admission	Yes	52 (20.63)
Lactation counselling	Yes	226 (89.68)
Initiation of breastfeeding	Immediately	82 (32.53)
	Less than 1 hour	66 (26.19)
	1-2 hours	56 (22.22)
	>2 hours	48 (19.05)
Pre-lacteal feeds	Yes	50 (19.84)

**[Table/Fig-1]:** Characteristics of study participants.  
NICU: Neonatal intensive care unit

Almost all the mothers (246/252) had exclusively breastfed at least till one month. The prevalence of EBF practice for six months was however reduced to 184 (73.01%). The mother-infant pairs were followed-up each month to check for the developmental milestones and growth of the infants (weight, head circumference and length). [Table/Fig-2] summarises the findings stratified by EBF practice for each month. No significant difference was found among the EBF and non-EBF groups in any of the growth and developmental milestones from 1<sup>st</sup> to 5<sup>th</sup> month. However, a significant difference was found in completed six months of EBF with regards to weight of the baby (7.34±0.82 kg vs 7.01±0.91 kg). Similarly, the average month of attaining the milestone of recognising stranger and saying monosyllables was significantly higher in the cases of exclusively breastfed babies [Table/Fig-3].

Milestones	Total (n=252)	Non-EBF (n=6)	EBF (n=246)	p-value (unpaired t test)
<b>1<sup>st</sup> month</b>				
Baby weight (kg)	3.92±0.60	3.50±0.44	3.93±0.60	0.08
Head circumference (cm)	35.08±1.29	35.00±0.89	35.08±1.30	0.86
Length (cm)	51.15±2.36	49.66±1.03	51.19±2.37	0.11
Sound alert (months)	2.00±1.21	2.33±0.51	1.99±1.22	0.49
<b>2<sup>nd</sup> month</b>				
Baby weight (kg)	4.90±0.69	4.70±0.74	4.91±0.69	0.27
Head circumference (cm)	37.34±1.49	37.85±37.31	37.31±1.51	0.18
Length (cm)	54.36±2.48	54.00±2.41	54.38±2.48	0.56
Social smile (months)	2.19±0.57	2.07±0.43	2.20±0.57	0.39
<b>3<sup>rd</sup> month</b>				
Baby weight (kg)	5.83±0.72	5.5±0.85	5.86±0.70	0.08
Head circumference (cm)	39.34±1.87	39.36±1.00	39.33±1.93	0.95
Length (cm)	57.31±2.41	57.77±2.70	57.26±2.38	0.35
Neck holding (months)	4.01±0.92	4.00±0.87	4.01±0.93	0.93
Recognise mother (months)	3.11±0.68	3.18±0.62	3.10±0.69	0.61
Coos (months)	2.86±0.94	2.81±0.95	2.86±0.94	0.80
<b>4<sup>th</sup> month</b>				

Baby weight (kg)	6.18±0.76	6.12±0.82	6.23±0.72	0.06
Head circumference (cm)	40.24±1.87	40.12±1.00	40.33±1.93	0.84
Length (cm)	58.98±2.43	58.97±2.59	59.16±2.48	0.42
Laughs loud (months)	4.33±0.95	4.47±0.96	4.30±0.94	0.28
Bidextrous grasp (months)	5.65±0.98	5.80±1.01	5.61±0.97	0.25
<b>5<sup>th</sup> month</b>		<b>(n=68)</b>	<b>(n=184)</b>	
Baby Weight (kg)	6.63±0.76	6.52±0.88	6.76±0.69	0.10
Head Circumference (cm)	40.94±1.97	40.86±1.10	41.13±1.73	0.97
Length (cm)	60.31±2.31	60.17±2.60	60.76±2.38	0.82
Rolls over (months)	5.25±0.94	5.41±0.95	5.19±0.93	0.10

**[Table/Fig-2]:** Growth and Developmental milestones in completed months (1<sup>st</sup> to 5<sup>th</sup>) stratified by exclusive breast feeding.

Variables	Total (n=252)	Non EBF (n=68)	EBF (n=184)	p-value (unpaired t-test)
Baby weight (kg)	7.25±0.86	7.01±0.91	7.34±0.82	<0.01
Head circumference (cm)	41.76±1.79	41.50±1.47	41.85±1.89	0.16
Length (cm)	61.19±5.69	61.10±3.17	61.22±6.38	0.87
Tripod position (months)	6.69±0.96	6.67±1.08	6.70±0.91	0.82
Unidextrous grasp (months)	6.91±0.94	6.97±1.10	6.89±0.88	0.55
Recognises stranger (months)	6.05±0.98	6.26±0.82	5.97±1.03	0.04
Monosyllable (months)	5.99±0.92	6.26±0.98	5.89±0.88	<0.01

**[Table/Fig-3]:** Growth and developmental milestones in completed six months stratified by exclusive breast feeding. EBF: Exclusive breast feeding; p significant at <0.05

The main reason cited behind discontinuation of EBF was perceived milk insufficiency {205 (81.34%)}. Among the non-EBF group (184), 141 (76.47%) reported an alternate feeding which mainly consisted of cow's milk {44 (31.20%)/formula milk {97(68.79%)}. About 90% of the participants were influenced by family members and doctors to start alternate feeding. The most common method to feed the same was through feeding bottle 173 (68.65%).

In [Table/Fig-4], the Odds Ratios (OR) for developmental delay associated with EBF for six months are shown for the cases.

The OR for social milestone (stranger anxiety) became non-significant upon adjustment for socioeconomic or psychosocial variables. However, the relationship between breastfeeding and language skill remained unchanged.

Breastfeeding pattern	Unadjusted OR	p-value	Adjusted OR <sup>†</sup>	p-value <sup>†</sup>
<b>Recognises stranger</b>				
EBF	0.79 (0.67-0.93)	0.04	0.98 (0.76-1.52)	0.32
Non-EBF	1.00		1.00	
<b>Monosyllables</b>				
EBF	0.62 (0.47-0.83)	<0.01	0.75 (0.58-0.96)	<0.05
Non-EBF	1.00		1.00	

**[Table/Fig-4]:** Odds of developmental delay according to exclusive breast feeding for six completed months.

OR: Odds ratio; EBF: Exclusive breast feeding; Bivariate and multivariate logistic regression analysis, p significant at <0.05; †: adjusted for confounders (mother's age at birth, family type, mother's employment status, sex of baby, birth order, birth weight, admission to NICU); EBF: Exclusive breast feeding

## DISCUSSION

In this study, it was found that infants who were exclusively breastfed for six months showed significantly more improvement in terms of weight gain and attainment of developmental milestones as compared to infants who were not exclusively breastfed. Specifically, they had an earlier attainment of communication and social interaction at six months. Though studies assessing impact of EBF on developmental milestones prior to six months is limited, similar findings were established by Leventakou V et al., in children of 18 months in whom a longer duration of breastfeeding appeared to improve cognitive and communication development [22]. Additionally, Oddy WH et al., suggested that infants that breastfed for <4 months had an increased risk of developmental delay in terms of communication and adaptability at ages 1–3 years compared to those who were breastfed for >4 months [23]. Longer breastfeeding period have also been found to help infants reach developmental milestones such as polysyllabic babbling earlier, and Pivik RT et al., established that breastfed infants are better at processing language stimuli over formula-fed infants [24,25]. Comparison of breastfeeding with formula feeding in a meta-analysis of 20 studies also proved that breastfed infants consistently had higher cognitive development mean scores than formula-fed infants [26].

The differences observed between breastfed, non-breastfed and formula-fed infants could be due to differences in parental skills, genetic potential or other potential confounding factors. However, another possible influential factor is that human milk contains substances essential for optimal neural development. Most of the evidence is related to Docosahexaenoic Acid (DHA),

present in human milk, but lacking in formulas [27]. Randomised trials also have shown that infants who were fed formula supplemented with DHA had more advanced neural maturation than infants fed with standard formula [9,28,29]. Similar findings showing brain development and improved problem-solving skills were observed by Crawford MA [30]. Apart from the above, social interaction scores were also higher in infants who were exclusively breastfed in many studies and similar findings were observed in the bivariate analysis of current study too. The reason cited by Burgard P is that the breastfeeding process involves mother–infant interactions that facilitate bonding and enhances social interaction [31]. Also, in a cohort study by Fergusson DM and Woodward LJ, breastfeeding children were found to have more positive relationships with their parents than formula-fed children; also interestingly children with longer duration of breastfeeding period perceived their mother's care as affectionate [32]. These findings were reverberated in a study by Britton JR et al., where breastfeeding mothers responded more sensitively to infant cues in mutual interactions and this in turn influenced the infant's secure attachment formation [33].

As noted earlier, the differences among the EBF and non-EBF groups were found only in cases where breastfeeding was continued till six months, while no significant difference was found in growth and development when exclusivity of breast feeding was assessed till five months of age. This could be due to the small sample size of the study which makes it difficult to extrapolate the findings to the general population or it could also be due to the fact that breastmilk doesn't play a significant role achieving the developmental milestones in the initial stages of life. Though previous studies have reported that the longer breastfeeding duration has a positive effect on infant development [8-10,32], but evidence supporting the objectives of current study couldn't be retrieved. However, it must also be noted that this finding doesn't refute the importance of EBF. Therefore, continued research on the effects of EBF in each month of infant development is necessary. Strength of the present study is that the overall growth and development of infants was measured through a six month follow-up for all the developmental milestones.

### Limitation(s)

There existed a significant difference in the working and non-working population with regards to EBF which could have affected the findings of study. Even though most of the potential confounders were addressed, family support and care of the child could also affect the growth and development. Secondly, due to the unequal distribution of the study participants among different groups (exclusively breastfed and nonexclusively breastfed across different months), generalisability of the study results is affected and additional studies are required to support generalisation.

## CONCLUSION(S)

EBF in infants up to six months was associated with significantly better infant development: the relationship was present for increased birth weight and communication skills. Though no association could be established in the first five months with growth and development, further research is needed to support the findings. This study could be further strengthened by expansion of this research to include a long term follow-up into early childhood with a larger sample size and a diverse population group.

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