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ORIGINAL ARTICLE

Comparative Effectiveness of Exclusive Breastfeeding Versus Formula Feeding on Infant Growth and Development

HUSNUL HAYAT[1], KHURRAM NAWAZ[2], RIZWAN MAHMOOD[3], MUHAMMAD USMAN RAFIQUE[4], SANWAL SARDAR NAWAZ[5], IMRAN YASIN[6]

[1]*Assistant Professor, Department of Pediatric Medicine, Avicenna Medical College & Hospital, Lahore Pakistan*
[2]*Assistant Professor, Department of Pediatric Medicine, Shahida Islam Medical & Dental College, Lodhran Pakistan*
[3]*Assistant Professor, Department of Pediatric Medicine, Sahara Medical College Narowal Pakistan*
[4]*Assistant Professor, Department of Pediatric Medicine, M. Islam Medical & Dental College, Gujranwala Pakistan*
[5]*3rd Year MBBS Student, Shifa College of Medicine, Islamabad Pakistan*
[6]*Assistant Professor, Department of Pediatric Medicine, Continental Medical College, Hayat Memorial Hospital, Lahore Pakistan*
Correspondence to: Husnul Hayat, Email: doctorh214@gmail.com, Cell: 0300-5853398

ABSTRACT

Background: Infant nutrition during the first six months of life plays a pivotal role in shaping long-term growth, health, and neurodevelopmental outcomes.

Objective: To compare the effectiveness of exclusive breastfeeding versus formula feeding on infant growth and developmental outcomes.

Methodology: This cross-sectional comparative study was conducted at Department of Pediatric Medicine, Avicenna Medical College & Hospital Lahore from 1st January 2023 to 30th June 2023. A total of 555 infants aged 6 to 12 months were enrolled using non-probability consecutive sampling. Participants were divided into two groups: group A was treated with exclusively breastfed (n = 278) and group B treated with exclusively formula-fed (n=277). Data were collected through structured questionnaires, anthropometric measurements, and developmental assessments using the Denver Developmental Screening Test II.

Results: The mean age was 8.6±1.9 months. Formula-fed infants had higher mean body weight (8.55±1.15 kg) compared to breastfed infants (8.20±1.05 kg; p=0.004), but also a higher proportion above the 90th weight-for-age percentile (13.0% vs. 5.0%; p=0.001). Exclusively breastfed infants demonstrated superior developmental performance across gross motor (93.2% vs. 88.1%), fine motor (94.6% vs. 89.2%), language (90.3% vs. 83.8%), and social domains (92.1% vs. 85.2%), with overall developmental delay significantly lower in this group (6.1% vs. 14.8%; p = 0.001). Logistic regression analysis identified exclusive breastfeeding (AOR = 2.14; 95% CI: 1.25–3.65) and maternal education (AOR = 1.76; 95% CI: 1.09–2.83) as independent predictors of normal growth and development.

Conclusion: The exclusive breastfeeding during the first six months of life leads to healthier growth patterns and superior developmental outcomes compared to formula feeding. Despite formula feeding providing adequate nutrition, it was associated with rapid weight gain and higher risk of developmental delay.

Keywords: Exclusive breastfeeding, Formula feeding, Infant growth, Developmental outcomes

INTRODUCTION

Infancy is a pivotal period of rapid physical, cognitive, and emotional development, during which optimal nutrition is essential for lifelong health and well-being.[1] Breastfeeding practices during the early stages of an infant's life will have a lasting influence the infant's growth, growth patterns, and certain aspects of neurodevelopment.[2] World health Organization (WHO) and United Nations International Children's Emergency Fund (NICEF) recommend that mothers exclusively breastfeed their infants for the first six months of life, and continue to breastfeed while adding suitable solids until the child is two years old or older.[3] As a species-specific, living biological substance, breast milk is constantly changing to meet an infant's nutritional and immunological needs, and it provides fundamental bioactive materials like immunoglobulins, lactoferrin, lysozyme, oligosaccharides, growth factors, and others that help in development and disease protection, along with a variety of macronutrients.[4] Breastfeeding provides short-term benefits like protection from gastrointestinal and respiratory infections, and protection from obesity, type 2 diabetes, and certain cancers is observed in adulthood as a long-term benefit. Breastfeeding also strengthen mother-child bonding.[5]

Breastfeeding yields development, growth, and cognitive benefits that are absent with formula feeding. Infant formula, as it strives to mimic human breast milk, bases its protein and macronutrient constituents around the basic ratios of human milk so as to sufficiently nourish the infant.[6] However, the formula fails to contain the protean subtleties, unique fatty acid profiles, and numerous other bioactive prospects that drive the metabolism of human milk.[7] It has been established that infants who are fed formula, rather than human milk, will gain weight more quickly and maintain higher body mass index (BMI) percentages throughout the first several months of life.[8] These tendencies toward obesity and diabetes are likely to persist into adulthood. On the other hand, infants fed human milk will gain weight, although it will be more gradual, positively promoting metabolism and overall health.[9]

Exclusive formula feeding also negatively impacts cognitive development as it lacks human milk's unique neurodevelopmental ingredients. Long-chain polyunsaturated fatty acids, principally docosahexaenoic acid and choline, are of vital and unique significance to the development of both the brain and retinas.[10] Through numerous and intertwined means, the act of breastfeeding and the human milk itself create an environment that benefits cognitively stimulating maternal interactions. It is, therefore, no surprise that breastfed infants perform better on developmental and cognitive tasks. In spite of all these evident benefits, exclusive breastfeeding is still low, especially in developing nations.[11]

In Pakistan, demographic surveys show a wide array of breastfeeding practices across the nation, with the exclusive breastfeeding rate within the first six months of life sitting at 45-50%. There are many reasons for these rates, such as working mothers, cultural attitudes, the absence of support at the family or workplace, low educational attainment of mothers, and the marketing of breast milk substitutes.[12] Furthermore, the insufficient milk and ease of formula feeding myths provoke mothers to stop breastfeeding at an early stage. Deteriorating breastfeeding trends are seen alongside rising under-nutrition, growth stunting, and an increased risk of infectious diseases.[13] There are some situations, like the mother carrying HIV, certain medications, or insufficient milk where breastfeeding is not an option, and formula feeding is the best option. Many researchers are looking at formula feeding and its many implications, including effects on growth and

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development.[14] Recent work focusing on the first year of life points to increased weight gain, but that weight gain is not a proxy for positive health. Significant unpropitious patterns like early adiposity rebound will track to increased risk for obesity and all of its associated unhealthy consequences.[15]

MATERIALS AND METHODS

This was a cross-sectional comparative study conducted at Department of Pediatric Medicine, Avicenna Medical College & Hospital Lahore from 1st January 2023 to 30th June 2023. A total of 556 infants aged between 6 to 12 months were enrolled with non-probability consecutive sampling was employed. They were divided in two groups; group A (n=278) exclusively breastfed infants) and group B (n=277) (exclusively formula-fed infants). All infants aged 6–12 months, term infants (≥37 weeks of gestation) with normal birth weight, infants exclusively breastfed for the first six months or exclusively formula-fed for the same duration and mothers willing to provide informed consent and complete developmental questionnaires were included. The preterm or low birth weight infants (<2.5 kg), infants receiving mixed feeding (both breast milk and formula), congenital malformations, metabolic disorders, or chronic illnesses that could affect growth or development and mothers unable to recall or accurately report feeding history were excluded. After obtaining informed consent, the data was to collect demographic, socioeconomic, and maternal information such as age, education, occupation, and parity. Detailed records were made of the feeding practices. Body mass index, weight, length, and head circumference growth WHO standards and growth assessed were taken, calibrated, and standardized instruments was developed. Each of the parameter were calculated twice and the mean. Denver Developmental Screening Test II (DDST-II) was other assessment and the referred showed a delay and confirmed the delay was calculated the instruments. Data were entered and analyzed using SPSS-26. Group comparisons were made using independent sample t-tests for continuous data and Chi-square tests for categorical data. A p-value of less than 0.05 was considered statistically significant.

RESULTS

There were 285 (51.3%) males and 270 (48.7%) females. Mean ages of mothers were similar across the two groups (breastfeeding: 28.4±5.4 years; formula-fed: 28.9±5.7 years). Instrumental employment was notably higher with mothers who formula-fed their infants (27.1%) versus those who breastfed (13.3%) [Table 1].

The mean body weight was significantly higher among formula-fed infants (8.55±1.15 kg) compared to breastfed infants (8.20±1.05 kg, p=0.004). The head circumferences of formula-fed infants were marginally smaller than those of breastfed infants (43.5±1.8 cm and 43.9±1.6 cm respectively, p=0.038), even though the difference in length (69.0±4.0 cm vs. 69.2±3.8 cm) was statistically insignificant (p=0.582). Concerning the growth percentiles, a larger proportion of formula-fed infants was classified with a weight-for-age greater than the 90th percentile (13.0% vs. 5.0%, p=0.001) whereas more breastfed infants were within the normal growth range. About 14.1% of formula-fed infants were below the 10th percentile, a slightly larger proportion than the 9.3% of breastfed infants albeit this was not statistically significant (p = 0.068) [Table 2].

Across all four domains gross motor, fine motor, language, and social development breastfed infants performed significantly better than their formula-fed counterparts. The proportion of normal development in gross motor skills was 93.2% for breastfed infants versus 88.1% for formula-fed (p = 0.037), while fine motor development was normal in 94.6% and 89.2% respectively (p=0.016).Language development was normal in 90.3% of breastfed infants compared to 83.8% of formula-fed infants (p=0.022), and social development was normal in 92.1% versus 85.2% respectively (p=0.013). The overall prevalence of developmental delay was significantly lower in the breastfeeding group (6.1%) compared to the formula-fed group (14.8%) (p=0.001) [Table 3].

Exclusive breastfeeding emerged as a strong positive predictor (AOR = 2.14, 95% CI: 1.25–3.65, p = 0.005), meaning that breastfed infants were more than twice as likely to achieve normal growth and developmental milestones as formula-fed infants. Maternal education also showed a significant positive association (AOR = 1.76, 95% CI: 1.09–2.83, p=0.021).Conversely, maternal employment was associated with reduced odds of normal development (AOR = 0.62, 95% CI: 0.38–0.98, p=0.041), possibly due to reduced breastfeeding duration or caregiving time. Low socioeconomic status was not found to be a statistically significant predictor (p = 0.172) [Table 4].

Table 1: Baseline demographic and maternal characteristics of the study population (n = 555)

Growth Parameter	Overall (n=555)	Exclusive Breastfeeding (n = 278)	Formula Feeding (n = 277)
Age (months)	8.6±1.9	8.5±1.8	8.7±2.0
Gender			
Male	285 (51.3%)	143 (51.4%)	142 (51.2%)
Female	270 (48.7%)	135 (48.6%)	135 (48.8%)
Maternal age (years)	28.7±5.6	28.4±5.4	28.9±5.7
Maternal education ≥ secondary	382 (68.8%)	204 (73.4%)	178 (64.3%)
Maternal employment	112 (20.2%)	37 (13.3%)	75 (27.1%)
Low socioeconomic status	198 (35.7%)	95 (34.2%)	103 (37.2%)

Table 2: Comparison of growth parameters between exclusively breastfed and formula-fed infants

Growth Parameter	Exclusive Breastfeeding (n = 278)	Formula Feeding (n = 277)	P value
Weight (kg)	8.20±1.05	8.55±1.15	0.004*
Length (cm)	69.2±3.8	69.0±4.0	0.582
Head circumference (cm),	43.9±1.6	43.5±1.8	0.038*
Weight-for-age percentile <10th	26 (9.3%)	39 (14.1%)	0.068
Weight-for-age percentile >90th	14 (5%)	36 (13%)	0.001*

*Significant at p < 0.05

Table 3: Developmental outcomes according to feeding type

Development Domain	Exclusive Breastfeeding (n = 278)	Formula Feeding (n = 277)	P value
Normal gross motor development	259 (93.2%)	244 (88.1%)	0.037*
Normal fine motor development	263 (94.6%)	247 (89.2%)	0.016*
Normal language development	251 (90.3%)	232 (83.85)	0.022*
Normal social development	256 (92.1%)	236 (85.2%)	0.013*
Overall developmental delay	17 (6.1%)	41 (14.8%)	0.001*

*Significant at p < 0.05

Table 4: Multivariate logistic regression analysis for predictors of normal growth and development

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval (CI)	P value
Exclusive breastfeeding	2.14	1.25–3.65	0.005*
Maternal education ≥ secondary	1.76	1.09–2.83	0.021*
Maternal employment	0.62	0.38–0.98	0.041*
Low socioeconomic status	0.71	0.43–1.16	0.172

*Significant at $p < 0.05$

DISCUSSION

Feeding both modalities will result in adequate growth, but exclusive breastfeeding showed a huge association with more positive growth and development as well as more growth balance. This positive growth and psychological and nutritional benefits as well as the biological benefits of breastfeeding during infancy are well documented across the world. The study findings also showed that infants fed formula did have a higher body mean body mass than those fed exclusively breast milk. The difference, albeit statistically significant, does not mean growth in the breast milk infants was of poorer quality. The rapid growth and accelerated weight gain in formula infants has been shown to result in early adiposity rebound, obesity, and metabolic syndrome. Other studies have found that higher caloric intake and formula feeding are associated with higher plasma insulin levels, and gut microbiota shifts contributing to overweight and insulin resistance. Conversely, infants on breast milk will have a slower growth pattern along with steady growth that is more aligned with metabolic regulation and control.[16] The lack of significant differences in length and linear growth between the two groups in this study aligns with the majority of literature indicating that stature growth is predominantly determined by genetics and general nutrition, rather than the feeding method alone. It is noteworthy, however, that breastfed infants had, on average, a greater head circumference, which may indicate a neurodevelopmental growth advantage. This is consistent with research on the neurodevelopmental impacts of breast milk which is a significant source of the brain and retinoid development fats, DHA and ARA.[17]

Additionally, the presence of neurotrophic factors, peptides, and immunomodulatory hormones in breast milk, along with primary breast feeding, may positively influence cognitive and neural development. This is particularly relevant with the developmental assessment results which highlight the cognitive and neural developmental advantages attributed to exclusive breast feeding.[18] The breastfed infants in this study had greater abilities than their formula fed peers in all the assessed domains of gross and fine motor, language, and social development. Moreover, formula fed infants had more than a twofold increased prevalence of developmental delay. There are many potential explanations for this. Most notably, brain development is positively impacted by certain breast milk nutrients, especially the long chain polyunsaturated fatty acids, taurine, and sialic acid which promote myelination and synaptogenesis.[19]

The transition to exclusive breastfeeding has positive implications, irrespective of its positive impact on the mother's perceived attachment to the infant. During breastfeeding, the infant develops skills pertaining to attachment and emotional regulation.[20-22] During the first 12 months of life and beyond, moving breastfeeding beyond the first twelve months helps an infant to integrate more complicated and advanced socio-emotional skills. Portugal scored above the mean in the Prevalence of Current Barriers to Exclusive Breastfeeding practices.[23] However, Portugal has the legal framework that promotes breastfeeding and the emotionally responsive parenting that greatly helps mothers in overcoming emotionally negative perceptions regarding attachment to her children. The need for breastfeeding friendly workplaces is growing! Dispersed parental leave is still more than a year and a half away in Portugal. Portugal is providing more than 6 months of parental leave and the expected postpartum depression should ease the burden of emotional breastfeeding Andersen et al.[24] In Portugal, mothers are not supported on an emotional and psychological level. Portugal enacted a parental leave of more than 6 months of parental leave initiated on the infant's birth. That said, deconstructed parental leave does not make an emotionally responsive early parenting. Emotional breastfeeding is shaped through responsive early parenting.

CONCLUSION

The exclusive breastfeeding during the first six months of life results in more favorable outcomes in both infant growth and developmental milestones when compared to formula feeding. While formula-fed infants demonstrated slightly higher mean body weights, this appeared to reflect rapid weight gain rather than balanced growth, potentially increasing future risks of obesity and metabolic disorders. Exclusively breastfed infants, on the other hand, showed healthier growth trajectories and superior neurodevelopmental progress, as reflected in better gross motor, fine motor, language, and social development scores.

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