IJBMC
International Journal of Body, Mind and Culture

Volume 13, Issue 2, pp 63-69
DOI: 10.61838/ijbmc.v13i2.1094

Article type:
Original Research

Feeding Patterns and Infant Morbidity: A Comparative Cross-Sectional Study of Breastfeeding, Bottle-Feeding, and Mixed Feeding in Infants Under 6 Months

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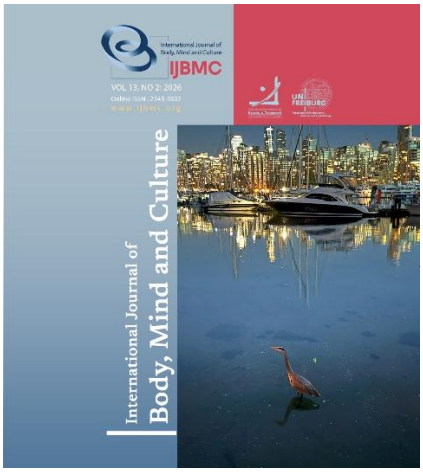

Article history:

Received 11 Oct 2025
Revised 27 Dec 2025
Accepted 30 Jan 2026
Published online 01 Feb 2026

How to cite this article:
Kadhim, M. A., Kassim, N. M., Obaid, A. F., & Abdulrasol, Z. (2026). Feeding Patterns and Infant Morbidity: A Comparative Cross-Sectional Study of Breastfeeding, Bottle-Feeding, and Mixed Feeding in Infants Under 6 Months. International Journal of Body, Mind and Culture, 13(2), 63-69.

ABSTRACT

Objective: Breastfeeding can lower the risk of morbidity and mortality in infants. However, more work is needed to compare different types of feeding with morbidity among infants, especially in developing countries.

Methods and Materials: A cross-sectional study was conducted from June 2020 to March 2021. A total of 300 mothers with infants under 6 months old were recruited and completed a questionnaire designed to assess objective achievement.

Findings: lower respiratory tract infection (23%), upper respiratory tract infection (18%), wheezing (14%), and diarrhea (12%) were the major morbidities among infants. Exclusive breastfeeding was significantly associated with lower odds of diarrhea (OR=0.53), wheezing (OR=0.52), allergy (OR=0.47), and respiratory infections (upper OR=0.57, lower OR=0.55). Bottle-feeding and mixed feeding were associated with increased odds of these morbidities, with bottle-feeding raising the risk of respiratory infections (OR=1.93–2.29), wheezing (OR=1.92), and diarrhea (OR=2.11), and mixed feeding similarly increasing the risk (OR=1.96–2.49). Compared to breastfeeding, bottle-fed and mixed-fed infants were approximately 2 to 2.4 times more likely to have respiratory infections and wheezing, with diarrhea and allergy risks also elevated.

Conclusion: Bottle-fed and mixed-fed babies are more susceptible to illnesses than breastfed babies. Exclusive breastfeeding throughout early infancy is protective, and public health measures should promote and support it to decrease preventable diseases.

Keywords: Breastfeeding, Bottlefeeding, Mixedfeeding, Infants, Morbidity.

Introduction

Exclusive breastfeeding (EBF) is defined by the World Health Organization (WHO) as the practice of a baby only consuming breast milk from his or her mother or a wet nurse for the first six months of life, without any additional dietary intake or fluids, not even water (Jama et al., 2020). The significant benefits of this practice for newborn growth and overall health have long made it the gold standard in infant feeding. Additionally, this practice meets an infant's nutritional needs, providing a mix of lipids, carbohydrates, vitamins, minerals, and proteins necessary for healthy growth. Breastfeeding has many short and long-term benefits (Horta & Victora, 2013), especially in reducing morbidity and mortality of respiratory infections and diarrhea, malnutrition disorders (Hossain & Mihrshahi, 2024), as it is rich in antibodies against diseases and strengthens the child's immunity throughout childhood (Al-Jawaldeh & Azza, 2018). In contrast, bottle feeding increases the risk of infection due to the absence of maternal IgA and inadequate equipment sterilization. Mixed feeding disrupts the protective properties of breast milk, alters the gut microbiome, and increases the risk of infection (Debes et al., 2013).

The United Nations Children's Fund, the World Health Organization, and the American Academy of Pediatrics recommend breastfeeding for the first 6 months to provide infants with proper nutrition and protection against infectious diseases (Behzadifar et al., 2019). Infants acquire immunity through breast milk, particularly colostrum, or through maternal antibodies, which can also reduce the incidence of infections and the risk of childhood obesity. (Feldman-Winter et al., 2020; Hockenberry & Wilson, 2018). This is mainly because mother's milk contains immunoglobulins that support a child's defense throughout infancy, providing essential protection against morbidity (Walker, 2010). Additionally, colostrum contains immunoprotective substances that play a vital role in activating the neonate's immune system and protecting them from infections during early life (Ballard & Morrow, 2013). The probability of hospital stay from lower respiratory tract infections in the first year of life is markedly diminished when infants are breastfed for over four months. (Breastfeeding et al., 2012). As reinforced by literature, there was a 48% reduction in the likelihood of bronchiolitis-related hospitalizations among infants whose mothers exclusively breastfed for at least three months (Geller et al., 2023).

Patterns of feeding are associated with a lower risk of childhood morbidity; infants who were breastfed had a lower risk of respiratory illness and diarrhea (Jebena & Tenagashaw, 2022; Ouda, 2025), as well as lower rates of weight gain and obesity, compared with infants who were fed formula (Mohammed et al., 2020). Other morbidity conditions are less likely to occur, such as allergies, ear diseases, colds, and gastrointestinal problems (Abbas et al., 2018; Nadhem et al., 2018), and infants who have been breastfed exclusively for four months are less likely to experience severe outcomes. Although the advantages of breastfeeding are well-established, the global adherence to exclusive breastfeeding for six months is still inadequate. Data from the World Health Organization estimated that only 44% of infants worldwide are exclusively breastfed during the first 6 months (Al Sabbah et al., 2022). The rates are significantly reduced in numerous developing nations, particularly in the Middle East and South Asia. Factors hindering exclusive breastfeeding encompass maternal employment, insufficient support and education regarding breastfeeding, and cultural perspectives (Debes et al., 2013). In addition, misinformation about breastfeeding adequacy and maternal health can, in certain instances, lead to early cessation or the introduction of formula supplementation (Ahmed et al., 2020). Most studies compare any two types of feeding, mainly breastfeeding and bottle-feeding or mixed feeding. Studies comparing all three types of feeding are rare, especially regarding morbidity among infants in developing countries. This study, therefore, aims to identify the association between different types of feeding, including exclusive breastfeeding, bottle-feeding, and mixed-feeding, and the morbidity among infants in Hilla/Babil Province.

Methods and Materials

Study Design

A cross-sectional study was conducted from June 2020 to March 2021 at a pediatric hospital in Hilla, Babylon Province. The target population included mothers of infants younger than six months hospitalized with certain infections unrelated to congenital

conditions that affect immunity. Non-probability/Purposive sample selected to evaluate specific health outcomes in infants experiencing morbidity, with a particular focus on those under six months of age. Sampling was calculated at 10% of total admissions, using the same criteria (sample size calculator), with a 95% CI, and estimated at 300 mothers. The respondent completed a questionnaire after obtaining informed consent from each participant during a face-to-face interview.

The researcher administered a questionnaire constructed after an extensive literature review by a panel of experts. The questionnaire captures data regarding the infants' and mothers' demographic characteristics, types of feeding (breastfeeding, bottle feeding, and mixed feeding; breast milk was the only source of milk for breastfeeding, whereas formula was the only milk used for bottle feeding and mixed feeding, including both sources [1], and the infants' morbidity in the first six months. Morbidity data were collected through direct interviews with infants' mothers, who were asked whether the infant had suffered from such health problems in the previous six months: vomiting and diarrhea that lasted more than two days, one or more episodes of chest wheezing/whistling, or waking up at night coughing (prolonged cough).

Data were also collected on whether the infant had previously been diagnosed by a doctor with a chest infection, pneumonia, bronchitis, bronchiolitis, or an ear infection, and had received complete management for the illness. The study includes infants younger than six months old whose parents are willing to participate. Still, it excludes those who are older than six months as initiates with complementary feeding or who have a family history of asthma, congenital deformities that inhibit immune system functions like immunodeficiency disorder (HIV), and, in particular, infants with GIT disorder such as Hirschsprung's disease; it affects absorption and feeding. However, several obstacles during the data collection process, including mothers' awareness, environmental allergens (such as dust and pollution), household smoking, seasonal variations, income, and the amount of breast- or bottle-fed milk consumed, interfered with the outcomes and morbidity. Most parents refused to participate in the study because of COVID-19 during the data-collection period, concerns about feeding practices, and misconceptions about infant feeding.

The Statistical Package for the Social Sciences (SPSS) version 23 was used to code and enter the data after it had been manually validated. Descriptive statistics were used to analyze these data, including frequencies and percentages. Chi-square tests, then binary logistic regression, and odds ratios (95% Confidence Interval) were used to investigate the relationship between feeding type and morbidity. A p-value of 0.05 was chosen as the significance level.

Findings and Results

The predominant age of infants was between five and six months, 50.7% of them were male, 80.7 % of them had disease recurrence, and 70% of them had one to three hospital visits. The mean age of mothers was 26.6 years (SD = 5.729), with the majority (38.7%) having primary education. Most mothers (38%) gave exclusive breastfeeding (Table 1). Upper (18%), lower respiratory tract infection (23%), wheezing (14%), and diarrhea (12%) were the major morbidities among infants as presented in Figure 1.

Chi square tests reveal a significant inverse association between breastfeeding with diarrhea (odds= 0.528, 95% CI: 0.295-0.912), wheezing (odds=0. 516, 95% CI: 0.284–0.846), allergy (odds=0.474, 95% CI: 0.200–0.885), upper (odds=0.574, 95% CI: 0.328–0.694) and lower respiratory tract infection (odds=0.551, 95% CI: 0.334–0.894) (Table 2).

Bottle-feeding was positively associated with upper respiratory tract infection (odds= 1.933,95% CI: 1.170-3.125), lower respiratory tract infection (odds=2.289, 95% CI: 1.435-3.993), wheezing (odds=1.924, 95% CI: 1.170-3.220), and diarrhea (odds=2.111, 95% CI: 1.250-3.511) (Table 3), likewise, mixed feeding was positively associated with upper (odds=2.344, 95% CI: 1.383-4.211) and lower respiratory tract infection (odds=2.489, 95% CI: 01.510-4.413), wheezing (odds=2.140, 95% CI: 1.297-3.819) and allergy (odds=1.955, 95% CI: 1.011-3.518) (Table 4). When comparing with breastfeeding group, infants in bottle-feeding and mixed-feeding groups were 1.9 and 2.3 times more likely to have upper respiratory tract infection, 2.2 and 2.4 times more likely to have lower respiratory tract infection, 2.0 and 2.1 times more likely to have wheezing,

and 2.1 times more likely to have diarrhea with bottle-feeding and 1.9 times high odd to develop allergy with mixed-feeding groups.

Discussion and Conclusion

Malnutrition has been one of the leading causes of child mortality, mainly in low- and middle-income nations, and poor breastfeeding practices have been associated with more than 10% of all infant deaths (Fang et al., 2021). Previous studies have found a reduced risk of respiratory tract infections and hospitalization among mothers who are aware of the importance of breastfeeding their babies for up to six months (Diallo et al., 2020; Duan et al., 2018). In contrast, infants who have never been breastfed during the first six months have an increased risk of morbidities (Elyas et al., 2017). Most previous studies focus on breastfeeding, bottle-feeding, or mixed feeding. This study compared the three types of feeding with respect to morbidity among infants. The existing study found significant associations between feeding types and morbidity, including a negative association between breastfeeding and diarrhea, as well as lower respiratory tract infections, upper respiratory tract infections, wheezing, and allergy. In contrast, bottle-feeding was positively associated with some morbidities. There is a positive relationship between mixed feeding and upper and lower respiratory tract infections, wheezing, and allergy, indicating that exclusive breastfeeding, bottle-feeding, and mixed feeding may yield different health outcomes. The findings confirm previous studies that found significant associations between bottle-feeding and lower respiratory tract infections such as pneumonia, bronchiolitis, and wheezing (Kadim & AL-Doori, 2020; Smith et al., 2017), and between mixed-feeding and allergy (Tromp et al., 2017). Several evidence-based studies have established an association between feeding type and respiratory disorders, diarrhea; infants less than six months old who are fed formula have an increased incidence of diarrhea by an odds ratio of 0.37 (95% CI: 0.27; 0.50) (Azad et al., 2017; Zielinska et al., 2017). In other studies, bottle-feeding for longer than three months was associated with an increased risk of respiratory and diarrheal illnesses between the ages of 6 and 12 months, compared with breastfeeding, which was linked to a lower risk. Because breastfeeding contains immunoglobulins, formula-fed infants are at lower risk of acquiring antibodies and bacterial communities from their mothers (Arora et al., 2017; Diallo et al., 2020; Duan et al., 2018; Hsu et al., 2012; Hunt et al., 2011).

Breastfed babies gain passive immunity from maternal antibodies, especially secretory IgA, which coats mucosal surfaces and prevents pathogen attachment. In contrast, without this defense, formula-fed newborns are vulnerable and at greater risk of infections and inflammation due to their underdeveloped immune systems, which are further exacerbated by early weaning, poor hygiene, and improper formula preparation, particularly in low-resource settings (Diallo et al., 2020; Lodge et al., 2015).

Additionally, when the formula is introduced too early, it exposes the infant's immune system to foreign protein may not be tolerated compared to breastfed milk, with underdeveloped gut barrier and immune system of infant, which raises the chance of hypersensitivity responses, like dermatitis, allergy to foods, and asthma (Graulau et al., 2019; Harvey et al., 2021; Victora et al., 2016; Zong et al., 2020).

Additionally, other research indicates that feeding type is strongly associated with the incidence of wheezing; formula feeding is linked to a higher likelihood of wheezing in infants, perhaps due to inadequate immune protection and increased exposure to allergens (Lodge et al., 2015). Conversely, breastfeeding for at least six months is associated with a lower incidence of wheezing in infants. Still, mixed feeding depends on the timing and amount of breast milk and formula administered (Organization, 2025).

Overall, current findings are consistent with the World Health Organization (WHO) guidelines, which emphasize the importance of exclusive breastfeeding as a public health intervention that can reduce infant mortality and morbidity (Organization, 2025). Particularly in low- and middle-income nations, the burden of these morbidities can be considerably decreased by effectively promoting breastfeeding exclusively through health education and supporting legislation.

The study emphasizes the need for public health efforts to promote EBF practices. Nurses and pediatric

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E-ISSN: 2345-5802

health educators help to provide a friendly environment for breastfeeding, maternal education, and community-based support to improve child health. In conclusion, exclusive breastfeeding is a natural, comprehensive nutritional method and an effective, cost-efficient public health strategy to reduce infant morbidity and improve long-term health. Improving breastfeeding rates is essential to infant health and survival.

The data have several limitations, Firstly; even though a large number of covariates were taken into account in our analysis, some significant confounders that could have an impact independently on the infant's health morbidity were overlooked, including environmental allergens lik (dust, pollution), seasonal influences, family history of astma, household smoking, infant vaccinations, and the quantity of breast- or bottle-fed milk consumed, income, mother education and employment, may interfer with a decision releated the selection type of feeding and child morbidity. Second, the practice of infant feeding reported by mothers (self-report without validation) will lead to recall bias. Third, selecting only hospital participants limits generalizability by excluding a non-hospitalized group with different income levels and health statuses.

Infants who are bottle-fed or mixed-fed have a higher susceptibility to infections and allergic problems compared to those who are exclusively breastfed. The findings illustrate the protective importance of exclusive breastfeeding during early infancy and the need for targeted community-based initiatives to promote and support it to reduce preventable young infant illnesses. Crucially, enhancing EBF practice and improving outcomes requires maternal education and training, as well as further research into the comprehensive effects of other variables.

The researchers recommended that the importance of emphasizing serious work on the exclusive breastfeeding practices program of baby-friendly hospitals be further promoted, and that partners collaborate to implement a community-based behaviour change. It is crucial to enhance women's education in particular, because mothers' education was a predictor of exclusive breastfeeding. To change community attitudes toward breastfeeding and implement the WHO recommendation in the near future, more effort is needed to investigate the underlying mechanisms that explain differences in health outcomes across feeding types.

Acknowledgments

The authors express their gratitude and appreciation to all participants.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants. An ethical consideration in this study was that participation was entirely optional.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was conducted independently, with personal funding and without financial support from any governmental or private institution or organization.

Authors' Contributions

All authors equally contribute to this study.

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