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RESEARCH ARTICLE

Evaluation of Bilirubin Level in Exclusively Breastfed Versus Formula-Fed Infants: A Retrospective Comparative Study

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ABSTRACT

Background: Neonatal jaundice is one of the most common clinical conditions encountered during the neonatal period, affecting approximately 60% of term and 80% of preterm newborns. Feeding practices play a significant role in bilirubin metabolism and may influence the incidence and severity of neonatal hyperbilirubinemia. Exclusive breastfeeding has been associated with a higher frequency of physiological jaundice compared to formula feeding.

Aim: To compare serum bilirubin levels among exclusively breastfed and formula-fed infants and evaluate the association between feeding pattern and neonatal hyperbilirubinemia.

Materials and Methods; A retrospective comparative study was conducted at the Department of Pediatrics, DRIEMS Medical College and Hospital, Tangi, Cuttack, Odisha, over a one-year period. Medical records of 100 neonates were reviewed, including 50 exclusively breastfed infants and 50 formula-fed infants. Demographic characteristics, gestational age, birth weight, age at bilirubin estimation, total serum bilirubin (TSB) levels, and requirement for phototherapy were analyzed. Statistical analysis was performed using SPSS version 26. Independent t-test, Chi-square test, and logistic regression analysis were used. A p-value <0.05 was considered statistically significant.

Results: The mean total serum bilirubin level was significantly higher among exclusively breastfed infants (13.28 ± 3.14 mg/dL) compared to formula-fed infants (9.86 ± 2.71 mg/dL) (p<0.001). Hyperbilirubinemia requiring phototherapy occurred in 18 (36.0%) breastfed infants and 7 (14.0%) formula-fed infants (p=0.011). Exclusive breastfeeding was independently associated with elevated bilirubin levels (OR=3.46, 95% CI:1.34–8.92, p=0.010).

Conclusion: Exclusively breastfed infants demonstrated significantly higher bilirubin levels and a greater requirement for phototherapy compared to formula-fed infants. Careful monitoring of bilirubin levels among breastfed neonates may facilitate early identification and management of neonatal jaundice.

Keywords: Neonatal jaundice, Bilirubin, Exclusive breastfeeding, Formula feeding, Hyperbilirubinemia, Phototherapy

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Introduction

Neonatal jaundice is a common clinical condition characterized by yellow discoloration of the skin and sclera resulting from elevated serum bilirubin concentrations. It remains one of the leading causes of neonatal hospital admissions worldwide and represents a major concern during the first week of life.[1]

Physiological jaundice occurs due to increased bilirubin production from accelerated breakdown of fetal erythrocytes combined with immature hepatic conjugation mechanisms.[2] Most cases are benign and self-limiting; however, severe hyperbilirubinemia may result in acute bilirubin encephalopathy and kernicterus if not recognized and treated promptly.[3]

The incidence of neonatal jaundice varies across populations and is influenced by gestational age, birth weight, ethnicity, genetic factors, and feeding practices.[4] Approximately 60% of term infants and 80% of preterm infants develop clinically detectable jaundice during the neonatal period.[5]

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Breastfeeding is universally recommended because of its nutritional, immunological, developmental, and psychological benefits.[6] The World Health Organization recommends exclusive breastfeeding during the first six months of life for optimal infant health and growth.[7]

Despite these advantages, exclusive breastfeeding has been associated with an increased risk of neonatal hyperbilirubinemia.[8] Breastfeeding-related jaundice usually develops during the first week of life and is primarily attributed to inadequate milk intake leading to dehydration, delayed meconium passage, and increased enterohepatic circulation of bilirubin.[9]

Another entity known as breast milk jaundice typically develops after the first week and may persist for several weeks. Various components present in breast milk are believed to inhibit bilirubin conjugation and enhance intestinal reabsorption of unconjugated bilirubin.[10]

Formula feeding, in contrast, has been associated with lower bilirubin concentrations due to increased caloric intake, improved hydration status, enhanced gastrointestinal motility, and reduced enterohepatic bilirubin circulation.[11]

Several investigators have reported significantly higher bilirubin levels among exclusively breastfed infants compared with formula-fed infants, although the magnitude of difference varies across studies.[12]

Early identification of infants at risk for significant hyperbilirubinemia is essential for preventing complications and reducing neonatal morbidity.[13]

Understanding the relationship between feeding practices and bilirubin levels may assist clinicians in developing effective surveillance strategies and counseling parents regarding neonatal jaundice.[14]

Therefore, the present study was undertaken to evaluate and compare bilirubin levels among exclusively breastfed and formula-fed infants attending a tertiary care teaching hospital.

Materials And Methods

Study Design

Retrospective comparative observational study.

Study Setting

Department of Pediatrics, DRIEMS Medical College and Hospital (DRIEMS), Tangi, Cuttack, Odisha, India.

Study Duration

One year.

Sample Size

100 infants.

Study Population

Medical records of neonates admitted to the neonatal unit during the study period.

Group Allocation

Group A: Exclusively breastfed infants (n=50)
Group B: Formula-fed infants (n=50)

Inclusion Criteria

- Healthy term neonates (≥37 weeks gestation)
- Age ≤14 days at bilirubin estimation
- Exclusive breastfeeding or exclusive formula feeding
- Availability of complete medical records

Exclusion Criteria

- Preterm infants
- Hemolytic disease of newborn
- Neonatal sepsis
- Congenital anomalies
- G6PD deficiency
- Birth asphyxia
- Mixed feeding
- Incomplete records

Data Collection

The following information was extracted:

- Age (days)
- Gender
- Birth weight
- Gestational age
- Feeding pattern
- Total serum bilirubin (TSB)
- Requirement for phototherapy
- Duration of hospital stay

Statistical Analysis

Data were analyzed using SPSS version 26.

- Mean ± Standard Deviation
- Frequency and Percentage
- Independent t-test
- Chi-square test
- Logistic regression analysis

Statistical significance was considered at $p<0.05$.

Results

A total of 100 neonates were included in the study, comprising 50 exclusively breastfed infants and 50 formula-

fed infants. The two groups were comparable with respect to age, sex distribution, birth weight, and gestational age. The primary outcome assessed was total serum bilirubin (TSB) level, while secondary outcomes included the requirement for phototherapy and predictors of significant hyperbilirubinemia.

Baseline Characteristics of Study Population

The baseline demographic and clinical characteristics of the study participants are presented in Table 1. No statistically significant differences were observed between the breastfed and formula-fed groups regarding age at bilirubin estimation, gender distribution, birth weight, or gestational age ($p>0.05$ for all comparisons), indicating comparable baseline characteristics.

As illustrated in Figure 1, both feeding groups contributed equally to the study population, ensuring balanced comparison.

Comparison of Total Serum Bilirubin Levels

The mean total serum bilirubin level was significantly higher among exclusively breastfed infants compared with formula-fed infants (13.28 ± 3.14 mg/dL vs 9.86 ± 2.71 mg/dL). Independent t-test analysis demonstrated a highly significant difference between the two groups ($t=5.84$, $p<0.001$) as shown in Table 2.

Figure 2 demonstrates that bilirubin levels were markedly higher among breastfed infants than formula-fed infants.

Distribution of Bilirubin Levels According to Severity

The distribution of bilirubin levels according to severity categories is shown in Table 3. Mild hyperbilirubinemia (<10 mg/dL) was more frequently observed among formula-fed infants, whereas moderate-to-severe hyperbilirubinemia was predominantly observed among breastfed infants.

The proportion of infants with bilirubin levels ≥15 mg/dL was substantially higher among breastfed infants (40.0%) compared with formula-fed infants (10.0%), as depicted in Figure 3.

Requirement for Phototherapy

The frequency of phototherapy requirement among study participants is summarized in Table 4. Phototherapy was required in 18 (36.0%) breastfed infants compared with 7 (14.0%) formula-fed infants. The difference was statistically significant ($\chi^2=6.45$, $p=0.011$).

Table 1: Baseline Characteristics of Study Population

Variable	*Breastfed (n=50)*	*Formula-fed (n=50)*	*p-value*
Mean Age (days)	5.8 ± 2.1	5.5 ± 2.3	0.492
Male Gender	28 (56.0%)	26 (52.0%)	0.688
Female Gender	22 (44.0%)	24 (48.0%)	
Birth Weight (kg)	2.91 ± 0.34	2.95 ± 0.37	0.571
Gestational Age (weeks)	38.6 ± 1.1	38.8 ± 1.0	0.338

Table 2: Comparison of Total Serum Bilirubin Levels

Parameter	*Breastfed (n=50)*	*Formula-fed (n=50)*	*t-value*	*p-value*
Total Serum Bilirubin (mg/dL)	13.28 ± 3.14	9.86 ± 2.71	5.84	<0.001

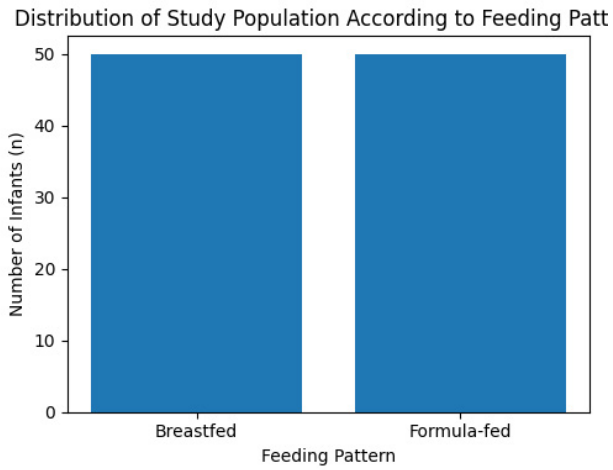

Figure 1: Distribution of Study Population According to Feeding Pattern

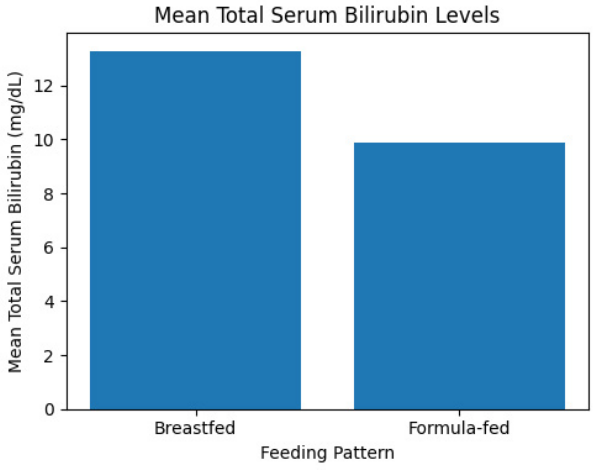

Figure 2: Mean Total Serum Bilirubin Levels According to Feeding Pattern

Table 3: Severity Distribution of Serum Bilirubin Levels

Bilirubin level (mg/dL)	*Breastfed n (%)*	*Formula-fed n (%)*
<10	10 (20.0%)	27 (54.0%)
10–14.9	20 (40.0%)	18 (36.0%)
15–19.9	15 (30.0%)	5 (10.0%)
≥20	5 (10.0%)	0 (0.0%)

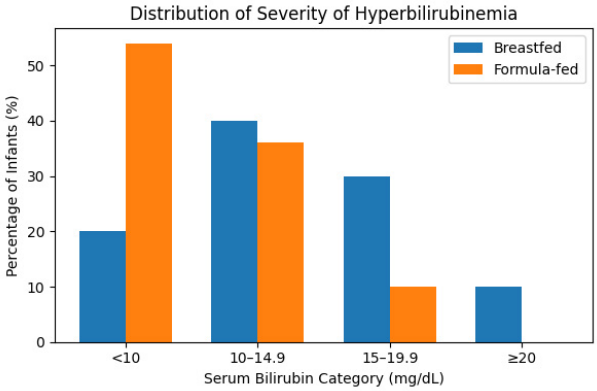

Figure 3: Distribution of Severity of Hyperbilirubinemia

Table 4: Requirement for Phototherapy According to Feeding Pattern

Phototherapy requirement	*Breastfed (n=50)*	*Formula-fed (n=50)*	*p-value*
Yes	18 (36.0%)	7 (14.0%)	0.011
No	32 (64.0%)	43 (86.0%)	

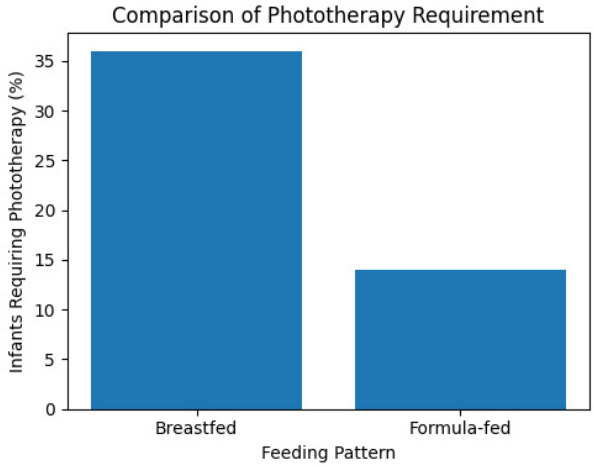

Figure 4: Comparison of Phototherapy Requirement

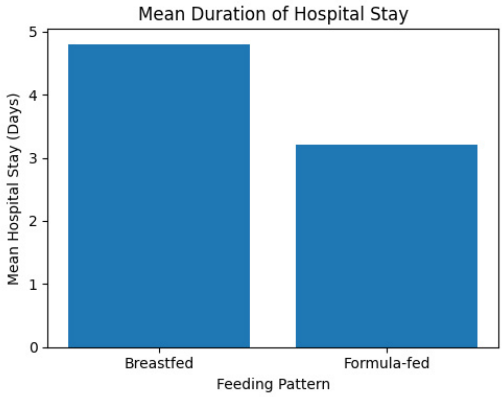

Figure 5: Mean Duration of Hospital Stay

Table 5: Duration of Hospital Stay

Variable	*Breastfed (n=50)*	*Formula-fed (n=50)*	*p-value*
Mean Hospital Stay (days)	4.8 ± 1.7	3.2 ± 1.3	<0.001

As shown in Figure 4, the proportion of infants requiring phototherapy was approximately 2.5 times higher among exclusively breastfed infants than formula-fed infants.

Duration of Hospital Stay

The duration of hospital stay was analyzed according to feeding pattern. Breastfed infants demonstrated a longer mean duration of hospitalization compared with formula-fed infants (4.8 ± 1.7 days vs 3.2 ± 1.3 days, p<0.001), likely reflecting increased frequency of clinically significant jaundice requiring treatment.

Figure 5 demonstrates that breastfed infants required longer hospitalization compared with formula-fed infants.

Univariate Logistic Regression Analysis

Factors associated with significant hyperbilirubinemia (bilirubin ≥15 mg/dL) were evaluated using univariate logistic regression analysis. Exclusive breastfeeding emerged as a significant predictor of hyperbilirubinemia, while gender and low birth weight were not statistically significant predictors.

As presented in Table 6, exclusively breastfed infants had nearly four-fold higher odds of developing significant hyperbilirubinemia.

Multivariate Logistic Regression Analysis

Variables entered into the multivariate logistic regression model included feeding pattern, gender, and birth weight.

Table 6: Univariate Logistic Regression Analysis for Significant Hyperbilirubinemia

Variable	*Odds ratio*	*95% CI*	*p-value*
Exclusive Breast feeding	3.89	1.58–9.59	0.003
Male Gender	1.21	0.54–2.74	0.641
Birth Weight <2.5 kg	1.73	0.67–4.48	0.258

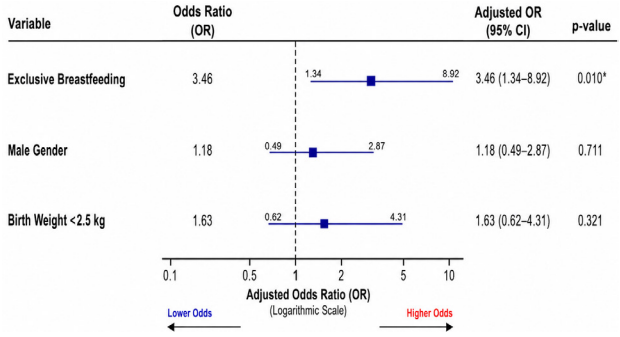

Figure 6: Forest Plot of Independent Predictors of Significant Hyperbilirubinemia

Table 7: Multivariate Logistic Regression Analysis

Variable	*Odds ratio*	*95% CI*	*p-value*
Exclusive Breastfeeding	3.46	1.34–8.92	0.010
Male Gender	1.18	0.49–2.87	0.711
Birth Weight <2.5 kg	1.63	0.62–4.31	0.321

Exclusive breastfeeding remained an independent predictor of significant hyperbilirubinemia after adjustment for confounding variables.

As illustrated in Figure 6, exclusive breastfeeding demonstrated the strongest association with significant neonatal hyperbilirubinemia (OR=3.46, 95% CI: 1.34–8.92, p=0.010).

Discussion

The present study evaluated the relationship between feeding practices and bilirubin levels among neonates and demonstrated significantly higher serum bilirubin concentrations among exclusively breastfed infants compared with formula-fed infants.

The mean bilirubin level in breastfed infants was 13.28 mg/dL compared with 9.86 mg/dL among formula-fed infants. These findings are consistent with those reported by Gartner et al., who described a higher prevalence of neonatal jaundice among exclusively breastfed newborns.[15]

Maisels and McDonagh emphasized that breastfeeding-associated jaundice remains one of the most common causes of neonatal hyperbilirubinemia during the first week of life.[16]

Our study demonstrated that 36% of breastfed infants required phototherapy compared with only 14% of formula-fed infants. Similar observations were reported by Newman et al., who identified exclusive breastfeeding as a major risk factor for significant neonatal hyperbilirubinemia.[17]

Bhutani et al. demonstrated that feeding adequacy strongly influences bilirubin metabolism during the early neonatal period and contributes to variation in bilirubin levels among newborns.[18]

The higher bilirubin levels observed among breastfed infants may be explained by increased enterohepatic circulation resulting from delayed intestinal transit and reduced caloric intake during the initial postnatal days.[19]

Watchko and Tiribelli reported that insufficient breastfeeding during the first few days after birth may enhance bilirubin reabsorption and increase the risk of clinically significant jaundice.[20]

Our findings regarding increased phototherapy requirements among breastfed infants are also supported by the work of De Carvalho et al., who demonstrated an association between exclusive breastfeeding and elevated bilirubin concentrations requiring intervention.[21]

Breast milk jaundice has been attributed to the presence of specific substances in breast milk that inhibit hepatic glucuronidation and promote intestinal bilirubin absorption.[22]

The association between exclusive breastfeeding and hyperbilirubinemia remained statistically significant after adjustment for potential confounders. Similar findings have been reported by Bertini et al., who found breastfeeding to be an independent determinant of neonatal bilirubin elevation.[23]

American Academy of Pediatrics guidelines emphasize the importance of monitoring breastfed infants closely during the early neonatal period for timely detection of significant jaundice.[24]

The present findings further support current recommendations regarding early lactation counseling, adequate feeding assessment, and routine bilirubin surveillance among breastfed neonates.[25]

Conclusion

Exclusively breastfed infants exhibited significantly higher serum bilirubin levels compared with formula-fed infants. The incidence of hyperbilirubinemia requiring phototherapy

was also substantially greater among breastfed neonates. Exclusive breastfeeding emerged as an independent predictor of elevated bilirubin levels. Close monitoring, early lactation support, and timely bilirubin assessment are essential to prevent complications associated with neonatal hyperbilirubinemia.

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