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Original Article

The Correlation Between Low Milk Supply in Breastfeeding and The Severity of Neonatal Hyperbilirubinemia

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Abstract:

Background: Inadequate breastfeeding can cause neonatal hyperbilirubinemia. Hyperbilirubinemia was the fifth leading cause of neonatal mortality in Indonesia with a prevalence of approximately 5.6%. The severe level of bilirubin concentration can cause life- threatening kernicterus. The study aimed to examine the correlation between low milk supply in breastfeeding and the severity of neonatal hyperbilirubinemia among newborns who were admitted to Assyifa Mother and Child Hospital in Tangerang, Banten.

Methods: A cross-sectional study was conducted on 20 neonates diagnosed with unspecified hyperbilirubinemia who were referred to either Emergency Department or Pediatric Department in Assyifa Mother and Child Hospital. Data were obtained from electronic medical records, including information related to mothers and neonates. Data on breast milk supply in breastfeeding mothers were obtained from patient anamnesis records. Statistical analysis was performed using the Fisher's test with SPSS version 30.

Result: Hyperbilirubinemia severity was categorized into three severity levels: level 1 (12-18 mg/dL), level 2 (19-24 mg/dL), level 3 (25-30 mg/dL). There were 8 neonates with adequate breastmilk supply that categorized who were classified into level 2. In contrast, 12 neonates with inadequate breastmilk supply were classified into levels 2 and 3. A significant correlation was found between inadequate breastmilk supply and increased severity of neonatal hyperbilirubinemia ($p = 0.042$). Higher severity of hyperbilirubinemia was associated with lower quantities of breastfeeding.

Conclusion: The study shows a significant correlation between inadequate breastmilk supply in breastfeeding and the severity of neonatal hyperbilirubinemia.

Keyword: breastfeeding, breastmilk supply, neonatal hyperbilirubinemia, severity of hyperbilirubinemia

Introduction

According to the 2023 Indonesian Basic Health Research and Ministry of Health of The Republic of Indonesia Survey (Kemenkes), hyperbilirubinemia was the fifth leading cause of neonatal mortality in Indonesia, with an overall prevalence of 51,47% among neonates. The prevalence is higher in preterm infants (around 58%) compared to term infants (around 50%).[1] Severe hyperbilirubinemia may progress to kernicterus, a permanent and life-threatening neurological condition. Several contributing factors have been identified, including blood group incompatibility, prematurity, sepsis, postnatal weight loss, inadequate feeding, and a family history of jaundice.[1, 2] Previous reports indicated that unconjugated bilirubin levels exceed 12.9 mg/dL in 6–7% of neonates with physiological jaundice, while nearly 3% present with levels above 15 mg/dL.[2, 3]

Neonatal hyperbilirubinemia is classified into physiological or pathological jaundice. Physiological jaundice is a benign, self-limiting condition characterized by a rise in total serum. bilirubin, which typically peaks at 5–12 mg/dL on days 3–5 of life and resolves within 1–2 weeks.[1, 4] Breastfeeding jaundice usually arises during the first week of life and is caused by insufficient breast milk intake, which leads to dehydration, increased enterohepatic circulation, and reduced bilirubin clearance.[3-5] Another example is breastmilk jaundice, which develops after the first week of life due to inhibitory substances in breast milk that delay bilirubin conjugation.[4]

Low milk supply plays a central role in the development of breastfeeding jaundice. It may occur due to maternal factors such as delayed onset of lactogenesis II, poor latch or ineffective sucking, primiparity, caesarean delivery, or maternal illness.[6-8]Inadequate milk intake is reflected in persistent infant hunger, reduced urine and stool output, excessive weight loss, and rising bilirubin levels. Without intervention, these conditions can lead to severe hyperbilirubinemia and, in some cases, kernicterus.[6, 9]

Early recognition and management of breastfeeding difficulties are therefore critical. Failure to address low milk supply before hospital discharge increases the risk of dehydration and bilirubin encephalopathy.[7, 9] Professional guidelines recommend that newborns breastfeed 8–12 times daily during the early neonatal period to ensure adequate intake and reduce the risk of jaundice. Providing timely breastfeeding education, rooming-in practices, and lactation support can significantly improve milk supply and reduce complications.

This study focuses on breastfeeding jaundice by examining the relationship between low milk supply and the severity of neonatal hyperbilirubinemia. By identifying low milk supply as a modifiable risk factor, this research aims to support the development of targeted breastfeeding support and clinical monitoring strategies to reduce the burden of severe neonatal hyperbilirubinemia.

Method

Study Design and Data Collection

A cross-sectional study was conducted between March to June 2025 involving 20 neonates with unspecified hyperbilirubinemia who were referred to the Emergency Department or the Department of Paediatric at Assyifa Mother and Child Hospital. Eligible participants were neonates aged 0–28 days diagnosed with neonatal jaundice (ICD-10 code P59.9) during the study period. Infants were excluded if their parents declined to provide informed consent or if hyperbilirubinemia was attributed to a specific underlying cause such as hemolytic disease, sepsis, or metabolic disorder.

Data were collected from electronic medical record**,** which contained demographic and clinical information of both mothers and infants. Maternal and neonatal anamnesis records were reviewed to obtain data on feeding practices and breast milk supply.

Variables and Operational Definitions

The dependent variable was the severity of neonatal hyperbilirubinemia, determined by total serum bilirubin (TSB) levels measured using standardized laboratory assays. Hyperbilirubinemia was operationally defined as a TSB level ≥12 mg/dL within the first 28 days of life. For analytical purposes, TSB values were stratified into three categories: Mild = Level 1 (12–18 mg/dL), Moderate = Level 2 (19–24 mg/dL), and Severe = Level 3 (25–30 mg/dL). These ranges were adapted from bilirubin level distributions reported in observational studies, including Hassan et al., to reflect increasing degrees of biochemical severity and to facilitate statistical comparison between study groups.[2] However, these categories were defined by the authors for research analysis and do not represent standardized clinical severity classifications. Current recommendations from the American Academy of Pediatrics (AAP) emphasize risk assessment and treatment decisions based on hour-specific bilirubin nomograms adjusted for gestational age and neurotoxicity risk factors rather than fixed TSB cutoff ranges. Accordingly, the severity groupings in this study should be interpreted as analytical stratifications rather than guideline-based clinical severity categories.[10, 11]

The independent variable was low milk supply in breastfeeding mothers, which was defined as maternal perception of insufficient breast milk production, indicated by persistent infant hunger after breastfeeding or the need for early formula supplementation. This information was obtained through maternal interviews and confirmed with feeding records in the medical charts.

Feeding practices were categorized into three categories: exclusive breastfeeding (infants receiving only breast milk without supplementation), formula feeding (infants receiving only commercially prepared formula), and mixed feeding (infants receiving

both breast milk and formula). Breastfeeding frequency was classified as adequate if breastfeeding occurred ≥ 8 times per 24 hours and inadequate if < 8 times, based on maternal report. This classification was based on the assumption that neonates aged 0-3 days are typically breastfed approximately eight times per day or receive an intake equivalent to 60 mL/Kg/day, increasing to approximately 120 mL/Kg/day during the first weeks of life.[10] Demographic variables included age (in completed days), sex (as recorded in medical charts), and birth weight. Birth weight was measured in grams at delivery and categorized into low birth weight (< 2500 g) and normal birth weight (≥ 2500 g).

Data Analysis

Hyperbilirubinemia severity and total serum bilirubin were compared across these groups. Infants were grouped according to feeding method (exclusive breastfeeding, formula feeding, or mixed feeding) and breastfeeding frequency (adequate or inadequate). Bilirubin levels were compared across these groups. All data were verified against patient records prior to analysis. Statistical analysis was performed using SPSS version 30. After testing for normality, the Fisher's test was used to assess associations between categorical variables. A p- value of < 0.05 was considered statistically significant.

Ethical Approval

Ethical approval for this study was obtained from the Ethics Committee of Assyifa Mother and Child Hospital with The Ethical Number: No. 498/SKT-RSIAA/X/2025. Written informed consent was obtained from the parents or legal guardians of all participating infants prior to data collection.

Result

The demographic and feeding characteristics of neonates with hyperbilirubinemia are summarized in **Table 1.** The study population consisted predominantly of female neonates, with most neonates delivered via caesarean section. Neonates were assessed during the early neonatal period, and birth weight as well as feeding frequency were generally within expected neonatal ranges. Variations in type of milk feeding practices were observed, including exclusive breastfeeding, formula feeding, and mixed feeding.

Table 2 summarizes the relationship between breastfeeding adequacy and serum bilirubin levels in neonates with hyperbilirubinemia. Adequate breastfeeding was observed in 40% (n = 8) of infants, all of whom presented with moderate hyperbilirubinemia (Level 2). In contrast, among neonates with inadequate breastfeeding (n = 12), 50% demonstrated progression to severe hyperbilirubinemia (Level 3).

Table 1. Demographic and feeding characteristics data of neonates with hyperbilirubinemia.

Variables	Values n (%)	Mean ± SD
Age (days)	–	8.9 ± 4.5
Gender		
Male	8 (40.0)	–
Female	12 (60.0)	–
Method of delivery		
Caesarean section	17 (85.0)	–
Pervaginam	3 (15.0)	–
Birth weight (g)	–	3,092 ± 359.18
Feeding frequency (times/day)	–	7.50 ± 2.56
Types of milk feeding		
Breastmilk	8 (40.0)	–
Formula feeding	4 (20.0)	–
Mixed feeding	8 (40.0)	–

A statistically significant association was found between breastfeeding adequacy and bilirubin severity (p = 0.042). Furthermore, neonates with inadequate breastfeeding had a twofold increased risk of developing severe hyperbilirubinemia compared with those receiving adequate breastfeeding (RR = 2.00; 95% confidence interval (CI), 1.36–3.52).

Table 2. Association between breastfeeding adequacy and hyperbilirubinemia severity in neonates with hyperbilirubinemia (n =20)

Breastfeeding Adequacy	Hyperbilirubinemia Severity		Risk Ratio	95% CI	p-value
	Level 2 n (%)	Level 3 n (%)			
Adequate Breastfeeding (n=8)	8 (100.0 %)	0 (0.0%)	2.00	1.36 - 3.52	0.042
Inadequate Breastfeeding (n=12)	6 (50.0%)	6 (50.0%)			

CI = Confidence Interval

Breastfeeding adequacy characteristics

Further analysis of the adequate breastfeeding group demonstrated variability in feeding practices within this category. Among neonates classified as having adequate breastfeeding, five neonates received exclusive breast milk feeding, three received mixed feeding, and none were exclusively formula-fed. These findings indicate that adequate breastfeeding in this study population was predominantly achieved through exclusive

breastfeeding, with a smaller proportion supported by combined breast milk and formula feeding.

Table 3 shows the analysis of brestfeeding frequency in relation to total serum bilirubin levels among neonates who were fed ≤8 times per day exhibited higher mean bilirubin concentrations compared with those feeding ≥ 8 times per day (mean 21.4 ± 4.1 mg/dL vs mean 18.5 ± 1.6 mg/dL). Although this difference did not reach statistical significance (Mann-Whitney test, p=0.667), the observed trend suggests that lower breastfeeding frequency may be associated with higher bilirubin levels. Taken together, these findings underscore the potential role of adequate and frequent breastfeeding in reducing the severity of neonatal hyperbilirubinemia.

Table 3. Association between breastfeeding frequency and total serum bilirubin

Breastfeeding Frequency	Total Serum Bilirubin (mg/dL)	p-value
< 8 times / day	21.4 ± 4.1	0.667
≥ 8 times / day	18.5 ± 1.6	

The association between demographic characteristics and the severity of neonatal hyperbilirubinemia is presented in **Table 4.** No statistically significant associations were observed between hyperbilirubinemia severity and sex, method of delivery, enteral feeding type, or breastfeeding frequency (all p > 0.05).

Table 4. The Association between demographic characteristics and hyperbilirubinemia severity

Characteristics	Category	Level 2 n (%)	Level 3 n (%)	p-value
Gender	Male	5 (62.5)	3 (37.5)	0.642
	Female	9 (75)	3 (25)	
Method of delivery	Caesarean section	9 (75)	5 (29.4)	0.898
	Pervaginam	2 (66.7)	1(33.3)	
Type of milk feeding	Breastmilk	7(87.5)	1(12.5)	0.077
	Formula	1(25)	3 (75)	
	Mixed feeding	6 (75)	2(25)	
Breastfeeding/day	< 8 times	6 (75)	5 (50)	0.141
	≥ 8 times	9 (90)	1 (10)	

Discussion

This study demonstrates a significant association between inadequate breastfeeding intake and increased severity of neonatal hyperbilirubinemia. Among the 20 neonates included, 40% had adequate breastfeeding, while 60% were classified as having inadequate intake. Insufficient breastfeeding may result in dehydration and reduced caloric intake, leading to increased enterohepatic circulation and impaired bilirubin elimination. When combined with early postnatal discharge and delayed recognition

of feeding difficulties, these conditions may contribute to severe hyperbilirubinemia and, in extreme cases, kernicterus. Previous studies have shown that reduced caloric intake during the early neonatal period may promote lipolysis, increase circulating free fatty acids, and interfere with bilirubin conjugation, thereby exacerbating bilirubin accumulation.[4, 12]

It is important to distinguish breastfeeding jaundice from breast milk jaundice, as their underlying mechanisms and clinical implications differ. Breastfeeding jaundice primarily results from insufficient milk intake during the early neonatal period, whereas breast milk jaundice develops later and is associated with bioactive components in human milk that inhibit bilirubin conjugation, resulting in prolonged but generally benign hyperbilirubinemia.[5, 7] Although breastfeeding jaundice is classically described as occurring within the first week of life, this distinction should not rely solely on chronological age. In the present study, neonates presented at a mean age exceeding one week of life; however, classification as breastfeeding jaundice was based on documented feeding inadequacy rather than timing of presentation alone. Persistent ineffective latch, delayed lactogenesis, or unrecognized breastfeeding difficulties may prolong inadequate milk intake beyond the early neonatal period, thereby explaining the later clinical presentation observed in this cohort. These findings emphasize that differentiation between breastfeeding jaundice and breast milk jaundice requires comprehensive evaluation of feeding adequacy, hydration status, and clinical progression rather than age of onset alone.

Consistent with this interpretation, neonates fed fewer than eight times per day exhibited higher mean total serum bilirubin levels compared with those receiving eight or more daily feedings. This observation supports existing evidence that insufficient breastfeeding frequency contributes to breastfeeding jaundice. Current recommendations from the American Academy of Pediatrics advocate 8–12 feedings per day during the early neonatal period to ensure adequate milk intake and reduce the risk of hyperbilirubinemia.[9]

Regarding feeding type, formula-fed infants in this cohort appeared to demonstrate higher bilirubin levels compared with mixed-fed and exclusively breastfed infants. However, this finding should be interpreted cautiously. Early formula supplementation may reduce breastfeeding frequency and breast stimulation, potentially impairing maternal milk production. Alternatively, the observed association may reflect reverse causation, whereby infants with early or more severe jaundice were more likely to receive formula supplementation as part of clinical management rather than formula feeding being the primary cause of elevated bilirubin levels. This interpretation is supported by interventional studies demonstrating that appropriately timed formula supplementation in selected high-risk neonates may reduce bilirubin levels and prevent excessive postnatal weight loss.[2, 8]

Several confounding factors and group heterogeneity may also have influenced the observed findings. Neonates categorized according to feeding type may have differed in gestational age, perinatal characteristics, or timing of bilirubin measurement, all of which substantially affect bilirubin concentrations.[3, 6, 12] Misclassification bias may also have occurred, as some infants initially breastfed could have transitioned to formula feeding secondary to inadequate intake or worsening jaundice during hospitalization. Furthermore, important neonatal variables known to influence hyperbilirubinemia severity including gestational age, degree of postnatal weight loss, timing of bilirubin assessment in hours of life, and hemolytic conditions such as ABO or Rh incompatibility and glucose-6-phosphate dehydrogenase deficiency were not consistently documented in the medical records. Consequently, multivariable adjustment could not be performed, and residual confounding cannot be excluded.

The relatively small sample size further limits generalizability and may amplify the influence of individual variability. In addition, differences in the timing of bilirubin measurement may have affected group comparisons, as bilirubin trajectories vary according to feeding patterns.[4, 9] Therefore, these findings should be interpreted cautiously. Nevertheless, the results underscore the clinical importance of early recognition of breastfeeding inadequacy as a potentially modifiable risk factor. Careful feeding assessment, detailed breastfeeding history, and standardized bilirubin monitoring remain essential components of neonatal care. Larger prospective studies are required to confirm these associations and to clarify whether observed differences across feeding groups reflect true biological effects or methodological limitations.

Limitations

This study included 20 neonates, representing the total eligible population during the study period based on strict inclusion and exclusion criteria. Although this sample size is comparable to other neonatal hyperbilirubinemia studies, where recruitment is often limited by ethical considerations, strict diagnostic criteria, and case availability, the small sample size may limit the statistical power of the analysis. This limitation may also reduce the generalizability of the findings to broader neonatal populations. In addition, the exploratory cross-sectional design of this study allows only for the identification of associations and does not permit causal inference. Further studies with larger sample sizes and multicenter designs are needed to validate and extend these findings.

Potential Bias

This study may be subject to several potential sources of bias. First, the sample was limited to a single hospital and included only 20 infants, which may limit the generalizability of the findings. Second, data on breastfeeding frequency and breast milk supply were obtained through anamnesis and medical records, which may

introduce recall or reporting bias. Additionally, the clinical assessment using Kramer's criteria was performed during initial evaluation. However, the classification of hyperbilirubinemia severity for statistical analysis was determined exclusively using laboratory-measured TSB levels. These factors should be considered when interpreting the results.

Conclusion

This study demonstrated a statistically significant association between breastfeeding adequacy and total serum bilirubin levels among neonates with hyperbilirubinemia, with inadequate breastfeeding more frequently observed in infants with greater bilirubin severity. Nevertheless, these findings should be interpreted cautiously due to the small sample size, cross- sectional study design, use of author-defined bilirubin severity groupings, and the inability to adjust for important neonatal confounding variables.

Although the results highlight the potential contribution of adequate and frequent breastfeeding to neonatal outcomes, causal relationships cannot be established. Future research involving larger sample sizes and longer observation periods is required to better clarify temporal relationships between feeding adequacy and bilirubin progression. In addition, studies incorporating objective measurements of nutritional intake, such as caloric intake assessment, together with hour-specific bilirubin nomograms and gestational age–adjusted risk stratification recommended in current clinical guidelines, are needed to strengthen clinical applicability and external validity.

From a clinical perspective, early identification of breastfeeding difficulties and appropriate monitoring of bilirubin levels remain essential components of neonatal care. The provision of structured lactation support and careful post-discharge follow-up may help optimize feeding adequacy and potentially reduce the risk of elevated bilirubin levels in newborns.

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Conflict of Interest

The authors declare no conflict of interest.

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None

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