RESEARCH PAPER

Early Predictors of Neonatal Hyperbilirubinemia in a Full-Term Newborn in Tertiary Care Hospital –A Prospective Observational Study

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ABSTRACT

Background: One of the most common clinical conditions in newborns is neonatal hyperbilirubinemia, which can lead to severe illness and kernicterus if left untreated. It continues to be a significant contributor to NICU admissions in India, with geographical differences such as a greater incidence in Puducherry associated with risk factor prevalence and healthcare access. Serum total bilirubin, transcutaneous bilirubin, and risk factor assessment are among the methods used to forecast this condition, which is defined as serum bilirubin over the 95th percentile for age. Bilirubin and albumin in umbilical cord blood, as well as the bilirubin/albumin ratio, have become trustworthy indicators for early risk assessment. The identification of newborns at risk is further improved by developments in artificial intelligence and predictive modeling. This study evaluates the correlation between cord blood bilirubin and subsequent hyperbilirubinemia, aiming to inform uniform screening protocols and preventive strategies to improve neonatal outcomes.

Aim and Objectives: The objective of the study is to estimate the relationship between newborn umbilical cord blood bilirubin and occurrence of neonatal hyperbilirubinemia, to estimate the relationship between newborn umbilical cord blood albumin and occurrence of neonatal hyperbilirubinemia and to assess the ratio of newborn umbilical cord blood bilirubin/newborn umbilical cord blood albumin in prediction of Neonatal hyperbilirubinemia

Materials and Methods: A prospective observational study was conducted at a tertiary hospital in Puducherry (Apr 2023–Apr 2024) after ethical approval. Term newborns meeting inclusion criteria were consecutively enrolled (n=70). Cord blood bilirubin and albumin were measured at birth; bilirubin was reassessed at 72 hours, with management per AAP 2022 guidelines. Data were analyzed using SPSS v22 with descriptive statistics, Chi-square/Fisher's exact test, Mann-Whitney U test, and Spearman's correlation; $p<0.05$ was considered significant.

Results: Among 70 neonates, most were delivered vaginally (61.4%) with a slight male predominance (57.1%). Mean birth weight was 2.95 kg and mean gestational age 38.4 weeks. Average cord bilirubin was 1.98 mg/dL and albumin 2.89 g/dL. A significant association was found between a cord bilirubin/albumin 2.89 g/dL. A significant association was found between a cord bilirubin/albumin ration >0.7 and hyperbilirubinemia (p=0.037), while cord bilirubin ≥1.9 mg/dL alone was not predictive. Spearman analysis showed a weak correlation with cord albumin. Overall, the bilirubin/albumin ration demonstrated better predictive value than individual parameters.

Among 70 neonates, most were delivered vaginally (61.4%) with a slight male predominance (57.1%). Mean birth weight was 2.95 kg and mean gestational age 38.4 weeks. Average cord bilirubin was 1.98 mg/dL and albumin 2.89 g/dL. A significant association was found between a cord bilirubin/albumin ratio >0.7 and hyperbilirubinemia (p=0.037), while cord bilirubin ≥1.9 mg/dL alone was not predictive. Spearman analysis showed a weak correlation between cord bilirubin and total serum bilirubin ($\rho=0.2276$, p=0.0581) and no significant correlation with cord albumin. Overall, the bilirubin/albumin ratio demonstrated better predictive value than individual parameters.

Conclusion: This study demonstrates that individual cord blood bilirubin (≥1.9 mg/dL) and albumin levels were not significantly associated with neonatal hyperbilirubinemia. However, the bilirubin/albumin ratio >0.7 showed a significant correlation (p=0.037), indicating superior predictive value compared to single parameters. The findings suggest that combined markers, particularly the B/A ratio, may enhance early risk stratification and guide preventive strategies for neonatal hyperbilirubinemia. Larger studies are warranted to validate these results and support uniform screening protocols.

Keywords: Neonatal hyperbilirubinemia, Serum total bilirubin, cord blood bilirubin, cord blood albumin.

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INTRODUCTION

Neonatal hyperbilirubinemia remains one of the most common clinical conditions encountered in newborns worldwide. Although often benign, in some cases, it can progress to severe hyperbilirubinemia, leading to kernicterus and irreversible neurological damage if not promptly treated. Each year, around 1.1 million newborns worldwide experience significant hyperbilirubinemia, predominantly in South Asia and sub-Saharan Africa (1). Severe cases contribute significantly to neonatal morbidity and mortality, especially in resource-limited settings where timely diagnosis and intervention are often delayed (2). It has been estimated that neonatal hyperbilirubinemia accounts for approximately 114,100 neonatal deaths annually, along with long-term impairments like cerebral palsy and hearing loss (3).

In India, the burden of neonatal hyperbilirubinemia is notably high, given the country's large birth cohort and diversity of risk factors such as G6PD deficiency, ABO/Rh incompatibility, prematurity, and sepsis (2). Hyperbilirubinemia remains a leading cause of neonatal admissions in Indian neonatal intensive care units (NICUs). Regional variations have been noted, with some areas, including Puducherry, reporting higher incidences due to differences in healthcare access, awareness, and prevalence of contributing factors. The significant proportion of newborns with severe jaundice who require phototherapy and intensive care has been highlighted by research conducted in South India, underscoring the significance of early management techniques and efficient screening.

Jaundice in neonates results from a transient deficiency in the liver's conjugation capacity, leading to elevated bilirubin levels in the blood (4). While most cases are benign and resolve spontaneously, severe hyperbilirubinemia can lead to kernicterus, a form of chronic bilirubin encephalopathy associated with devastating neurological outcomes (5).

Hyperbilirubinemia is defined as a serum total bilirubin concentration greater than the 95th percentile for the infant's postnatal age (6). It is estimated that approximately 60% of term and 80% of preterm neonates experience hyperbilirubinemia, with about two-thirds of neonates developing clinical jaundice (7).

Various factors contribute to this condition, including an increased erythrocyte turnover, immature hepatic conjugation mechanisms, and reduced uridine diphosphoglucuronosyl transferase (UDPGT) activity (8).

Neonates are at risk for developing substantial hyperbilirubinemia due to a number of risk factors in addition to physiological jaundice. Prematurity, exclusive nursing without proper supervision, blood type incompatibility, cephalohematoma, and sepsis are some of these (9). Increased bilirubin levels have also been linked to genetic variables, such as variations in the UGT1A1 gene (7). Early detection of at-risk newborns is essential for prompt care since severe hyperbilirubinemia carries high hazards. Transcutaneous bilirubin (TcB) measurement, clinical assessment of risk factors, and serum total bilirubin (STB) assessment before to discharge are some of the predictive methods that have been established (10). Among them, cord blood albumin (CBA) and umbilical cord blood bilirubin (CBB) have drawn interest as trustworthy indicators of neonatal hyperbilirubinemia, supporting early risk assessment (11).

The bilirubin/albumin ratio has also emerged as an important metric for assessing bilirubin toxicity and determining clinical decisions in hyperbilirubinemia management (12).

Furthermore, new developments in artificial intelligence and predictive modeling have demonstrated promise in detecting newborns at risk for severe hyperbilirubinemia. Early detection and customized management approaches may be improved by machine learning algorithms and risk stratification models based on electronic health records (13).

The purpose of this study is to identify early signs of neonatal hyperbilirubinemia in full-term neonates admitted to a tertiary care hospital. We want to offer insights into early risk assessment and preventive measures to lessen unfavorable neonatal outcomes by assessing the relationship between umbilical cord blood bilirubin and the later development of hyperbilirubinemia. The findings of this study could improve neonatal health and assist establish consistent screening protocols.

There is little information unique to the Indian environment, particularly in areas like Puducherry, despite the fact that numerous research have demonstrated the prognostic significance of the cord bilirubin/albumin ratio for neonatal hyperbilirubinemia worldwide. The majority of the research that is now accessible originates from various populations with varying genetic, medical, and socioeconomic characteristics that may affect bilirubin metabolism and results. Validation studies tailored to various regions are required.

AIM AND OBJECTIVES

1. To estimate the relationship between newborn umbilical cord blood bilirubin, albumin and occurrence of neonatal hyperbilirubinemia.
2. To assess the ratio of newborn umbilical cord blood bilirubin/newborn umbilical cord blood albumin in prediction of Neonatal hyperbilirubinemia.

MATERIALS AND METHODS

After receiving approval from the Institute Ethics and Scientific Committee (Ref no:85/SVMCH/IEC-Cert/May23), a prospective observational study was carried out in the Department of Pediatrics at a tertiary care hospital in Puducherry from April 2023 to April 2024. Before enrolling, bystanders gave their informed consent. Hospital-delivered term newborns (>37 weeks) who satisfied the requirements of birth weight 2.5–4 kg, Apgar score >7 at 1 minute, and gestational age ≥35 weeks were included. Neonates at risk of sepsis (PROM >18 hours),

hypoxia at delivery, intrauterine growth restriction, infants of mothers with diabetes, and neonates with severe congenital defects were among the exclusion criteria.

Sample size and sampling method:
Using the WN Arifin calculator, the necessary sample size of 70 was found based on the sensitivity of the CBB/CBA ratio (0.97) given by Sharma et al., with a precision of 0.09 and a 95% confidence interval (14,12). Every eligible newborn who met the inclusion criteria was recruited one after the other until the desired sample size was achieved using a successive non-probability sampling procedure.

Data Collection:
Prior to registration, parents gave their informed written agreement after being informed of the study's purpose in their native tongue and being assured of its confidentiality. A standardized proforma was used to record maternal and neonatal information. Newborns were given a thorough physical examination at birth, which included an assessment of gestational age, screening for trauma or abnormalities, and Apgar score at one and five minutes. For the purpose of estimating serum bilirubin and albumin, a 3 mL cord blood sample was obtained using the modified Jendrassik Grof's method and the dye-binding BCP method, respectively (15). Every day, newborns were checked for jaundice, and bilirubin was measured according to procedure at 72 hours. According to AAP 2022 guidelines, cases of substantial hyperbilirubinemia were treated with phototherapy or exchange transfusion, depending on their severity (16).

STATISTICAL ANALYSIS:
SPSS program, version 22, was used to analyze the data once it had been imported into Microsoft Excel. Birth weight, gestational age, and levels of albumin and bilirubin in cord blood were among the continuous variables that were described using descriptive statistics such as mean, standard deviation, and range. Frequencies and proportions were used to convey categorical characteristics including Rh status, the newborn's sex, and the manner of delivery. Associations and predictive correlations were assessed using inferential statistics. The Chi-square test and Fisher's exact test were used to identify correlations between categorical variables, specifically the incidence of neonatal hyperbilirubinemia, and categorical predictors, such as categories of bilirubin/albumin ratios. The Mann-Whitney U test (Wilcoxon rank-sum) was used to compare continuous variables between two independent groups.
The association between the AAP hyperbilirubinemia risk groups and cord blood parameters (bilirubin, albumin, and bilirubin/albumin ratio) was evaluated using Spearman's rank correlation coefficient. For all analyses, a p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Mode of Delivery and Gender Distribution of Study Participants

Distribution of Study Participants According to Mode of Delivery		
Mode of Delivery	**Frequency (n)**	**Percentage (%)**
Cesarean Delivery (CD)	27	38.57
Normal Delivery (ND)	43	61.43
Total	70	100.00
Distribution of Newborns According to Sex		
Sex of Baby	Frequency	Percent
Male	40	57.14%
Female	30	42.86%
Total	70	100.00%

Delivery trends in the study population are reflected in Table 1, which shows that the majority of deliveries were normal vaginal (61.43%) and 38.57% were cesarean sections. There was a small male majority among the 70 neonates, with 57.14% of them being male and 42.86% being female. With values ranging from 2.5 to 3.7 kg, the mean birth weight was 2.95 kg (SD 0.266), indicating moderate variation in birth weights.

Table2: Distribution of Newborns According to Gestational Age

Gestational Age (weeks)	**Value**
Mean	38.43
Std. Dev.	0.498
Minimum	38
Maximum	39

Table 2 shows that the mean gestational age of 70 neonates was 38.43 weeks (SD 0.498), with values ranging only slightly between 38 and 39 weeks, indicating little variation in gestational age within the study cohort.

Table 3: Distribution of Serum Bilirubin Levels

Parameters/Statistical Analysis	Serum Total Bilirubin (mg/dL)	Cord Blood Bilirubin (mg/dL)	Cord Blood Albumin (g/dL)
Mean	12.53	1.98	2.89
Std. Dev.	2.64	0.85	0.43
Minimum	6.17	0.2	0.38
Maximum	18.71	4.92	3.9

The mean blood total bilirubin in this cohort of 70 neonates was 12.53 mg/dL (SD 2.64; range 6.17–18.71), indicating significant variability, whereas the average cord blood bilirubin was 1.98 mg/dL (SD 0.85; range 0.2–4.92), indicating some variation. The average cord blood albumin levels were 2.89 g/dL (SD 0.43; range 0.38–3.9), indicating variation among the research participants. Two Rh-positive and one Rh-negative newborn were born to three Rh-negative moms, whereas 63 Rh-positive and 4 Rh-negative newborns were born to 67 Rh-positive mothers. There was a preponderance of Rh-positive status, with 65 newborns (92.86%) being Rh positive and 5 (7.14%) being Rh negative (Table 3).

Table 4: Correlation of Cord Blood Parameters with AAP Hyperbilirubinemia Risk Score

Variable Pair	Spearman's rho	p-value	Interpretation
Cord blood bilirubin vs AAP cut-off	-0.3007	0.0114	Significant: cord blood bilirubin lower in the hyperbilirubinemic group
Cord blood albumin vs AAP cut-off	-0.0823	0.4980	Not significant: no clear difference between groups
Cord blood bilirubin and albumin ratio vs AAP cut-off	0.2611	0.0290	Significant: Cord blood bilirubin and albumin ratio higher in hyperbilirubinemic newborns

P value < 0.05 is significant

Table 4 represents Spearman correlation analysis revealed a significant negative correlation (ρ = -0.3007, p = 0.0114) between cord bilirubin and the AAP cut-off, indicating unexpectedly lower cord bilirubin levels among neonates requiring phototherapy. There was no significant group difference shown by the lack of a significant correlation between cord albumin and AAP (ρ = -0.0823, p = 0.4980). On the other hand, newborns with hyperbilirubinemia had higher ratios, and the CBB/CBA ratio demonstrated a strong positive correlation with AAP (ρ = 0.2611, p = 0.0290).

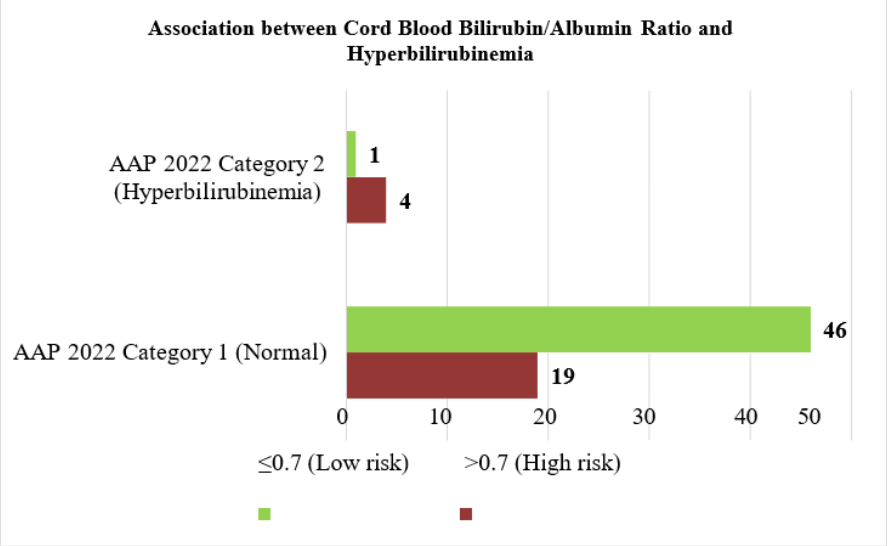

Figure 1: Association between Cord Blood Bilirubin/Albumin Ratio and Hyperbilirubinemia

Figure 1 depicts among newborns with a cord bilirubin/albumin ratio >0.7, 4 out of 23 (17.4%) developed hyperbilirubinemia based on AAP 2022 criteria. In contrast, among those with a ratio ≤0.7,only 1 out of 47

(2.1%) developed hyperbilirubinemia.The Fisher's exact test yielded a p-value of 0.037, indicating a statistically significant association between a high cord bilirubin/albumin ratio and the occurrence of hyperbilirubinemia.This result supports the predictive value of the cord bilirubin/albumin ratio: newborns with a ratio >0.7 are significantly more likely to develop hyperbilirubinemia.

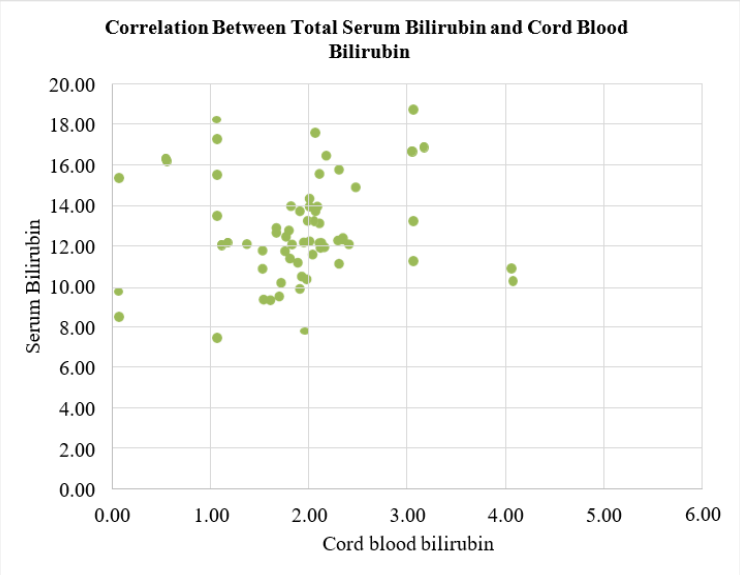

Figure 2: Correlation between Total Serum Bilirubin and Cord Blood Bilirubin

There is a slight positive association between total serum bilirubin (TSB) and cord blood bilirubin (CBB), as indicated by the Spearman correlation coefficient (ρ) = 0.2276. This implies that there is a weak correlation between the rise in total serum bilirubin and the rise in cord blood bilirubin. Although there is some evidence of a relationship, it is not strong enough to be deemed statistically significant at the 5% level, as indicated by the p-value of 0.0581, which is marginally above the 0.05 threshold for statistical significance (Figure 2).

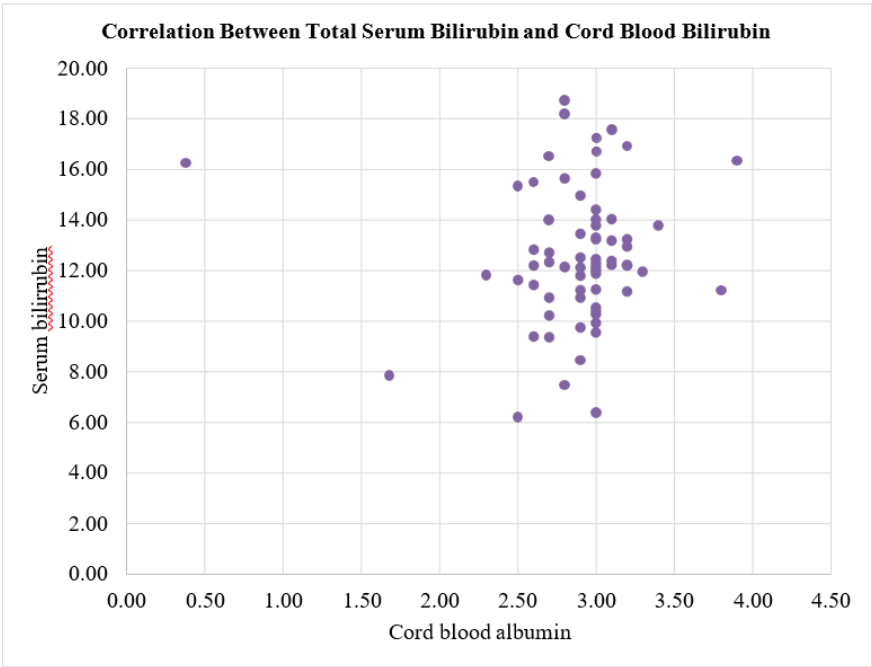

Figure 3: Correlation Between Total Serum Bilirubin and Cord Serum Albumin

The Spearman correlation coefficient (ρ) = 0.1558 suggests a very weak positive correlation between total serum bilirubin (TSB) and cord serum albumin (CSA). The p-value = 0.1979 is much higher than the 0.05 significance threshold, meaning the correlation is not statistically significant. This indicates that cord serum albumin is not strongly associated with total serum bilirubin in this study population (Figure 3).

Table 5: Comparison of Cord Blood Bilirubin Levels in Pathological Hyperbilirubinemia

Serum total bilirubin	Observations (n)	Rank Sum	Expected Rank Sum
<15mg/dl	57	2005.5	2023.5
>15mg/dl	13	479.5	461.5
Combined	70	2485	2485

Z-score = -0.272 P-value = 0.7857 Adjusted Variance = 4382.41

Table 5 shows that the Wilcoxon rank-sum (Mann-Whitney) test was conducted to compare the cord bilirubin levels between two groups classified based on serum total bilirubin levels. The test yielded a z-score of -0.272 and a p-value of 0.7857. This suggests that there is no statistically significant difference in cord bilirubin levels between the two groups of serum total bilirubin.

Table 6: Comparison of Cord Blood Albumin Levels Pathological Hyperbilirubinemia

Serum total bilirubin	Observations (n)	Rank Sum	Expected Rank Sum
Category 1 (< 15 mg/dL)	57	2068.5	2023.5
Category 2 (> 15 mg/dL)	13	416.5	461.5
Combined	70	2485	2485

Z-score = 0.691 P-value = 0.4896 Adjusted Variance = 4242.26

The Z-score for the test was 0.691, and the corresponding P-value was 0.4896, indicating no significant difference in cord blood albumin levels between the two groups (table 6).

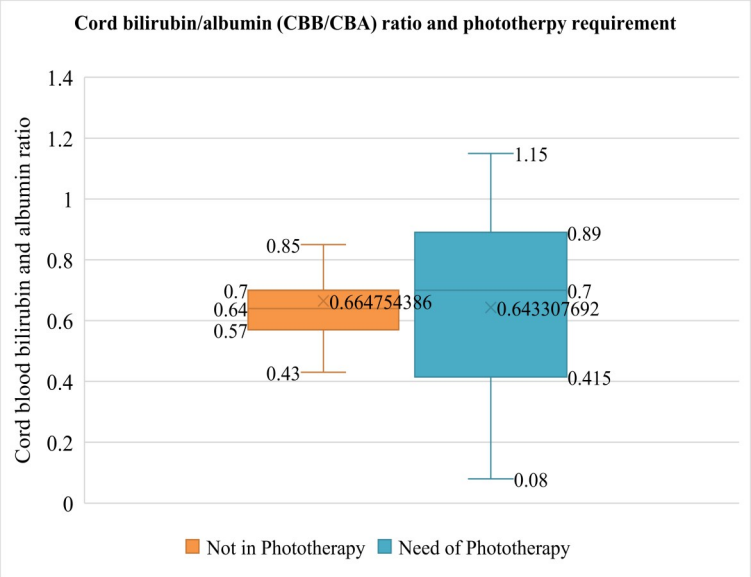

Figure 4: Comparison of cord bilirubin/albumin (CBB/CBA) ratio in Phototherapy requirement

The current findings indicate that the cord bilirubin/albumin (CBB/CBA) ratio does not show a significant association with an increase in serum bilirubin levels in newborns. This suggests that the CBB/CBA ratio may not be a strong predictor of hyperbilirubinemia in this dataset (Figure 4).

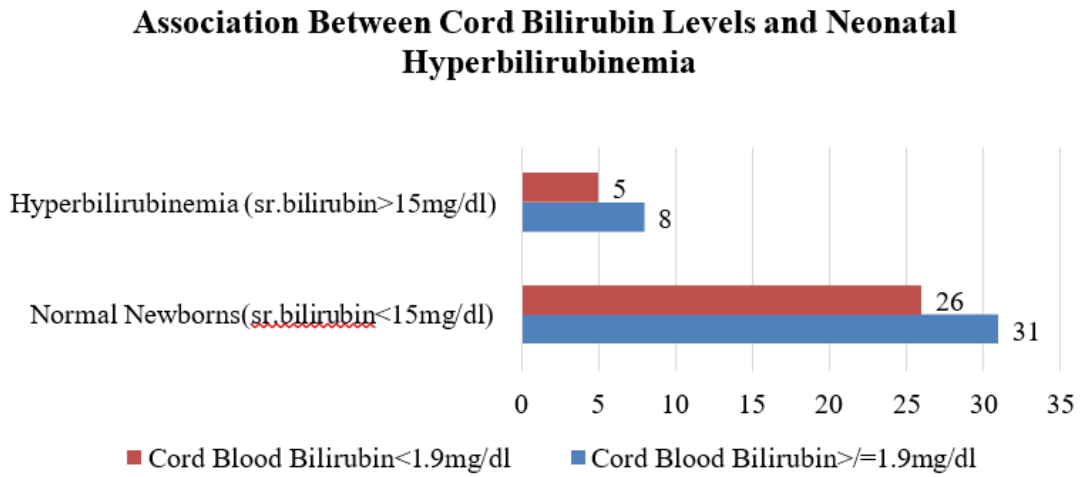

Figure 5: Association Between Cord Bilirubin Levels and Neonatal Pathological Hyperbilirubinemia

The Chi-square test was used to evaluate the relationship between cord blood bilirubin levels and serum total bilirubin categories. There is no statistically significant correlation between the two variables, according to the findings ($\chi^2 = 0.2195$, df = 1, p = 0.639). This indicates that there was no significant difference in the percentage of neonates with cord blood bilirubin levels ≥1.9 mg/dL and those with levels <1.9 mg/dL who had hyperbilirubinemia (serum bilirubin >15 mg/dL). Thus, cord blood bilirubin ≥1.9 mg/dL did not seem to be a good indicator of future hyperbilirubinemia in this investigation (Figure 5).

Table 7: Range of Cord Blood Bilirubin/albumin Levels in Newborns with and without pathological Hyperbilirubinemia

Range of Cord Blood Bilirubin Levels in Newborns with and without pathological Hyperbilirubinemia		
Serum total bilirubin	**Minimum Cord Blood Bilirubin (mg/dL)**	**Maximum Cord Blood Bilirubin (mg/dL)**
Category 1 (<15 mg/dL)	0.46	4.92
Category 2 (>15 mg/dL)	0.20	3.24
Range of Cord Blood Albumin Levels in Newborns with and without pathological Hyperbilirubinemia		
Serum total bilirubin	**Minimum Cord Blood Albumin (g/dL)**	**Maximum Cord Blood Albumin (g/dL)**
Category 1 (<15 mg/dL)	1.68	3.80
Category 2 (>15 mg/dL)	0.38	3.90

The cord blood bilirubin levels of newborns without hyperbilirubinemia ranged from 0.46 mg/dL to 4.92 mg/dL, whereas those with hyperbilirubinemia had a reduced range, from 0.20 mg/dL to 3.24 mg/dL. This result implies that hyperbilirubinemia can occur in neonates with lower bilirubin levels at birth. The fact that the two groups' bilirubin levels overlap suggests that cord blood bilirubin by itself might not be a reliable indicator of hyperbilirubinemia.

Significant variations can be seen when comparing the cord blood albumin levels of babies with and without hyperbilirubinemia. The cord blood albumin levels of newborns with hyperbilirubinemia ranged from 0.38 mg/dL to 3.90 mg/dL, while those without the condition ranged from 1.68 mg/dL to 3.80 mg/dL. Low cord blood albumin levels may be linked to an increased chance of developing hyperbilirubinemia, as seen by the lower

minimum albumin value in neonates who experienced the illness (Table 7).

DISCUSSION

In the current study, 38.57% of deliveries were cesarean sections and 61.43% of deliveries were normal vaginal births. This reflects institutional trends in India, where cesarean rates are rising but still fall short of vaginal births. In line with Ahire et al. (50.44% males, 49.55% females) and Patil et al. (56% men, 44% females), there was a male predominance (57.14%) compared to 42.86% females, supporting the modest male prevalence in newborns (5,17).

A homogeneous full-term group was indicated by the gestational age, which ranged narrowly between 38 and 39 weeks (mean 38.43 ± 0.498 weeks). Ahire et al., on the other hand, reported a wider range (37–40 weeks), with 23% falling between 39–40 weeks and 77% between 37–38 weeks. Interestingly, 4.6% of newborns at 37–38 weeks had substantial hyperbilirubinemia, whereas none of the group at 39–40 weeks experienced jaundice (5).

The present study found that the average birth weight was 2.95 ± 0.26 kg, which is within the usual range for term newborns. This is in close agreement with Ahire et al., who found that 79.6% of newborns weighed between 2.5 and 3.0 kg, indicating comparable intrauterine growth and nutritional status (5). While all studies show a typical distribution predicted in healthy, full-term infants, Sharma et al. reported a significantly lower mean of 2.86 ± 0.47 kg (12).

Newborns with hyperbilirubinemia had lower cord bilirubin levels, according to the study's statistically significant negative connection between cord blood bilirubin (CBB) and AAP categorization. In contrast, Chakrahari et al. (2023) found that infants with CBB ≥1.75 mg/dL were more likely to have hyperbilirubinemia (18), while El Mashad et al. (2019) found a cut-off of 1.88 mg/dL with excellent sensitivity for predicting the condition (19). The disparity could be explained by differences in bilirubin metabolism just after birth, feeding habits, and population features like the low-risk cohort and limited gestational age range in this investigation.

The study found no significant correlation between cord blood albumin (CBA) and hyperbilirubinemia, consistent with Shekhar et al., who reported modest specificity (48%) for CBA as a predictor (20). Other studies, however, noted that lower CBA levels (<2.8–3.0 g/dL) increase risk (21), suggesting that the lack of significance here may reflect sample size or baseline variability. In contrast, the cord bilirubin/albumin (CBB/CBA) ratio showed a significant positive correlation, supporting its role as a stronger predictor. This aligns with Bhat et al. (2019), who demonstrated excellent predictive performance for a ratio >0.98 (sensitivity 78.79%, specificity 95.51%), and Nguyen et al., who confirmed its utility even in preterm infants (22, 23).

Although newborns with a cord bilirubin/albumin ratio >0.7 showed a higher incidence of hyperbilirubinemia, the association was not statistically significant ($p = 0.074$). However, this p-value approaches significance and suggests potential clinical relevance that could become evident with larger sample sizes. Studies by Ramteke et al. and Afolayan et al. also support the bilirubin/albumin ratio as a valuable early warning tool (24, 25).

When assessing the correlation between cord bilirubin and subsequent total serum bilirubin (TSB) measured after 72 hours, only a weak, non-significant positive correlation was observed (Spearman's $\rho = 0.2276$, $p = 0.0581$). Similarly, neither cord albumin nor the CBB/CBA ratio demonstrated significant correlations with the development of hyperbilirubinemia ($p = 0.4896$ and $p = 0.7681$, respectively).

A CBB level ≥3.0 mg/dL, on the other hand, exhibited 100% sensitivity and 98.17% specificity for predicting severe hyperbilirubinemia, according to earlier research by Ahire et al. (2016) (5). Additionally, Khairy et al. (2019) discovered a high predictive value for cut-offs of 1.84 mg/dL and 2.5 mg/dL, respectively (13). Due to the smaller gestational age (38–39 weeks) and lack of strong hemolytic risk factors, our mean CBB value (1.98 mg/dL) was near these criteria, but it did not provide any prognostic value in our homogeneous, low-risk term sample. Kardum et al. discovered a sensitivity of 76.85% and specificity of 69.58% for predicting hyperbilirubinemia within 48 hours in a high-risk population, further demonstrating the predictive utility of CBB (26).

The mean cord blood albumin (CBA) level was 2.89 g/dL, with no significant difference between hyperbilirubinemic and normal neonates. In contrast, Khairy et al. reported a threshold of ≤3.0 g/dL (13), whereas El Mashad et al. observed CBA <2.8 g/dL substantially predictive of hyperbilirubinemia (18). When evaluating predictive markers, the study found that a cord bilirubin/albumin ratio >0.7 was significantly correlated with increased risk ($p = 0.037$), indicating its superior predictive value, whereas cord bilirubin (≥1.9 mg/dL) and CBA alone were not significantly associated with hyperbilirubinemia ($p = 0.639$ and $p = 0.4896$, respectively).

The current AAP guidelines (2022) have revised the phototherapy thresholds by increasing the acceptable range of serum bilirubin levels before initiating treatment, as compared to the previous guidelines where narrower thresholds prompted earlier initiation of phototherapy (15). Neonatal bilirubin levels are influenced by dynamic physiological processes that occur postnatally, including

hepatic enzyme activity, feeding patterns, intestinal flora, and bilirubin conjugation. Cord blood levels reflect intrauterine conditions and may not fully capture these postnatal contributors to hyperbilirubinemia, thereby limiting their predictive power.

Although many studies have suggested that cord blood bilirubin (CBB) and cord blood albumin (CBA) can serve as early predictors of neonatal hyperbilirubinemia, our findings did not show a significant association for either marker individually. This could be explained by the fact that while bilirubin metabolism rapidly changes after delivery due to liver enzyme maturation, feeding beginning, and hemolysis patterns, cord blood reflects intrauterine circumstances. As a result, these dynamic postnatal processes might not be captured by CBB levels at delivery. Furthermore, significant biological variability is suggested by the broad overlap in cord bilirubin and albumin levels between hyperbilirubinemic and normal newborns, with genetic variations in bilirubin conjugation, feeding habits, dehydration, and subclinical hemolysis probably having a greater impact after birth than cord measurements alone.

CONCLUSION

This study aimed to assess the predictive value of umbilical cord blood bilirubin (CBB), cord blood albumin (CBA), and the bilirubin/albumin (B/A) ratio for identifying the risk of neonatal hyperbilirubinemia in full-term newborns. The average CBA was 2.89 ± 0.37 g/dL and the average CBB was 1.98 ± 0.65 mg/dL. Hyperbilirubinemia was not significantly correlated with either CBB (≥1.9 mg/dL) or CBA ($p = 0.639$ and $p = 0.4896$, respectively). With a mean birth weight of 2.95 ± 0.26 kg, gestational ages between 38 and 39 weeks (mean 38.43 ± 0.498 weeks), usual gender distribution (57.14% male, 42.86% female), and delivery distributions (61.43% vaginal, 38.57% cesarean), the cohort was essentially homogeneous. Crucially, the B/A ratio >0.7 showed a statistically significant correlation with hyperbilirubinemia ($p = 0.037$), suggesting that combined indicators offer better predictive accuracy than individual values.

LIMITATIONS

The study was limited to healthy, full-term neonates with narrow gestational age and birth weight ranges, reducing variability and potentially masking subtle associations. The small sample size (n = 70) may have been underpowered to detect significant trends. Exclusion of high-risk neonates (e.g., sepsis, prematurity) restricts generalizability, and being a single-center study limits external validity. Monitoring of serum bilirubin only up to 72 hours may have missed delayed or prolonged cases. Postnatal factors such as feeding adequacy, hydration, and hepatic maturation were not controlled. Importantly, none of the neonates required exchange transfusion or developed severe hyperbilirubinemia (>20 mg/dL), further limiting applicability to populations with severe hemolytic jaundice.

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