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**Original Research Article**

# Maternal Anemia and Neonatal Cord Blood Hemoglobin: A Hospital-Based Cross-Sectional Study

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**Abstract**

**Background:** Maternal anemia remains one of the most common nutritional disorders during pregnancy and is associated with adverse maternal and neonatal outcomes. Although physiological mechanisms facilitate preferential placental iron transfer to the fetus, severe maternal anemia may compromise fetalhematological status. Umbilical cord blood hemoglobin serves as an important indicator of neonatal iron status at birth. This study was undertaken to evaluate the association between maternal anemia and neonatal cord blood hemoglobin among mother–newborn pairs.

**Methods:** A hospital-based analytical cross-sectional study was conducted among 190 mother–newborn pairs at Government Cuddalore Medical College and Hospital, Tamil Nadu, India. Maternal anemia was defined according to World Health Organization criteria (hemoglobin<11 g/dL). Statistical analysis was performed using IBM SPSS Statistics version 26.0. Student's *t*-test, one-way ANOVA, Pearson's correlation coefficient, and Chi-square test were applied where appropriate. A *p*-value <0.05 was considered statistically significant.

**Results:** Among the 190 mothers included, 117 (61.6%) were anemic and 73 (38.4%) had normal hemoglobin levels. Moderate anemia was the most common category (30.5%), followed by mild anemia (25.3%) and severe anemia (5.8%). Low birth weight (<2.5 kg) occurred significantly more frequently among neonates born to anemic mothers than among those born to non-anemic mothers (33.3% vs. 13.7%; *p*=0.002).

**Conclusion:** Maternal anemia is highly prevalent and is significantly associated with reduced neonatal cord blood hemoglobin and an increased risk of low birth weight. Increasing severity of maternal anemia is accompanied by progressively lower neonatal hemoglobin concentrations.

**Keywords:** Maternal Anemia; Cord Blood Hemoglobin; Neonatal Anemia; Pregnancy; Iron Deficiency; Birth Weight; Maternal Hemoglobin; Cross-Sectional Study.

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## Introduction

Maternal anemia remains one of the most prevalent nutritional disorders affecting pregnant women worldwide and continues to be a significant public health challenge, particularly in low- and middle-income countries. According to the World Health Organization (WHO), anemia during pregnancy is defined as a hemoglobin concentration below 11 g/dL and is most commonly caused by iron deficiency, although deficiencies of folate, vitamin B12, chronic infections, hemoglobinopathies, and inflammatory conditions also contribute substantially [1]. Pregnancy is associated with marked physiological changes, including plasma volume expansion that exceeds the increase in red cell mass, resulting in physiological hemodilution. However, when maternal iron stores are inadequate or nutritional demands are not met, pathological anemia develops, increasing the risk of adverse maternal and fetal outcomes [2]. Globally, nearly 40% of pregnant women are estimated to be anemic, with the highest burden observed in South Asia and Sub-Saharan Africa [1]. In India, maternal anemia remains a persistent concern despite the implementation of national iron supplementation and maternal health programs. The high prevalence of maternal anemia reflects inadequate dietary iron intake, poor bioavailability of iron, frequent pregnancies, short inter-pregnancy intervals, parasitic infestations, socioeconomic deprivation, and limited access to quality antenatal care [3]. Maternal anemia contributes significantly to maternal morbidity and mortality by increasing the risk of postpartum hemorrhage, infections, cardiac failure, preterm labor, and poor obstetric outcomes [4].

The fetus depends entirely on the mother for its oxygen supply and iron requirements throughout gestation. Iron is actively transported across the placenta through specialized transport proteins, allowing preferential fetal iron acquisition even when maternal stores are depleted. Nevertheless, severe or prolonged maternal anemia may overwhelm these compensatory mechanisms, resulting in diminished fetal iron reserves and altered neonatal hematological parameters [5]. Consequently, neonatal cord blood hemoglobin has emerged as an important biomarker reflecting the hematological status of the newborn at birth and serves as an indirect indicator of intrauterine iron availability [6].

Umbilical cord blood hemoglobin measurement provides valuable information regarding neonatal oxygen-carrying capacity and fetal iron status without subjecting the newborn to additional venipuncture. Reduced cord blood hemoglobin has been associated with neonatal anemia, impaired neurodevelopment, delayed psychomotor performance, susceptibility to infections, and suboptimal growth during infancy [7]. Furthermore, neonatal anemia may remain clinically silent during the immediate postnatal period, making cord blood hemoglobin estimation an effective screening tool for identifying newborns at risk of iron deficiency and related complications [8].

Although several physiological mechanisms attempt to preserve fetal iron transport despite maternal deficiency, the relationship between maternal hemoglobin concentration and neonatal cord blood hemoglobin remains controversial. Some investigators have reported a significant positive correlation between maternal and cord blood hemoglobin concentrations, suggesting that maternal anemia adversely influences fetalhematological status [9,10].

Conversely, other studies have demonstrated minimal or no association, proposing that placental adaptations maintain adequate fetal iron transfer until maternal iron depletion becomes severe [11]. These conflicting observations may be attributed to differences in study design, severity of maternal anemia, gestational age, nutritional status, socioeconomic factors, ethnicity, and laboratory methodologies.

Several observational studies conducted across different populations have attempted to clarify this relationship. Sareen et al. demonstrated that neonates born to anemic mothers had significantly lower cord blood hemoglobin levels compared with those born to non-anemic mothers [12]. Similar findings were reported by Najeeba et al. and Debbarma et al., who observed a direct relationship between maternal hemoglobin concentration and neonatal cord blood hemoglobin, emphasizing the importance of preventing maternal anemia during pregnancy [13,14]. Timilsina et al. also reported a positive correlation between maternal hemoglobin and umbilical cord blood hematological indices among pregnant women in Nepal [15]. These findings support the hypothesis that maternal nutritional status directly influences fetalhematopoiesis and neonatal iron stores.

Maternal anemia has implications extending beyond delivery. Iron deficiency during fetal life may impair brain development, neurotransmitter synthesis, myelination, and cognitive maturation, potentially producing long-term neurodevelopmental consequences even when postnatal iron supplementation is provided [16]. Therefore, early identification of newborns at risk through cord blood hemoglobin estimation may facilitate timely interventions aimed at preventing neonatal anemia and improving developmental outcomes.

Hospital-based cross-sectional studies provide valuable evidence regarding the association between maternal anemia and neonatal hematological status by evaluating paired maternal and cord blood hemoglobin measurements at delivery. Such studies are particularly relevant in regions where maternal anemia remains highly prevalent, as they help quantify disease burden, identify high-risk populations, and guide preventive strategies within antenatal care services [17]. Moreover, understanding the relationship between maternal anemia and neonatal cord blood hemoglobin may strengthen existing maternal nutrition programs and reinforce recommendations regarding routine screening, iron supplementation, dietary counseling, and comprehensive antenatal monitoring.

In view of the continuing burden of maternal anemia and the inconsistent findings reported in previous studies, the present hospital-based cross-sectional study was undertaken to evaluate the association between maternal anemia and neonatal cord blood hemoglobin among mother–newborn pairs. Establishing this relationship may contribute to improved neonatal risk assessment and provide evidence for strengthening maternal health interventions aimed at reducing both maternal and neonatal anemia.

## Methods

This hospital-based analytical cross-sectional study was conducted in the Department of Pediatrics in collaboration with the Department of Obstetrics and Gynecology at Government Cuddalore Medical College and Hospital, Tamil Nadu, India. The study was carried out over a period of 18 months after obtaining approval from the Institutional Ethics Committee. The hospital is a tertiary care referral center catering to urban and rural populations of Cuddalore district and neighboring regions.

The study included pregnant women admitted for delivery and their corresponding live-born neonates delivered during the study period. Mother–newborn pairs fulfilling the eligibility criteria were recruited consecutively until the required sample size was achieved.

Pregnant women delivering singleton or twin live babies delivering at Government Cuddalore Medical College Hospital either Vaginal and lower segment caesarean deliveries were included in the study. Neonates with birth asphyxia, Rh incompatibility, Mothers with hematological malignancies or known hemoglobinopathies, Mothers who had received blood transfusion within four weeks before delivery were excluded from the study.

**Sample Size Estimation:** The sample size was calculated using the formula for estimation of a population mean based on the standard deviation reported in a previous study by Dhanasekaran et al. The standard deviation of neonatal cord blood hemoglobin was considered as 1.04 g/dL. Assuming a 95% confidence level (Z = 1.96) and an absolute precision of 0.15 g/dL, the minimum calculated sample size was 185. To compensate for incomplete records and possible exclusions, the final sample size was rounded to 190 mother–newborn pairs. A consecutive sampling technique was employed. Every eligible mother admitted during the study period was invited to participate until the predetermined sample size was reached.

**Exposure Variable:** Maternal anemia was defined according to the World Health Organization criteria as a hemoglobin concentration of <11.0 g/dL during pregnancy. Maternal anemia was further classified into:

- Mild anemia: 10.0–10.9 g/dL
- Moderate anemia: 7.0–9.9 g/dL
- Severe anemia: <7.0 g/dL

**Outcome Variable:** The primary outcome variable was neonatal umbilical cord blood hemoglobin concentration (g/dL) measured immediately after birth. Secondary outcomes included

- Correlation between maternal and neonatal hemoglobin
- Birth weight
- Gestational age
- Association between severity of maternal anemia and neonatal hemoglobin

**Data Collection Procedure:** Eligible mothers were identified immediately after admission to the labour ward or operation theatre. Following detailed explanation of the study objectives, written informed consent was obtained. A structured case record form was used to collect information regarding maternal age, educational status, occupation, socioeconomic status, parity, gestational age, antenatal iron supplementation, obstetric history, medical illnesses, mode of delivery.

Maternal hemoglobin values obtained within 24 hours before delivery were retrieved from hospital laboratory records.Immediately after delivery and before placental expulsion, approximately 2–3 mL of umbilical cord blood was collected from the placental end of the umbilical cord using sterile disposable syringes under strict aseptic precautions. Blood samples were transferred into EDTA vacutainer tubes and transported to the hematology laboratory within one hour of collection.

**Laboratory Analysis:** Cord blood hemoglobin estimation was performed using an automated hematologyanalyzer (Sysmex XN-Series, Sysmex Corporation, Kobe, Japan) based on the cyanide-free sodium lauryl sulfatehemoglobin method. Daily internal quality control procedures were performed using manufacturer-provided control materials at low, normal, and high concentration levels before processing study samples. External quality assurance protocols followed institutional laboratory standards. Maternal hemoglobin measurements were performed using the same automated hematologyanalyzer to eliminate inter-instrument variability.

**Statistical Analysis:** Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality using the Shapiro–Wilk test together with visual inspection of histograms and Q–Q plots.

Normally distributed continuous variables were expressed as mean ± standard deviation, whereas non-normally distributed variables were summarized as median (interquartile range). Categorical variables were presented as frequency and percentage. Comparisons between two independent groups were performed using the Student's independent t-test for normally distributed variables or the Mann–Whitney U test for skewed data.

Comparison among different grades of maternal anemia was performed using one-way analysis of variance (ANOVA) followed by Bonferroni post hoc analysis. Associations between categorical variables were evaluated using the Chi-square test or Fisher's exact test, wherever appropriate.

Correlation between maternal hemoglobin concentration and neonatal cord blood hemoglobin was assessed using Pearson's correlation coefficient for normally distributed variables or Spearman's rank correlation coefficient for non-normal data.

Adjusted regression coefficients (β) or adjusted odds ratios (AORs) with 95% confidence intervals (95% CI) were reported. Model assumptions, residual diagnostics, and goodness-of-fit statistics were examined before interpretation of regression models. A two-sided p-value <0.05 was considered statistically significant.

**Ethical Considerations:** Ethical approval was obtained from the Institutional Ethics Committee of Government Cuddalore Medical College and Hospital before commencement of the study.

Written informed consent was obtained from all participating mothers before enrollment. Confidentiality and anonymity of study participants were maintained throughout the study by assigning unique identification numbers. Participation was voluntary, and mothers were free to withdraw from the study at any stage without affecting their medical care. The study was conducted in accordance with the principles of the Declaration of Helsinki (2013 revision).

**Results**

A total of 190 mother–newborn pairs fulfilling the inclusion criteria were included in the study. The mean maternal age was 25.8 ± 4.3 years, and the mean gestational age at delivery was 38.1 ± 1.6 weeks. The prevalence of maternal anemia (Hb<11 g/dL) was 61.6%(117/190), while 38.4% (73/190) mothers had normal hemoglobin levels.

**Table 1: Baseline characteristics of the study participants (n = 190)**

| Variable | Frequency | Percentage |
|---|---|---|
| Maternal age (years) | | |
| <20 | 18 | 9.5 |
| 20–24 | 62 | 32.6 |
| 25–29 | 71 | 37.4 |
| ≥30 | 39 | 20.5 |
| Gravida | | |
| Primigravida | 84 | 44.2 |
| Multigravida | 106 | 55.8 |
| Gestational age | | |
| Preterm | 22 | 11.6 |
| Term | 168 | 88.4 |
| Mode of delivery | | |
| Normal vaginal delivery | 121 | 63.7 |
| LSCS | 69 | 36.3 |

Table 1 presents the baseline demographic and obstetric characteristics of the study participants. Among the 190 enrolled mothers, the majority (37.4%) belonged to the 25–29 years age group, followed by 32.6% in the 20–24 years age group.

Multigravida women constituted 55.8% of the study population, while 44.2% were primigravida. Most pregnancies (88.4%) reached term gestation, whereas 11.6% resulted in preterm delivery. Normal vaginal delivery was the predominant mode of delivery (63.7%), with the remaining 36.3% delivered by lower segment caesarean section (LSCS).

These findings indicate that the study population mainly comprised term pregnancies and multiparous women.

**Table 2: Distribution of mothers according to severity of anemia**

| Maternal hemoglobin status | Frequency | Percentage |
|---|---|---|
| Non-anemic (≥11 g/dL) | 73 | 38.4 |
| Mild anemia | 48 | 25.3 |
| Moderate anemia | 58 | 30.5 |
| Severe anemia | 11 | 5.8 |

Table 2 illustrates the distribution of mothers according to maternal hemoglobin status. Maternal anemia was identified in 117 (61.6%) participants, while 73 (38.4%) mothers had normal hemoglobin levels. Among the anemic mothers, moderate anemia was the most frequent category (30.5%), followed by mild anemia (25.3%), whereas severe anemia accounted for only 5.8% of cases. These findings demonstrate a high prevalence of maternal anemia among pregnant women included in the study, with moderate anemia representing the largest subgroup.

**Table 3: Comparison of neonatal cord blood hemoglobin between anemic and non-anemic mothers**

| Maternal anemia status | n | Cord blood Hb (Mean ± SD) | t-value | p-value |
|---|---|---|---|---|
| Non-anemic | 73 | 16.82 ± 1.15 | 6.48 | <0.001* |
| Anemic | 117 | 15.41 ± 1.32 | | |

Table 3 compares the mean cord blood hemoglobin concentration between neonates born to anemic and non-anemic mothers. Neonates born to non-anemic mothers had a significantly higher mean cord blood hemoglobin level (16.82 ± 1.15 g/dL) compared with those born to anemic mothers (15.41 ± 1.32 g/dL). The difference was statistically significant ($t = 6.48$, $p < 0.001$), indicating that maternal anemia was associated with lower neonatal cord blood hemoglobin concentrations.

**Table 4: Cord blood hemoglobin according to severity of maternal anemia**

| Maternal anemia | n | Cord blood Hb (Mean ± SD) |
|---|---|---|
| Non-anemic | 73 | 16.82 ± 1.15 |
| Mild anemia | 48 | 15.93 ± 1.09 |
| Moderate anemia | 58 | 15.21 ± 1.18 |
| Severe anemia | 11 | 14.38 ± 0.96 |

Table 4 demonstrates the variation in neonatal cord blood hemoglobin according to the severity of maternal anemia. A progressive decline in mean cord blood hemoglobin was observed with increasing severity of maternal anemia. Neonates born to non-anemic mothers had the highest mean cord blood hemoglobin (16.82 ± 1.15 g/dL), whereas those born to mothers with severe anemia had the lowest mean value (14.38 ± 0.96 g/dL). One-way ANOVA revealed a statistically significant difference among the groups ($F = 18.92$, $p < 0.001$), suggesting that increasing severity of maternal anemia adversely affects neonatal hemoglobin status.

**Table 5: Correlation between maternal hemoglobin and neonatal cord blood hemoglobin**

| Variables | Pearson correlation (r) | p-value |
|---|---|---|
| Maternal Hb vs Cord blood Hb | 0.692 | <0.001* |

Table 5 presents the correlation analysis between maternal hemoglobin concentration and neonatal cord blood hemoglobin. Pearson's correlation analysis demonstrated a strong positive correlation ($r = 0.692$, $p < 0.001$), indicating that higher maternal hemoglobin levels were associated with higher neonatal cord blood hemoglobin concentrations. This statistically significant correlation supports the hypothesis that maternal hematological status has a direct influence on fetalhemoglobin at birth.

**Table 6: Association between maternal anemia and neonatal birth weight**

| Birth weight | Anemic Mothers n (%) | Non-anemic Mothers n (%) | Chi-square | p-value |
|---|---|---|---|---|
| <2.5 kg | 39 (33.3) | 10 (13.7) | 9.27 | 0.002* |
| ≥2.5 kg | 78 (66.7) | 63 (86.3) | | |

Table 6 shows the association between maternal anemia and neonatal birth weight. Low birth weight (<2.5 kg) was observed more frequently among neonates born to anemic mothers (33.3%) than among those born to non-anemic mothers (13.7%). Conversely, normal birth weight (≥2.5 kg) was more common in the non-anemic group (86.3%) compared with the anemic group (66.7%). The association was statistically significant ($\chi^2 = 9.27$, $p = 0.002$), indicating that maternal anemia was significantly associated with an increased risk of low birth weight.

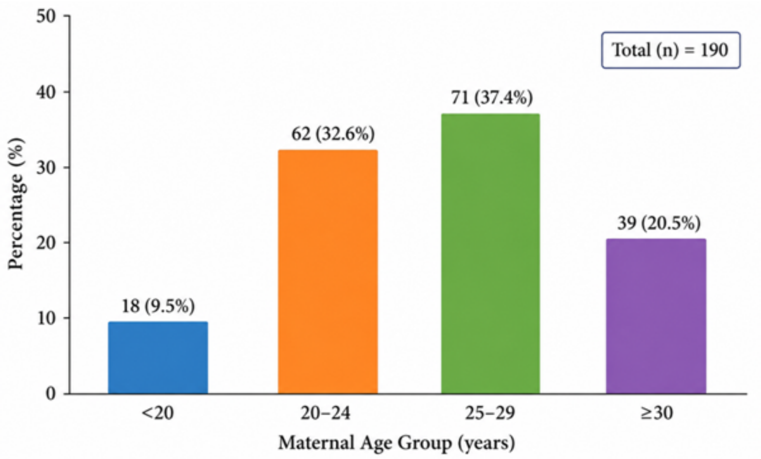


**Figure 1: Distribution of study participants according to maternal age group**

Figure 1 illustrates the distribution of the 190 study participants according to maternal age group. The highest proportion of mothers belonged to the 25–29 years age group (37.4%), followed by the 20–24 years age group (32.6%). Mothers aged ≥30 years constituted 20.5% of the study population, whereas those aged <20 years accounted for the smallest proportion (9.5%). Overall, the study population predominantly comprised women aged between 20 and 29 years, representing nearly 70% of all participants, indicating that the majority of deliveries occurred among women in the optimal reproductive age group.

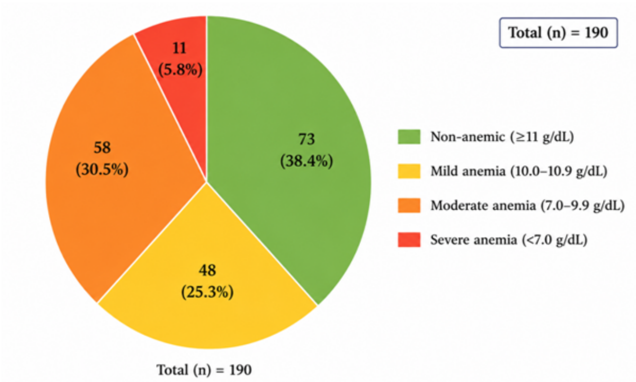


**Figure 2: Severity of maternal anemia among study participants**

Figure 2 demonstrates the prevalence and severity of maternal anemia. Moderate anemia represented the largest proportion of anemic mothers, followed by mild anemia, whereas severe anemia was comparatively uncommon.

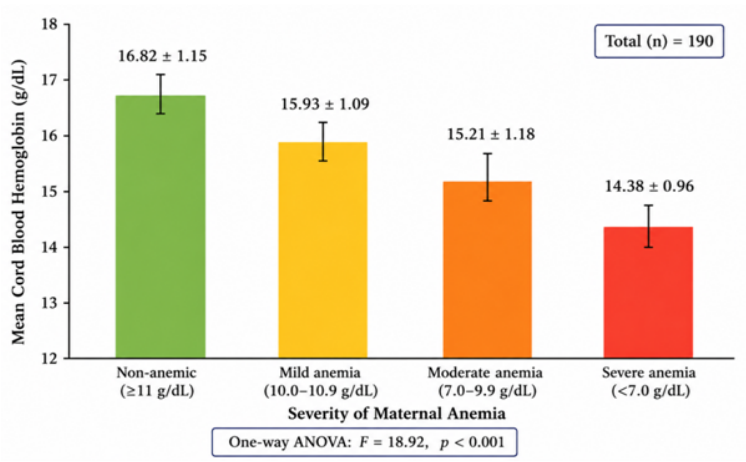


**Figure 3: Mean cord blood hemoglobin according to severity of maternal anemia**

Figure 3 shows a gradual decline in neonatal cord blood hemoglobin with increasing severity of maternal anemia. Neonates born to non-anemic mothers had the highest mean hemoglobin levels, whereas those born to mothers with severe anemia had the lowest values.

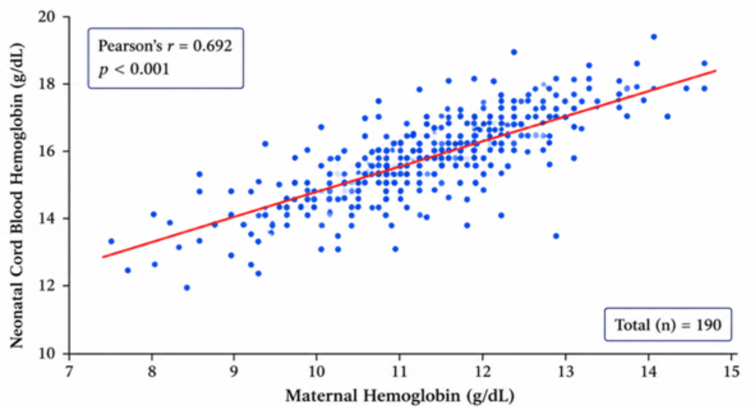


**Figure 4: Correlation between maternal hemoglobin and neonatal cord blood hemoglobin**

Figure 4 scatter plot demonstrates a positive linear relationship between maternal hemoglobin concentration and neonatal cord blood hemoglobin. The regression line indicates that neonatal cord blood hemoglobin increases with increasing maternal hemoglobin levels, supporting the statistically significant positive correlation observed in the study.

## Discussion

The present hospital-based cross-sectional study evaluated the association between maternal anemia and neonatal cord blood hemoglobin among 190 mother–newborn pairs. Maternal anemia was highly prevalent, affecting 61.6% of pregnant women, with moderate anemia constituting the largest subgroup. Furthermore, maternal anemia was associated with significantly lower neonatal cord blood hemoglobin concentrations, a progressive decline in cord blood hemoglobin with increasing severity of maternal anemia, a strong positive correlation between maternal and neonatal hemoglobin levels, and a significantly higher frequency of low birth weight among neonates born to anemic mothers. These findings reinforce the importance of maintaining adequate maternal hemoglobin during pregnancy to optimize neonatal hematological outcomes.

The prevalence of maternal anemia observed in the present study (61.6%) remains consistent with reports from several developing countries where nutritional deficiencies continue to represent a major public health concern. Similar prevalence has been documented in Indian hospital-based studies by Kumar et al. and Bencaiova et al., who emphasized that iron deficiency, inadequate antenatal supplementation, poor dietary intake, and low socioeconomic status remain the principal contributors to maternal anemia during pregnancy [18,19]. The persistently high prevalence observed despite national iron supplementation programs indicates that anemia prevention strategies require strengthening through improved antenatal surveillance, nutritional counseling, and early therapeutic intervention.

One of the principal findings of this study was the significantly lower mean cord blood hemoglobin among neonates born to anemic mothers compared with those born to non-anemic mothers (15.41 ± 1.32 vs. 16.82 ± 1.15 g/dL, p<0.001). This observation agrees with several previous investigations demonstrating that maternal anemia adversely influences neonatal hematological status. Marahatta reported significantly reduced cord blood hemoglobin among neonates delivered by anemic mothers and suggested that prolonged maternal iron deficiency eventually compromises placental iron transfer despite compensatory physiological mechanisms [20]. Similarly, Levy et al. demonstrated that severe maternal anemia substantially reduced neonatal hemoglobin concentrations and neonatal iron stores, emphasizing that fetal protection mechanisms become inadequate once maternal iron depletion progresses beyond a critical threshold [21]. These observations strongly support the findings of the present study. The present study further demonstrated a progressive reduction in neonatal cord blood hemoglobin with increasing severity of maternal anemia. Neonates born to mothers with severe anemia exhibited the lowest mean cord blood hemoglobin values, suggesting a dose-response relationship between maternal hemoglobin concentration and fetalhematological status. Comparable findings have been reported by Kumar et al., who observed that worsening maternal anemia was associated with progressively declining neonatal hemoglobin and serum ferritin concentrations [22]. Similarly, Colomer et al. reported that severe maternal iron deficiency impaired fetal iron endowment, thereby increasing the likelihood of neonatal anemia during infancy [23]. These findings collectively indicate that although placental iron transport is preferentially maintained during pregnancy, severe maternal anemia eventually compromises fetal iron acquisition.

A notable observation of the present study was the strong positive correlation between maternal hemoglobin concentration and neonatal cord blood hemoglobin ($r = 0.692$, $p<0.001$). This finding suggests that maternal hematological status directly influences fetalhemoglobin levels at birth. Similar positive correlations have been reported in studies conducted across different populations. Sweet et al. demonstrated that maternal hemoglobin concentration significantly predicted neonatal hematological indices and recommended early correction of maternal anemia during antenatal care to improve neonatal outcomes [24]. Likewise, Allen highlighted that maternal nutritional deficiencies directly affect fetal iron accretion, particularly during the third trimester when fetal iron requirements are greatest [25]. The strong correlation observed in the present study therefore provides additional evidence supporting routine screening and effective management of maternal anemia throughout pregnancy. The present study also identified a significant association between maternal anemia and low birth weight. Approximately one-third of neonates born to anemic mothers had birth weights below 2.5 kg compared with only 13.7% among non-anemic mothers. These findings are consistent with previous epidemiological studies demonstrating that maternal anemia contributes to impaired fetal growth. Rahman et al. reported that maternal anemia significantly increased the risk of low birth weight and preterm delivery among South Asian populations [26]. Similarly, Figueiredo et al., in a comprehensive systematic review and meta-analysis, concluded that maternal anemia is associated with increased risks of low birth weight, small-for-gestational-age infants, and adverse perinatal outcomes [27]. These observations support the present findings and further emphasize the broader consequences of maternal anemia beyond neonatal hematological status. The biological mechanisms underlying these observations are well established. Maternal iron deficiency reduces maternal oxygen-carrying capacity and decreases iron availability for fetal erythropoiesis. Although placental transferrin receptors increase iron transport during mild maternal deficiency, prolonged or severe anemia eventually overwhelms these adaptive mechanisms, resulting in reduced fetal iron stores and diminished cord blood hemoglobin [28]. In addition, chronic maternal hypoxia may impair placental vascular development, reduce uteroplacental perfusion, and contribute to fetal growth restriction and low birth weight [29]. These mechanisms provide a plausible physiological explanation for the observed relationship between maternal anemia, lower neonatal cord blood hemoglobin, and reduced birth weight in the present study.

The strengths of the present study include the use of standardized WHO criteria for classification of maternal anemia, uniform laboratory analysis using the same automated hematologyanalyzer for maternal and cord blood samples, and inclusion of an adequate sample size. These methodological measures minimized measurement bias and enhanced the reliability of the observed associations. Nevertheless, certain limitations should be acknowledged. The cross-sectional design precludes causal inference, and the study was conducted at a single tertiary care center, which may limit generalizability to other populations. Furthermore, maternal serum ferritin, vitamin B12, folate levels, inflammatory biomarkers, and neonatal iron stores were not assessed; therefore, the specific etiological factors contributing to anemia could not be determined. Longitudinal multicenter studies incorporating comprehensive iron status biomarkers would provide further insight into the causal relationship between maternal anemia and neonatal hematological outcomes. Overall, the findings of the present study demonstrate that maternal anemia remains highly prevalent and is significantly associated with lower neonatal cord blood hemoglobin concentrations, progressive reduction in fetalhemoglobin with increasing anemia severity, and an increased risk of low birth weight. These findings underscore the importance of strengthening antenatal screening programs, ensuring early diagnosis and treatment of maternal anemia, improving compliance with iron supplementation, and promoting nutritional interventions throughout pregnancy. Such preventive strategies may substantially improve neonatal hematological status and reduce the burden of adverse perinatal outcomes.

## Conclusion

The present hospital-based cross-sectional study demonstrated that maternal anemia remains highly prevalent among pregnant women, affecting more than half of the study population. Maternal anemia was significantly associated with lower neonatal cord blood hemoglobin concentrations, and a progressive decline in cord blood hemoglobin was observed with increasing severity of maternal anemia. A strong positive correlation between maternal hemoglobin and neonatal cord blood hemoglobin further confirms that maternal hematological status has a direct influence on the newborn'shematological profile at birth. In addition, maternal anemia was significantly associated with an increased incidence of low birth weight, highlighting its adverse impact on neonatal outcomes.

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