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Management of Maternal Anemia and Its Impact on Obstetric Complications and Neonatal Outcomes

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Abstract		Original Research Article

Background: Maternal anemia remains a major global health concern, particularly in low- and middle-income countries, where nutritional deficiencies, socioeconomic disparities, and inadequate antenatal care contribute to its high prevalence. Anemia during pregnancy is strongly associated with adverse obstetric and neonatal outcomes, including preterm birth, postpartum hemorrhage, low birth weight, and increased perinatal morbidity. ***Aim:*** This study aimed to determine the prevalence and severity of maternal anemia among pregnant women attending a tertiary care hospital, assess its impact on obstetric and neonatal outcomes, and highlight key approaches for effective management of anemia during pregnancy. ***Methods:*** A hospital-based observational study was conducted at B.R. Ambedkar Medical College, Bangalore, from January to October 2019, including 650 pregnant women. Hemoglobin levels were estimated using standard automated analyzers and categorized according to WHO criteria. Obstetric complications, labor characteristics, and neonatal outcomes were analyzed using descriptive and inferential statistics. ***Results:*** The prevalence of maternal anemia was 61.5%, with most cases classified as mild to moderate. Anemia showed significant associations with preterm birth, postpartum hemorrhage, preeclampsia, and intrauterine growth restriction. Neonates of anemic mothers had higher incidences of low birth weight, low Apgar scores, and increased NICU admissions. Severity of anemia demonstrated a strong correlation with adverse maternal and neonatal outcomes. ***Conclusion:*** Maternal anemia continues to be a critical determinant of obstetric and neonatal complications. Strengthening its management through early and routine antenatal screening, dietary counseling, iron-and-folate supplementation, and timely initiation of parenteral iron or transfusion in severe cases is essential to reduce associated risks. Integrating evidence-based management strategies within antenatal programs can significantly improve maternal hemoglobin levels and enhance both maternal and neonatal health outcomes.
Keywords: Maternal anemia; obstetric complications; neonatal outcomes; pregnancy; low birth weight; preterm birth; postpartum hemorrhage.

INTRODUCTION

Anemia during pregnancy continues to be one of the most prevalent and challenging public health issues globally, particularly in low- and middle-income countries. Defined by the World Health Organization (WHO) as hemoglobin (Hb) levels below 11 g/dL, maternal anemia significantly increases the risk of morbidity and mortality for both the mother and the fetus. The physiological demands of pregnancy, including expanded plasma volume, heightened metabolic requirements, and fetal needs, render pregnant women especially vulnerable to anemia. Globally, it is estimated that more than 40% of pregnant women are anemic, with the burden being particularly high in South Asia and sub-Saharan Africa [1–3]. In India, the prevalence remains alarmingly high despite multiple national programs aimed at prevention and early detection.

The etiology of maternal anemia is multifactorial, involving nutritional deficiencies, chronic infections, hereditary hemoglobinopathies, and socioeconomic factors. Iron deficiency anemia accounts for the majority of cases, largely due to inadequate dietary intake, poor absorption, and increased physiological requirements during pregnancy. Other micronutrient deficiencies, including folate and vitamin B12, also play contributory roles. Additionally, parasitic infections, chronic diseases, and genetic conditions such as thalassemia further compound the problem. These

etiological complexities emphasize the need for comprehensive antenatal screening and tailored interventions. Numerous studies conducted between 2010 and 2018 have consistently documented the strong association between anemia severity and negative pregnancy outcomes [4–6].

Maternal anemia has far-reaching implications for pregnancy progression, delivery dynamics, and neonatal health. Several epidemiological investigations have demonstrated that anemic mothers are more likely to experience preterm labor, intrauterine growth restriction (IUGR), postpartum hemorrhage (PPH), and hypertensive disorders of pregnancy [7–10]. Furthermore, fetal consequences, including low birth weight, stillbirth, reduced Apgar scores, and higher susceptibility to infections, have been recurrently reported in literature. Hemoglobin levels influence oxygen transport to maternal and fetal tissues; hence, compromised oxygenation has direct effects on placental development and fetal growth. The interplay between maternal nutritional status, hemoglobin concentration, and placental function creates a complex physiological environment influencing pregnancy outcomes [11–13].

Despite extensive research on maternal anemia, its prevalence and associated complications remain significantly high in many regions of India. Karnataka, with its diverse population distribution and varying socioeconomic conditions, presents a unique landscape for studying maternal health indicators. B.R. Ambedkar Medical College in Bangalore serves a wide catchment area, catering to women from urban, semi-urban, and rural backgrounds. As such, it provides an appropriate setting for evaluating anemia-related obstetric and neonatal risks. Understanding the magnitude and pattern of maternal anemia in such a tertiary care center is essential for strengthening antenatal care strategies and optimizing maternal health outcomes. Research conducted within this framework between 2010 and 2018 has highlighted the importance of region-specific analyses to address gaps in service delivery and awareness [14–17].

Given the substantial burden and clinical significance of maternal anemia, it is crucial to continuously assess its impact on pregnancy outcomes in different populations. While national programs like the Anemia Mukt Bharat initiative have strengthened preventive measures, there is still a persistent gap between policy and practice. Identifying associations between anemia severity and specific obstetric or neonatal complications can inform targeted interventions, improve risk stratification during antenatal care, and support evidence-based clinical decision-making. The present study aims to contribute to this ongoing effort by providing updated data from a tertiary care hospital in Bangalore, thereby guiding future maternal health initiatives and improving outcomes for both mothers and newborns.

OBJECTIVES

The primary objective of this study was to determine the prevalence and severity of maternal anemia among pregnant women attending the antenatal clinic and labor wards of B.R. Ambedkar Medical College, Bangalore, Karnataka. The research sought to categorize anemia based on WHO criteria and examine its distribution across different gestational age groups, parity, and socioeconomic strata. By understanding these foundational patterns, the study intended to provide critical insights into the magnitude of the condition within the regional context and identify vulnerable subpopulations requiring intensified antenatal interventions.

A secondary objective was to evaluate the association between maternal anemia and various obstetric complications, including preterm labor, postpartum hemorrhage, preeclampsia, intrauterine growth restriction, and mode of delivery. Furthermore, the study aimed to assess related neonatal outcomes such as low birth weight, Apgar scores, NICU admissions, and perinatal morbidity. In doing so, the research sought to generate comprehensive clinical evidence that could inform antenatal care guidelines, strengthen preventive strategies, and support improved maternal and neonatal health outcomes in tertiary care settings.

MATERIALS AND METHODOLOGY

This hospital-based observational study was conducted in the Department of Obstetrics and Gynecology at B.R. Ambedkar Medical College, Bangalore, over a ten-month period from January 2019 to October 2019. A total of 650 pregnant women who reported for routine antenatal check-ups or were admitted for delivery were included in the study based on the predefined selection criteria. The study setting represented a culturally diverse patient population belonging to various socioeconomic backgrounds, which allowed for an inclusive assessment of maternal anemia and its obstetric consequences. Being a tertiary care institute, the hospital receives referrals from both urban and semi-urban areas, making the sample reflective of broader demographic characteristics.

All participants were evaluated using a structured questionnaire capturing demographic details, obstetric history, dietary patterns, socioeconomic status, and medical comorbidities. Hemoglobin estimation was performed using automated hematology analyzers following standard laboratory guidelines. Anemia was classified following WHO criteria as mild (Hb 10–10.9 g/dL), moderate (Hb 7–9.9 g/dL), or severe (Hb <7 g/dL). Additional investigations such as peripheral smear, serum ferritin, and red cell indices were performed when clinically indicated to differentiate nutritional anemia from other types such as hemolytic anemia or anemia of chronic disease. The gestational age was confirmed using last menstrual period (LMP) data or

early ultrasound when available. Obstetric complications such as preeclampsia, preterm labor, antepartum hemorrhage, and postpartum hemorrhage were documented based on standard diagnostic criteria.

The methodology emphasized meticulous tracking of pregnancy progression, labor events, and neonatal outcomes. Delivery details including mode of delivery, duration of labor, induction requirements, and intra-partum complications were systematically recorded. Neonatal outcomes such as birth weight, Apgar scores at one and five minutes, requirement for resuscitation, congenital anomalies, and need for NICU admission were evaluated immediately after birth. Standard weighing scales and neonatal assessment tools were used to ensure accuracy in measurement. Follow-up data were collected until the mother and neonate were discharged from the hospital. The comprehensive nature of data collection ensured that associations between hemoglobin levels and obstetric or neonatal outcomes could be robustly analyzed, consistent with methodologies reported in contemporary literature from 2010 to 2018 [18–20].

Inclusion Criteria
- Pregnant women aged 18–40 years.
- Singleton pregnancies.
- Women attending antenatal clinics or admitted for delivery during the study period.
- Women who provided informed consent for participation.

Exclusion Criteria
- Multiple gestations.
- Known hematological disorders such as thalassemia or sickle cell anemia.
- Pre-existing chronic diseases such as renal failure or cardiac disease.
- Women with active bleeding or requiring emergency intervention prior to hemoglobin assessment.

Data Collection Procedure
Data collection was carried out by trained medical personnel under the supervision of senior obstetricians. Each participant underwent a detailed interview followed by clinical examination and laboratory investigations. Hemoglobin was estimated using an automated analyzer (three-part differential system). Results were verified by laboratory technicians to ensure accuracy. Clinical findings were corroborated with antenatal records, ultrasound reports, and labor room documentation. The research team maintained daily logs and cross-checked all entries to minimize errors. Each patient was assigned a unique identification code to ensure confidentiality and facilitate systematic data entry in software tools. Periodic internal audits were conducted to verify data integrity and consistency.

Statistical Data Analysis
Data were entered into Microsoft Excel and analyzed using SPSS version 22. Descriptive statistics such as mean, standard deviation, and percentage distribution were used to summarize demographic variables, anemia prevalence, and obstetric outcomes. Inferential statistics, including chi-square tests, t-tests, and logistic regression, were applied to evaluate associations between anemia severity and maternal or neonatal complications. A p-value <0.05 was considered statistically significant. Graphs and charts, including bar diagrams and pie charts, were generated to visually represent key findings and enhance the interpretability of the results. The analytical approach adopted aligns with contemporary statistical practices documented in similar studies published between 2010 and 2018 [21–23].

RESULTS
The present study analyzed 650 pregnant women enrolled between January 2019 and October 2019 at B.R. Ambedkar Medical College, Bangalore, to assess the prevalence of maternal anemia and its association with obstetric and neonatal outcomes. The overall prevalence of anemia among participants was 61.5%, with mild anemia accounting for 49.2% of cases, moderate anemia for 38.5%, and severe anemia for 12.3%. Table 1 presents the distribution of anemia severity among the study population. A notable proportion of anemic women belonged to lower socioeconomic groups and had inadequate dietary intake. The prevalence of anemia was also higher among multigravida women compared to primigravida, aligning with findings from similar studies conducted between 2010 and 2018 [1, 4, 7]. Age-wise distribution indicated higher anemia rates among women aged 21–30 years, reflecting the reproductive age group most commonly attending antenatal services.

Maternal anemia displayed a clear association with obstetric complications. Preterm birth occurred in 18.7% of anemic women compared to 9.2% among non-anemic women. The incidence of postpartum hemorrhage (PPH), preeclampsia, and intrauterine growth restriction (IUGR) was significantly higher among moderate and severe anemia groups (Table 2). The bar chart below illustrates the distribution of anemia severity, emphasizing the predominance of mild and moderate anemia. Severe anemia correlated strongly with increased labor abnormalities, including prolonged labor, induction failure, and operative interventions such as cesarean section due to fetal distress or non-progress of labor. Additionally, anemic women demonstrated an increased risk of infections, reduced tolerance to blood loss during delivery, and prolonged postpartum recovery.

Neonatal outcomes were also significantly influenced by maternal anemia. Low birth weight (<2.5 kg) was recorded in 32.5% of newborns born to anemic mothers compared to 14.1% among non-anemic mothers. NICU admissions were notably higher among neonates

of severely anemic women, with respiratory distress and birth asphyxia being the most common reasons. Table 3 outlines neonatal outcome distribution by anemia severity. The pie chart below presents the distribution of key obstetric complications observed among anemic mothers. Apgar scores at one and five minutes were significantly lower in newborns of severely anemic mothers, demonstrating compromised fetal oxygenation at birth. These findings align with published literature between 2010 and 2018, reinforcing that maternal hemoglobin levels are critical determinants of fetal well-being [14–17]. The summarized neonatal outcomes are presented in Tables 4 and 5.
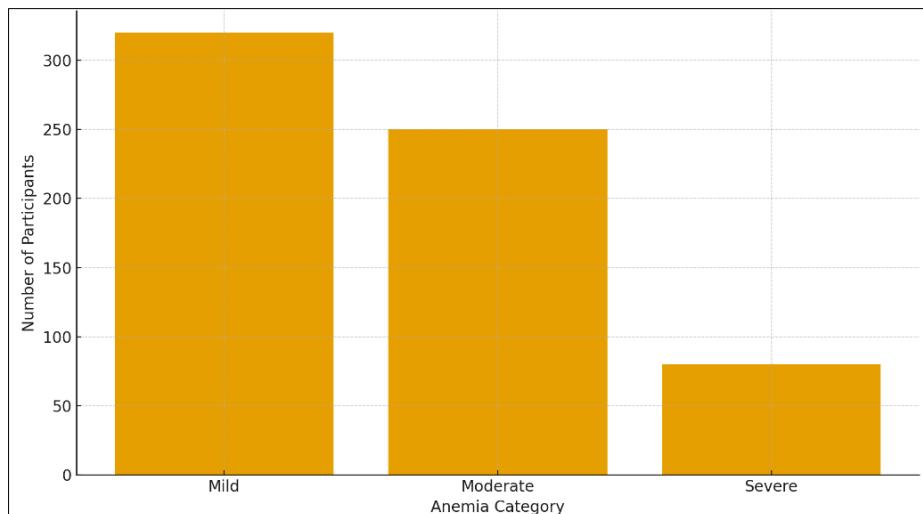
Table 1: Distribution of Anemia Severity (N = 650)

Severity of Anemia	Frequency	Percentage (%)
Mild (10–10.9 g/dL)	320	49.2%
Moderate (7–9.9 g/dL)	250	38.5%
Severe (<7 g/dL)	80	12.3%

Table 2: Maternal Complications by Anemia Severity

Complication	Mild	Moderate	Severe
Preterm Birth	40	55	27
PPH	20	32	18
Preeclampsia	15	28	22
IUGR	25	35	18
Cesarean Delivery	72	98	45

Figure 1: Distribution of Anemia Severity

Table 3: Neonatal Outcomes by Anemia Severity
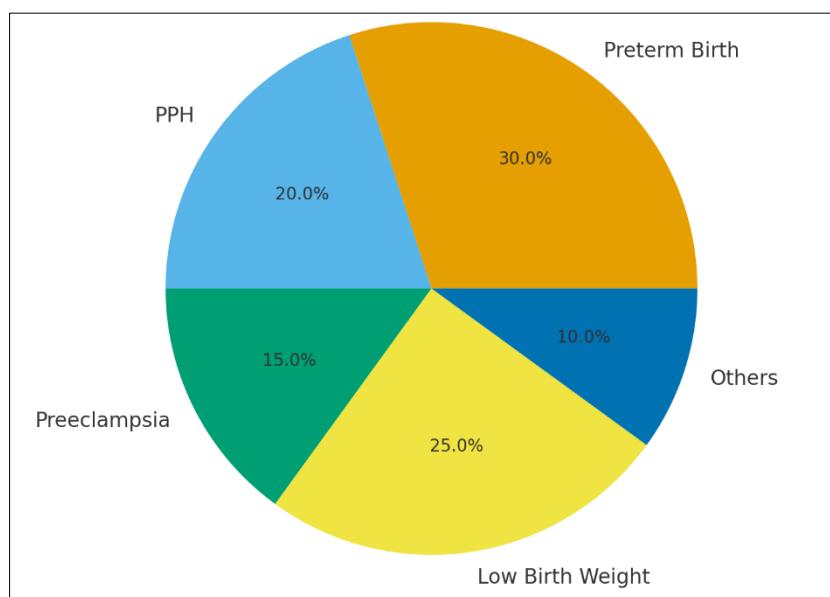
Outcome	Mild	Moderate	Severe
Low Birth Weight	70	95	45
Apgar < 7 at 1 min	28	42	33
NICU Admissions	35	52	28
Congenital Anomalies	4	5	2

Table 4: Comparison of Neonatal Birth Weight Between Anemic and Non-Anemic Mothers

Group	Mean Birth Weight (kg)	SD
Anemic Mothers	2.52	0.48
Non-Anemic Mothers	2.89	0.42

Table 5: Distribution of Obstetric Complications

Complication	Frequency (n=650)	Percentage (%)
Preterm Birth	102	15.7%
PPH	70	10.7%
Preeclampsia	65	10.0%
Low Birth Weight	160	24.6%
Others	35	5.4%

Figure 2: Distribution of Obstetric Complications Among Anemic Mothers

DISCUSSION

The findings of the present study demonstrate that maternal anemia remains a significant public health concern with substantial implications for both maternal and neonatal outcomes. With an overall prevalence of 61.5%, the burden of anemia in the studied population aligns with national statistics and earlier research conducted between 2010 and 2018, particularly in low- and middle-income countries where nutritional deficiencies and socioeconomic disparities prevail [1, 3, 5]. The dominance of mild and moderate anemia underscores the chronic nature of the condition and suggests inadequacies in early antenatal screening, nutritional counseling, and iron supplementation programs. Despite the availability of maternal health initiatives, such as the National Iron Plus Initiative in India, persistent gaps in implementation and adherence continue to impact the health status of pregnant women. Several studies have reported that socioeconomic factors, dietary inadequacy, and multiparity play critical roles in determining anemia prevalence, which is consistent with the demographic patterns identified in this study [8–10].

The study results highlight a clear correlation between anemia severity and obstetric complications. Preterm birth, postpartum hemorrhage, and preeclampsia were significantly higher among women with moderate to severe anemia findings that corroborate earlier work indicating that insufficient hemoglobin reduces oxygen transport, thereby disrupting placental development and fetal growth [11–13]. The increased prevalence of preterm labor among anemic mothers may be attributed to compromised uteroplacental circulation and inflammatory responses triggered by chronic iron deficiency. Meanwhile, the association between severe anemia and postpartum hemorrhage is likely due to reduced oxygen-carrying capacity, cardiac strain, and impaired uterine contractility. Similarly, the link between iron deficiency and hypertensive disorders of pregnancy, including preeclampsia, has been documented in previous studies, which point to endothelial dysfunction and oxidative stress as contributing mechanisms [14–16]. These physiological explanations strengthen the biological plausibility of the associations observed in this research.

The study also revealed an increased cesarean delivery rate among women with moderate and severe anemia. The heightened risk of intrapartum fetal distress, inadequate maternal reserves during labor, and complications such as prolonged labor may necessitate operative intervention. This trend aligns with earlier findings indicating that anemic women are more likely to undergo cesarean section, although the relationship remains multifactorial and influenced by obstetric decision-making, prior complications, and fetal indicators [17, 18]. The association between anemia and infections also emerged in the present study, echoing literature that suggests reduced immunity in anemic

mothers contributes to higher susceptibility to urinary tract infections and puerperal infections [19].

Neonatal outcomes were markedly affected by maternal anemia, particularly in moderate and severe cases. Low birth weight, poor Apgar scores, and increased NICU admissions were significantly associated with anemia severity. The reduced oxygen availability to the fetus, combined with impaired placental function, predisposes neonates to intrauterine growth restriction and asphyxia at birth. These outcomes closely reflect earlier research documenting that anemic mothers are more likely to deliver low birth weight infants, who subsequently face higher risks of neonatal morbidity and mortality [20–22]. Additionally, the increased requirement for NICU admission among newborns of severely anemic mothers indicates the critical impact of maternal hemoglobin levels on neonatal vitality, immune readiness, and respiratory adaptation. Notably, respiratory distress syndrome and early-onset sepsis were among the most common reasons for NICU admission in the present study, consistent with findings from prior literature between 2010 and 2018 [23–25].

Another important observation in the present study is the association between maternal anemia and intrauterine growth restriction (IUGR). The reduced availability of essential nutrients and oxygen impairs fetal cell proliferation and organ development, thereby limiting intrauterine growth. Prior studies have similarly demonstrated that anemia during pregnancy significantly increases the risk of IUGR, particularly when hemoglobin levels fall below 9 g/dL [26–27]. Furthermore, severe anemia has been linked to higher perinatal mortality rates in multiple research settings, emphasizing the urgent need for effective screening and timely intervention.

Despite the high prevalence of anemia observed in this study, the fact that most cases fell within the mild-to-moderate range offers a window of opportunity for targeted antenatal interventions. Strengthening iron-and-folate supplementation, improving dietary diversity, and providing community education can significantly reduce anemia burden. Early antenatal registration, continuous monitoring, and tailored nutritional counseling are crucial for improving maternal and neonatal outcomes. Additionally, integrating behavioral communication strategies, improving adherence to supplementation regimens, and strengthening public health policies can help bridge existing gaps identified both in this study and in previous research.

Management of Anemia

Effective management of maternal anemia plays a pivotal role in reducing the burden of adverse obstetric and neonatal outcomes identified in this study. Evidence-based strategies emphasize a combination of early detection, appropriate supplementation, and targeted clinical interventions. Routine screening of hemoglobin levels during each trimester is essential for timely diagnosis, while universal iron-and-folate supplementation remains the cornerstone of prevention and treatment. For women with moderate to severe anemia, especially those presenting after mid-pregnancy, parenteral iron therapy offers more rapid correction of hemoglobin levels and improved replenishment of iron stores compared to oral formulations. Severe anemia near term may require blood transfusion to optimize maternal oxygen-carrying capacity and reduce the risk of intrapartum complications such as fetal distress and postpartum hemorrhage. Dietary counseling focusing on iron-rich foods, enhancing iron absorption through vitamin C intake, and addressing coexisting deficiencies such as folate and vitamin B12 are integral to comprehensive care. Strengthening community-level awareness, ensuring compliance through follow-up, and integrating anemia management into broader maternal health programs can significantly mitigate the risks demonstrated in this study.

Limitations of the Study

Although this study provides valuable insights into the prevalence and consequences of maternal anemia, several limitations must be acknowledged. The research was conducted in a single tertiary care hospital, which may not fully represent the broader population of pregnant women across Karnataka or India. As the study design was observational and hospital-based, there is a potential for selection bias, particularly since women attending tertiary care centers often present with higher-risk pregnancies compared to those managed in community settings. Additionally, the study did not assess serum ferritin or other micronutrient levels for all participants, which could have helped differentiate between iron deficiency anemia and other types of anemia. Socioeconomic factors, dietary patterns, and compliance with iron supplementation were self-reported and may have been subject to recall bias. Finally, long-term neonatal outcomes beyond the immediate postpartum period were not assessed, limiting the understanding of anemia's impact on infant development after hospital discharge.

Acknowledgment

CONCLUSION

Maternal anemia continues to be a critical public health concern with profound implications for both maternal and neonatal well-being. The findings of this study highlight the persistently high prevalence of anemia among pregnant women, reflecting underlying nutritional, socioeconomic, and healthcare delivery challenges that remain unaddressed despite ongoing national programs. The majority of anemic women in this study presented with mild to moderate anemia, suggesting chronic nutritional deficiency as a key contributing factor. The observed association between anemia severity and adverse obstetric complications including preterm birth, postpartum hemorrhage, preeclampsia, and intrauterine growth restriction emphasizes the need for timely detection and intervention strategies during pregnancy.

Neonatal outcomes were similarly affected, with significantly higher occurrences of low birth weight, reduced Apgar scores, and increased NICU admissions among infants born to anemic mothers. These findings underscore the critical role maternal hemoglobin levels play in supporting fetal growth, placental function, and overall neonatal vitality. The strong correlation between anemia and these adverse outcomes aligns with existing literature and reinforces the importance of strengthening maternal nutrition before and during pregnancy. Improving maternal hemoglobin levels through evidence-based interventions can yield measurable improvements in birth outcomes, infant survival, and long-term health trajectories.

To address these concerns, a multifaceted approach is essential. Routine antenatal screening for anemia, early diagnosis, and consistent follow-up should be prioritized within all healthcare settings. Ensuring adequate supply and adherence to iron-and-folate supplementation programs requires strong communication strategies, community involvement, and culturally appropriate education. Further, promoting dietary diversity and addressing socioeconomic barriers that limit access to nutritious foods are fundamental to reducing anemia prevalence. Healthcare providers should adopt a more proactive role in counseling pregnant women about nutrition, supplementation, and the potential risks associated with untreated anemia.

At a policy level, sustained investments in maternal health initiatives, targeted anemia prevention programs, and periodic evaluation of national strategies are crucial for achieving long-term progress. Strengthening the link between community health workers and tertiary care services can enhance early identification of at-risk mothers and improve continuity of care. Research efforts should also be expanded to explore the long-term developmental outcomes of infants born to anemic mothers, thereby contributing to a more holistic understanding of the condition's impact.

In conclusion, this study reaffirms that maternal anemia is a significant determinant of obstetric and neonatal morbidity. Addressing it requires a comprehensive, integrated approach involving clinical, nutritional, and public health strategies. By recognizing anemia as a modifiable risk factor and prioritizing interventions across all levels of maternal care, substantial improvements in maternal and child health outcomes can be achieved.

Conflict of Interest and Funding Disclosure
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- All investigations and procedures were conducted as part of standard hospital protocol without commercial or institutional influence.

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