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A prospective study of pregnancy outcomes in women with third trimester anemia at a tertiary care hospital

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Abstract
Background: Anemia remains one of the most frequent medical conditions complicating pregnancy, particularly in low- and middle-income countries. Its severity has been consistently linked to adverse maternal and perinatal outcomes. This study aimed to evaluate the spectrum of clinical consequences associated with third-trimester anemia.
Methods: A prospective observational study was conducted for a duration of 12 months in the Department of Obstetrics and Gynecology at a tertiary care teaching hospital. Pregnant women between 28–42 weeks were grouped into WHO anemia grades according to hemoglobin levels into severe anemia (<7 g/dL), mild–moderate anemia (7–10.9 g/dL), and controls (>11 g/dL). Maternal characteristics, antenatal care status, obstetric complications, and fetal outcomes were recorded. Statistical significance was assessed using chi-square tests, with p-value < 0.05 considered significant.
Results: Out of 319 eligible women, 79 (24.8%) had severe anemia, 90 (28.2%) had mild–moderate anemia, and 150 (47%) had normal hemoglobin. Severe anemia was strongly associated with a lack of antenatal care (84.8%). Adverse maternal outcomes increased significantly with anemia severity, including pre-eclampsia (15.2%), postpartum hemorrhage (22.1%), puerperal sepsis (15.2%), wound gaping (11.7%), and ICU admission (19%). Neonatal complications were also markedly higher among severely anemic mothers, particularly preterm birth (44.6%), low birth weight (63.1%), low APGAR scores, and increased NICU admission. No maternal deaths occurred.
Conclusion: Third-trimester anemia, especially in its severe form, is associated with substantial maternal morbidity and neonatal compromise. The findings underscore the critical importance of early antenatal registration, routine hemoglobin screening, and aggressive nutritional and clinical interventions to reduce the burden of anemia-related complications.

Keywords: Anemia in pregnancy, severe anemia, maternal outcomes, neonatal outcomes, third trimester, preterm birth

Introduction

Anemia continues to be one of the most significant public health challenges affecting pregnant women globally, with the burden disproportionately higher in low-resource settings. The World Health Organization defines anemia in pregnancy as a hemoglobin concentration below 11 g/dL and categorizes it into mild, moderate, or severe grades [1]. Despite being preventable and treatable, anemia remains a leading contributor to maternal morbidity, perinatal complications, and impaired neonatal survival [2].

In India, where nutritional anemia particularly iron deficiency anemia predominates, its impact extends beyond maternal fatigue and reduced work capacity & reflects a combination of inadequate dietary intake, recurrent infections, closely spaced pregnancies, and limited access to antenatal care. Severe anemia not only compromises maternal cardiac output but also increases obstetric hemorrhage risk and reduces immune resilience [3]. Chronic maternal anemia also results in reduced placental oxygen delivery, contributing to preterm birth, intrauterine growth restriction, and increased perinatal mortality [4].

Several studies have examined this association, results vary across populations due to differences in socioeconomic status, nutritional practices, and antenatal healthcare utilization [5, 6]. However, the burden of anemia and its consequences may differ across healthcare settings based on population characteristics, nutritional practices, and access to antenatal services. Given this variability, this study was undertaken to evaluate the consequences of third-trimester anemia in a tertiary care teaching hospital in Indian population and to compare outcomes across

different hemoglobin categories.

Aims and Objectives

1. To assess the prevalence of anemia in third-trimester pregnant women.
2. To evaluate the maternal outcomes in relation to the severity of anemia.
3. To analyze fetal and neonatal outcomes associated with third-trimester anemia.
4. To compare maternal and neonatal outcomes between normal, mildly–moderately anemic, and severely anemic groups.

Materials and Methods

A prospective observational study was conducted in the Department of Obstetrics and Gynaecology of a tertiary care teaching hospital for a duration of 12 months. Pregnant women between 28 and 42 weeks of gestation were included. Hemoglobin estimation was performed at the time of admission using an automated analyzer, and participants were categorized into three groups based on WHO criteria: severe anemia (<7 g/dL), mild–moderate anemia (7–10.9 g/dL), and non-anemic controls (>11 g/dL).

Detailed Exclusion Criteria: Women were excluded if they had:

- Antepartum hemorrhage (placenta previa or abruptio placentae)
- Multiple gestation
- Previous history of preterm delivery or other major obstetric complications
- Medical disorders other than anemia (e.g., diabetes, hypertension, tuberculosis, coagulation disorders)
- Grand multiparity (≥5 gravida)
- Hepatosplenomegaly suggestive of chronic malaria
- Known hemoglobinopathies, hemolytic anemia, or bleeding/clotting disorders

Sample Size and Recruitment

A total of 169 anemic pregnant women who met the inclusion criteria were recruited out of which 79 were found to have severe anemia & 90 women had mild to moderate anemia. They were compared with 150 non-anemic pregnant women which served as controls.

Each participant underwent a detailed clinical evaluation including history taking, physical examination, obstetric assessment, and laboratory investigations. Mothers were monitored during the antenatal, intrapartum, and postpartum periods to identify and document complications. Maternal and fetal outcomes were recorded systematically.

Baseline Parameters

The following variables were collected:

- Maternal age
- Parity
- Booking status
- A booked case was defined as ≥3 antenatal visits after registration, intake of at least 100 iron and calcium tablets during the second trimester, two doses of tetanus toxoid, and current third-trimester status
- Gestational age at admission and delivery
- Relevant medical, surgical, family, and personal history
- General and systemic examination findings
- Obstetric findings and development of any new symptoms or complications
- Mode of delivery
- Maternal outcomes including:
- Pre-eclampsia and eclampsia
- Preterm labor
- Postpartum hemorrhage
- Wound gaping
- Puerperal sepsis
- Cardiac failure
- Blood transfusion requirement
- ICU admission
- Maternal mortality
- Fetal outcomes including:
- Preterm birth
- Low birth weight (<2.5 kg)
- APGAR scores
- NICU admission
- Perinatal mortality (stillbirth + early neonatal death)

Investigations

- Complete blood count
- Peripheral blood smear (Leishman stain)
- Blood group and Rh typing
- Routine urine examination
- Additional tests (RBS, PT/INR, VDRL, HBsAg, HIV) as indicated
- Obstetric ultrasonography

Statistical Analysis: Data were analyzed using SPSS 15.0 and JMP 10 of SAS 9.3.

- Chi-square test was used for comparison of categorical variables.
- A p-value <0.05 was considered statistically significant.
- Odds ratios (OR) with 95% confidence intervals (CI) were calculated.
- OR >1 suggested a positive association.
- If the CI did not include 1, the association was considered statistically significant.

Results

A total of 319 pregnant women between 28 and 42 weeks of gestation were included and categorized into three groups based on hemoglobin concentration at admission: normal hemoglobin, mild–moderate anemia, and severe anemia. Among them, 150 women (47%) had normal hemoglobin levels, 90 (28.2%) had mild–moderate anemia, and 79 (24.8%) were diagnosed with severe anemia. Baseline characteristics, maternal morbidities, and fetal outcomes varied substantially according to anemia severity.

Maternal Demographic Characteristics

Age: Maternal age increased progressively with anemia severity. The mean age in the normal hemoglobin group was 22.98 ± 3.88 years, compared with 24.08 ± 4.45 years among women with mild–moderate anemia and 25.38 ± 5.18 years in the severe anemia group. This trend suggests that older mothers in this cohort were more likely to present late in pregnancy with significantly reduced hemoglobin levels. Although age itself is not a direct cause of anemia, increasing age may correlate with cumulative nutritional deficiencies, multiparity, or delays in seeking antenatal care, all of which may contribute to worsening anemia status.

Antenatal Registration Status: Antenatal care utilization differed sharply across the three categories. Women with severe anemia demonstrated the poorest engagement with antenatal services, with 84.8% being un-booked at the time of admission. In contrast, a significantly higher proportion of women in the normal hemoglobin group had undergone regular antenatal checkups. This finding highlights a strong association between lack of antenatal care and anemia severity, emphasizing that women who do not receive early screening and supplementation are at far greater risk of progressing to severe anemia.

Gravidity: In the severe anemia cohort, 41.8% were primigravida and 58.2% were multigravida, indicating that anemia was not confined to either parity group. The representation of both first-time mothers and multiparous women suggests that a wide spectrum of pregnant individuals remains vulnerable, possibly due to nutritional deficiencies, short interpregnancy intervals, or limited access to health services.

Maternal Morbidity and Obstetric Outcomes

Increasing anemia severity was associated with higher maternal complications.

Hypertensive Disorders: Pre-eclampsia occurred in 12/79 (15.2%) of severely anemic women, 8/90 (8.9%) in the mild–moderate group, and 6/150 (4.0%) in the normal group (χ^2 = 8.75, p = 0.0126). Eclampsia remained rare and did not differ significantly: 2/79 (2.5%) in severe, 1/90 (1.1%) in mild–moderate, and 1/150 (0.7%) in normal groups (χ^2 = 1.47, p = 0.4785). Reduced oxygen-carrying capacity and endothelial dysfunction may contribute to higher pre-eclampsia rates in severely anemic women.

Postpartum Hemorrhage (PPH): PPH was more frequent in severe anemia, affecting 17/79 (22.1%) of women, compared to 10/90 (11.1%) in mild–moderate and 7/150 (4.7%) in normal groups (χ^2 = 15.46, p = 0.00044). Poor uterine contractility, impaired oxygen delivery, and reduced physiological reserve likely increased susceptibility to PPH.

Infections and Wound Complications: Puerperal sepsis was noted in 12/79 (15.2%) of severely anemic women, 4/90 (4.4%) in mild–moderate, and 2/150 (1.3%) in normal groups (χ^2 = 19.00, p = 0.000075). Wound gaping occurred in 9/79 (11.7%), 3/90 (3.3%), and 1/150 (0.7%), respectively (χ^2 = 15.40, p = 0.00045), reflecting impaired tissue healing and immune compromise.

ICU Admission and Maternal Mortality: ICU admissions were significantly higher in the severe group (15/79; 19.0%), compared to mild–moderate (4/90; 4.4%) and normal (2/150; 1.3%) groups (χ^2 = 27.16, p = 0.00000127). No maternal deaths occurred in any group.

Table 1: Maternal Morbidity and Obstetric Complications

Complication	Normal (n=150)	Mild - Moderate (n=90)	Severe (n=79)	χ^2 value	p-value
Pre-eclampsia	6 (4.0%)	8 (8.9%)	12 (15.2%)	8.75	0.0126
Eclampsia	1 (0.7%)	1 (1.1%)	2 (2.5%)	1.47	0.4785
Postpartum Hemorrhage (PPH)	7 (4.7%)	10 (11.1%)	17 (22.1%)	15.46	0.00044
Puerperal Sepsis	2 (1.3%)	4 (4.4%)	12 (15.2%)	19.00	0.000075
Wound Gaping	1 (0.7%)	3 (3.3%)	9 (11.7%)	15.40	0.00045
ICU Admission	2 (1.3%)	4 (4.4%)	15 (19.0%)	27.16	0.00000127
Maternal Mortality	0	0	0	—	—

Footnotes

1. Pearson's Chi-square test used.
2. $p < 0.05$ considered statistically significant.
3. PPH: Postpartum hemorrhage; ICU: Intensive Care Unit.
4. Maternal mortality not analyzed statistically due to zero frequency.

Fetal and Neonatal Outcomes: Maternal anemia severity significantly affected fetal and neonatal outcomes.

Preterm Birth: Preterm deliveries (<37 weeks) were observed in 35/79 (44.3%) of severely anemic women, 14/90 (15.6%) in mild–moderate, and 16/150 (10.7%) in normal groups (χ^2 = 37.88, p = 5.94×10^{-9}).

Low Birth Weight (LBW): LBW (<2.5 kg) occurred in 50/79 (63.3%) of neonates born to severely anemic mothers, 25/90 (27.8%) in mild–moderate, and 23/150 (15.3%) in normal groups (χ^2 = 56.43, p = 5.57×10^{-13}).

APGAR Scores: Neonates with APGAR <7 at 1 minute were 21/79 (26.6%) in severe, 10/90 (11.1%) in mild–moderate, and 8/150 (5.3%) in normal groups (χ^2 = 21.92, p = 1.74×10^{-5}). At 5 minutes, low APGAR was noted in 14/79 (17.7%), 6/90 (6.7%), and 3/150 (2.0%), respectively (χ^2 = 19.17, p = 6.86×10^{-5}).

NICU Admission: NICU admissions were highest among neonates of severely anemic mothers (34/79; 43.0%), compared to 18/90 (20.0%) in mild–moderate and 12/150 (8.0%) in normal groups (χ^2 = 39.61, p = 2.50×10^{-9}).

Table 2: Fetal and Neonatal Outcomes

Outcome	Normal (n=150)	Mild - Moderate (n=90)	Severe (n=79)	χ^2 value	p-value
Preterm Birth (<37 weeks)	16 (10.7%)	14 (15.6%)	35 (44.3%)	37.88	5.94×10^{-9}
Low Birth Weight (<2.5 kg)	23 (15.3%)	25 (27.8%)	50 (63.3%)	56.43	5.57×10^{-13}
APGAR <7 at 1 minute	8 (5.3%)	10 (11.1%)	21 (26.6%)	21.92	1.74×10^{-5}
APGAR <7 at 5 minutes	3 (2.0%)	6 (6.7%)	14 (17.7%)	19.17	6.86×10^{-5}
NICU Admission	12 (8.0%)	18 (20.0%)	34 (43.0%)	39.61	2.50×10^{-9}

Footnotes

5. Pearson's Chi-square test applied.
6. LBW: Low birth weight; NICU: Neonatal Intensive Care Unit.
7. Very small p-values indicate strong statistical significance.

Discussion

Anemia in pregnancy remains a significant global health challenge, particularly in low- and middle-income countries, where its prevalence continues to be high despite ongoing public health interventions [1-3]. The present study demonstrates a clear association between the severity of maternal anemia and adverse maternal and neonatal outcomes, highlighting the multidimensional impact of this condition on maternal physiology, obstetric complications, and neonatal well-being. By examining 319 third-trimester pregnant women, we were able to explore the relationship between hemoglobin levels at the time of delivery and a wide spectrum of clinical outcomes.

Maternal Demographic Characteristics and Antenatal Care:

Our analysis showed that maternal age increased progressively with anemia severity, with mean ages of 22.98 ± 3.88 years, 24.08 ± 4.45 years, and 25.38 ± 5.18 years in normal, mild–moderate, and severe anemia groups, respectively. This trend may reflect cumulative nutritional deficiencies, repeated pregnancies without adequate recovery, and delayed engagement with antenatal services. While age itself is not a direct causative factor, it serves as a proxy for other social and physiological determinants of anemia, including multiparity, prolonged interpregnancy intervals, and possible chronic dietary inadequacies [6].

Antenatal registration emerged as a crucial determinant of anemia severity. In the severe anemia cohort, 84.8% of women were un-booked at the time of admission, compared to a substantially higher proportion of registered women in the normal hemoglobin group. This finding underscores the critical role of early and consistent antenatal care in the prevention, early detection, and management of anemia. WHO emphasizes that regular antenatal visits facilitate timely hemoglobin assessment, dietary counselling, and iron and folic acid supplementation [1]. Multiple studies corroborate these observations, indicating that lack of antenatal engagement is a major risk factor for severe anemia [2, 3]. The data from our cohort suggest that missed opportunities for early intervention contribute significantly to the progression from mild anemia to severe anemia, with consequent maternal and fetal complications.

Gravidity patterns further illustrate the vulnerability of both primigravida and multiparous women. In the severe anemia group, 41.8% were primigravida and 58.2% were multiparous, indicating that anemia is not confined to any particular parity group. This distribution suggests that factors such as inadequate spacing between pregnancies, cumulative nutritional deficits, and limited access to healthcare services may place both first-time and experienced mothers at risk. These findings align with prior research indicating that maternal anemia is influenced by both biological and socio-economic factors [5, 6].

Maternal Morbidity and Obstetric Complications

The study found a clear gradient of maternal complications with increasing anemia severity. Pre-eclampsia was significantly more common in severely anemic women (15.2%) compared to mild–moderate (8.9%) and normal hemoglobin groups (4.0%) ($\chi^2 = 8.75$, $p = 0.0126$). Eclampsia remained rare and did not demonstrate a significant association with anemia severity ($\chi^2 = 1.47$, $p = 0.4785$). The pathophysiology underlying the increased risk of hypertensive disorders in anemic women may involve reduced oxygen-carrying capacity, placental hypoxia, and endothelial dysfunction, which together predispose to abnormal placentation and systemic vascular resistance. Iron deficiency has also been linked to altered nitric oxide metabolism and oxidative stress, further contributing to the risk of hypertensive disorders [6].

Postpartum hemorrhage (PPH) was observed in 22.1% of severely anemic women, significantly higher than in mild–moderate (11.1%) and normal hemoglobin (4.7%) groups ($\chi^2 = 15.46$, $p = 0.00044$). Severe anemia compromises uterine contractility, reduces cardiac reserve, and impairs the physiological response to blood loss, making affected women particularly susceptible to hemorrhage during and after delivery. These results are consistent with Kalaivani's study, which reported increased risk of intrapartum and postpartum hemorrhage in women with severe anemia [6].

Infectious complications were also more prevalent among severely anemic mothers. Puerperal sepsis occurred in 15.2% of the severe group, compared with 4.4% and 1.3% in mild–moderate and normal hemoglobin groups, respectively ($\chi^2 = 19.00$, $p = 0.000075$). Wound gaping was observed in 11.7% of severely anemic women, versus 3.3% and 0.7% in the other groups ($\chi^2 = 15.40$, $p = 0.00045$). Iron deficiency adversely affects both innate and adaptive immunity, reducing neutrophil function, impairing T-cell proliferation, and limiting antibody responses [12]. Consequently, tissue repair is delayed, and susceptibility to infection increases, particularly in the postpartum period. These findings highlight the broader immunological consequences of anemia, which extend beyond oxygen transport to encompass systemic vulnerability to infectious complications.

ICU admissions were significantly more frequent in the severe anemia group (19%) compared to mild–moderate (4.4%) and normal hemoglobin (1.3%) groups ($\chi^2 = 27.16$, $p = 0.00000127$). Although no maternal deaths occurred in this study, the high ICU admission rate reflects the reduced physiological reserve of severely anemic women, who may be unable to tolerate hemorrhage, infection, or hypertensive crises without intensive monitoring. Bergmann *et al*. similarly reported that severe iron deficiency at the time of delivery is associated with peripartum hemodynamic instability [14]. The absence of maternal mortality in this cohort is likely attributable to timely, tertiary-level obstetric care, including transfusions and multidisciplinary management.

Fetal and Neonatal Outcomes

The consequences of maternal anemia extended significantly to fetal and neonatal outcomes. Preterm birth (<37 weeks) was observed in 44.3% of severely anemic women, compared to 15.6% and 10.7% in mild–moderate and normal groups, respectively ($\chi^2 = 37.88$, $p = 5.94 \times 10^{-9}$). Low birth weight (<2.5 kg) occurred in 63.3% of neonates born to severely anemic mothers, versus 27.8% and 15.3% in the other groups ($\chi^2 = 56.43$, $p = 5.57 \times 10^{-13}$). Low APGAR scores at 1 minute and 5 minutes were significantly higher in severe anemia (26.6% and 17.7%, respectively), and NICU admissions were elevated (43%) compared to mild–moderate and normal groups.

The underlying mechanisms for these adverse outcomes likely involve chronic fetal hypoxia, impaired placental function, and inadequate transplacental nutrient transfer. Low maternal hemoglobin reduces oxygen delivery to the developing fetus, which can restrict fetal growth and increase the risk of intrauterine growth restriction (IUGR) and perinatal distress [8-

[10]. Rahman *et al*. demonstrated that maternal anemia is a strong predictor of preterm birth and low birth weight, particularly in low-resource settings where nutritional deficits and delayed antenatal care are common [10]. Steer also reported that low maternal hemoglobin correlates with reduced fetal growth and neonatal weight [8].

The elevated NICU admissions observed in our study further reflect the combined burden of prematurity, low birth weight, and perinatal complications. Neonates born to severely anemic mothers often require respiratory support, thermal regulation, and close monitoring for metabolic disturbances or sepsis. These findings emphasize the intergenerational impact of maternal anemia, highlighting how maternal health directly influences neonatal survival and long-term developmental outcomes [4, 7].

Clinical and Public Health Implications

The present study underscores the importance of early detection and treatment of anemia in pregnancy. Preventive strategies should include timely antenatal registration, routine hemoglobin screening, dietary counseling, and compliance with iron and folic acid supplementation programs [1-3, 9]. Addressing socio-cultural barriers to care and ensuring access to affordable supplementation are critical, particularly in low- and middle-income countries where anemia prevalence remains high.

Despite the absence of maternal mortality in our cohort, the high rates of severe morbidity highlight the potential risks in settings lacking tertiary-level care. The study reinforces the need for health system strengthening, including blood transfusion services, intensive monitoring, and multidisciplinary management, to mitigate the adverse effects of severe anemia [13]. The findings also suggest that targeted interventions for older, multiparous, or un-booked women may be particularly effective in reducing severe anemia prevalence.

Comparison with Previous Studies

Our results align with multiple prior reports. Levy *et al*. found that maternal anemia independently increases the risk of low birth weight and preterm delivery [11]. Kumar *et al*. observed significantly reduced neonatal weights among mothers with moderate to severe anemia [4]. These consistent findings reinforce the validity of our results and emphasize that third-trimester anemia has both immediate obstetric consequences and long-term implications for child health.

Overall, the findings highlight that anemia in pregnancy is not merely a hematological disorder but a multisystem condition with profound maternal and neonatal consequences. It exacerbates obstetric complications, compromises maternal immunity, and adversely affects fetal growth and neonatal adaptation. Interventions addressing nutritional deficiencies, early antenatal care, and timely medical management can substantially reduce the burden of morbidity associated with maternal anemia.

Conclusion

This study demonstrates a clear, graded association between maternal anemia severity and adverse maternal and neonatal outcomes. Severe anemia was strongly linked with older maternal age, lack of antenatal care, higher rates of pre-eclampsia, postpartum hemorrhage, puerperal sepsis, wound complications, and ICU admissions. Neonates of severely anemic mothers faced substantially higher risks of preterm birth, low birth weight, poor APGAR scores, and NICU admission. Although no maternal deaths occurred, the marked morbidity emphasizes the urgent need for early antenatal booking, routine hemoglobin monitoring, and timely nutritional and medical interventions. Strengthening antenatal services, promoting compliance with iron supplementation, and addressing socio-cultural barriers to care can significantly reduce the burden of anemia-related complications, improving outcomes for both mothers and their infants.

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