

Original Research Article

IMPACT OF MATERNAL ANEMIA ON BIRTH OUTCOMES A HOSPITAL-BASED STUDY

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Received : 09/09/2024
Received in revised form : 08/11/2024
Accepted : 23/11/2024

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DOI: 10.70034/ijmedph.2024.4.262

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2024; 14 (4); 1442-1448

ABSTRACT

Background: Maternal anemia is a significant public health issue, particularly in developing countries, where it contributes to increased maternal and perinatal morbidity. Anemia during pregnancy, commonly caused by iron deficiency, folate deficiency, or chronic diseases, is associated with an increased risk of preterm birth, low birth weight, intrauterine growth restriction, and neonatal complications. Despite ongoing prevention and management efforts, maternal anemia remains a major risk factor for adverse pregnancy outcomes. This study aims to assess the association between maternal anemia and birth outcomes, providing insights into the extent of adverse effects and the need for targeted interventions. **Objectives:** The primary objective of this study is to evaluate the impact of maternal anemia on birth outcomes, including gestational age at delivery, neonatal birth weight, Apgar scores, neonatal intensive care unit admissions, and perinatal complications. Additionally, the study aims to determine whether anemia severity correlates with worsening neonatal outcomes, emphasizing the importance of early detection and management.

Materials and Methods: This hospital-based observational study was conducted in the Department of Obstetrics and Gynaecology, GMC Srinagar, from August 2018 to January 2020. A total of 100 pregnant women diagnosed with anemia, defined as hemoglobin levels below 11 g/dL, were enrolled and classified into mild, moderate, and severe anemia groups based on WHO criteria. A control group of 100 non-anemic pregnant women was included for comparison. Maternal demographics, hemoglobin levels, and obstetric history were recorded. Pregnancy outcomes, including gestational age at delivery, birth weight, Apgar scores at 1 and 5 minutes, neonatal intensive care unit admissions, and perinatal complications, were assessed. Statistical comparisons were performed using chi-square tests for categorical variables and t-tests for continuous variables, with significance set at $p < 0.05$.

Results: Maternal anemia was significantly associated with adverse birth outcomes. The incidence of preterm birth was notably higher in anemic mothers compared to non-anemic mothers. Low birth weight was more prevalent among neonates born to anemic mothers, with the risk increasing with anemia severity. Apgar scores at 1 and 5 minutes were lower in the anemic group, with a higher likelihood of neonatal intensive care unit admissions. Neonatal complications, including respiratory distress and neonatal anemia, were significantly elevated in anemic pregnancies. The risk of intrauterine growth restriction and perinatal mortality was also increased in cases of severe maternal anemia. The findings indicate a strong correlation between maternal hemoglobin levels and neonatal well-being, reinforcing the need for early screening, nutritional interventions, and adequate antenatal care to mitigate the risks associated with maternal anemia.

Conclusion: This study highlights the detrimental impact of maternal anemia on birth outcomes, emphasizing the need for routine antenatal screening, early correction of anemia through iron supplementation, dietary modifications, and timely medical interventions. Strengthening maternal health programs and ensuring access to preventive measures can significantly reduce the burden of anemia-related perinatal complications. Future research should focus on longitudinal studies evaluating the long-term effects of maternal anemia on child growth and development to further establish preventive and management strategies.

Keywords: Maternal anemia, birth outcomes, preterm birth, low birth weight, neonatal complications, intrauterine growth restriction, pregnancy.

INTRODUCTION

Maternal anemia is one of the most prevalent global health concerns affecting pregnant women, particularly in developing countries, where it significantly contributes to maternal and perinatal morbidity. Defined by the World Health Organization as hemoglobin levels below 11 g/dL during pregnancy, anemia is most commonly caused by iron deficiency, although other factors such as folate and vitamin B12 deficiencies, chronic infections, hemoglobinopathies, and inflammation can also contribute to its development.^[1] The physiological changes in pregnancy, including expanded plasma volume, further exacerbate anemia, increasing the risk of maternal complications such as fatigue, reduced work capacity, and increased susceptibility to infections. In severe cases, maternal anemia has been linked to an increased risk of postpartum hemorrhage, maternal mortality, and poor fetal outcomes.^[2]

Anemia during pregnancy has profound implications for fetal development, as it can lead to reduced oxygen transport to the placenta, impairing fetal growth and increasing the risk of intrauterine growth restriction, preterm birth, and low birth weight.^[3] Several studies have reported a direct correlation between maternal hemoglobin levels and neonatal outcomes, with severe maternal anemia being associated with higher rates of neonatal intensive care unit admissions, lower Apgar scores, and an increased likelihood of neonatal anemia. The pathophysiological mechanisms underlying these outcomes include chronic hypoxia, placental insufficiency, and altered fetal metabolism due to iron deficiency. Additionally, maternal iron deficiency anemia has been linked to long-term neurodevelopmental deficits in offspring, making it a critical public health concern.^[4]

Despite widespread antenatal screening and iron supplementation programs, anemia remains a major challenge in pregnancy management. Socioeconomic factors, dietary habits, lack of prenatal care, and coexisting medical conditions contribute to its persistence. While iron and folic acid supplementation are routinely recommended during pregnancy, adherence to supplementation protocols remains inconsistent, often leading to

suboptimal outcomes.^[5] Moreover, the severity of anemia at the time of diagnosis plays a crucial role in determining fetal and neonatal complications, necessitating timely intervention to minimize adverse effects.

This hospital-based study was conducted in the Department of Obstetrics and Gynaecology, GMC Srinagar, from August 2018 to January 2020, to evaluate the impact of maternal anemia on birth outcomes. The study aims to assess whether the severity of maternal anemia influences gestational age at delivery, neonatal birth weight, Apgar scores, and the incidence of neonatal complications. By comparing anemic pregnant women to non-anemic controls, this research seeks to provide insights into the extent of anemia-related adverse outcomes and reinforce the need for effective antenatal interventions. Understanding these associations will help strengthen maternal health programs and improve strategies for the prevention and management of anemia during pregnancy.

MATERIALS AND METHODS

This hospital-based observational study was conducted in the Department of Obstetrics and Gynaecology, GMC Srinagar, over a period of 18 months, from August 2018 to January 2020. The study aimed to evaluate the impact of maternal anemia on birth outcomes by comparing anemic pregnant women with non-anemic controls. Pregnant women attending the antenatal clinic and labor ward during the study period were screened for anemia, and those meeting the inclusion criteria were enrolled after obtaining informed consent.

A total of 100 anemic pregnant women with hemoglobin levels below 11 g/dL, as defined by the World Health Organization criteria, were included in the study. They were further classified into mild anemia (10.0–10.9 g/dL), moderate anemia (7.0–9.9 g/dL), and severe anemia (<7.0 g/dL) based on hemoglobin levels measured during the third trimester. A control group of 100 non-anemic pregnant women with hemoglobin levels ≥ 11 g/dL was also included for comparison. Women with multiple pregnancies, known hemoglobinopathies, chronic medical conditions such as diabetes or hypertension, or any pregnancy complications

unrelated to anemia were excluded to minimize confounding factors.

Detailed maternal demographic data, including age, parity, socioeconomic status, dietary intake, and antenatal care history, were recorded using a structured proforma. Hemoglobin levels were assessed using an automated hematology analyzer. Other hematological parameters, including mean corpuscular volume, serum ferritin, and serum iron levels, were documented where available to assess the type and severity of anemia. Pregnancy outcomes were closely monitored, and birth outcomes were recorded at the time of delivery. Neonatal parameters, including gestational age at birth, birth weight, Apgar scores at 1 and 5 minutes, need for neonatal intensive care unit admission, and the occurrence of perinatal complications such as intrauterine growth restriction, neonatal anemia, and respiratory distress, were documented.

Statistical analysis was performed using IBM SPSS Statistics version 25.0. Continuous variables, such as hemoglobin levels, birth weight, and gestational age, were expressed as mean \pm standard deviation and compared using independent t-tests. Categorical variables, such as the incidence of preterm birth and neonatal complications, were analyzed using the chi-square test. A p-value of <0.05 was considered statistically significant. Subgroup analysis was conducted to determine whether the severity of anemia had a graded impact on birth outcomes.

Ethical approval for the study was obtained from the Institutional Ethics Committee of GMC Srinagar. All participants provided informed consent before enrollment, and confidentiality of patient data was maintained throughout the study. The findings from this research are expected to contribute to improving antenatal screening strategies and reinforcing the importance of early intervention in managing maternal anemia to optimize neonatal health outcomes.

RESULTS

This study included 100 anemic pregnant women and 100 non-anemic pregnant women as controls, assessing the impact of maternal anemia on birth outcomes. The results demonstrated a significant association between maternal anemia and adverse neonatal outcomes, including preterm birth, low birth weight, lower Apgar scores, and increased neonatal intensive care unit (NICU) admissions. The findings also revealed a graded effect, where increasing anemia severity correlated with worsening birth outcomes.

Baseline Characteristics of Study Participants

The demographic and clinical characteristics of the study participants were analyzed to ensure comparability between groups.

Table 1: Baseline Maternal Characteristics

Variable	Anemic Group (n=100)	Non-Anemic Group (n=100)	p-value
Mean Age (years)	26.2 \pm 4.3	25.9 \pm 4.1	0.62
Primigravida (%)	48 (48.0%)	46 (46.0%)	0.78
Multigravida (%)	52 (52.0%)	54 (54.0%)	0.79
Mean Hemoglobin (g/dL)	9.1 \pm 1.5	12.4 \pm 0.9	<0.001
Mild Anemia (%)	42 (42.0%)	—	—
Moderate Anemia (%)	44 (44.0%)	—	—
Severe Anemia (%)	14 (14.0%)	—	—

Gestational Age and Incidence of Preterm Birth

A significant association was observed between maternal anemia and lower gestational age at delivery. The incidence of preterm birth (<37 weeks gestation) was markedly higher in anemic mothers compared to the non-anemic group.

Table 2: Gestational Age at Delivery and Preterm Birth Rates

Gestational Age (weeks)	Anemic Group (n=100)	Non-Anemic Group (n=100)	p-value
<34 weeks (%)	18 (18.0%)	5 (5.0%)	0.002
34–37 weeks (%)	26 (26.0%)	12 (12.0%)	0.01
>37 weeks (%)	56 (56.0%)	83 (83.0%)	<0.001
Mean Gestational Age (weeks)	36.1 \pm 2.3	38.2 \pm 1.6	<0.001

Preterm birth was significantly more common in the anemic group, with 44% delivering before 37 weeks compared to 17% in the non-anemic group. The mean gestational age at delivery was significantly lower in anemic mothers.

Birth Weight and Incidence of Low Birth Weight

Maternal anemia was strongly associated with **low birth weight**, with neonates born to anemic mothers having a significantly lower mean birth weight.

Table 3: Neonatal Birth Weight and Low Birth Weight Incidence

Birth Weight (kg)	Anemic Group (n=100)	Non-Anemic Group (n=100)	p-value
<2.5 kg (%)	41 (41.0%)	18 (18.0%)	<0.001
2.5–3.0 kg (%)	45 (45.0%)	58 (58.0%)	0.03

>3.0 kg (%)	14 (14.0%)	24 (24.0%)	0.04
Mean Birth Weight (kg)	2.48 ± 0.41	2.87 ± 0.46	<0.001

Low birth weight was observed in **41% of neonates in the anemic group compared to 18% in the non-anemic group**. The mean birth weight was significantly lower in neonates of anemic mothers.

Apgar Scores and Neonatal Distress

Neonates born to anemic mothers had **significantly lower Apgar scores at 1 and 5 minutes**, indicating a higher risk of birth asphyxia and neonatal distress.

Table 4: Apgar Scores at 1 and 5 Minutes

Apgar Score	Anemic Group (n=100)	Non-Anemic Group (n=100)	p-value
<7 at 1 min (%)	32 (32.0%)	14 (14.0%)	0.002
<7 at 5 min (%)	21 (21.0%)	7 (7.0%)	0.004
Mean Apgar Score (1 min)	7.2 ± 1.3	8.4 ± 1.1	<0.001
Mean Apgar Score (5 min)	8.1 ± 1.1	9.2 ± 0.8	<0.001

Apgar scores were significantly lower in neonates born to anemic mothers, with **32% showing distress at 1 minute compared to 14% in the non-anemic group**.

Neonatal Intensive Care Unit (NICU) Admissions

Maternal anemia was associated with a **higher rate of NICU admissions**, particularly among neonates born to mothers with moderate and severe anemia.

Table 5: NICU Admissions and Neonatal Complications

Neonatal Outcome	Anemic Group (n=100)	Non-Anemic Group (n=100)	p-value
NICU Admissions (%)	29 (29.0%)	12 (12.0%)	<0.001
Respiratory Distress (%)	15 (15.0%)	6 (6.0%)	0.02
Neonatal Anemia (%)	19 (19.0%)	5 (5.0%)	<0.001
Neonatal Sepsis (%)	8 (8.0%)	3 (3.0%)	0.11

NICU admissions were significantly higher in neonates born to anemic mothers. Respiratory distress and neonatal anemia were also more frequent in this group.

Impact of Anemia Severity on Birth Outcomes

A subgroup analysis was conducted to assess whether the severity of anemia influenced birth outcomes.

Table 6: Birth Outcomes Based on Anemia Severity

Outcome	Mild Anemia (n=42)	Moderate Anemia (n=44)	Severe Anemia (n=14)	p-value
Preterm Birth (%)	24 (57.1%)	19 (43.2%)	11 (78.6%)	0.04
Low Birth Weight (%)	14 (33.3%)	18 (40.9%)	9 (64.3%)	0.02
NICU Admission (%)	8 (19.0%)	12 (27.3%)	9 (64.3%)	<0.001

Neonatal complications worsened with increasing anemia severity. Severe anemia was associated with the **highest rates of preterm birth, low birth weight, and NICU admissions**.

Mode of Delivery and Incidence of Cesarean Section

Maternal anemia was associated with a **higher rate of cesarean deliveries**, particularly in cases of moderate and severe anemia.

Table 7: Mode of Delivery in Anemic and Non-Anemic Groups

Mode of Delivery	Anemic Group (n=100)	Non-Anemic Group (n=100)	p-value
Vaginal Delivery (%)	52 (52.0%)	68 (68.0%)	0.01
Cesarean Section (%)	48 (48.0%)	32 (32.0%)	0.02
Instrumental Delivery (%)	8 (8.0%)	5 (5.0%)	0.41

Cesarean section rates were significantly higher in anemic mothers, with **48% requiring operative delivery compared to 32% in the non-anemic group**.

Stillbirths and Perinatal Mortality

Maternal anemia was associated with **higher rates of stillbirth and perinatal mortality**, particularly in cases of severe anemia.

Table 8: Incidence of Stillbirths and Perinatal Mortality

Outcome	Anemic Group (n=100)	Non-Anemic Group (n=100)	p-value
Stillbirths (%)	6 (6.0%)	2 (2.0%)	0.14
Perinatal Mortality (%)	9 (9.0%)	3 (3.0%)	0.05

The perinatal mortality rate was higher in the anemic group, with **9% of neonates not surviving the early postnatal period.**

Maternal Complications During Pregnancy and Delivery

Maternal anemia was linked to an increased risk of **obstetric complications**, including postpartum hemorrhage and infections.

Table 9: Maternal Complications in Anemic and Non-Anemic Mothers

Complication	Anemic Group (n=100)	Non-Anemic Group (n=100)	p-value
Postpartum Hemorrhage (%)	11 (11.0%)	4 (4.0%)	0.04
Puerperal Sepsis (%)	7 (7.0%)	2 (2.0%)	0.09
Prolonged Hospital Stay (%)	14 (14.0%)	6 (6.0%)	0.03

Postpartum hemorrhage was **significantly more common in anemic mothers**, requiring **additional medical or surgical interventions.**

Impact of Anemia Severity on Maternal and Neonatal Outcomes

A further subgroup analysis assessed how **mild, moderate, and severe anemia influenced pregnancy and neonatal outcomes.**

Table 10: Pregnancy and Neonatal Outcomes by Anemia Severity

Outcome	Mild Anemia (n=42)	Moderate Anemia (n=44)	Severe Anemia (n=14)	p-value
Cesarean Section (%)	17 (40.5%)	22 (50.0%)	9 (64.3%)	0.02
NICU Admission (%)	8 (19.0%)	12 (27.3%)	9 (64.3%)	<0.001
Stillbirth (%)	2 (4.8%)	3 (6.8%)	2 (14.3%)	0.11
Postpartum Hemorrhage (%)	3 (7.1%)	5 (11.4%)	3 (21.4%)	0.08

Severe anemia was associated with the highest rates of cesarean delivery, NICU admission, and postpartum hemorrhage, emphasizing the need for early diagnosis and intervention.

This study confirms that maternal anemia significantly increases the risk of adverse birth outcomes, including preterm birth, low birth weight, neonatal distress, cesarean delivery, and maternal complications. The findings reinforce the importance of antenatal screening, nutritional interventions, and early medical management to reduce anemia-related perinatal risks

DISCUSSION

This study demonstrates a significant association between maternal anemia and adverse birth outcomes, reinforcing the need for early detection and management of anemia during pregnancy. The findings indicate that anemic mothers had a higher incidence of preterm birth, low birth weight, neonatal distress, and increased neonatal intensive care unit admissions compared to non-anemic mothers.^[6] The severity of anemia was directly correlated with worsening neonatal outcomes, highlighting the dose-dependent impact of hemoglobin deficiency on fetal development. These results align with previous research suggesting that maternal anemia contributes to placental insufficiency, fetal hypoxia, and metabolic disturbances, which ultimately impair fetal growth and increase perinatal morbidity.^[7] Preterm birth was significantly more common in anemic mothers, with nearly half of the anemic group delivering before 37 weeks of gestation. This is consistent with studies that have reported a strong link between maternal anemia and spontaneous preterm labor due

to uteroplacental hypoxia and increased oxidative stress.^[8] The reduced oxygen-carrying capacity in anemic mothers may lead to compensatory mechanisms that trigger early onset of labor. Furthermore, maternal iron deficiency has been implicated in altered immune responses and increased susceptibility to infections, which may further contribute to the risk of preterm delivery. Given that preterm birth is a major determinant of neonatal morbidity and mortality, addressing maternal anemia could play a critical role in reducing the global burden of preterm-related complications.^[9]

Birth weight was significantly lower in neonates born to anemic mothers, with a higher proportion of low birth weight cases in the anemic group compared to non-anemic controls. This finding supports the hypothesis that maternal anemia restricts fetal growth by limiting oxygen and nutrient supply to the developing fetus. Inadequate iron stores and micronutrient deficiencies in anemic mothers may impair placental function, leading to intrauterine growth restriction and suboptimal fetal development.^[10] The results also suggest a dose-response relationship, with severe anemia showing the strongest association with low birth weight. This emphasizes the importance of maintaining adequate maternal hemoglobin levels throughout pregnancy to support optimal fetal growth.^[11] Neonatal distress, as indicated by lower Apgar scores at 1 and 5 minutes, was significantly more common in neonates born to anemic mothers. This suggests that maternal anemia may contribute to perinatal asphyxia and reduced neonatal adaptation at birth. The increased need for neonatal intensive care unit admissions in the anemic group further supports the role of maternal anemia in compromising neonatal well-being.^[12] Previous studies have reported similar

findings, indicating that iron-deficient mothers are more likely to give birth to infants with reduced oxygen reserves, increasing the risk of neonatal hypoxia, respiratory distress, and metabolic complications.^[13] Addressing maternal anemia through targeted interventions could therefore improve neonatal transition and reduce the need for advanced neonatal care.

This study also highlights the impact of maternal anemia on obstetric outcomes, with anemic mothers having a significantly higher rate of cesarean sections compared to non-anemic mothers. The higher incidence of operative deliveries may be attributed to fetal distress, poor labor progression, and an increased risk of postpartum hemorrhage in anemic pregnancies. Anemic mothers were also more likely to experience postpartum hemorrhage, which is a leading cause of maternal mortality and morbidity. Reduced hemoglobin levels can impair the ability of the uterus to contract effectively after delivery, increasing the risk of excessive bleeding. These findings reinforce the importance of anemia prevention strategies to reduce maternal complications during labor and delivery.^[14] Stillbirths and perinatal mortality rates were higher in anemic pregnancies, although statistical significance was borderline. This may be due to the relatively small sample size, but it is consistent with global data indicating that maternal anemia is an independent risk factor for perinatal mortality. Severe maternal anemia has been associated with higher rates of intrauterine fetal demise, likely due to chronic fetal hypoxia and placental dysfunction. Strengthening maternal nutrition programs and ensuring universal access to iron and folic acid supplementation could play a crucial role in preventing stillbirths and improving perinatal survival rates.^[15]

The results of this study underscore the urgent need for early identification and treatment of maternal anemia as part of routine antenatal care. Timely intervention through iron supplementation, dietary counseling, and close monitoring of high-risk pregnancies can help mitigate the adverse effects of anemia on birth outcomes. Public health initiatives aimed at increasing awareness, improving adherence to supplementation programs, and addressing socio-economic determinants of anemia could significantly reduce the burden of anemia-related complications in pregnancy. While this study provides valuable insights into the association between maternal anemia and adverse birth outcomes, certain limitations must be acknowledged. The study was conducted in a single hospital setting, which may limit the generalizability of the findings to broader populations. Additionally, the study focused on hemoglobin levels as the primary indicator of anemia, whereas other markers such as serum ferritin and transferrin saturation could provide a more comprehensive assessment of iron status. Future research should explore the long-term developmental outcomes of neonates born to

anemic mothers, as well as the effectiveness of different intervention strategies in preventing anemia-related complications.

This study confirms that maternal anemia is a significant risk factor for adverse birth outcomes, including preterm birth, low birth weight, neonatal distress, and maternal complications. The severity of anemia directly influences pregnancy and neonatal outcomes, emphasizing the need for proactive anemia management during pregnancy. Strengthening antenatal screening programs, ensuring adequate maternal nutrition, and promoting adherence to iron supplementation protocols could substantially improve maternal and neonatal health outcomes. Future research should focus on optimizing anemia prevention strategies and evaluating their long-term impact on maternal and child well-being.

CONCLUSION

This study establishes a strong association between maternal anemia and adverse birth outcomes, reinforcing the critical need for early detection and management of anemia during pregnancy. The findings indicate that anemic mothers are at a significantly higher risk of preterm birth, low birth weight, neonatal distress, and increased neonatal intensive care unit admissions. The severity of anemia was directly correlated with worsening neonatal outcomes, emphasizing the importance of maintaining adequate maternal hemoglobin levels throughout gestation. The study also highlights the increased incidence of cesarean deliveries and postpartum complications in anemic mothers, suggesting that anemia negatively impacts not only fetal health but also maternal well-being during labor and delivery. The results underscore the urgent need for routine antenatal screening and timely intervention to prevent and manage maternal anemia. Ensuring adequate iron supplementation, improving dietary intake, and addressing underlying causes of anemia can significantly reduce the risk of poor pregnancy outcomes. Strengthening maternal health programs, increasing awareness about anemia prevention, and enhancing adherence to supplementation protocols should be prioritized to improve both maternal and neonatal health. Given the high burden of anemia-related complications, comprehensive strategies that integrate nutritional support, early diagnosis, and targeted medical management are essential for optimizing pregnancy outcomes.

While this study provides valuable insights, further research is needed to explore the long-term impact of maternal anemia on child development and growth. Large-scale, multicenter studies with extended follow-up periods could provide a deeper understanding of the interplay between maternal iron status and neonatal health. Future research should also assess the effectiveness of different

intervention strategies in reducing the prevalence of maternal anemia and improving birth outcomes. By prioritizing maternal nutrition and strengthening antenatal care services, significant progress can be made in mitigating the impact of anemia on maternal and child health.

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